ENCYCLOPEDIA BRITANNICA

A New Survey of Universal Knowledge

Volume 18

PLANTS to RAYMUND OF TRIPOLI

THE UNIVERSITY OF CHICAGO

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POTATO *(in part)*.

F. L. B. **Francis Lyall Birch, O.B.E., M.A.**
Lecturer in History, University of Cambridge, 1921–28. Fellow of King's College, 1915–34. PRIME MINISTER; PRIVY COUNCIL.

F. Ll. G. **Francis Llewellyn Griffith, M.A., Ph.D.**
Former Professor of and Reader in Egyptology, Oxford University. Editor of the Archaeological Survey and Archaeological Reports of the Egypt Exploration Fund. PSAMMETICHUS.

F. M. S. **F. M. Stenton, F.B.A.**
Professor of History, University of Reading. POLAND *(in part)*.

F. O. B. **Frederick Orpen Bower, F.R.S., F.R.S.E.**
Emeritus Professor of Botany, University of Glasgow, 1885–1925. Thrice President of the Botanical Section of the British Association and Ex-President of the Royal Society of Edinburgh. Author of *The Origin of a Land Flora; Plant Life on Land;* etc.
PLANTS *(in part)*; PTERIDOPHYTA.

F. P. C. **F. P. Cullinan, B.S., Ph.D.**
Assistant Chief, Bureau of Plant Industry, Soils, and Agricultural Engineering, Washington, D.C. QUINCE.

F. R. C. **Frank Richardson Cana, F.R.G.S.**
Editorial Staff, *Encyclopedia Britannica*, 1903–11 and 1914–5. Staff of *The Times*, London, 1916–34. Author of *South Africa from the Great Trek to the Union.*
PORTUGUESE EAST AFRICA *(in part)*.

F. Si. **F. Simon**
Counsellor of the Foreign Office, Berlin. Formerly Private Secretary to Herr Rathenau. RATHENAU, WALTWER.

F. T. W. **Frederick Theodore Weber**
Portrait painter, sculptor and etcher. Represented in the Metropolitan Museum and other museums and collections.
PORTRAIT PAINTING *(in part)*.

F. W. A. **Francis William Aston, Sc.D., F.R.S.**
Fellow of Trinity College, Cambridge. Nobel Prize for Chemistry, 1922. Author of *Isotopes;* etc. POSITIVE RAYS.

G. A. K. **George A. Kelly**
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PULLMAN INCORPORATED (DELAWARE).

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POLYGONS.

G. A. R. C. Sir **Geoffrey A. R. Callender, M.A., F.S.A., F.R.Hist.S.**
Director, National Maritime Museum. Secretary to the Society for Nautical Research and Former Professor at the Royal Naval College, Greenwich. Author of *The Naval Side of British History;* etc. QUIBERON, CAMPAIGN AND BATTLE OF *(in part)*.

G. Buc. **Sir George Seaton Buchanan, C.B., M.D., B.Sc., F.R.C.P.**
Former Senior Medical Officer, Ministry of Health. Member of Court of Governors of London School of Hygiene, of Army Advisory Committee on Hygiene, and of Council Royal Society of Medicine. PUBLIC HEALTH *(inart)*.

G. C. W. **George Charles Williamson, Litt.D., F.R.S.L.**
Chevalier of the Legion of Honour. Author of *Portrait Miniatures; Life of Richard Cosway, R.A.;* etc. Editor of Bryan's *Dictionary of Painters and Engravers.*
PLIMER, ANDREW; PRIEUR, PIERRE.

G. E. C. **George Earl Church**
Explorer of the Amazon, 1868–79. Late Vice-President, Royal Geographical Society (London). PLATA, RIO DE LA *(in part)*.

G. E. E. **G. E. Ellis**
Secretary, Committee on Automatic Train Control, American Railway Association, Chicago. RAILWAYS *(in part)*.

G. F. St. **George Frederick Stout, M.A., LL.D., F.B.A.**
Professor of Logic and Metaphysics in St. Andrews University, 1903–36. PSYCHOLOGY *(in part)*.

G. F. Z. **George Frederick Zimmer, A.M.Inst.C.E.**
Former Consulting Engineer and Joint-Editor of *Engineering and Industrial Management.* PNEUMATIC CONVEYING.

G. G. A. **Major General Sir George (Grey) Aston, K.C.B.**
Former Lecturer on Naval History, University College, London. Formerly Professor of Fortification at the Royal Naval College, Greenwich. Author of *Sea, Land and Air Strategy; Memories of a Marine; The Navy of To-day.* Editor of *The Study of War.*
POLAND *(in part)*; PORTUGAL *(in part)*.

G. G. W. **George G. Wilson, Ph.D., LL.D.**
Professor Emeritus of International Law, Harvard University. Author of *International Law Situations and Topics;* etc.
PRIZE COURTS AND PRIZE LAW *(in part)*.

G. H. Ga. **Sir George Henry Gater, C.M.G., D.S.O.**
Education Officer, London County Council, 1924–33. Formerly Director of Education, Lancashire County Council.
POLYTECHNICS.

G. J. P. **Gilbert Jocelyn Ponsonby, B.A.**
Assistant Secretary to the Railway Research Service, London School of Economics. RAILWAYS *(in part)*.

G. M. D. **George M. Darrow, A.M., Ph.D.**
U.S. Bureau Plant Industry (1918–). Senior Pomologist in charge Small Fruit Investigations. Originator of many varieties of strawberries, raspberries and blackberries. Editorial board of *Journal of Heredity.* RASPBERRY.

G. N. **Sir George Newman, G.B.E., K.C.B.**
Chief Medical Officer, Ministry of Health and Board of Education, London, 1907–35. Author of *An Outline of the Practice of Preventive Medicine; Recent Advances in Medical Education in England;* etc. PREVENTIVE MEDICINE *(in part)*.

G. S. B. **George Sidney Brett, M.A.**
Professor of Philosophy, University of Toronto since 1916. Professor of Ethics, Trinity College, Toronto, and Lecturer in the University of Toronto, 1908–16. Author of *Philosophy of Gassendi; History of Psychology;* etc. PSYCHOLOGY, HISTORY OF.

G. T. M. **Sir Gilbert T. Morgan, O.B.E., D.Sc.**
Formerly Mason Professor of Chemistry, University of Birmingham, Professor in the Faculty of Applied Chemistry, Royal College of Science for Ireland and Professor of Applied Chemistry, Technical College, Finsbury.
PYRAZOLES; PYROGALLOL; PYRONES; PYRROLE; QUINONES.

H. A. B. **H. A. Baylis, D.Sc., F.Z.S.**
Deputy Keeper, Department of Zoology, British Museum (Natural History). PLATYHELMINTHES.

H. A. J. **Henry A. Jones, Ph.D.**
Principal Olericulturist, U.S. Department of Agriculture, Washington, D.C. Author of (with J. T. Rosa, Jr.) *Truck Crop Plants;* (with S. L. Emsweller) *The Vegetable Industry.*
POTATO *(in pavt)*.

H. Bp. **Rev. Herbert Louis Bishop**
Missionary, Lourenço Marques, 1909–26.
PORTUGUESE EAST AFRICA *(in part)*.

H. C. C. **Henry Cope Colles, M.A., F.R.C.M.**
Musical Critic of *The Times,* London. Editor of third edition, Grove's *Dictionary of Music and Musicians.* RAVEL, MAURICE.

H. C. Ro. **H. C. Robbins**
General Manager, Press Association. PRESS ASSOCIATION, THE.

H. Dev. **Henry Devine, O.B.E., M.D., F.R.C.P.**
Examiner in Psychology, Royal College of Physicians, London. Lecturer in Psychology, Maudsley Hospital, London. Medical Superintendent, Holloway Sanatorium, Virginia Water, England. Co-editor of *The Journal of Mental Science.*
PSYCHOSIS *(in part)*.

H. D. N. **H. Darnley Naylor, M.A.**
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H. E. **Haven Emerson, A.M., M.D.**
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PUBLIC HEALTH *(in part)*.

H. E. A. **Hugh E. Agnew, A.B., Litt.D.**
Chairman, Department of Marketing, New York University School of Commerce, Accounts and Finance. Author of *Co-operative Advertising by Competitors;* etc. PRICE-CUTTING.

H. E. Bar. **Harry Elmer Barnes, A.M., Ph.D.**
Professor of History and Sociology, Smith College, Northampton, Mass., 1923–30. Historian, New Jersey Prison Inquiry Commission. Author of *History of Penal Reformatory and Correctional Institutions of New Jersey; Progress of American Penology; The Repression of Crime;* etc. PRISON *(in part)*.

H. E. Van Ge. **H. E. Van Gelder**
Director of Service for Art and Science (incl. the Town Museums) of The Hague, Holland. Editor of *Oud. Holland.* Author of *Pottenbahkers; Kunst in Nedersland.*
POTTERY AND PORCELAIN *(in part)*.

H. Fi. **Herman Finer, D.Sc.**
Reader in Public Administration, University of London. Author of *Foreign Governments at Work; The Case Against Proportional Representation; Theory and Practice of Modern Government; English Local Government;* etc., as well as articles in journals of the social sciences. PROPORTIONAL REPRESENTATION.

H. Fr. **Henri Frantz**
Art Critic, *Gazette des Beaux Arts,* Paris.
PUVIS DE CHAVANNES, PIERRE CÉCILE *(in part)*.

H. Fs. **Homer Folks, LL.D.**
Secretary of the State Charities Aid Association of New York. Chairman of the Executive Committee, Welfare Council of New York City. Chairman, National Child Labor Commission. Author of *Care of Destitute, Neglected and Delinquent Children; The Human Costs of the War.* POOR LAW *(in part)*.

H. J. R. **Herbert Jennings Rose, M.A.**
Professor of Greek, University of St. Andrews, Fife. Fellow and Lecturer of Exeter College, Oxford, 1907–11. Associate Professor of Classics, McGill University, 1911–5. Professor of Latin, University College of Wales, Aberystwyth, 1919–27. Author of *The Roman Questions of Plutarch; Primitive Culture in Greece; Pvinziti.de Culture in Italy; A Handbook of Greek Mythology;* etc.
PROMETHEUS *(in part)*.

H. L. Cr. **Harold L. Cross**
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Publicity Representative of the Union Switch and Signal Company, General Railway Signal Company, New York.
RAILWAYS *(in pavt)*.

H. M. T. **Horace Mann Towner, LL.B.**
Former Governor of Puerto Rico. PONCE; PORTO RICO.

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Textile Technologist and Consultant. Author of *Grammar of Textile Design.* PRUNELLA.

H. O. **Hermann Oelsner, M.A., Ph.D.**
Late Taylorian Professor of the Romance Languages in University of Oxford. Member of Council of the Philological Society. Author of *Frederic, Mistral; A History of Provençal Literature;* etc. PROVENÇAL LANGUAGE AND LITERATURE *(in part)*.

H. R. M. **Henry R. Mussey, A.B., Ph.D.**
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H. S. H.-S. **Henry Selby Hele-Shaw, D.Sc., LL.D., M.Inst.C.E., M.I.Mech.E., F.R.S.**
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POWER TRANSMISSION *(in part)*.

H. S. N. **Harry Stewart New, LL.D.**
Postmaster General, Washington, 1923–9. Former Editor and Publisher of *Indianapolis Journal.*
POST AND POSTAL SERVICES *(in part)*.

H. T. A. Rev. Herbert Thomas Andrews
Xuthor of "The Commentary on Acts" in the *Westminster New Testament; Handbook on the Apocryphal Books in the* "Century" Bible. POLYCARP *(in part).*

H. T. N. Harry T. Newcomb, LL.M.
General Counsel of the Delaware and Hudson Company, New York, 1921–34. Trustee and Treasurer of the American Institute of the City of New York, 1929–39. Chairman of the Administrative Committee of the Council for Tariff Reduction. Author of *Railway Economics;* etc. RAILWAYS *(in part).*

H. Wo. Humbert Wolfe, C.B., C.B.E.
Poet and Writer. Deputy Secretary, Ministry of Labour. Substitute British Government Member, Governing Body International Labour Office. Author of *London Sonnets; Circular Saws; The Unknown Goddess; Cursory Rhymes; Notes on English Verse Satire; The Uncelestial City; A.B.C. of the Theatre; Out of Great Tribulation;* etc. POETRY *(in part).*

H. W. P. H. W. Parker, B.A.
Assistant in the Department of Zoology, Natural History Museum, South Kensington. PYTHON; RATTLESNAKE.

H. W. R. Rev. Henry Wheeler Robinson, M.A., D.D.
Principal of Regents Park College, Oxford, 1920–42. Formerly Professor of Church History and the Philosophy of Religion in Rawdon College, Leeds. Examiner in Theology or Hebrew in the Universities of Oxford, London, Wales, Edinburgh, Birmingham, Bristol, Leeds, Liverpool, Manchester, 1915–42. Author of *The Religious Ideas of the Old Testament; The Old Testament: Its Making and Meaning; The History of Israel: Its Facts and Factors;* etc. PSALMS.

H. W. S. Henry Wickham Steed
Proprietor and Editor of *The Review of Reviews,* 1923–30. Editor of *The Times,* London, 1919–22. Lecturer on Central European History, King's College, London University. Author of *The Anfecedents of Posf-War Europe; Hitler: Whence and Whither?; The Meaning of Hitlerism; The Press; A Way to Social Peace; Our War Aims;* etc. PROPAGANDA.

H. Y. Sir Henry Yule, K.C.S.I., C.B.
British Orientalist. Author of *Cathay and the Way Thither; The Book of Ser Marco Polo;* etc. POLO, MARCO *(in part).*

I. E. L. Isabel Ely Lord
Author of *Getting Your Money's Worth.* Editor of *Everybody's Cook Book.* PRESERVING AND BOTTLING *(in part).*

J. A. S. John Addington Symonds, LL.D.
Author of *Renaissance in Italy; Studies of the Greek Poets;* etc. POGGIO *(in part);* POLITIAN *(in part).*

J. A. Th. Sir John Arthur Thomson, M.A., LL.D.
Regius Professor of Natural History in the University of Aberdeen, 1899–1930. Author of *The Study of Animal Life; Outlines of Zoology; Heredity; Darwinism and Human Life; What Is Man?; Concerning Evolution.* PLAY IN ANIMALS; PROTOPLASN *(in part).*

J. Ci. J. Ciechanowski
Ambassador from Polish Government in Exile to United States, POLAND *(in part).*

J. C. Os. John Clyde Oswald
President of the New York Employing Printers Association, Inc. Author of *Benjamin Franklin, Printer.* PRINTING *(in part).*

J. E. Co. J. E. Coates, O.B.E., D.Sc., F.I.C.
Professor of Chemistry, University College, Swansea. PRUSSIC ACID.

J. E. S. John Edward Sears, C.B.E., M.A., M.I.Mech.E., A.M.Inst.C.E., F.Inst.P.
Deputy Warden of the Standards, Board of Trade, London, 1921–31. Superintendent of the Metrology Department, National Physical Laboratory, Teddington, Middlesex. PRECISION GAUGES AND COMPARATORS.

J. F. C. F. Major General John Frederick Charles Fuller, C.B., C.B.E., D.S.O.
Military Assistant to Chief of Imperial General Staff (retired). Chief General Staff Officer, Tank Corps, 1917–8. Formerly Chief Instructor, Camberley. Author of *Tanks in the Great War; Sir John Moore's System of Training;* etc. PYDNA, BATTLE OF.

J. F.-K. James Fitzmaurice-Kelly, Litt.D., F.R.Hist.S.
Late Gilmour Professor of Spanish Language and Literature, University of Liverpool. Author of *A History of Spanish Literature.* QUEVEDO Y VILLEGAS, FRANCISCO GOMEZ DE.

J. G. Fr. Sir James George Frazer, O.M., F.R.S.
Author of *The Golden Bough.* PRAENESTE *(in part).*

J. G. H. James G. Harbord, M.S.
Major General, United States Army, retired. Chairman of the Board, Radio Corporation of America, New York. RADIO CORPORATION OF AMERICA.

J. H. John Hilton, M.A.
Professor of Industrial Relations, University of Cambridge. Director of Statistics, Ministry of Labour, London, 1919–31. PROFIT-SHARING *(in part);* RATIONALIZATION OF INDUSTRY.

J. H. B. Joseph H. Bonneville, A.M.
Department of Banking and Finance, New York University School of Commerce. Accounts and Finance. New York. Author of *Elements of Business Finance.* PREFERRED STOCK.

J. H. Co. Julius Henry Cohen, LL.B.
Counsel for the Port of New York Authority; Special Attorney General, State of New York, in Housing Cases. Author of *Law and Order in Industry;* etc. PORT AUTHORITY.

J. H. McG. James Howard McGregor, M.A., Ph.D.
Professor of Zoology, Columbia University, New York. Xuthor of various papers on reptilian and primate Palaeontology. PRIMATES *(in part).*

J. H. Mi. John Henry Middleton, M.A., Litt.D., F.S.A., D.C.L.
Slade Professor of Fine Arts in the University of Cambridge, 1886–95. Director of the Fitzwilliam Museum, Cambridge, 1889–92. Art Director of the South Kensington Museum, 1892–6. Author of *The Engraved Gems of Classical Times; Illuminated Manuscripts in Classical and Mediaeval Times.* RAPHAEL *(in part).*

J. H. Mo. J. H. Morgan, K.C., M.A.
Professor of Constitutional Law, University of London. Brigadier-General, late Deputy Adjutant-General. Reader in Constitutional Law to the Inns of Court, 1926–36. Editor of the Law section of the *Encyclopædia Britannica.* PREROGATIVE; PUBLIC AUTHORITIES PROTECTION ACT.

J. H. V. C. Brigadier-General John Henry Verinder Crowe, C.B.
Commandant of the Royal Military College of Canada, 1909–13. Formerly Chief Instructor in Military Topography and Military History and Tactics, Royal Military Academy, Woolwich. Author of *Epitome of the Russo-Turkish War, 1877–78; Problems in Manoeuvre Tactics;* etc. PLEVNA.

J. Mac. Sir John Macdonell, C.B., LL.D.
Late Master of Supreme Court, Quain Professor of Comparative Law, University College, London, and Editor of *State Trials; Civil Judicial Statistics;* etc. Author of *Survey of Political Economy; The Land Question;* etc. PROTECTORATE.

J. McG. **J. E. M. McGregor, A.C.G.I., A.M.I.E.E.**
Engineer-in-Chief's Office, General Post Office, London.
PNEUMATIC DISPATCH.

J. McL. T. **J. McLean Thompson, M.A., D.Sc., F.L.S., F.R.S.E.**
Professor of Botany, University of Liverpool. Author of memoirs on the anatomy and affinity of ferns, and on the problems of floral structure, presented to the Royal Society of Edinburgh and in the publications of the Hartley Botanic Laboratories.
PLANTS *(in part).*

J. M. La. **J. M. Landis, A.B., LL.B., S.J.D.**
Dean of the Faculty, Harvard Law School. Author of *The Business of the Supreme Court of the United States.* POLICE POWER.

J. Mof. **James Moffatt, M.A., D.D., D.Litt.**
Washburn Professor of Church History in Union Theological Seminary, New York. Formerly Professor of Church History, United Free Church College, Glasgow. Author of *The Presbyterian Churches; Introduction to Literature of the New Testament; Everyman's Life of Jesus;* etc. PRESBYTERIANISM *(in part).*

J. O. McC. **John Oppie McCall, A.B., D.D.S.**
Director, Murry and Leonie Guggenheim Dental Clinic. Co-Author of *Textbook of Clinical Periodontia.*
PYORRHOEA *(in part).*

J. P. E. **Jean Paul Hippolyte Emmanuel Adhémar Esmein**
Late Professor of Law in the University of Paris. Officer of the Legion of Honour and Membre de l'Institut. Author of *Cours élémentaire d'histoire du droit français.* PROVOST.

J. P. P. **J. P. Postgate, M.A., Litt.D., F.B.A.**
Late Professor of Latin in the University of Liverpool and Fellow of Trinity College, Cambridge. Editor of the *Classical Quarterly.* Editor-in-Chief of the *Corpus Poetarum Latinorum;* etc.
PROPERTIUS, SEXTUS.

J. Rd. **John Read, M.A., Sc.D., Ph.D.**
Professor of Chemistry at the University of St. Andrews, Scotland. Author of *Textbook of Organic Chemistry; Introduction to Organic Chemistry;* etc. PYRIDINE.

J. Ro. **John Ross, Ph.D., B.Sc., A.R.C.S., D.I.C.**
Research Chemist, Chemical Research Laboratory, Teddington, Middlesex. QUINOLINE.

J. R. R. **John Robertson Riddell**
Printers' Consultant. Formerly Principal of the London School of Printing and Kindred Trades. PRINTING *(in part).*

J. S. F. **Sir John Smith Flett, K.B.E., M.A., D.Sc., F.R.S.**
Director, Geological Survey of Great Britain and Museum of Practical Geology, 1920–35. PNEUMATOLYSIS; PORPHYRY; PUMICE; QUARTZITE; QUARTZ-PORPHYRY.

J. S. Fa. **John Shields Fairbairn, M.B., B.Ch., F.R.C.S., F.R.C.P.**
Consulting Obstetric Physician and Gynaecologist, St. Thomas's Hospital, and Consulting Physician, General Lying-In Hospital, London. Author of *A Textbook for Mid-wives; Gynaecology with Obstetrics;* etc. PUERPERAL FEVER.

J. Wil. **James Williams, M.A., D.C.L., LL.D.**
Late Barrister at Law, Lincolns Inn; formerly All Souls' Reader in Roman Law, University of Oxford and Fellow of Lincoln College. PRESCRIPTION *(in part).*

K. F. D. **Brig. Knightley Fletcher Dunsterville, D.S.O., R.A.**
Chief Inspector of Armaments, War Office, London.
RANGE-FINDERS *(in part).*

K. G. J. **Kingsley Garland Jayne**
Sometime Scholar of Wadham College, Oxford. Matthew Arnold Prizeman, 1903. Author of *Vasco da Gama and His Successors.*
PORTUGAL *(in part).*

K. T. B. **Karl Bělař**
Professor of Zoology, University of Berlin. PROTOZOA.

L. B. **Louis M. Brandin, Ph.D.**
Former Professor of French and of Romance Philology in the University of London.
PROVENÇAL LANGUAGE AND LITERATURE *(in part).*

L. C. L. **Lionel Charles Liddell, M.V.O.**
Sometime British Consul at Copenhagen. Successively Secretary of the Restriction of Enemy Supplies Committee, and the Grand Committee on Trade in the War, 1914–8.
RATIONING OF NEUTRALS (BLOCKADE).

L. C. M. **Sir Leo Chiozza Money, F.R.Stat.S., F.R.G.S., F.Z.S.**
Author and Journalist. Member of the War Trade Advisory Committee, 1915–8. Parliamentary Secretary to the Ministry of Shipping, 1916–8. Chairman of the Tonnage Priority Committee, 1917–8. Editor of the Economics, Engineering and Industries section of the 14th Edition of the *Encyclopædia Britannic~.* PLASTER-WORK *(in part).*

L. D. S. **Laurence Dudley Stamp, B.A., D.Sc., A.K.C., F.G.S., M.I.T.P.**
Sir Ernest Cassel Reader in Economic Geography in the University of London. Author of *An Introduction to Stratigraphy,*
PLIOCENE; QUATERNARY.

L. E. T. **Leon E. Truesdell, Ph.D., Sc.D.**
Chief Statistician for Population, United States Bureau of the Census, Washington, D.C. PRODUCTION, CENSUS OF *(in part).*

L. H. D. B. **L. H. Dudley Buxton, M.A., D.Sc., F.S.A., F.R.G.S.**
Former Reader in Physical Anthropology in the University of Oxford. Author of *Peoples of Asia.* RACES OF MANKIND.

L. J. S. **L. J. Spencer, M.A., Sc.D., F.G.S., F.C.S., F.R.S.**
Former Keeper of Department of Mineralogy, Natural History Museum, South Kensington. Formerly Scholar of Sidney Sussex College, Cambridge, and Harkness Scholar. Editor of the *Mineralogical Magazine.* POLLUX OR POLLUCITE; QUARTZ *(in part).*

L. O. H. **Leland Ossian Howard, Ph.D., M.D., LL.D., Sc.D.**
Principal Entomologist, United States Department of Agriculture, Bureau of Entomology, 1927–31. Author of *Mosquitoes: How They Live; The Insect Book; The Insect Menace; Fighting the Insects; The House Fly, Disease Carrier.* PLUM CURCULIO.

L. S. M. **Lewis S. Mudge, M.A., D.D., LL.D.**
Stated Chairman Emeritus of General Council of Presbyterian Church in the United States. PRESBYTERIANISM *(in part).*

L. S. Ma. **Lionel S. Marks, B.Sc., M.M.E.**
Professor of Mechanical Engineering, Harvard University. Editor-in-Chief of *Mechanical Engineer's Handbook;* Author of *The Airplane Engine;* etc. POWER.

L. Un. **Louis Untermeyer**
Author, Critic, and Editor. Editor of *Modern American Poetry; Modern British Poetry;* etc. Author of *American Poetry since 1900; Play in Poetry;* etc. POETRY *(in part).*

M. A. J. **Morley A. Jull, M.Sc., Ph.D.**
Head of the Poultry Department, University of Maryland. Author of *Poultry Husbandry* and *Successful Poultry Management.* POULTRY AND POULTRY FARMING.

M. C. **Max Cary, D.Litt.**
Professor of Ancient History in the University of London. Secretary to the Classical Association, 1911–4.
PLATAEA; PUNIC WARS.

M. Fi. **Morris Fishbein, B.Sc., M.D.**
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PUBLIC HEALTH (in *part); *QUACKERY *(in part).*

M. G. G. **Martin G. Glaeser, Ph.D.**
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M. J. Ro. **Milton J. Rosenau, M.A., M.D.**
Emeritus Professor of Preventive Medicine and Hygiene, Harvard Medical School. PREVENTIVE MEDICINE *(in part).*

M. *M.* **F.** **Myrtle Meritt French, M.S.**
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POTTERY AND PORCELAIN *(in part).*

M. N. T. **Marcus Niebuhr Tod, M.A.**
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M. S. **Morton Snyder, A.B.**
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M. W. v. B. **M. W. von Bernewitz**
Formerly with Federal Bureau of Mines. Author of *Cyanide Process, 1910–1913; Handbook for Prospectors.* PROSPECTING.

N. B. J. **N. B. Jopson, M.A.**
Professor of Comparative Philology, University of Cambridge.
POLISH LANGUAGE.

N. D. **Mrs. Noëlle Davies, Ph.D.**
PRUSSIA *(in part).*

N. E. C. **Norman E. Crump**
Statistical Correspondent to the *Financial Times,* London. Member of the Council of the Royal Statistical Society. Joint-Author of *Clare's A. B. C. of the Foreign Exchanges.*
POOLS, IN INDUSTRY *(in part);* POUND STERLING.

N. F. G. **Neil Forbes Grant, C.B.E., M.A.**
Foreign Editor of *The Morning Post,* London, 1918–25.
PORTUGAL *(in part).*

N. Tr. **Norman Taylor**
Assistant Curator at the New York Botanical Garden, 1905–11. Director of Cinchona Products Institute, Inc., New York. Editor of *The Garden Dictionary.* Botanical and Horticultural Editor of *Webster's Dictionary.* Author of *Botany: The Science of Plant Life; Guide to the Wild Flowers;* etc. POPPY *(in part).*

N. W. McL. **Norman W. McLachlan, D.Sc.(Eng.)**
Chief Electrical Research Engineer, Telegraph Construction and Maintenance Company. Inventor of various forms of radio and sound reproducing apparatus. RADIO RECEIVER.

O. C. H. **Olive Clio Hazlett, Ph.D.**
Associate Professor of Mathematics, University of Illinois. Associate Editor of the *Transactions of the American Mathematical Society.* Member of the Council of the American Mathematical Society. QUATERNIONS.

O. Ha. **O. Halecki, D.Ph.**
Former Professor of History in University of Warsaw. Member of the Polish Academy. Foreign Correspondent of the Institut de France and of the Royal Historical Society. POLAND *(in part).*

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ENCYCLOPÆDIA BRITANNICA

VOLUME 18

PLANTS TO RAYMUND OF TRIPOLI

PLANTS. In the most generally used sense a plant is a member of the vegetable class of living things, plants and animals being the two classes into which living things (organisms) are roughly divided. With the higher forms the difference is very definite and leaps to the eye. In the case of lower forms of life the distinction is often very difficult and indeed an artificial one, since plants and animals have had common ancestors in evolution. The early use of the word was for a twig, shoot, cutting or sapling which is the meaning of the Latin *planta.*

Other meanings of the word are derived from the verb "to plant" *i.e.,* to fix in position or place. It is thus used of the fixtures, machinery or apparatus necessary for carrying on an industry or business; in colloquial or slang use it is applied to a swindle, a carefully arranged plot or trap laid to deceive. (Cf. also PLANTATION.) In the following sections the botanical sense of the term is followed. An outline of the classification of plants is given under BOTANY and the chief groups, Algae, Fungi, Gymnosperms, etc., are dealt with in separate articles.

CLASSIFICATION OF PLANTS

In the article BOTANY reference has been made to the earlier systems of classification and the evolution of the idea of a natural system in which families are grouped according to their affinities. Details of classification *within* the large groups are given in the special articles on these groups. An outline of the generally accepted system of classification of the groups themselves is given below.

Plants are usually divided into CRYPTOGAMS, in which there are no flowers producing seeds, the sexual reproductive organs being inconspicuous, and PHANEROGAMS, in which the plants bear flowers or flower-like structures from which seeds arise. The term SPERMOPHYTA is sometimes used for Phanerogams. To the more complex Cryptogams which show vascular strands (see PLANTS: Anatomy) the term Vascular Cryptogams is often applied.

Cryptogams.—The lower groups of Cryptogams are classified as THALLOPHYTA, *i.e.,* plants possessing a thallus or plant body which shows no differentiation into stem and leaves. The large groups of the Thallophyta are the PROTOPHYTA, the most primitive group of plants; ALGAE, a group mostly of aquatic plants, showing various coloured pigments (green, red, brown, etc.); BACILLARIALES or DIATOMS, a group of minute, brown plants sometimes classed with the Algae; and the FUNGI and BACTERIA, which are colourless parasitic or saprophytic plants probably derived by reduction from alga-like ancestors. To all these groups special articles are devoted, and also to the lichens, which are a peculiar group of composite plants, consisting of an alga and a fungus living in association.

The BRYOPHYTA (*q.v.*), which include the liverworts and the Musci or true mosses, are distinguished from the Thallophyta by the fact that the plant body often shows a distinction into stem and leaves, and the female reproductive organs are structures known as archegonia.

The group PTERIDOPHYTA, or fern-like plants, includes all the cryptogams higher than the Rryophyta. The plants often show a marked differentiation into leaves, some of these being of very great size and much divided. Furthermore they show well marked vascular strands (see p. 6) and their female reproductive organs are archegonia. This large group includes the Filicineae (true ferns), the Equisetineae (horsetails, etc.); the Lycopodineae (club-mosses, etc.) and the Pteridospermae (a fossil group) which are described under PALAEOBOTANY.

Phanerogams.—To this group, which is sometimes termed SPERMOPHYTA (or *Spermatophyta*), all the higher plants belong. It includes the GYMNOSPERMS, in which the seed is not enclosed in an ovary and the male and female reproductive organs are not found contained in a single flower, and the ANGIOSPERMS, in which the seed is not naked but enclosed in an ovary and the male and female reproductive organs (stamens and carpels) are usually associated in a single flower.

Classification of Angiosperms.—This very large group of plants falls into two classes, MONOCOTYLEDONS and DICOTYLEDONS. The first being characterised by an embryo with one cotyledon (seed-leaf), a stem which usually shows no secondary thickening, and flowers with parts in threes. The second shows an embryo with two cotyledons, a stem which exhibits secondary thickening, and flowers with parts in fours or fives. The classification of angiosperms which is now usually followed, is that of A. Engler, the monocotyledons and dicotyledons being divided into a number of classes termed orders (or cohorts or series), the name of each order usually terminating in -ales. Each order includes a number of families (formerly termed "natural orders") many of which are dealt with in special articles; the name of the family usually terminates in *-aceae.*

An outline of Engler's classihcation is given below, the orders (series) being printed in block type and the families in italics. For the 11 *orders of Monocotyledons a synopsis of the chief characteristics is given. A selection of the more important* families *is made in the case of the orders which include a large number of families.*

MONOCOTYLEDONS

Order 1. **Pandanales**—(Marsh *herbs or shrubs or trees with large narrow leaves and compound heads or spikes of flowers. Seeds rich in endosperm.) Typhaceae, Pandanaceae, Sparganiaceae.*

Order 2. **Helobieae**—(Water *or marsh plants with cyclic or hemicyclic flowers, often enclosed in a spathe. Embryo large with little or no endosperm.) Potamogetonaceae, Najadaceae, Alismaceae, Butomaceae.*

Order 3. **Triuridales**—(Saprophytes *with scaly leaves and small long-stalked flowers.) Triuridaceae.*

Order 4. **Glumiflorae**—(Usually *annual or perennial herbs with naked flowers covered by bracts. Ovary unilocular with one ovule.) Graminaceae, Cyperaceae.*

Order 5. **Principes**—(Plants *often trees, leaves of large size often fan-like or feather-like, male and female flowers usually in spikes enclosed in a spathe, ovary superior and fruit a berry or drupe with rich endosperm.) Palmaceae.*

Order 6. **Synanthae**—(Often *palm-like or climbers or large herbs with male and female flowers arranged alternately over the surface of a spike.) Cyclanthaceae.*

Order 7. **Spathiflorae**—(Herbaceous *or woody plants, sometimes climbing, flowers on a simple spike [spadix] more or less enclosed in a bract.) Araceae, Lemnaceae.*

Order 8. **Farinosae**—(Herbaceous *or sometimes grass-like in habit, flowers cyclic, hermaphrodite or unisexual, androecium often reduced, ovary usually orthotropous, endosperm mealy.) Bromeliaceae, Commelinaceae, Pontederiaceae.*

Order g. **Liliiflorae**—(Usually *herbs, often with bulb, corm or rhizome, perianth petaloid or glume-like; ovary* trilocular *superior or inferior; fruit a capsule or berry; ovule anatropous; endosperm fleshy or oily.) Juncaceae, Liliaceae, Amaryllidaceae, Dioscoreaceae, Iridaceae.*

Order 10. **Scitamineae**—(Tropical, *large, perennial herbs often with sheathing leaves; flowers hermaphrodite and irregular, androecium often reduced; ovary inferior usually trilocular; fruit, a berry or capsule with numerous seeds with much* peri*sperm, little or no endosperm.) Musaceae, Zingiberaceae, Cannaceae.*

Order 11. **Microspermae**—(Flowers *of a pentacyclic* trimer*ous type but often with great reduction in the stamens; ovary inferior; fruit, a capsule with numerous minute seeds containing a very small undifferentiated embryo.) Orchidaceae, Burmanniaceae.*

DICOTYLEDONS

Archichlamydeae.—(Flowers often *without* a *perianth, usually polypetalous; pollination entomophilous in the lower orders, anemophilous in the higher orders.)*

Order 1. **Verticillatae**—*Casuarinaceae.*
Order 2. **Piperales**—*Piperaceae*. Chloranthaceae.
Order 3. **Salicales**—*Salicaceae.* ·
Order 4. *Garryales — Garryaceae.*
Order 5. **Myricales**—*Myricaceae.*
Order 6. **Balanopsidales**—*Balanopsidaceae.*
Order 7. **Leitneriales**—*Leitneriaceae.*
Order 8. **Juglandales**—*Juglandaceae.*
Order 9. **Batidales**—*Batidaceae.*
Order 10. Julianiales — Julianiaceae.
Order 11. **Fagales**—*Betulaceae, Fagaceae.*
Order 12. **Urticales**—*Ulmaceae,* Moraceae, *Urticaceae.*
Order 13. **Proteales**—*Proteaceae.*
Order 14. **Santalales**—*Santalaceae,* Loranthaceae, *Balanophoraceae.*
Order 1j. **Aristolochiales**—*Aristolochiaceae, Rafflesiaceae,* Hydnoraceae.
Order 16. **Polygonales**—*Polygonaceae.*
Order 17. **Centrospermae**—*Chenopodiaceae,* Amarantaceae, Phytolaccaceae, Caryophyllaceae.
Order 18. **Ranales**—*Nymphaeaceae, Ranunculaceae, Berberidaceae, Magnoliaceae,* Lauraceae.
Order 19. **Rhoeadales**—*Papaveraceae,* Cruciferae, Resedaceae.
Order 20. **Sarraceniales**—*Sarraceniaceae, Nepenthaceae, Droseraceae.*
Order 21. **Rosales**—*Podostemaceae, Crassulaceae, Saxifragaceae,* Hamamelidaceae, *Platanaceae,* Rosaceae, *Leguminosae.*
Order 22. **Pandales**—*Pandaceae.*
Order 23. **Geraniales**—*Geraniaceae,* Oxalidaceae, *Tropaeolaceae, Linaceae, Rutaceae,* Meliaceae, *Polygalaceae, Euphorbiaceae, Callitrichaceae.*
Order 24. **Sapindales**—*Buxaceae,* Empetraceae, Aceraceae, Sapindaceae, Balsaminaceae.
Order 25. **Rhamnales**—*Rhamnaceae,* Vitaceae.
Order 26. **Malvales**—*Tiliaceae,* Malvaceae, Sterculiaceae.
Order 27. **Parietales**—*Dilleniaceae,* Ochnaceae, *Elatinaceae,* Cistaceae, *Bixaceae, Violaceae, Passifloraceae, Begoniaceae.*
Order 28. **Opuntiales**—*Cactaceae.*
Order 29. **Myrtiflorae**—*Thymelaceae,* Elaegnaceae, *Lythraceae,* Rhizophoraceae, Myrtaceae, Onagraceae, *Hippuridaceae.*
Order **30. Umbelliflorae**—*Araliaceae, Umbelliferae, Cornaceae.*

Sympetalae—(Flowers usually sympetalous, *i.e., with the* parts *of the corolla more or less united, often resulting in a tubular flower.)*

Order 1. **Ericales**—*Pyrolaceae,* Ericaceae, Epacridaceae.
Order 2. **Primulales**—*Myrsinaceae,* Priwzulaceae.
Order 3. Plumbaginales—*Plumbaginaceae.*
Order **4. Ebanales**—*Sapotaceae,* Ebenaceae.
Order 5. **Contortae**—*Oleaceae, Gentianaceae,* Apocynaceae, Asclepiadaceae.
Order 6. **Tubiflorae**—*Convolvulaceae, Polemoniaceae, Boraginaceae,* Verbenaceae, Labiafae, *Solanaceae, Scrophulariaceae,* Bignoniaceae, Orobanchaceae, Acanthaceae.
Order 7. Plantaginales—*Plantaginaceae.*
Order 8. **Rubiales**—*Rubiaceae, Caprifoliaceae,* Adoxaceae, *Valerianaceae,* Dipsaceae.
Order g. **Cucurbitales**—*Cucurbitaceae.*
Order 10. **Campanulatae**—*Campanulaceae,* **Compositae.**

Bibliography.—The *best survey of the classification of* Plants is *given by A. Engler and E. Gilg, Syllabus der Pflanzenfamilien (Berlin,* 1924); *see also the larger botanical text-books such as Strasburger, Lehrbuch der Botanik (Jena,*1923), *and the English translation, Text-book of Botany (London,* 1920). *For the classification of* phanero*gams see A. B. Rendle, The Classification of Flowering Plants* (Vol. i. 1904, *Vol. ii.* 1925); *also* J. C. Willis, *A Dictionary of the Flowering Plants and Ferns (Cambridge,*1925), *which not only includes an outline of classification but gives in alphabetical order a brief account of the families and genera of all gymnosperms and angiosperms and also of the ferns. The fullest account of the classification of the plant kingdom is given by A. Engler, Die naturlichen Pflanzenfamilien (Berlin* 1887–1908), *a work in over* 20 *volumes of which a new edition is now in progress. A good' introduction to the systematic botany of flowering plants is* D. B. Swingle, *A Textbook of Systematic Botany* (1928); *this explains the basis of taxonomy (classification) and the terms used, and gives a review* of *some of the important works in systematic botany.* (V. *H.* B.)

MORPHOLOGY OF PLANTS

The morphology of plants consists in their comparative study from the point of view of Form. It treats not only of the external contour of the plant-body, External Morphology; but also of the internal contours of the constituent tissues, as revealed by anatomical study, the Morphology of Tissues. For the full understanding of form it does not suffice to examine the adult state only. It was found early that difficult questions of comparison could be illuminated by observation of development of the individual, that is, of its Ontogeny. This led to views based upon comparison as to the historical origin and descent of the parts compared, or even of the plant as a whole. A further step to the study of the parts as organs, carrying out certain distinct functions, gives the aspect now designated as Organography. These methods of *enquiry are used collectively as a basis for evolutionary or* systematic conclusions. But such conclusions are apt in critical cases to take the form of expressions of opinion which may differ widely. In arriving at a decision the most positive source of knowledge is the evidence of geological succession in time, and comparison of the forms constituting that succession. This is yielded by the study of fossil plants, called *Palaeophytology* or *Palaeobotany* (*q.v.*). But its record is so incomplete as to leave many problems unsolved. The morphology of plants thus conceived bears within it the possibility of reconstructing the evolutionary history of the vegetable kingdom, which is the goal to which all such study converges. This is called *Phylogeny*.

Pre-evolutionary and Evolutionary Morphology.—The aspect of morphology thus sketched is modern, dating in its present form from the period of the *Origin of Species*. But with varying success pioneer efforts had been made to found a science of plant-form before 1859, when Darwin's book was published. At first these related to the parts that constitute the plant-body as seen in the higher flowering plants, The foundation of organography was traced to Aristotle by Vines. More recently classification of members of the plant-body by Jung (1657), and observations on their ontogeny by Wolff (1759) resulted in a view summarized by the latter in these remarkable words: "In the entire plant whose parts we wonder at as being, at the first glance, so extraordinarily diverse, I finally perceive and recognize nothing beyond leaves and stem, for the root may be regarded as a stem. Consequently all parts of the plant, except the stem, are modified leaves." With such a conclusion already before him it was an easy step for Goethe (1790) to enunciate his theory of Metamorphosis of Plants: in particular he visualized an ideal leaf of the nature of a foliage leaf, of which the bracts and floral parts were held to be metamorphosed types.

The theory of evolution, long entertained before but galvanized into active existence by the genius of Darwin, revolutionized morphology (*Origin of Species*, 1859). For those whose vision was clear it converted it at a single stroke from a deductive handling of abstract ideas based chiefly on the higher plants, to an inductive argument rising, as Bacon said, successively from particulars to axioms of the lowest generality, then to intermediate axioms, and so to the highest.

This newer evolutionary or phyletic morphology, better designated as organography, starts with simple unicellular and aquatic organisms, such as the Flagellates. Each is a minute naked protoplast of inconstant form. A first step towards definite plant-organization is *encystment* within a firm cell-wall: this state appears as an incident in the life of many Flagellates, the encysted cell taking an approximately spherical form. Growth of such a green cell gives better opportunity for nutrition, and for storage of the material acquired: and an enlarging spherical form may be retained by organisms that float in the uniform medium of water. But the relation of an enlarging body to external conditions not uniform is liable to result in *polarity*, with the fundamental distinction of *apex* and *base*. The latter commonly attaches itself to any solid substratum, even without division of the single cell. But usually cell-division follows upon increasing size. If polarity be strongly marked, and growth continued, a filamentous plant-body may result, consisting of a chain of cells attached at its base. This may be further elaborated by cleavage of cells and by branching, while still attached at its base. In this we see initiated another leading characteristic of plant-organization, viz., *fixity of position*.

The sacrifice of mobility consequent on a fixed position is seen in all but the simplest plants: it accords well with the requirements of a self-nourishing green organism, but it imposes limits upon certain of the essential functions of competitive life. The nourishment of the plant must be brought to it by external agencies, such as diffusion, and absorbed from the medium, molecule by molecule. A raptorial habit, as in animals, is then unnecessary, and is even precluded by the fixed habit. On the other hand, the propagative cells must either themselves be motile or must be easily spread by external forces: otherwise any extension of field would be impossible. Throughout descent these two facts have dominated the morphological evolution of plants.

Since all nutrition is primarily a function of surface, the larger the size of the organism and the more complicated its form, other things being equal, the better the nourishment of the individual, and the greater will be its propagative capacity. In simple organisms increase in size may be general throughout the plant-body. But in all larger plants *growth is localized*. Sometimes it is *intercalary* at some point between apex and base; but usually it is distal or apical. Where tissue-formation is thus localized the cells involved in it retain their youth as embryonic cells: this is especially marked at the distal tip, which has thus the character of a *growing point*, or *punctum vegetationis*. Here not only is provision made for continued growth of a central axis, but also for the initiation of successive branchings, which often mature as lateral appendages upon it. The result in the higher plants is the leafy shoot. These elaborations of the vegetative system may be seen illustrated either in the successive stages of an individual life, or by comparison of distinct organisms, such as a seaweed, a liverwort, a fern or a flowering plant. With varying detail these all share that distinctive feature of the more elaborated plant-body, its *continued embryology*. In all the higher animals the embryonic phase is a transient step towards full development, resulting in limbs definite in number and position: but plants have the power of forming an indefinite number of parts, in a succession theoretically without term or limit. Every bud of a forest tree or of a herb contains its own growing point deeply embedded among the successive leaves it has produced, and holds the potentiality of unlimited further development. *This continued embryology is the leading feature in the organization of the enlarging plant-body.*

Categories of Parts.—The vegetative system of the more highly organized plants consists of parts which have been classed as *stem, leaf, root, emergence* and *hair*. So long as the more highly organized plants alone are studied these categories appear fairly distinct. But when such comparison is applied to include forms lower in the scale, the less complete differentiation of their parts raises many questions touching the evolutionary origin of the several categories themselves. Here the fossil evidence takes its place: for conclusions based upon structure, position, individual development or comparison are liable to be checked by the discovery of some ancient form that may raise a doubt, or present even a firm negative. Thus the conception of a leaf as a lateral appendage upon a stem that is fixed at its base by roots, involves three categories of parts well marked in the higher vascular plants. How does this accord with the existence of the Devonian fossil *Hornea*, which is a vascular plant without leaves or roots? It is clear that those categories are not absolute, but are results of evolutionary history still incomplete in *Hornea*.

Many difficult questions as to the category of parts are apt to arise when we attempt their classification in plants at large. Mere comparison of external form or even of internal structure will not suffice: decisions must be based upon the origin and the place which the parts take relatively to other parts at the time when they first appear. Following this method, those parts of the individual, or of different individuals, species or genera, have been distinguished as *homologous* which bear the same relation to the whole plant-body, whatever their form or function or external conditions may be. On the other hand, parts may resemble one another in form and in function, though they may differ in their relation to the whole plant-body. Such parts have been described as *analogous* one with another. For instance, the flat green organs of the butcher's broom are by origin axillary buds, not leaves. Though their main function is like that of leaves, nutritional, they are only analogous to leaves.

Homology presents a more difficult problem, for in plants there may be various degrees of that closer correspondence of parts connoted by the term. The strictest conception of homology is that designated *homogeny*, which may be defined as including those structures which are genetically related in so far as they have a single representative in a common ancestor (Lankester). This implies repetition of an individual part bearing a definite relation to the whole organism. In plants with their continued embryology such correspondence is rarely possible, owing to the indefinite number of appendages produced. And yet the leaves of a shoot are comparable in other respects; but their homology can only be recognized in a less stringent sense than homogeny. Further, it may be held as doubtful whether all such parts as those designated "leaves" represent any essential plan of construction applicable to plants generally. The question arises whether leaf-like organs may not have originated independently in distinct phyletic lines: for instance, among the higher Algae, the Bryophytes, and the vascular plants. These diverse leaf-like organs may rather be regarded as being based upon such uniformity of results as has been achieved polyphyletically in descent, that is, by various types of organisms independently. In that case their likeness would be described as *homoplastic* (Lankester).

Limiting Factors.—Given a sufficient nutritive supply, continued growth of the plant-body may bring the organism up against certain limiting factors, of which the most obvious are concerned with mechanical stability, and the preservation of a due balance between surface and bulk, whether of the external contours, or of the internal tissue-surfaces. The size-factor may thus dominate not only the possible dimensions, but also the form of the plant-body and of its constituent tissues. The underlying principle is that of "similar structures," long ago recognized by Galileo, and familiar to architects and engineers. Applying it mechanically the strength of a structure varies as the square of the linear dimensions, and the mass or weight as the cube. Any plant endowed with continued growth, and with branching, is constantly approaching a size-limit defined by mass versus strength. Somewhat more than 300ft. is the extreme practicable height for a tree with the usual proportions and type of construction of the trunk, branches and twigs. A higher trunk would bend or break under the stress of wind.

The size-factor is also an effective influence on form; this is seen in respect of the proportion of surface to bulk. If the same form is maintained in an enlarging body, its surface increases as the square, whiie the bulk increases as the cube of the linear dimensions. Since nutrition and transit of materials are dependent upon surface action, the maintenance of a due proportion of surface to bulk in an enlarging organism may become critical. Its effect may be traced externally in the subdivision of submerged leaves, or indeed in foliar development itself: or it may appear internally in the complicated segregation of the vascular tracts in plants where cambium is absent or sluggish, as in the ferns or Lycopods. Such influences of the size-factor have long been recognized by animal morphologists: they are now beginning to find their place in the morphology of plants. (See F. O. Bower, Proc. Roy. *Soc.* Edin., vol. xli., xliii.)

Causal Morphology.—The influence of the size-factor may be offered as an example of causal morphology, that is, the relation of form to environmental influence. It must suffice here merely to mention those better known branches of its experimental study which deal with the relation of form to such influences as gravity and light. Hofmeister introduced experiment in this field in his *Allgemeine Morphologie* der Gewachse (1868) as a corrective to the idealistic morphology of the previous period. His observations dealing with the arrangement and final form of the parts constituting the shoot were the natural precursors of the later work of Sachs, who recognized that the form and manner of life of plants "must in great part have arisen through the perpetual operation of gravity and light." (*Vorlesungen,* zte *Aufl:* p. 545.)

Adaptation.—The scalyness or succulence of isolated species or genera under xerophytic conditions may be taken as examples of protective adaptation. Such characters are often hereditary: for instance, the succulence of a cactus or of a spurge appears in the seedling, even when grown in moist air: a seedling parasite, such as the dodder, produces parasitic seedlings that require attachment to the host for full development. Here the germ cell carries the character held as adaptive. On the other hand many formal characters that are specially related to climate or soil may be less marked, or even absent in the offspring grown under medium conditions. They have not been permanently stamped upon the germ-cells. Such differences raise the general question of the inheritance of adaptive form.

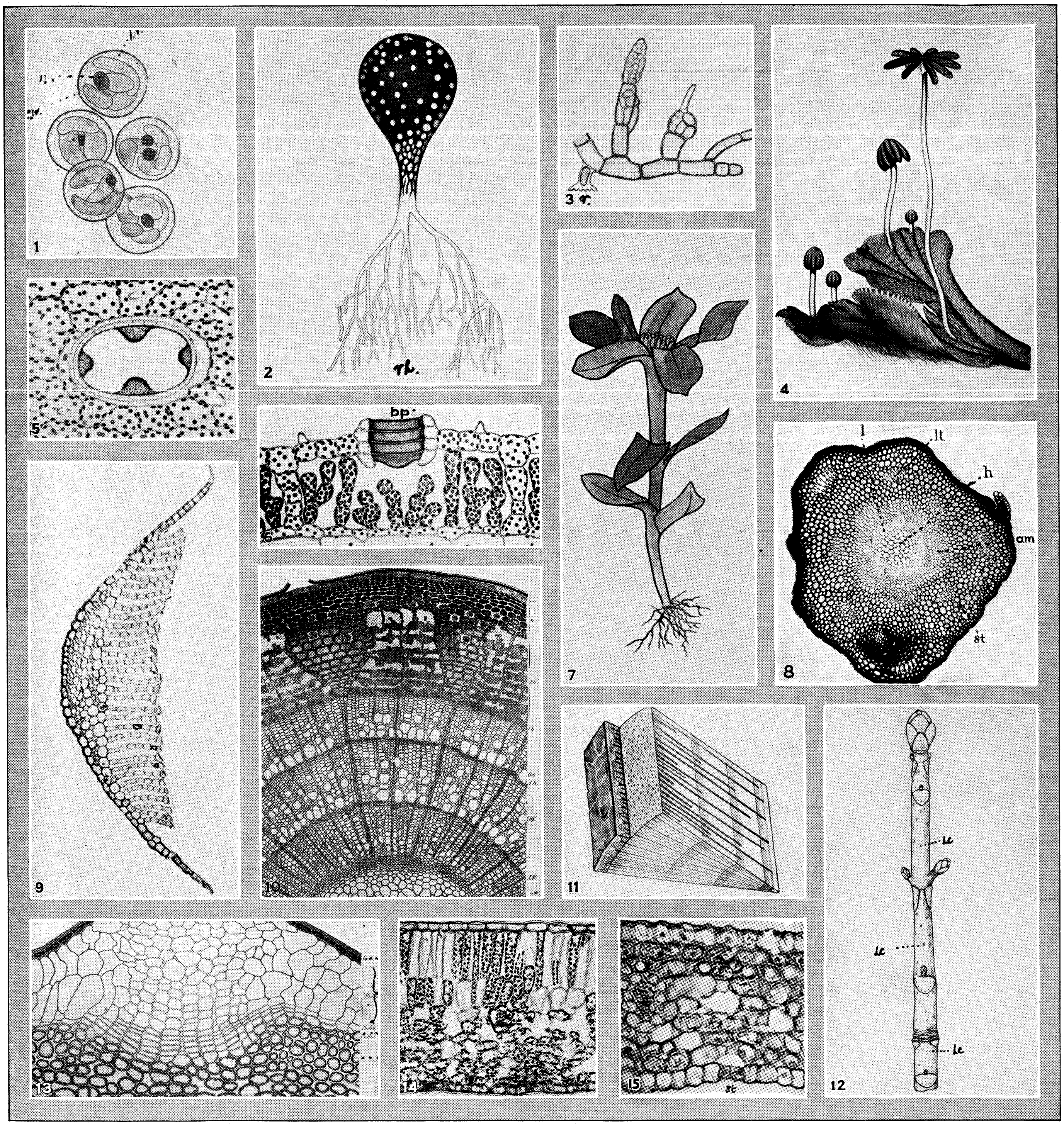
Inheritance of Adaptive **Characters.**—Direct experiments that adaptive or impressed characters may be inherited in plants have so far given indecisive or negative results. All such experiments necessarily range within the narrow limits of laboratory time. If, however, a sequence of events conducted with the latitude of geological time gives a positive result, it seems right to give such a positive conclusion precedence over observations limited to a brief period. More than one good case has recently been brought forward showing the establishment of an ontogenetic adjustment as a permanently inherited character, where a consecutive evolutionary sequence of steps in its appearance can be traced from early geological periods, and confirmed by comparison of living species and genera. (See F. O. Bower, Ferns, vol. iii., Cambridge, 1928.) The conclusion follows that, in plants at least, direct ontogenetic adjustments, if repeatedly imposed, may become hereditary. Other opinions are held on this point, especially by zoologists (see LAMARCKISM, HEREDITY). If such inheritance were wide-spread or general, an important factor would be supplied in explanation of the prevalent phenomenon of adaptation.

But it would not provide a full explanation. The nature of the organism is the more decisive factor in adaptation. It suggests a tendency of initiative in the organism itself, which would go far to explain certain broad features in evolution. Intensive study of the coherent class of the ferns has shown similar trends of advance in distinct phyla-parallel changes which constitute together a positive phyletic drift. This may be held as determined by the "nature of the organism": and to it, acting on differences in that nature, may be attributed the results which we see worked out in those distinct classes and divisions of the vegetable kingdom, which nevertheless may have evolved under conditions essentially alike.

A frequent consequence of homoplastic adaptation is convergent evolution, with a high degree of similarity, or even of standardization as the final result. Examples of this are frequent in the vegetative system: for instance, in the phyllodes of Acacia and *Oxalis,* and the xerophytic leafage of Veronica and *Cupressus:* also in the prevalence of trimerous and pentamerous flowers. But it is in the propagative organs that it is most remarkable; leading to the high uniformity of the archegonia seen throughout the higher cryptogams, of the megaspores of the heterosporous types, and of the embryo-sacs in Angiosperms. Such standardization of parts, which can hardly have been in any of these examples strictly homogenetic, greatly increases the difficulty of their phylogenetic treatment, so far as it is based upon features apparently so similar.

Alternation of Generations.—A few examples must suffice in illustration of the working out of the principies thus underlying the more recent developments of plant-morphology. The first is the phenomenon of Alternation of *Generations.* In mosses and ferns the life-history comprises two distinct phases, or generations, which appear in alternate succession. In the ferns the one is the leafy fern-plant, which as it bears sporangia containing spores, is called the *sporophyte:* the other is a small green scale, the prothallus, which bears the sexual organs, or gametangia, containing the gametes, known as the spermatozoid, and ovum or egg: it is therefore called the *gametophyte.* These alternate generations together constitute a life-cycle of two somatic stages, each limited by a unicellular state, for each spore may germinate to form a prothallus, and each fertilized egg may grow into a new fern-plant (see PTCRIDOPHYTA). Such a cycle exists in the life-history of all mosses and ferns, while its correlative stages appear also in modified form in seed-plants: moreover it is now proved that a like alternation exists also in many Algae and Fungi. In fact an alternating cycle, with varying proportion of somatic development, underlies the morphology of *all plants that* possess sexuality.

Strasburger (1897) related this cycle with the cytological state of the respective stages (see CYTOLOGY). Since in fertilization (syngamy) the number of chromosomes is doubled, the generation that springs from it is (zx) diploid (*e.g.,* fern-plant, moss sporogonium): in the tetrad-division that precedes spore-formation, a corresponding reduction (meiosis) is effected, and the generation that springs from the spore is (x) haploid (*e.g.,* fern-prothallus,

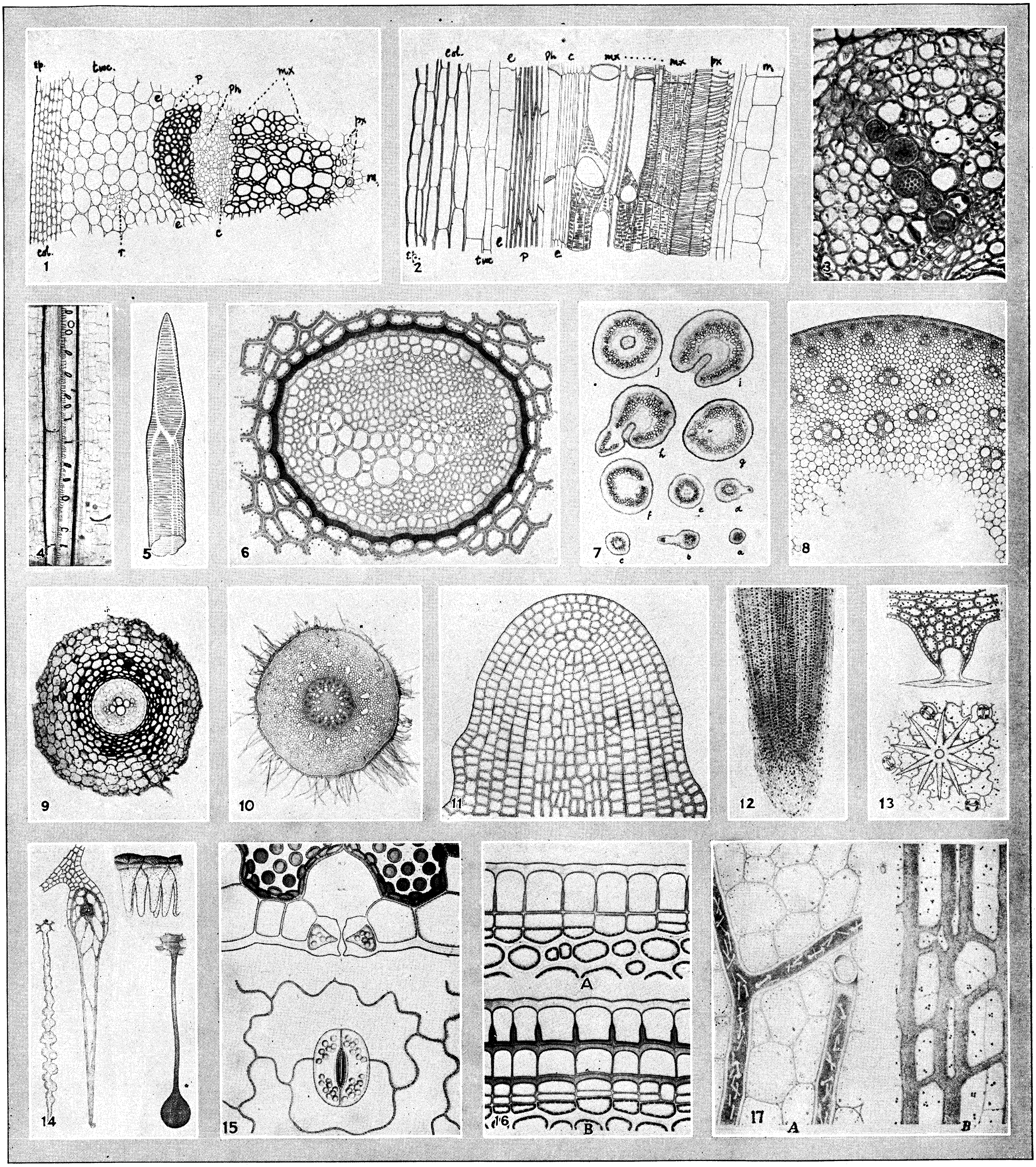


BY COURTESY OF (2-6, 10, 13) PAUL PAREY, FROM KNY, "BOTANISCHE WANDTAFELN"

EXAMPLES OF THE DIFFERENTIATION OF PLANT CELLS

1. Group of individuals of the unicellular Green Alga (*Chroococcus*), one of which is in a state of division, as an example of an undifferentiated autonomous assimilating cell. (n.) nucleus; (chl.) chloroplasts; (pr.) cell protoplasm; (c.w.) cell-wall. 2. Plant of the primitive Siphoneus Green Alga (*Botridium granulatum*). The cell sends colourless tublets (rhizoids, rh.) into the mud on which it grows. The upper part contains the chloroplast. 3. Portion of a plant of a multicellular Red Alga (Le-*jolisia* mediterranea). The upper branches are reproductive, and a basal cell is expanded as a special holdfast (r.). 4. Portion of a fertile plant of the Liverworth (Marchantia polymorpha), with numerous rhizoids, lower surface. 5. Surface view of a breathing pore of Marchantia *poly*-morpha. 6. Section of the upper layers of the body of a mature plant of *Marchantia* polymorpha. (b.p.) breathing pore. 7. Male plant of the Moss (*Funaria* hygrometrica), with basal rhizoids. 8. Transverse section of the aerial stem of the Moss (*Polytrichum* commune): (h) hydrom, (1) leptom, (am) arnylon, (st) sterom, (lt) leaftrace. 9. Transverse section of "leaf" of Polytrichum commune, showing photo-synthetic plates attached to upper surface on right. 10. Portion of a transverse section of a stem of the common Lime (*Tilia* europea), showing three annual rings and peripheral cork. 11. Plan of construction of a Lime stem after four years of secondary thickening. The medullary rays are represented by black lines in the radial and transverse views, and by black dots on the exposed tangential wood surface. 12. Twig of the Horse Chestnut (*Aesculus Hippocastanum*), with lenticels (lc). 13. Transverse section of a lenticel and subjacent cortex, from the stem of the Elder (*Sambucus nigra*). 14. A dorsiventral leaf. Portion of a transverse section of the leaf-blade of the Privet (*Ligustrum*), showing upper palisade and lower spongy tissue. 15. An isobilateral leaf. Portion of a transverse section of the leaf-blade of the Iris, showing a stoma of the lower surface (near centre, lower margin of picture), and no differentiation of palisade tissue

PLANTS



PHOTOGRAPHS, (6, 11, 13, 14, 15, 16, 17) AFTER KNY'S "BOTANISCHE WANDTAFELN" BY COURTESY OF PAUL PAREY

ANATOMY OF VARIOUS PLANT STRUCTURES

1. Part of transverse section of the stem of Sunflower, ep. epidermis; col. collenchyma; twc. thin-walled cortex; r. resin passage; e. endodermis; p. pericyclic fibres; ph. phloem; c. cambium; mx. metaxylem; m. medulla. px. protoxyiem. 2. Radial longitudinal section, same stem. (Lettering as in fig. 1.) 3. Cross-section of phloem of stem of Cucumber, showing four sieve plates. 4. Longitudinal section of the wood of a stem bundle of Maize plant, showing reticulately pitted, spiral and annular vessels. 5. Part of a Fern tracheid, with pointed end and scalariform pits. 6. Cross-section of a vascular bundle from the leaf-stalk of a Fern. 7. Sections of the stele of a Fern (*Loxsoma*), from the juvenile to the adult stem: (a) solid protostele; (b) medullated protostele; (c) and (d) medullated protostele with inner phloem; (e) and (f) widening of the phloem cylinder; (g) and (h) pocket of inner endodermis joined to outer endodermis at a leaf gap; (i) a transitional state to (j), which shows solenostele of adult stem. 8. Cross-section of stem of young Bamboo, showing scattered bundles. 9. Transverse section of the root of a Fern (Pellaea), with diarch xylem and sclerotic cortex. 10. Transverse section of the aerial root of Vanilla, with polyarch xylem and numerous root hairs. 11. Radial longitudinal section, stem apex of an Angiospermio plant. 12. Radial longitudinal section, tip of root of the Onion, showing root cap. 13. Surface and sectional views of a stellate hair of an Angiosperm. 14. Examples of forms of hairs of Angiosperms. 15. Sectional and surface views of a stoma from the leaf of an Angiosperm stem. 16. Stages in formation of cork and phelloderm as seen in cross-section of an Angiospermio stem: (A) the first division of the sub-epidermal phellogen; (Lower) the completion of a layer of cork. 17. (A) Part of a Laticiferous Cell from the stem of a *Euphorbia*, containing bone-shaped starch grains; (B) Laticiferous vessels in the root of an Angiosperm

moss-plant). It is a morphological problem of the first rank to determine the evolutionary relation of these generations to one another, whether in the individual, the phylum, or in plants at large.

Whatever the historical origin of alternation may have been, certain features in its further development were probably as follows. The land-habit of the Archegoniatae appears to have encouraged or fixed a biological difference between the generations: the gametophyte is characteristically semi-aquatic, while sexuality which is its end depends upon external liquid water: the sporophyte is characteristically a land-living body, often rooted in the soil, while the dissemination of the spores depends normally on dry conditions. Thus the alternate generations of the Archegoniatae accord well with an amphibial life, one being distinctly sub-aerial, the other not fully freed from dependence on external water. But the tie of aquatic fertilization (zoidiogamic) is inconvenient for land-living organisms: hence it is no surprise to find that the higher flowering plants have broken loose from it, by adopting fertilization by a pollen-tube (siphonogamic). The gametophyte by successive steps of reduction loses its independence as a separare generation, while rile sporophyre becomes dominant. This state may be held as the last essential step in the adaptation of plant-life to a land-habit.

A second illustration of the working out of the principles summarised above may be taken from the leaf. Of all the vegetative organs the leaf raises questions most open to debate. In the older morphology an ideal leaf was envisaged, and other types of leaf were regarded as modifications of it. But the duty of an evolutionist is to look not to an idea, but to the facts supplied by the lower organisms. They show that, whether in the gametophyte or the sporophyte, a leafless state preceded foliar development. Moreover both fossils and living plants suggest that all leaf-like appendages did not spring from a common source, but polyphyletically.

The effect of such considerations is to relax the old rigid conception of "the leaf" as a morphological constant. Biologically a leafy shoot appears as a favourable advance on a simpler organization, bringing with it an increasing proportion of absorptive surface to bulk. The existence of a demand for this is common to enlarging organisms, and the foliar development appears as a consequence in any or all such. The facts indicate an independent response in many distinct phyletic lines, with the result that the leaves so produced would not be all homogenetic, but probably in high degree homoplastic.

Conclusions.——From the preceding sketch of current plant-morphology it is seen to be founded on the theory of evolution, used as a working hypothesis. Observed facts are interpreted from the point of view of phylesis, the argument leading towards the reconstitution of evolutionary history. The difference between the older idealistic and the newer inductive morphology has been well drawn by Sachs. He pointed out "that the former fits new facts into a scheme of old conceptions, the latter deduces new conceptions from new facts" (*History* of *Botany,* 1890). But morphologists are still bound by an idealistic evolution theory, for some preconceived type is in their minds. The remedy lies in a refusal to accept any conclusion from comparison as definitive, unless based upon consecutive data derived from actual organisms phyletically related one to another. The consequence of this would be a greatly increased recognition of polyphyletic sequences. But it is better to entertain a wide theory of polyphylesis, with that apparent indefiniteness of conclusion that follows in its train, than to accept questionable doctrines that bring satisfaction only to uncritical minds.

Finally therr remains the question of causality. The causes of development can best be unravelled and their relations to the environment established by experiment. On the other hand, experiment by itself cannot reconstruct history: for it is impossible to rearrange for purposes of experiment all the conditions exactly as they were in an earlier evolutionary period: and even if this were done, can it be assumed that the subjects of experiment will really be the same? Consequently there must always be a margin of uncertainty whether a reaction observed under experiment to-day mould be the exact reaction of a past age. Nevertheless there is a great future before experimental morphology: and though it cannot wholly unravel the history of form, this should still be approached experimentally as well as objectively.

Thus the way had already been prepared for Modern views, associated with "hormones," and their influence on individual development indicates from yet another angle how morphology is becoming ever more closely knit to physiology. It has been said that it deals with the stereotyped results of physiology. This is true in so far as it points towards the historical aspect of morphology, extending back as it does to the remotest fossil records: while physiology deals observationally with the reactions of the present time. But a better summing up of the relations of these two branches of biological science would be that morphology deals with all phenomena of form, including such as are not yet physiologically understood.

Bibliography—J. W. von Goethe, *Collected* Works, vol. xxxvi. (Cotta, 1858); Strasburger. "Periodic Reduction" in *Annals of Botany* (Oxford, 1894); Lignier, Bull. *Soc. Linn. de Normandie* (Caen, 1903); F O. Bower. *Origin* of *a Land Flora* (1908); Von Goehel, *Organographie,* (Jena, 1913–24); Wilhelm Hofmeister (Ray Society, 1920); Church, *Thalassiophyta* (Oxford, 1919). (F. O. B.)

ANATOMY OF PLANTS

The term "Anatomy," originally employed in biological science to denote a description of the facts of structure revealed on cutting up an organism, whether with or without the aid of lenses for the purposes of magnification, is restricted in the present article, in accordance with a common modern use, to those facts of internal structure not concerned with the constitution of the individual *cell* or structural unit of the plant body.

An account of the anatomy of plants naturally begins with the cell which is the proximate unit of organic structure. The cell is essentially an individualized mass of protoplasm, of small dimensions, and containing a differentiated protoplasmic body, called a *nucleus.* Other protoplasmic bodies, known as plastids, and inanimate matter, mainly in solution or suspension, are present. But all cells which are permanent tissue-elements of the plant body possess, in addition, a more or less rigid limiting membrane or *cell-wall,* consisting primarily of cellulose or some allied substance excreted by the living cell-body and serving to connect the different cells of a tissue *(see* below). Upon the characters of constitution, thickness and sculpture of the cell-walls the qualities of a plant-tissue largely depend. The life of all the cells in a plant-body may be prolonged or a number of the cells may die and their protoplasm be removed. Thus a tissue may consist of living encysted units combined with an inanimate framework of cell-walls, enclosing in their cavities solely liquids and gases. In such cases the characters of the adult tissue largely depend on the proportion and distribution, the stature, form and contents of the living and dead units, and on the nature of their walls. It is customary in plant anatomy to speak of the cell-wall with its enclosed cavity as "the cell," and of the contained protoplasm or other substances as *cell-contents.*

In all but the simplest forms the plant-body is composed of a number of cells associated in more or less definite ways. In the higher or more complicated plants the cells come to differ greatly among themselves so that the adult body is composed of definite systems of units. Each system has its own characteristic structure, depending partly on the characters of the component cells and partly on the method of association. Such a system is called a *tissue-system,* the word tissue being employed for any collection of cells with common developmental, functional or structural characters to which it may be conveniently applied, and accepted by the general resemblance which was thought to exist between the texture of plant-substance and that of a textile fabric before the fundamental constitution of plant-substance was discovered.

It is convenient here to define the two chief types of cell-form which characterize the tissues of the higher plants. The term *parenchyma* is applied to tissues the celis of which are isodiametric or cylindrical in form. The term *prosenchyma* is applied to tissues consisting of long narrow cells with pointed ends.

The reader is referred to special articles on the anatomy of the lower plants (Thallophyta: Algae and Fungi, and Bryophytes: mosses and liverworts) in which the differentiation of tissues is comparatively slight. It must suffice here to mention that both Algae and Fungi range from the simplest unicellular forms with no external differentiation of the body to forms of greater stature and compiexity of organization. The progress in complexity is closely associated with division of physiological labour among the component cells and with the adaptation of the multicellular organism to the needs of its environment. But whatever are the various states attained by individual genera the majority of the cells of the adult bodies of both Algae and Fungi remain alive and the tissues are essentially parenchymatous.

In accordance with the greater complexity in the conditions of life on land for self-supporting plants, considerably more advanced tissue-differentiation is exhibited by the Bryophyta, which are mainly terrestrial plants. In a general way this greater complexity consists (1) in the restriction of regular absorption of water to those parts of the plant-body which are in close contact with the soil, and (2) in the more regular evaporation of water from the parts exposed to the air. It is, however, in the higher vascular plants that those two principles find their fuller expression, for in the bryophytes water is still absorbed, as, for example, from rain or dew, by the general plant-surface. The lowest liverworts have an extremely simple vegetative structure comparable to that of many of the simpler Algae, for as their bodies are small and normally live in damp air the demands of terrestrial life on them are at a minimum. Thus their bodies consist of true parenchyma, and the vast majority of the component cells remain alive. Rooting and absorbing thread-like cells (*rhizoids*) universally occur on their lower surfaces in contact with the soil, and considerable tissue-differentiation may occur within the body. Thus some possess a distinct assimilative system consisting of branched chains of thin-walled cells packed with green plastids (*chloroplasts*) and arising from the bases of large cavities directed towards their upper illuminated surfaces. These cavities are completely roofed by a layer of surface cells pierced by pores, surrounded by special cells, and through which aeration and evaporation are freely maintained. In certain forms in which the body consists of thick midribs and delicate lateral leaf-like appendages strands or bundles of long thick-walled fibre-like (*prosenchymatous*) cells with pointed ends run longitudinally through the midribs, which are devoid of special assimilative tissue. The walls of these cells are strongly lignified (*i.e.*, consist of woody substance) and are irregularly thick and thin so as to be closely studded by simple pits which are usually arranged in spirals running round the cells and often elongated in the direction of the spiral. There is much variety of detail in the differentiation of the tissues of the liverworts, but the general plan of construction resembles that adopted in the leaves of higher plants.

In the mosses the plant-body is generally more elaborate in accordance with its fuller commitment to terrestrial life. There is always a radially organized supporting and conducting axis (stem) bearing laterally throughout the greater part of its length thin, flat assimilating and transpiring appendages (leaves). To the base of the stem or to those parts in contact with the soil are attached branched rhizoids. In some cases the stem possesses a special surface or epidermal layer of cells, but usually all the outer layers of the stem are composed of brown, thick-walled, lignified, prosenchymatous, fibre-like cells forming a peripheral *stereom* (mechanical and supporting tissue) which forms the *outer* cortex. This passes gradually into the thinner-walled parenchyma of the *inner cortex.* The entire cortex is generally alive and its cells often contain reserve foods in the form of starch. The centre of the stem, in the forms which live on soil, is composed of a strand of narrow, elongated, thin-walled, unlignified, dead water-conducting cells (*hydroids*) which are seldom pitted. This hydrom strand has in most cases no connection with the leaves, but runs straight up the stem and spreads out locally below the reproductive organs. In the aquatic and semi-aquatic forms, and in those mosses which live under conditions of extreme drought the entire plant-surface absorbs water, perpetually in the first two cases, and during rain in the third. In such forms the hydrom strand is either slightly developed or altogether absent. The leaves of most mosses are flat plates, each consisting of a single layer of square or oblong assimilating cells containing chloroplasts. The marginal cells of the plates are frequently produced as teeth and their walls are thick. The centre of the leaf is often occupied by a midrib consisting of several layers of parenchymatous cells elongated in the direction of the long axis of the leaf and poor in chloroplasts. This midrib may be considered a primitive conductive foliar strand or leaf-bundle. Associated with this conducting parenchyma are frequently found hydroids like those of the central strand of the stem, and in some cases continued into the cortex of the stem as a leaf-trace *bundle* (the anatomically demonstrable trace of the leaf in the stem). In several cases the leaf-trace runs vertically downwards for some distance in the outer cortex and ends blindly in a fan-shaped expansion: in others it joins the central hydrom strand so that a connected water-conducting system is established between stem and leaf.

Further differentiation of tissues characterizes the highest family of mosses, the Polytrichaceae. In these elongated, living, nucleated cells with a thin lining of protoplasm surround the dead hydrom, and form the *leptom,* inferred to serve for the conduction of organic substances, since the entire cavity of a leptom cell is sometimes occupied by proteid contents. The ends of each leptom cell are slightly swollen and fit to the similar swollen ends of the next leptoids in a row. The end walls are usually very thin, and the protoplasm, on artificial contraction, commonly sticks to them though no perforations of the walls have been found. It is considered that these cells are in some measure comparable to the sieve-tubes of higher plants (see below). Associated with the leptoids are similar cells without swollen ends and with thick end walls, while between the hydrom and leptom is a cylinder of cell-layers, known as amylon, which may serve for the temporary reservation and in the distribution of carbohydrates, since they sometimes contain an abundance of starch. The underground portion of the stem (rhizome) bears rhizoids and simple scales. The aerial parts bear leaves, each with a simple midrib several cells thick with a strong band of stereom above and below a bundle of leptom, hydrom and amylon cells which join the central cylinder of the stem. Each midrib bears two wings, one cell thick, while above the midrib is a series of closely set, vertical, longitudinally-running plates of green assimilative cells.

Vascular Plants. — It is, however, in the higher vascular plants (Pteridophyta, *e.g.,* ferns, horse-tails, club-mosses and Phanerogama or flowering plants) that the greatest anatomical complexity is found, for these are the dominant land plants. Such plants are not exactly comparable with the bryophytes for while the body of the latter bears the sexual organs and is called a *gametophyte,* and later nourishes a simple spore-bearing body (*sporophyte*), the vascular plant is a sporophyte which later nourishes a simple and reduced gametophyte. Nevertheless the gametophytic bryophyte and the sporophytic vascular plant have similar physiological needs and are both fixed to the soil. The chief new feature in external conformation of the body of a vascular plant compared with that of a bryophyte is the presence of "true" roots, the first formed of which is a downward prolongation of the primary axis of the plant. From this and from various parts of the shoot-system other roots originate. The roots of Pteridophytes are structurally simple and uniform compared with those of Phanerogams, but all manifest a primary plan of construction in direct relation to their normally subterranean life and fixative and absorptive functions; they differ from aerial stems in the characters of their surface tissues, in the absence of the green assimilative pigment chlorophyll, in the arrangement of their vascular systems, and in their mode of apical growth. Great variety in stem- and leaf-form and structure is shown by the vascular plants.

But in spite of the many considerable differences of detail between Pteridophytes and Phanerogams, we can trace, alike in root, stem and leaf a threefold division of tissue systems, already indicated among the bryophytes, and expressive of the fundamental conditions of evolution of the bulky body of a land plant. Thus there is (1) a specializatiori of a surface layer of cells which regulates the immediate relations of the plant with its surroundings. while varying in expression in the subterranean and aerial parts. In the former the surface layer is pre-eminently absorptive and in the latter protective provision at the same time being made for the gaseous interchange of oxygen and carbon dioxide involved in respiration, and for such vital functions as assimilation and transpiration. This surface layer is known as the epidermis. On the other hand we have (2) an internal differentiation of conductive tissue, prefigured in the bryophytes, and collectively known in the vascular plants as the vascular system. The remaining tissue of the plant-body, which shows varied local differentiation and is concerned with special functions, is known by reason of its peripheral position in relation to the central conductive tissue as (3) the cortex. But besides absorption, assimilation, conduction and protection, provision is made for support and the storage of food. Thus locally in the cortex and vascular system special supporting tissues (stereom) may be developed according to the varied needs and the conditions of body-differentiation, and living cells of both the cortex and the vascular system may serve for temporary storage of foods and are specialized accordingly. The functions of aeration, assimilation and transpiration, by which the bulky tissues of the plant-body obtain oxygen for breathing and carbon dioxide for food-manufacture, and the removal of excess water is assured, are maintained by an extensive system of *intercellular* spaces communicating with the external air.

Epidermis.—The epidermis of the subaerial stems and leaves is primarily protective and usually consists of a single layer of living cells devoid of chloroplasts, and with thickened and cuticularized outer walls, defensive to slight shock and small parasites, but permitting controlled evaporation. At intervals it is interrupted by small pores (stomata) leading from the outer air to the system of cortical intercellular spaces, and serving for gaseous interchange between the primary tissues and the outer air. Each stoma is surrounded by a pair of peculiarly modified epidermal cells called guard cells which possess chlorophyll and open and close the pore, especially in accordance with the conditions of transpiration. The stomata of leaves are often situated at the bottom of pits in the leaf-surface. Thus transpiration is checked by the creation of a still atmosphere in the pit above the pore. Such an arrangement of the stomata is found especially in plants which require to economize their water supply if transpiration is in excess of absorption. In many plants living in conditions which tend to promote excessive transpiration at certain hours of the day, the epidermis is doubled or trebled and forms a water tissue which supplies the immediate needs of transpiration, and prevents the injury which would result in the epidermis if its cells were excessively depleted.

Hairs *and* Scales.—The epidermis of many species of vascular plants bears hairs or scales of varied form and function. Hairs are characteristic of stems and leaves of primitive pteridophytes and of many flowering plants, while scales characterize such pteridophytes as the advanced ferns. The simplest hairs consist of single elongated cells projecting above the general surface of the epidermis, while others consist of simple or branched cell-chains. The more complex scales are flat plates of cells commonly inserted on mounds or stalks, and may be placed parallel to the leaf-surface or projecting directly from it. By such emergencies transpiration is diminished by the stillness of the atmosphere between them. In other instances the hairs are glandular and excrete ethereal oils which tend to reduce transpiration, or they may be stinging, as in the common stinging nettle, in which the top of the hair is brittle, and when broken penetrates the skin and injects formic acid into the slight wound thus formed. In many cases both hairs and scales are shed before the stems and leaves are mature: in others they are retained throughout the life of the plant.

Hydathodes.—In many vascular plants special epidermal organs, known as hydathodes, are developed, especially on foliage leaves, and serve for the excretion of water in liquid form when transpiration is diminished so that the pressure in the water-channels of the plant has come to exceed a certain limit. Hydathodes are widely distributed in plants in certain tropical climates under which active root-absorption continues while the air is nearly saturated with water-vapour. In some cases the hydathodes are specially modified single epidermal cells or are multicellular hairs without direct connection with the vascular system. The cells concerned, like all excreting organs, have abundant protoplasm and large nuclei, and in many cases part of the cell-wall is perforated and resembles a filter. In others the hydathodes are associated with the ends of conductive strands and consist of groups of richly protoplasmic cells, as in the leaves of many ferns, while in flowering plants the hydathodes are most commonly directly connected with subjacent water-collecting cells known as *epithem* which act as intermediaries for the hydathodes and conductive strands. To illustrate, water expelled through hydathodes is often observable on the tips of grass leaves on a summer's evening and is commonly confounded with dew. Its expulsion as droplets is, however, due to the more rapid cooling of the air than of the soil as night approaches. Thus while active absorption continues by the roots, transpiration by the leaves is reduced in the evening and the conductive strands are overcharged with water which is expelled by the hydathodes. There are many other types of glands such as nectaries, *digestive-glands, resin-* and *mucilage-glands,* serving the most varied purposes in plant-life. Some involve epidermal cells, while others are more deeply seated, but as they are not involved in the primary activities of the epidermis they are here passed over. It will, however, be apparent that the epidermis of the stem and leaf of a vascular plant may be highly specialized.

Epidermis of Root.—The epidermis of the root is fundamentally different from that of the stem or the leaf. In relation to its normal function of water-absorption its cell-walls are not cuticularized and usually remain thin. The absorbing surface is increased by many of the cells being produced into tortuous, delicate, unicellular tubes (root-hairs) which aid in anchoring the root, and readily absorb the surface films of water from the soil particles. A root-hair thus corresponds in function with a rhizoid of a bryophyte. The hairs are normally definitely restricted to a more or less definite zone of the root a little removed from the growing root-tip. At the lower limit of this zone hairs are constantly being formed as the root advances in the soil, while at the upper limit they have passed maturity, are dying and are being destroyed. Thus beyond the zone which at any moment bears living absorbing hairs (the *piliferous* zone) the epidermis is extensively or completely destroyed, and its place is taken by the immediately subjacent cortical layer, which is not absorptive, but becomes protective like the epidermis of the stem or leaf. At the apex of the root, covering and protecting the delicate tissue of the growing point, is a special root-cap, consisting of a number of layers of cells produced by continual active local division of the apical epidermal cells, and which break down into mucilaginous products towards the outer surface of the cap, thus facilitating the passage of the apex as it pushes between the soil particles, and keeping the apex continually moist.

The **Cortex.**—The cortex consists primarily of living parenchyma, but its differentiation may be extremely varied, and in the complex bodies of vascular plants its functions are varied and may be modified. The cortex of a young stem is usually green as its cells possess chloroplasts, and a fine system of intercellular spaces communicates with the external air through stomata. With age the inner cortical layers may lose their chlorophyll and become storage tissue, and the outer layers may be extensively modified (see p. 10, secondary tissues). In many pteridophytes (*e.g.,* ferns) the mature outer cortical layers of the stem and root are hard sclerenchyma with thick brown walls, but in flowering plants, while the stems are still slender, the cells of the outer cortical layers elongate and become cylindrical so that their intercellular spaces are widened. Vertical bands of cellulose thicken those regions of the walls which are in contact with the intercellular spaces, but the remaining regions of the walls usually remain thin. Such a tissue is known as collenchyma. It provides peripheral support for the growing stem, and as its cells are alive, is open to later modifications with changing needs in stems which undergo annual increase in girth. The wonderful recovery, after bending and stretching, which is often observable in herbaceous stems, is in large measure due to the effective distribution of this elastic collenchyma. On the other hand sclerenchyma is commonly dead and provides a more rigid but usually unmodifiable supporting tissue. Its adequacy will be evident for stems such as those of modern ferns which do not increase annually in girth. Less commonly, scattered cells or cell-groups which increase little in length may become *stone* cells, with irregularly but inordinately thickened hard walls, while in some cases longitudinal rows of cells disintegrate thus forming canals, such as *resin canals,* the cortical wall-cells of which are excretory. Many such minor modifications of the original cortex of the stem occur in association with special localized functions.

Phloeotherma.—The innermost layer of the living cortex investing the central cylinder of the stem is, however, often early and peculiarly modified as a continuous cylinder called the *phloeotherma.* Throughout its entire course its cell-walls remain in close contact so that the system of intercellular spaces in the cortex is not continued into the central cylinder of conductive tissue. Towards the upper limit of the phloeothermal cylinder, while the stem is still young, the component cells may be rich in plastids in which starch grains are formed. In some localities the phloeotherma is known as a starch *sheath,* which is variously thought to play some rôle in the controlled conduction of carbohydrates from the assimilatory cortical cells to the vascular cylinder, or in some connection with the directional growth of the young stem. In the more mature regions of the stem starch grains are absent from the phloeothermal cells, the walls of which are somewhat thickened. In particular, a band of the lateral longitudinal and of the end walls is modified, being impregnated with a fatty substance which is thought to prevent radial transfer of foods in solution athwart the phloeotherma save under protoplasmic control of its cells. The phloeotherma is here known as an endodermis, and is thought to serve as a physiological barrier between the cortex and the central conductive cylinder.

Mesophyll.—The cortex of the leaf is primarily concerned with the primitive fundamental function of carbon assimilation, and to the active performance of this function the maximum exposure of living parenchymatous tissue containing chloroplasts is necessary. Thus the cortex of the leaf is essentially a green expanse of thin-walled parenchyma, known as the *mesophyll,* and is penetrated by a large and elaborate system of intercellular spaces which serve at one and the same time for the promotion of transpiration and respiration. The pathways for the gases which thus pass between the mesophyll and the outer air are the stomata, which in land plants with dorsiventral leaves are mainly or exclusively placed on the lower leaf-surface. By this means over-transpiration tends to be avoided, since the liberated water-vapour, being lighter than air, tends to remain in contact with the lower leaf-surface and checks evaporation. The stomata are in direct communication with the ample system of intercellular spaces in the mesophyll, the lower layers of which are commonly loosely arranged as *spongy tissue* with extensive intercellular spaces. This is the main transpiring tissue of the leaf, and in it chloroplasts may be comparatively few. It is protected from direct illumination and is at the same time liable to over-evaporation. The main assimilating tissue, on the other hand, is under the upper epidermis, is well illuminated, its cells are densely packed with chloroplasts, and are commonly oblong with their long axes perpendicular to the leaf-surface. The intercellular spaces are here narrow as between sticks in a bundle, and are in open communication with the spaces in the spongy tissue below. By reason of its resemblance to the boards in a fence, when viewed in a transverse section of the leaf, this portion of the mesophyll is called the palisade tissue. Leaves with blades held in a vertical position commonly possess palisade tissue on both sides or have little or no distinction in the form and arrangement of the cells of the mesophyll, since there is no difference in the illumination or other external conditions, while cylindrical or approximately cylindrical leaves may have palisade tissue all round. The leaves of shade plants have little or no differentiation of the palisade tissue. In fleshy leaves, which contain a great bulk of tissue in relation lo their chlorophyll content, the central mesophyll contains little or no chlorophyll and may consist of water-storage tissue, while locally a layer or mass of sub-epidermal cells may be thick-walled and fibrous.

The cortex of the leaf-stalk is transitional in structure to that of the stem and leaf-blade. The leaf-stalk is traversed by one or more vascular strands connected below to the central conductive system of the stem, and leading forward in the leaf-blade to a complex system of minor strands which ramify the mesophyll and run their course in the plane of junction of the spongy and palisade tissue. The layer of mesophyll immediately investing each bundle is phloeotherma and usually takes the form of a special parenchymatous sheath of elongated cells, distinguished otherwise from the rest of the mesophyll only by their poverty in chloroplasts. In a few rare cases the phloeothermal cells are rich in chlorophyll. These bundle-sheaths are considered important in the conduction of carbohydrates from the assimilative cells to the conductive strands and in the supply of water from the latter for transpiration. Their function is thus considered in some measure comparable with that of the phloeotherma of the stem.

The cortex of the roots of Pteridophytes is commonly extensively sclerotic at maturity, but in flowering plants the root-cortex generally remains a living parenchymatous food-storing tissue. Its innermost layer is invariably an endodermis.

VASCULAR SYSTEM

Among the most striking characters of Pteridophytes and Phanerogams is the possession of a double (hydrom-leptom) conducting system, such as has been noted in the higher mosses, but with more sharply defined and specialized features. This is the *vascular* system, and associated with it are other tissues consisting of parenchyma and special stereom. The whole tissue-system is known as the *stelar system* (from the way in which in its simpler forms it runs through the whole axis of the plant as a column). When it is remembered that the moss plant is a gametophyte while the vascular plant is a sporophyte it will be realized that the vascular system of the latter is not the result of elaboration of the conductive system of the former, but that these vascular systems are most readily interpreted as somewhat similar products of differentiation in plants fitted for life on land.

Tissue Elements. — The hydroid of a Pteridophyte (*e.g.,* a fern) is initially a living undifferentiated parenchymatous cell. As it dies it usually elongates and its wall is irregularly thickened and becomes woody (lignified). Its contents at maturity are watery solutions and air. The thickenings are on the inner wall-surface, are insufficient to line the wall entirely, and take the form of a spiral or complex network. The mature hydroid is called a *tracheid.* Its end walls persist and are commonly oblique. When the walls are mainly thickened their unthickened portions are called pits, and according to the varied distribution of the thickenings, the size, form, number and distribution of the pits depend. Thus in spiral *tracheids* a broad spiral band of unthickened wall persists, while when the thickenings on a wall-face are more or less transverse bars (often joined by short vertical bars) there is a resemblance to the rungs of a ladder, and we have a scalariform *tracheid.* All manner of transitions from spiral to scalariform tracheids may be found in a single plant. Spiral thickening is, however, characteristic of tracheids in which lignification begins and is completed while elongation of the cell is still in progress. Scalariform thickening is typical of tracheids which mature late or slowly, so that thickening may be continued after elongation is completed. The pits of scalariform tracheids are typically bordered pits, as the bars of thickening last deposited are widest. The pits on tracheid-walls which are in contact with each other are at similar levels so that at regular intervals the cavities of contiguous tracheids are only separated by a common thin area of wall (the pit-membrane). Sooner or later the pit-membrane disappears so that the mature tracheids come to consist of a framework of lignified bars with numerous small open communications between the cell cavities. Collectively with associated parenchyma the tracheids constitute the xylem or wood.

The leptoid of a Pteridophyte is also an elongated cell. It, however, remains alive, its wall is unlignified, it has a thin lining of protoplasm, but is destitute of a nucleus. It is always in communication with its neighbouring cells in a leptom strand by exceedingly minute wall perforations through which protoplasmic continuity is maintained. It is generally supposed that through these perforations organic substances are passed from cell to cell as through a sieve. The cells are accordingly called *sieve-tubes,* and collectively with associated parenchyma constitute the tissue called the *phloem,* or *bast.* The phloem is typically distributed at the periphery of the xylem when the latter is massed centrally, but may occur in other positions *(see* below). Between the phloem and the phloeotherma is a mantle of one or more layers of parenchyma forming the pericycle.

Arrangement **of the** Vascular System— In vascular plants the xylem and phloem are nearly always found in close association in strands or *bundles,* but as is to be expected in so complex and varied a group as the Pteridophytes the arrangement of such bundles is by no means stereotyped either in the group or in the different parts or members of the plant-body. A connected vascular system runs, however, through the entire body. In the roots and leaf-blades the vascular system is comparatively simple. In the former a solid. slender xylem core is virtually invested by phloem, with a single layer of pericycle as a mantle in direct contact with a continuous cylindrical endodermis, beyond which is the bulky and often sclerotic cortex. The arrangement is thus virtually radial. The bundles in the leaf-blade are on a somewhat similar plane of simplicity, but their phloem is directed downwards, their xylem upwards, the tracheids are dominantly spirally thickened, and the phloem is scanty or entirely absent towards the slender bundle-endings. Similarly throughout the entire length of stem there may be a solid xylem core, surrounded successively by phloem, pericycle and endodermis. Such a vascular system is a *solid protostele.* The slender stems of most juvenile Pteridophytes are protostelic and despite widening of the *stele* in the more bulky portions of the adult plant, this primitive protostelic state may be maintained throughout the entire stem. In many cases, however, as in advanced ferns, the vascular system of the juvenile stem alone is a solid protostele. When followed upwards the core of the xylem strand may remain entirely parenchymatous. This parenchymatous core is the *medulla* or *pith,* and the stele is here called a *medullated protostele.* At higher levels the stem may show a different vascular arrangement, sieve tubes being differentiated in the centre of the medulla, at first as a solid strand, but later or higher as a cylinder with parenchymatous pith at its core and parenchyma between it and the xylem. At a still higher level there may be an inner endodermis between the pith and the inner phloem so that the succession of tissues from within as viewed in a transverse section of the stem may be medulla, inner endodermis, parenchyma (or inner pericycle), inner phloem, parenchyma, xylem, parenchyma, outer phloem, outer pericycle and outer endodermis. Such a local arrangement of the stelar elements is said to be *siphonostelic,* is considered an evolutionary advance on the protostelic state, and may characterize the entire upper portion of the adult stem.

When the vascular system is entirely protostelic the decurrent bundles from the leaves join the vascular system of the stem without disturbing the continuity of the latter. Thus throughout the entire plant the endodermis is an unbroken mantle. But in the siphonostelic portions of the vascular system of the stem, the pith and cortex are commonly in open parenchymatous connection through *gaps* in the stele, and round the edges of these gaps the inner and outer endodermal cylinders are united by endodermal cells. Thus here again the endodermis is a continuous tissue, and isolates completely the pith and the cortex from the vascular tissues. The gaps which occur immediately above the level of insertion of the leaf-trace bundles on the stele of the stem are called *foliar gaps,* while those which occur elsewhere are called *perforations.* When there is no overlapping of leaf-gaps the siphonostele is said to be *solenostelic;* when two or more leaf-gaps overlap, the stele is *dictyostelir.* Thus locally the vascular system of a Pteridophytic stem may be solenostelic or dictyostelic: likewise it may be locally a *perforated solenostele* or a *perforated dictyostele.* Rarely among ferns is there more than a single vascular cylinder. The condition is described as *polycyclic,* and an outer and inner cylinder may be even united by oblique lateral strands. In such cases the leaf-rrace strands are joined to the outer cylinder, while the inner cylinder may best be considered concerned with internal conduction.

Structure **of** the Stele **in Seed-plants.**—The typical structure of the vascular cylinder of the adult primary stem of the Gymnosperms (firs and their allies) and Dicotyledons (the dominant group of higher flowering plants)—all of which are seed-bearing plants—is, like that of the higher ferns, a hollow cylinder of vascular tissue enclosing a central parenchymatous pith. But unlike the ferns the seed-plants have no internal phloem (except as a special development in certain families) and there is no internal endodermis. The xylem and phloem rarely form perfectly continuous layers as in the solenostelic ferns, for the vascular tissue is typically separated into distinct *collateral bundles,* the xylem of which is usually wedge-shaped in cross section with the first formed xylem (*protoxylem*) at the inner extremity, while the phloem forms a band on the outer side of the xylem, and is separated from the latter by a band of conjunctive tissue *(mesoderm).* These collateral bundles are separated from one another by bands of conjunctive tissue called *primary medullary rays,* which may be quite narrow or of considerable breadth.

When the pith is large-celled, the xylem of the bundles is often separated from it by a distinct layer of conjunctive tissue called the endocycle. and a similar layer, the *pericycle,* separates the phloem from the cortex. The inner layer of the cortex (phloeotherma) may form a well-marked *endodermis,* or may differ in other ways from the rest of the cortex. The pericycle, medullary rays, endocycle and mesoderm all form part of one tissue-system, the *external conjunctive.* The external conjunctive is usually a living and comparatively small-celled tissue, the cells of which are greatly elongated in the direction of the stem-axis and may be collenchymatous, sclerenchymatous, fibrous or food-storing. The conjunctive tissue of the stem is open to *secondary changes,* bound up with the thickening of the stem as it grows old. Most of the collateral bundles are leaf-trace bundles, *i.e.,* they can be traced upwards from any given point till they pass out of the cylinder, travel through the cortex of the stern, and enter the leaves. The remaining bundles *(compensation bundles)* which go to make up the cylinder, are united at some level with the leaf-trace bundles, and in turn form the traces of leaves at some higher level. Purely cauline vascular strands (*i.e.,* confined to the stem) are rare in the flowering plants, though common in Pteridophytes. The leaf-trace of any given leaf rarely consists of a single bundle only, the number of bundles in a trace is generally odd, and the median bundles of the trace are typically the largest.

Foliar- or *leaf-gaps* are formed in essentially the same way as in the ferns, but as the distribution of the bundles of a single trace may be wide and long, there may be a number of gaps in the cylinder associated with the insertion of the bundles of a single leaf-trace. The gaps are, however, often filled as they are formed by the development of external conjunctive tissue immediately above the points at which the bundles begin to bend out of the stele, so that sharply defined open gaps, such as occur in fern steles, are but rarely met with in flowering plants. The constitution of the stele of a flowering plant entirely from bundles as above described, which are either themselves leaf-traces or will form leaf-traces after junction with similar bundles, is the great characteristic of the stem-stele of flowering plants. These collateral bundles are obviously highly individualized. The external conjunctive tissue is often arranged in relation to each bundle separately, so that, for example,-there may be pericyclic fibres immediately outside the phloem-masses alone. In some cases the individualization is carried further, the cortex and pith becoming continuous between the bundles, which appear as isolated strands embedded in a general ground tissue. Each bundle has its own investment of tissue corresponding with external conjunctive. The bundles sometimes keep their arrangement in a ring corresponding with the stele, though there may be no continuous cylinder. This condition is known as *astely.*

The Monocotyledons, one of the primary divisions of Angiosperms, typically possess large leaves with broad sheathing bases, containing numerous bundles. This results in the number of bundles present at any given level of the stem being high. These bundles are scattered in a definite though not superficially obvious order through the conjunctive tissue of the stele, which occupies nearly the whole diameter of the stem, the cortex being restricted to a very narrow layer, or scarcely recognizable as a definite zone. The mass of conjunctive tissue is developed as a large-celled ground-tissue, and around each bundle there is a fibrous investment. In the stems of many water plants various stages of reduction of the vascular system, especially of the xylem, are met with, and very often this reduction leads to the-formation of a compact stele in which the individuality of the separate bundles may be suppressed, so that a closed cylinder of xylem surrounds the pith. The phloem is seldom so reduced, and there is normally a well-marked endodermis. In other cases the reduction goes much further till the endodermis comes to surround nothing but an intercellular channel, formed in place of the stelar tissue.

To the vascular tissue of the typical leaf and root of the Phanerogams reference is made below. But there are peculiarities of organization of the hydroids and leptoids of the bundles of flowering plants which here call for special mention. Generally the end walls of superimposed developing hydroids break down, so that the final product of differentiation is a continuous tube with lignified pitted walls. Such tubes are called vessels, and are characteristic of the vast majority of Phanerogams, though tracheids still dominate the Gymnosperms. There is every degree of transition between spirally thickened and reticulately thickened vessels. The sieve-tubes of Phanerogams in their most advanced forms which dominate the Angiosperms have the end walls or portions of the end walls specially perforated. Such walls are accordingly called sieve-plates. It is assumed that by such end sieve-plates the longitudinal movement of slimy foods is accelerated. Associated with the sieve-tubes are, in addition, cells of the same length as the sieve-tubes, generally narrow, thin walled and enucleate, and which are thought to co-operate in some intimate way with the sieve-tubes. They are known as companion cells, and a sieve-tube and its companion cell arise during tissue-differentiation from the same mother-cell. On the whole the leptoids and hydroids of the Phanerogams are considerably more specialized than those of the Pteridophytes.

Stelar Tissue of Leaf and Root.—In the leaf of the average Phanerogam the vascular tissue takes the form of a number of branching or approximately parallel, and usually anastomosing, strands, above and below which the mesophyll is raised so as to produce the so-called veins. The vein-system is typically very elaborate, and the bundle-system is concentrated in the leaf-stalk (petiole) as the tributaries of a river are massed in the main stream. The leaf-bundles are always collateral (the phloem being turned downwards and the xylem upwards), and the whole bundle may be protected above and below by fibrous cells. As the bundles are followed towards their blind endings in the mesophyll the fibres first disappear, the sieve-tubes are replaced by narrow elongated parenchyma which soon dies out, and the bundles usually end in short or long spiral or reticulate tracheids covered by the phloeothermic sheath.

The stele of the primary root of a Gymnosperm or Angiosperm is of radial structure. There are usually two or four xylem strands radially alternating with phloem strands (the stele being thus diarch or tetrarch), and the first formed xylem groups (protoxylem) are peripheral. A polyarch state is, however, common in adventitious roots (which arise on other stems or roots in "chance" positions), and the protoxylem groups are then numerous. The centre of the stele is seldom solid xylem, but is generally pithed, and sclerotic cells are by no means uncommon in the conjunctive tissue. The roots of some palms and orchids show a peculiar "polystelic" structure. Thus it will be seen that while the vascular systems of the stems of Phanerogams are highly individualized, those of the leaves and primary roots are of simpler organization, but are of varied structure.

Laticiferous Tissue.—There are, however, in certain families of Angiosperms peculiar tissues which are not met with in the Pteridophytes. Such, for example, is the laticiferous tissue found in Compositae and Euphorbiaceae, which takes the form of long, usually branched tubes which penetrate the other tissues of the plant in a general longitudinal direction. The tubes possess a delicate layer of protoplasm with numerous nuclei lining the walls, while the interior of the tube (corresponding with the cell-vacuole or cavity) contains a fluid called latex, consisting of an emulsion of fine granules and drops of very various substances, suspended in a watery medium, in which other substances (salts, sugars, rubber-producers, tannins, alkaloids and various enzymes) are dissolved. Of the suspended substances, grains of caoutchouc, drops of resin and oil, proteid crystals and starch grains may be mentioned. Of this varied mixture of substances some are undoubtedly plastic (*i.e.*, of use in constructing new plant tissue), while others are apparently end-products of metabolism, secreted within the plant-body. The relation of the laticiferous tissue to the assimilating cells, under which they often run, and the fact that where this tissue is richly developed the conducting parenchyma of the bundles, and sometimes also the sieve-tubes, are poorly developed, as well as various other facts, point to the conclusion that the laticiferous tissue has an important function in conducting plastic materials, in addition to acting as a reservoir for excreta. As a secondary function we may recognize, in certain cases, the power of closing wounds, which results from the rapid coagulation of latex in contact with the air. The use of certain plants as rubber-producers (notably Hevea *brasiliensis*, the Para rubber tree), depends on this property of coagulation. The trees are regularly tapped and the coagulated latex which exudes is collected and worked up into rubber. Opium is obtained from the latex of the opium poppy (*Papaver somniferum*) which contains the alkaloid morphine.

Laticiferous tissue is of two kinds: (1) laticiferous cells, which branch but do not anastomose, and the apices of which keep pace in their growth with the other tissues of the plant (Apocynaceae and most Euphorbiaceae), (2) laticiferous vessels, which are formed from rows of actively dividing (meristematic) cells. The end walls of these cells break down so that a network of laticiferous tubes arises (Papaveraceae, Hevea). In some cases, as in Allium and in the Convolvulaceae, rows of cells with latex-like contents occur, but the walls separating the individual cells do not break down.

Such facts serve to illustrate the advanced specialization of the higher plants compared with the land bryophytes, but by no means exhaust the anatomical peculiarities of the former. In particular, mention may be made of tissues which arise by modification of primary living tissues, and are accordingly known as secondary tissues.

CAMBIUM

Secondary Tissues.—In most of the modern Pteridophytes, Monocotyledons, and in annual plants among the Dicotyledons, there is no further growth of much structural importance after the tissues above considered have been differentiated. But in nearly all perennial Dicotyledons, and in all dicotyledonous and gymnospermous trees and shrubs, certain layers of cells retain the power of division, although they may be for long mature, and are apparently fixed elements of a tissue. By this power of growth and division they become the originators of new or secondary tissues, which bring in their train many modifications in the plant-body. Primary tissues which are thus awakened to new divisional activity become, like the growing points of stems and roots, meristems or the initials of tissues, but while the apical *meristems* of stems and roots give rise to the primary tissues above considered. these new meristems are secondary *meristems* since they give rise to secondary tissues. There are two chief secondary meristems, the cambium and the phellogen.

The cambium typically continues the formation of xylem and phloem, thus adding to the conductive tissue already produced. It is merely the cycle or band of parenchymatous tissue lying between the primary xylem and primary phloem. Its cell walls are generally thin, and as its cells enlarge by special nourishment, they are divided principally by tangential walls, thus producing radial rows of cells. The primary xylem remains stationary, but as the cell rows thus formed increase in number and the individual cells enlarge, the primary phloem and all the external tissues move outwards. The tracts of cambium between the strands of xylem and phloem are called *fascicular cambium,* while those which cross the primary medullary rays from bundle to bundle are called *interfascicular cambium.* The cells of the interfascicular cambium likewise divide mainly by tangential walls, and with the same frequency as the fascicular cambium. Thus radially within the interfascicular cambium the primary medullary rays are left stationary, while the surrounding tissue is pushed outwards. There is usually one cylindrical layer of actively dividing cells in the cambial cylinder, and it may be imagined that at any moment it has given rise by tangential division to two such layers. The products of the interfascicular cambium may first be considered. The inner products differentiate as parenchymatous cells which are added to the medullary rays; the outer products retain the power of division. Thus the cambium is moved slightly outwards and its cells divide as before by tangential walls into outer and inner layers. The inner layer thus formed differentiates as a parenchymatous addition to the medullary ray, and the outer layer retains the power of division. Thus a general outward movement of the cambium proceeds, leaving behind or within layers of cells which radially augment the medullary rays.

From time to time it is the outer layer of cells produced by cambial activity which becomes differentiated as parenchymatous cells, while the inner layer remains cambial. In this way the outward progress of the cambium is temporarily delayed but is not arrested. After a long period of cambial activity the interfascicular cambium has moved outwards to a considerable distance, having greatly augmented the medullary ray within and radially, and to a lesser extent, but also radially, without. It will be apparent that the interfascicular cambium is not a fixed or permanent layer of cells, but that the power of division is steadily transferred outwards, and the locus of the cambium is changed with time. It will be further evident that with each step in the outward movement of the cambium the circumference of the cambium must increase. The division of the cambial cells is accordingly not accomplished solely by tangential walls, but from time to time radial divisions also occur. Thus the cambial cylinder is widened and its integrity is maintained as it moves outwards. But while in the vast majority of higher plants the additions to the medullary rays thus produced are uniformly parenchymatous, and these *primary medullary rays* increase outwards as wedges, there is some complication in the products of cambial division between the primary xylem and phloem. The fascicular cambium is generally moved outwards with the same rapidity as the interfascicular cambium, so that the cylindrical form of the cambium is maintained.

Moreover, of the inner products of division in the fascicular cambium many differentiate as *segments of a vessel, tracheids, fibres* or *parenchyma,* which may be variously grouped, but which collectively constitute the *secondary xylem.* In many instances sooner or later one or more cambial cells, within which radially such elements have differentiated, produce exclusively radial rows of parenchyma. These rows have in general the characters of medullary rays, but are obviously purely of secondary origin, and continue neither inwards to the pith nor outwards to the cortex like the primary rays. They are indeed *secondary rays* of purely cambial origin. Of the outer products of division in the fascicular cambium many differentiate as *sieve-tubes* and *companion cells,* or as *fibres* or *parenchyma* arranged in various patterns and collectively constituting *secondary phloem.* With this tissue may also be associated minor *secondary rays,* reaching inwards to the cambium, often the direct radial continuations of similar rays in the xylem, but not reaching the cortex without. It will be apparent that the tangential dimension of each tract of fasicular cambium is steadily increased as the cambium mores outwards, so that the secondary wood increases as an outward widening wedge, while the secondary phloem appears as an inward widening wedge, the two wedges meeting at the cambium. It is not to be supposed that at any moment uniform behaviour is maintained by all the cambial cells in a longitudinal row. so that while at one level, and at various points in the fascicular cambium, secondary medullary rays are being formed in both xylem and phloem, immediately above and below this level, fibres, vessel-segments, sieve-tubes, wood-parenchyma and phloem-parenchyma are being produced. The secondary medullary rays are accordingly of no great depth, and may well be described as narrow bands of parenchyma placed radially in the xylem and phloem. Similarly the behaviour of the interfascicular cambium is not uniform at all levels or at all stages in its outward progress, for while for a time it may produce parenchyma exclusively, locally its products may be secondary phloem and secondary xylem. Thus after a time an island of secondary wood and phloem is seen in a cross section of the stem, dividing the primary ray into two branches, which, when followed outwards, reach the cortex. Nor are the primary rays of great depth, though on an average they are much deeper than the secondary rays, for the downward course of both xylem and phloem is tortuous, and fusion of strands occurs above and below the rays, which are accordingly of lenticular outline when seen in a tangential section of the stem.

Annual Rings.—In those plants whose annual activity is interrupted by a regular winter or dry season the limit of each year's increment of secondary wood, and to a less obvious degree of secondary bast, is marked by a more or less distinct line which is produced by the sharp contrast between the elements formed in the late summer of one year and those produced in the spring of the next. It is believed that in relation to the large and rapid supply of water and other substances to the unfolding leaves in spring and early summer, large vessels are produced by the cambium in the spring, while as summer advances and the need for water diminishes, the vessels formed are narrower. and as the supply diminishes still further, more abundant fibres, with greatly reduced cavities, arise. Thus in a single season of cambial activity a rough outward progression may be traced in the secondary wood of that season from wide vessels to narrow fibres, beyond which the transition to the wide vessels of the succeeding spring is sudden. Each zone thus recognized in a cross section of the stem is called an *annual ring,* and the lines of separation of successive rings mark the temporary halting places of the cambium at the end of successive seasons.

Sap-wood and Heart-wood.—The older wood of large trees, forming a cylinder in the centre of the trunk, frequently undergoes marked changes in character. The wood-parenchyma and medullary rays die, and the walls of all the cells often become greatly hardened, owing to the deposit in them of special substances. Wood thus altered is called *heart-wood* or *duramen,* as distinguished from the younger *sap-wood* or *alburnum,* which is nearer the cambium, carries on the active function of conduction, and retains its parenchymatous cells in life. The heart-wood ceases to be of any use to the tree except as a support, and owing to its dryness and hardness is much used for industrial purposes.

Phellogen and **Periderm.**—It will be obvious that secondary increase of xylem and phloem involves an outward movement of the primary phloem and of all the elements which surround the latter, and that the cortex, and particularly the epidermis, must accommodate for this movement, either yielding passively to a limit and being injured or destroyed by the outward pressure, or being to some extent modified so as to persist. In most cases the epidermis is unable to maintain the active radial division of its cells necessary for such expansion as occurs, is soon stretched to its limit, dies and is destroyed. Extensive radial division in the cortical cells is progressively less essential as the inner cortex is followed inwards, and as a rule, by a combination of radial and tangential divisions, the integrity of the cortex is maintained. Towards the periphery of the cortex, and commonly by modification of its outer layer, a secondary meristem, similar to the cambium, arises and produces external and internal secondary tissues. This meristem is the *phellogen,* and the whole of the tissue it gives rise to is known as *periderm.* The phellogen derives its name from the fact that its external product is the characteristic tissue known as *cork.* This consists typically of closely fitting layers of cells which quickly die, and when mature, have completely suberised walls which collectively serve to replace the epidermis as an external protective layer, when the former is ruptured. The outer layers of the cork are constantly being destroyed, but new layers are in progress of formation within. The internal tissue formed by the phellogen is known as *phelloderm;* it augments the cortex, and typically consists of living parenchymatous cells to some extent capable of further division. Indeed, an inward succession of phellogens may arise in the phelloderm and in even more deeply seated living layers. In certain cases the epidermis becomes the phellogen. To the great activity of the phellogen, and to the power of formation of a series of phellogens in deep layers, the value of the cork oak as a source of cork is due.

Cambium in Roots.—The cambium in the root, which is generally found in those plants which have a cambium in the stem, always arises in the conjunctive tissue internal to the primary phloem, and forms new (secondary) phloem in contact with the primary and secondary xylem internally. In roots which thicken but slightly, and whose cambium usually appears late, it is confined to these regions. If the development of secondary tissues is to proceed further, arcs of cambium are formed in the pericycle external to the primary xylem, and the two sets of cambial arcs join, forming a continuous, wavy line in transverse section, with bays opposite the primary phloems and promontories opposite the primary xylems. Owing to the resistance offered by the first formed secondary xylem, the bays are pushed outwards as growth proceeds, and the wavy line becomes a circle. Opposite the primary xylems the cambium either (a) forms parenchyma on both sides, making a broad, secondary (principal) ray, which interrupts the vascular ring and is divided at its inner extremity by the islets of primary xylem, or (b) forms secondary xylem and phloem, completing the vascular ring. In either case narrow secondary rays are formed at intervals, just as in the stem. Thus the structure of an old thickened root approximates to that of an old thickened stem, and so far as the vascular tissues are concerned, can often be distinguished from the latter only by the position and orientation of the primary xylem.

Growing Points.—The tissues above considered all owe their origin ultimately to the growing points or apical *meristems* defined in the embryonic plant-body. To the great variety of apical meristems found in vascular plants reference alone can here be made. It must suffice to note that in most Pteridophytes there is a single large apical cell at the end of each stem- and root-axis, that it usually has the form of a tetrahedron, that its base occupies the surface of the growing point, and that its apex points inwards. By definite and regular divisions of such a cell a mass of still undifferentiated cells is produced immediately behind the growing point, which is continuously occupied by a residual apical cell. From these undifferentiated cells the tissues above considered sooner or later arise by further growth, divisions and differentiation. In most Phanerogams the apical (or primary) *meristems,* instead of consisting of single apical cells or of a definite group of initials, are stratified, *i.e.,* there is more than one layer of initials. Throughout the Angiosperms the epidermis of the shoot originates from separate initials which never divide tangentially, so that the young shoot is covered by a single layer of dividing cells, the *dermatogen.* Below this are the initials of the cortex and the central cylinder. Whether these are always in layers which remain separate is not known, but it is certain that in many cases such-layers cannot be distinguished. This, however, may be due to irregularities of division and displacement of the cells by irregular tensions, destroying the obviously layered arrangement. In some cases there is a perfectly definite line of separation between the young cylinder (*plerome*) and young cortex (*periblem*), the latter having one or more layers of initials at the actual apex. The separation of layers in the apical meristem of the root is usually much more obvious than in the stem. The outermost layer is the calyptrogen, which gives rise to the root-cap, and in Dicotyledons to the piliferous layer as well. The periblem, one cell thick at the apex, produces the cortex, to which the piliferous layer belongs in the Monocotyledons; and the plerome, which is nearly always sharply separated from the periblem, gives rise to the vascular system.

There is generally some definite progression in the actual differentiation of the individual tissues, so that, for example, comparatively simple xylem and phloem elements may be recognized in certain portions of a stem or root before the differentiation of xylem and phloem is accomplished in the stele as a whole. Such first formed xylem and phloem elements are known respectively as *protoxylem* and *protophloem,* and serve for the initial conduction of food-materials, while the later formed elements of the primary xylem and phloem are called respectively metaxylem and *metaphloem.*

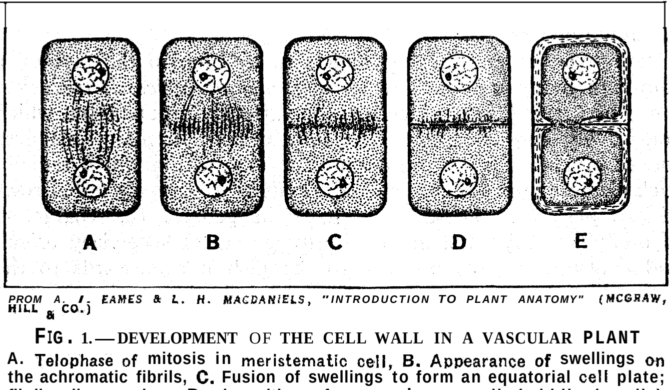
The branches of the stem arise by multiplication of the cells of the epidermis and cortex at a given point, thus forming a protuberance at the end of which an apical meristem is organized The vascular system is connected in various ways with that of the parent axis by the differentiation of bundles across the cortex of the latter. This is known as exogenous branch formation. In the root, on the other hand, the origin of branches is *endogenous.* The cells of the pericycle, usually opposite a protoxylem strand, divide tangentially and give rise to a new growing point, the outward path for which is prepared by digestion of the surrounding tissues. The connections of the stele of such a root with that of the parent axis are made across the pericycle of the latter. The cortex of the new root is never connected with that of the parent, but with its pericycle. *Adventitious* roots, arising from the stem, usually take origin in the pericycle, but sometimes from other parts of the conjunctive tissue.

Thus it will be seen that throughout the vascular plants thkre are definite and orderly methods of production and distribution of the tissues destined to play their parts in the major or minor processes of life, and that such organisms are well fitted for life on land. (J. McL. T.)

CYTOLOGY

The structure and development of the vegetable cell so far as the protoplasm and the nucleus are concerned are considered in their broader aspects in the article **Cytology.**

The recognition of the fundamental similarity of the cells of plants and animals and the identity in structure and functions of animal and vegetable protoplasm which formed the starting point in the study of cytology are conceptions which subsequent investigations have only broadened and confirmed. Nevertheless this agreement, whether it be in the minute structure of the protoplasm or in the details of nuclear mitosis, is accompanied by peculiarities in the cell structure of plants which have had a profound influence in the evolution of the vegetable body. Of these the most important, because far-reaching in their effects, are the presence of



FROM A. J. EAMES & L. H. MACDANIELS, "INTRODUCTION TO PLANT ANATOMY" (MCGRAW, HILL & CO.)

FIG. 1.—DEVELOPMENT OF THE CELL WALL IN A VASCULAR PLANT

A. Telophase of mitosis in meristematic cell, B. Appearance of swellings on the achromatic fibrils, C. Fusion of swellings to form an equatorial cell plate; fibrils disappearing, D. deposition of new primary wall (middle lamella) between the halves of the split cell plate, E. deposition of a secondary wall layer between the plasma membrane and middle lamella, except in region of a large pit. Primary wall. solid black: cytoplasm stippled, plasma membrane densely stippled; secondary wall shaded

plastids in the protoplasm and the existence of the cell wall. In the higher plants the egg is necessarily a naked cell, but when fertilization is accomplished the new cell secretes around itself a membrane—a cell wall—before it begins to grow and divide, and the myriad cells to which it gives rise in the course of its further development are from the first enclosed in a similar membrane.

The continuous development which is such a characteristic feature of the structure of the higher plants depends on the presence of persistent embryonic regions or growing points at such places *e.g.*, as the tips of stems and roots. This enables us to study in these regions the formation of new cells, and to trace their development and modification to form the adult tissues of the member to which they belong.

The individual cells appear rectangular in form and consist of a mass of protoplasm containing a large nucleus and separated from the neighbouring cells by a delicate membrane. It is unnecessary to refer to the detailed structure of the protoplasm and the nucleus, since these have already been fully described *(see* CYTOLOGY), but with suitable treatment it is possible to distinguish in the protoplasm of these merislem cells the rudiments of definite protoplasmic organs, the plastids. The nature, purpose and function of these important bodies will be considered below: for the present it is sufficient to say that they are differentiated portions of the protoplasm which perform definite functions.

From such embryonic cells all the tissues of the plant body are formed by processes of growth and differentiation. Growth involves an increase in size of the individual cells which may in some cases result in an enlargement to many thousand times their original volume. This enlargement does not however necessitate a proportional increase in all the parts of the cell. Increase in size is mainly the result of active extension of the cell wall. The protoplasm does not increase in volume in the same proportion and hence cavities appear in it which are filled with a watery fluid —the cell sap. As the wall enlarges these spaces or vacuoles increase in size and number and eventually coalesce to form one large central vacuole in the protoplasm which thus becomes restricted to a comparatively thin layer closely applied to the cell wall (fig. 1, E). The nucleus, which undergoes little change during this process or may even be reduced in size, is at all times embedded in the protoplasm and thus comes to lie close to the cell wall or in some cases it may be slung by delicate protoplasmic strands in a more or less central position in the cell. It is often possible to observe a circulation of the material in these strands, definite streams moving from the cell wall towards the nucleus and vice versa. It is, however, uncertain as to whether this is a general phenomenon.

The Cell Sap.—The cell sap which fills the vacuoles is water in which are dissolved substances of various kinds. some of which are food materials others products of the metabolism of the protoplasm. Its composition is constantly changing but among the substances of constant occurrence are inorganic salts, carbohydrates such as the sugars and soluble nitrogenous compounds; in addition the sap of fully developed cells may contain colouring matters such as the anthocyanins, which are red, violet, or blue and give their characteristic colour to the petals of many flowers, the leaves of such trees as the copper beech-and the tissue of the beetroot. The large proportion of the total volume of the cell occupied by the cell sap explains the large percentage of water present in soft vegetable tissues; *e.g.*, cabbage and spinach leaves, roots of turnip and beet and shoots of asparagus contain over 90% of water.

The cell wall and the protoplasm are both freely permeable to water and indeed the former is also permeable to the molecules of crystalloid substances. The living protoplasm, however, may be described as semi-permeable since it may restrict the passage of dissolved substances either into or out of the vacuole. One result of this property of the protoplasm is that, whereas at a given moment the pressure of molecules of water inside and outside the cell may be equal, there may exist in the vacuole in addition a pressure due to the molecules of the salts; the cell is in consequence distended, the wall is stretched and owing to its elasticity exerts a counter-vailing pressure. Such a cell is described as turgid and in this condition it acquires a certain rigidity analogous to that of a distended air bladder.

This characteristic of the vegetable cell has played an important part in the evolution of the plant body since it has rendered possible the development of plant organs of relatively large size with a minimum organization of skeletal tissue. Such structures as the leaves of herbaceous plants—though provided with a network of veins—maintain their form and position only by the turgidity of the living cells of which they are largely built up. Loss of water from the individual cells results in a shrinkage of the tissues as a whole, and the familiar appearance of wilting or flagging of plants deprived of water is brought about in this way.

Plastids.—The plastids or chromatophores are portions of the protoplasm which have become specialized for the performance of certain functions. They are readily distinguished in the adult cell by their size and definite form and they are often conspicuously coloured. Leucoplasts are colourless and occur in the cells of the deeper lying tissues where light cannot penetrate—if exposed to light they often become green. They are frequently concerned with the formation of starch grains. Chromoplasts are colour-carrying bodies giving red and yellow colours to the petals of Rowers, ripe fruits, etc.; they contain yellow and red pigments such as xanthophyll and carotin. The most important of all the plastids, however, are the green chloroplasts, chlorophyll bodies or chlorophyll corpuscles as they are variously termed. They contain chlorophyll and are of universal occurrence throughout the vegetable kingdom with the sole exception of the important group of the Fungi. It is by means of this pigment that the plastids are enabled in the presence of light to form carbohydrates from water and carbon dioxide.

The importance of this process cannot be overestimated, since it is the starting point in the manufacture of the food of all living organisms and its activity has made possible the existence of plants and animals upon the earth. *(See* PHYSIOLOGY.) Chlorophyll when extracted from plants by suitable solvents can be shown to contain a number of pigments. The green, blue-green, yellow and red have been already mentioned. In form the chloroplasts are extremely variable and the Algae (*q.v.*) show a rich variety of shape; in the higher plants however they are discoid in form. Like the leucoplasts they frequently show inclusions of starch grains. They may increase in number by dividing into two halves by simple constriction. They have been shown to be present in the egg cell of some plants and are, in these cases, thus passed on from one generation to another, but they have not been demonstrated in the sexual cells of all plants.

The Cell Wall.—The cell wall in meristematic cells is an extremely delicate membrane but, with the completion of the growth in size of the cell, it is increased in thickness and may in certain cases undergo considerable modification. It is commonly regarded as a secretion of the protoplasm and it is in living cells in intimate relation with the protoplasm which may interpenetrate the particles of its substance. This close relation can be readily appreciated when the process by which the wall is first laid down is considered. From the beginning of the plant's existence as a single cell, all new cell formation consists in the division of a pre-existing cell into two halves by the formation of a dividing wall. In this process the cytoplasmic spindle which functioned in the preceding nuclear division *(see* CYTOLOGY) plays an important part. The spindle fibres—increased in number—show swellings or thickenings in the middle of their length (fig. 1, B), which coalesce and form a continuous "cell plate" which is extended until it reaches the side walls of the mother cell. This cell plate is not however the cell wall; it is of protoplasmic nature and splits into two layers between which the true wall substance is laid down (fig. 1, D). The subsequent growth of the cell wall is facilitated by its intimate penetration by the protoplasm, which lays down fresh materials between the existing particles (intussusception), and later adds to its thickness by the deposit of fresh layers of material on the inner surface of the primary wall (apposition).

The primary wall, laid down in the manner above described, might be regarded as common to the two cells concerned in its formation, but many facts go to show that it is either a double membrane from its inception or that it readily splits into two. The result is that every cell is surrounded by its own individual wall. This is seen very clearly in the development of elongated cells such as fibres, which may grow to many hundred times their original length. In this process they may change their position, sliding over the surface of neighbouring cells and making contact with cells of different, and of more remote, origin. Such elongated cells as the fibres undergo considerable thickening of their walls when their growth is completed. This thickening is originally of cellulose, but it may undergo secondary changes becoming wholly or in part lignified, thus rendering the wall firm and hard and better adapted to serve the purpose of mechanical support. Thickening and lignification of the wall is also characteristic of the cells concerned in the formation of the water-conducting elements. With the completion of these changes in the cells of the strengthening and water conducting tissues the protoplasm disappears and the walls alone remain.

Plasmodesma.—The living cell in a complex multicellular plant body is a unit, but not an independent one, and its functions must be conditioned by, and related to, the activities of the organism as a whole. This must involve a close connection between the living protoplasm of neighbouring cells and this is effected by delicate connecting strands, the plasmodesma, which traverse the walls. These represent in some cases the persistence of the original continuity of the protoplasm of two sister cells, but for the most part they are probably new contacts established when growth is completed. The presence of these delicate connections has been established in a large number of cases, and it is probable that they are of universal occurrence in the higher plants. They play a part in the correlation of the functions of the cells, and they may also provide the means by which stimuli can be conveyed through long tracts of tissue in those cases, where the region stimulated is distant from that in which the response is shown.

(R. J. T.)

DISTRIBUTION AND ECOLOGY

The distribution of plants can be considered from two main aspects. The present or past distribution of species, genera and families, termed *floristic* plant geography, can be studied both for its own sake and as a factor in determining the location of human activities or features of the earth's surface. But besides this purely geographical aspect the facts of distribution can be considered in relation to their causes; the influences of climate, of topography, of the soil conditions, of other plants, of animals, and even of the past history of the superficial crust of the earth and of the species itself. It is this relation of plants to their environment, in its widest sense, and the mutual effect of environment and organism, which is the province of ecological plant geography, or briefly plant ecology.

Floristic Distribution.— The floristic distribution of species exhibits the greatest possible variation from the species which as a wild plant is confined to a limited area (endemic) to wide-ranging species such as many microscopic plants (*e.g.,* some bacteria) which are apparently universal in their occurrence. There are probably no vascular plants that are strictly cosmopolitan, but the common bracken (Pteridium *aquilinum*) and the reed (*Phragmites communis*), though far less common in the tropical regions, are feral species in the most diverse climes (the former, however, notably absent from oceanic islands). In striking contrast are such plants as the fern *Thyrsopteris elegans,*—an endemic confined to the Island of Juan Fernandez or Pringlea *antiscorbutica* restricted to the tempestuous shores of Kerguelen.

Endemics are an especial feature of oceanic islands as is shown by the flora of Madagascar, which comprises some 4,000 species of vascular plants and contains no less than 75% of endemics. In New Zealand the proportion of endemics is 74%, whilst in Hawaii the endemics constitute 80% of the entire flora. By contrast the floras of continental islands are practically destitute of endemics, as is shown by that of Britain, which amongst its flowering plants probably includes but one endemic of specific rank, namely, the wolf's-bane (Aconitum anglicum).

It is clear that when a new species originates it will not immediately attain its climatic limits but its spread will be a gradual process, occupying a longer or a shorter time according to the efficiency of the means whereby the dispersal of its seeds or other reproductive bodies is attained. It is the belief that this process is in general secular rather than rapid, which has led to the view that the area occupied by a species, genus, or family is roughly dependent upon its age. Willis has adduced evidence to show that the majority of endemics are species of recent origin which have either not had sufficient time to spread over a larger area (*e.g.,* local endemics in continental areas) or have been prevented, by the presence of natural barriers, extending beyond their place of origin. The latter explains the high proportion of endemics on oceanic islands. On the other hand, it is certain that some endemic species are relics of a former more extensive area of occupation, the remnants of a bygone vegetation. The fern genus *Matonia* is at the present day represented by three species, of which two are confined to Borneo and the third also occurs in the Malay Peninsula; yet fossil evidence indicates that ferns of this affinity had an almost cosmopolitan distribution in Mesozoic times. The Gleicheniaceae, the Schizeaceae, and Marattiaceae, families of ferns now practically absent from the northern hemisphere, furnish further examples of area diminishing with the lapse of time. Amongst the flowering plants the present restricted distribution of Ginkgo biloba, the tulip tree (Liriodendron tulipifera) and the sequoias, affords a marked contrast to the widespread occurrence of species of these genera in Tertiary times and shows the importance of the past history of a group in appreciating the significance of the existing representatives.

Frequently the members of a genus comprise one or more species which extend over a large area, whilst the remainder are of much more restricted distribution and occupy areas either included in or overlapping the range of their more widespread congeners. Illustrations are furnished by the she-oaks of Australia (Casuarina), with the littoral C. *equisetifolia* extending from east Africa and Madagascar to the Society islands and Burma and the Philippines to Tasmania, within which area occur a number of other species. Again the genus Mercurialis includes the dog's mercury (M. *perennis*) and M. annua, which are of wide range, whilst the five or six other species extend over comparatively small areas in the Mediterranean region and eastern Asia. It is probable that in such genera the species of more local occurrence are derivatives of the wide-ranging types, but it is also evident that were the widely dispersed parent types to die out the other species of restricted distribution would come to present the condition of discontinuous distribution which is a feature of many genera and families at the present day. The pipeworts (*Eriocaulon*) are chiefly found in tropical and sub-tropical regions, but E. *septangulare* is found in the eastern United States, the west of Scotland, and the west of Ireland. Of over 400 species of heath belonging to the genus Erica, the majority are concentrated in Cape Colony and the Mediterranean area. The Proteaceae and Cycadaceae, containing many very localized genera, now exhibit a discontinuous distribution in tropical and sub-tropical regions, but there is little doubt that the Cycadaceae extended over a large part of the world in Jurassic times and the Proteaceae were probably much more widely distributed in the Tertiary epoch than at the present day. Discontinubus distribution in the species may be the outcome of irregularities of dispersal, the result of extinction from parts of its former range, or even due to origin of the species in more than one locality.

Effects **of** Glaciation.— It is quite impossible to appreciate the present distribution of species in either North America or northern Europe without recognition of the profound changes consequent upon the last glacial epoch. During Cretaceous times there would appear to have been a remarkable uniformity in the character of the vegetation of the world, with warm temperate types as far nor'th as Greenland. This uniformity was succeeded by a differentiation in the Tertiary period. On either side of the tropical belt there probably existed a zone of forest presenting a mixture of temperate and subtropical types, southern types being present in the northern hemisphere and northern types, such as the true beeches and the common oak (Quercus Robur), being present in the southern hemisphere. Mrs. Clement Reid has admirably demonstrated, by a comparison of successive floras of the Pliocene period of Europe, the gradual disappearance of exotic types as the Pleistocene approached, probably accompanying a diminution of temperature. It is due to the work of Heer on the arctic fossil flora, the writings of Asa Gray, Saporta and Hooker that the fossil floras of the past have been so ably utilized in the elucidation of the peculiarities of the distribution of the present. The holarctic distribution of a large assemblage of species prior to the glacial refrigeration is the clue to the resemblances between the American and east Asiatic floras. Of these migrants, driven southwards by the increasing cold, relics remain in the genus *Sequoia,* now only represented by two north-west-American species, in *Ginkgo biloba,* confined to western China, in the American genus *Liriodendron* and the Chinese *Glyptostrobus.* The magnolias no longer occur wild in Europe as they did in the past, but still survive both in Asia and America. Of the genera cited Depape has recorded Pliocene remains from the valley of the Rhone of *Sequoia sempervirens, Liriodendron tulipifera, Ginkgo biloba,* and *Glyptostrobus heterophyllus.* The elimination of these and many others from the European flora is probably to be attributed mainly to the presence of natural barriers against the southward retreat, such as the Mediterranean, whereas in Asia and America there was a continuous land bridge to a climatic sanctuary, the temporary home of some, the permanent retreat of others.

During the Ice age itself the flora consisted of definitely arctic types and a considerable number of other hardy species which survived the cold in the areas, probably of considerable extent, which were not actually covered by ice. Judged by the frequency of the remains in sub-fossil deposits of the glacial period in Europe the commonest species were the mountain dryas (*Dryas octopetala),* the dwarf birch *(Betula nana)* and various willows of mat-like habit, such as *Salix reticulata,* S. *polaris,* etc. It is noteworthy that the species cited and a number of others prevalent at that period are now most characteristic of arctic regions but also occur in warmer climates on what may be termed arctic islands, namely, the summits of the higher mountains, a discontinuous distribution that can be attributed to survival from glacial times. With the final retreat of the ice, which in northern Europe probably took place somewhere about 14,000 years ago, the recolonization of the glaciated areas by the less hardy species began.

The colonization thus begun has continued ever since. The fact that Ireland possesses but two-thirds of the vascular plants of Britain whilst the flora of England, though richer than that of Scotland, is less varied than that of the neighbouring areas of France emphasizes the importance of the facilities for dispersal of fruits and seeds in determining the distribution of species. The rapid spread of the Canadian pondweed *(Elodea canadensis)* from Market Harborough, where it first appeared in England in 1847, of *Veronica persica,* or more recently of the rayless mayweed *(Matricaria suaveolens),* a native of Oregon, all of which have become abundant over a great part of Britain; or, again, the spread of the prickly pear (*Opuntia inermis*) at the rate of a million acres a year in Australia and the choking of the waterways of Florida by the water hyacinth *(Eichornia crassipes*) all bear witness that area is not necessarily a criterion of age and that the process of colonization is still going on, a process in which the disturbing influence of the hand of man plays no small part.

Ecological Factors.—The most superficial observation shows that species are not uniformly distributed throughout their range and that certain conditions favour one kind of plant rather than another. In the ecological concept the idea of competition is never absent and the effect of the external conditions upon the constituents of the vegetation of any region is largely dependent upon their selective action. The sum total of the external circumstances surrounding the plant is termed the *habitat* and the various conditions that together determine distribution are termed the habitat *factors,* of which some are physical and others biological.

Climatic Factors.—Of the physical factors the most important are climatic and of these temperature would appear to play the major rôle. Hence we find that the main vegetation zones on the earth's surface have a latitudinal distribution and that the species which has an extensive north and south range has commonly a wide range in the east and west direction also. Whilst some species, as already noted, are almost cosmopolitan, it is true of the majority that they do not occur both in tropical and arctic regions. In some cases it has been shown that the species comprises several geographical races with different capacities for endurance of climatic extremes, but there is little evidence to show that species can become adapted to climatic extremes that they could not initially endure. Many garden plants are cultivated in the open beyond the limits of their natural range, showing that the climatic conditions need not be lethal in order to delimit the area of a species.

By diminishing the rate of growth or inhibiting reproduction temperature may effectually prevent the maintenance of a species in competition with other plants although there is a considerable margin before the lethal limit is reached. Extremes of temperature, however, cause death in many plants by coagulation of the living cell contents, and in general the susceptibility to such extremes is directly proportional to the amount of water which the plant or part of the plant contains. Hence seeds which have a very low content of water are exceptionally resistent whilst succulent shoots are especially susceptible. Rapid changes of temperature are far more liable to prove fatal than changes of the same amplitude which occur slowly.

In tropical and sub-tropicai regions where there is no dry season the vegetation consists of broad-leaved evergreen forests, but where, as in temperate latitudes, a warm and cold season alternate, the characteristic type is deciduous woodland; whilst in still higher latitudes, where the growing season, or frostless period, is of short duration, the prevailing types of forest consist of narrow-leaved evergreen conifers. A similar zonation to that presented from the Equator to the Poles is seen in the altitudinal zonation on the higher mountain masses. Such is well illustrated in Corsica where the olive characterizes the belt from sea-level to 400 metres, the chestnut from 400m. to 1,000m., pines *(P. Pinaster* and *P. Laricio)* and beech from 1,000m. to 1,600m.; the alder (*Alnus suaveolens)* the sub-alpine zone from 1,600m. to 1,900m. and scrub of the dwarf juniper (*Juniperus nanus)* with *Berberis aetnensis* up to 2,000 metres.

The importance of temperature and the length of the growing season is further shown by the altitudinal distribution of individual species, which varies markedly in correspondence with the latitude. For example, *Polygonum viviparum* attains to 1,230m. in Scotland at 56·48 N. Lat., on the Swiss alps it is found at over 2,850m. (9,000ft.), and on Mt. Everest (27·59 N. Lat.) reaches an elevation of 4,460m. (14,500ft.). Study of comparative altitudes in different latitudes shows that the upper limits tend to rise on the higher mountains and in areas of large mountain masses, which indicates the importance of exposure conditions.

The extreme conditions tolerated by living vegetable organisms is shown by the fact that spores of bacteria can endure immersion in liquid air whilst certain blue-green algae (*Phormidium laminosum, Mastigocladus laminosus)* occur in water at temperatures above 49°C. Even amongst the flowering plants the resistance of some species to cold is considerable, *Larix siberica* for instance growing where temperatures of —70°C are not unknown, whilst seeds are particularly resistant to both heat and cold. Here, too, attention may be called to the extreme altitudes attained by some flowering plants, *Arenaria muscosa* being found at 20,400ft. on Mt. Everest, the highest recorded station for a member of this class.

Precipitation.—Of almost equal importance to temperature is the amount and seasonal distribution of precipitation either in the form of rain or snow or as dew and fog. In regions of equivalent temperature forests will in general occupy the areas of highest precipitation, deserts the areas of lowest precipitation, and grasslands the areas of intermediate humidity. In the United States, for instance, the mean annual rainfall in the desert region ranges from 0–30in., in the prairies from 20–30in., and in the regions of forest from 30–90in. In any estimate of the influence of rainfall, however, the humidity of the air is necessarily a considerable factor and the efficacy of a given precipitation will be largely influenced by the temperature changes, upon which the rate of water-loss from the surface of the plant and from the soil in which it grows so largely depends. Further, this water-loss will be greatly augmented by wind, and so the velocity and frequency of air movements have an important influence on the limits of species and plant-communities. The frequent incidence of high winds inhibits the gro th of trees near the summits of mountains, both by their drying action and mechanical effect, whilst the strong winds and low temperature together determine the distribution of arctic Tundra.

Illumination.— Since all green plants manufacture their organic food by means of the radiant energy absorbed from sunlight, the intensity and duration of this illumination naturally aifects the distribution of species. Many woodland plants are so constituted as to function best in this respect when growing in comparatively weak illumination, whilst others, such as many littoral species, attain their optimum rate of food production in full sunlight. Even the weak light which reaches the floor of a woodland is sufficient for the requirements of some mosses, but when the shade is too intense the vegetation is confined to parasites and saprophytes and so the rich fungus flora of a dense beechwood or pinewood becomes one of its salient characteristics. It has, moreover, been found that the length of the period of daily illumination may be an important factor in influencing reproduction. Some species appear to be indifferent to the length of the period of daylight, except in so far as the amount of organic food they manufacture is dependent on the total radiant energy they receive. Other species respond to a shorter daily illumination by earlier flowering and fruiting, whilst with still other species the effect is a retardation in the reproductive process.

Nevertheless, though the individual climatic factors play each their separate part, it is mainly upon their interaction that distribution of species depends. Thus it is that some are particularly associated with oceanic climates characterized by small amplitude of temperature and high humidity, whilst others are found in the drier and more extreme conditions of continental areas. Examples of the former are furnished by the petty whin (*Genista anglica)* and the wild hyacinth (*Scilla nutans*), features of the west of Europe, whilst the latter are represented by various species of *Eryngium* and *Artemisia* of the Russian steppes.

The Soil.—The character of the soil is chiefly important as to its physical structure, except where the chemical constitution exhibits extreme conditions. For upon the size of the constituent mineral particles and the proportion of organic material which the soil contains depends in large part its capacity to retain the water which reaches it in the form of precipitation or by capillarity. It is the feeble power of such retention that renders the conditions on a sand dune or a shingle beach comparable to those of a desert even in regions of high precipitation and humidity. It is in great measure differences in *water capacity,* as this power of water retention is termed, that are responsible for the different types of vegetation on clay, sand, and peat, within an area of uniform climatic conditions. Nevertheless, other soil factors, such as the chemical nature, the reaction, the nature of the soil atmosphere and the constitution of the teeming population of micro-organisms, etc., all play a part in determining the relative suitability of soils for one species or another. The soil conditions in untouched vegetation, however, present a very different distribution from the comparative uniformity of agricultural land, a definitely stratified organization, as a consequence of which species growing intermingled but with root systems of differing depths of penetration may be occupying very different types of soil both as regards chemical and physical constitution. The direct influence of the chemical nature of the soil is often difficult to separate from its indirect influence on water supply, absorption of soluble salts, etc. This is well seen in the vegetation of calcareous and non-calcareous soils. The so-called calcicole species which frequent the former may prefer calcareous soils either because of their physical qualities, because of their neutral or slightly alkaline reaction, or because of their chemical properties. Further, such association may be obligatory or merely preferential. Preference for a particular soil type is sometimes a feature of an entire genus, as that of *Clematis* for calcareous soils, whilst in other groups closely allied species may have very different requirements.

Biological Factors.—These comprise the effects of plant on plant and the relation between animals and plants. Of these biological factors, however, the most important is the influence of man. It is largely due to man that the present tree limit in the alps is considerably below its former altitude, whilst even in comparatively unsophisticated regions of the tropics considerable changes have resulted from the practice of migratory cultivation and the artificial extension of grassland at the expense of forest, both for domestic animals and the encouragement of wild game. The profound effect of rabbits on natural vegetation has been well exemplified in New Zealand and Australia, whilst the attacks of field mice, mollusca and various parasitic fungi, *inter alia,* considerably affect the efficiency of reproduction in many wild species. On the other hand, the beneficial effects of earthworms, moles, ants, etc., is analogous in nature to tht action of the plough in maintaining adequate aeration of the soil. Many flowers depend upon insects for their pollination, and hence the area of a species may be restricted by that of its pollinating agent.

In addition to the effects of climatic, edaphic (soil), and biotic factors, there are the historical factors to which allusion has already been made, and in this connection it must be recognized that the vegetation of yesterday has in large part been responsible for the conditions which determine the vegetation of to-day. The habitat is not static, but dynamic, and the present is but the link which joins the conditions of the past to those of the future.

Autecology.—The success or failure of the individuals of the species in one area will depend not merely on its ability to flourish in the environment there present but also on its capacity to modify that environment and itself to become modified. The study of this relation of the individual to its surroundings is termed *autecology.* A few examples will serve to illustrate the importance of the life history and structure of the organism in determining its fitness for a particular station or habitat. Thus annuals are an especial feature of deserts, where the short relatively wet season is occupied in rapid growth and reproduction whilst the dry hot season is passed in the seed state. The same quality has enabled many plants to become weeds of arable land and others to survive the rigours of a cold season. By contrast the vegetation of arctic regions is characteristically rich in perennials, for the growing season is so short and the temperature so low that growth is a slow process, and the annual species which occupies a considerable period in attaining the reproductive state is at a disadvantage in competition with perennial types in which the flower rudiments are often formed already in one season preparatory to their expansion in the next. Many of the herbaceous plants of woodlands exhibit exceptionally early leaf expansion, and hence their leaves are receiving light and manufacturing food material for weeks, and sometimes months, before the canopy of foliage of the shrubs and trees is formed above. This quality of precocious leaf development has enabled its possessors to occupy woodlands in which the light intensity during the summer months may be less than 1% of that in the open.

The possession of a relatively small leaf surface, a tufted habit, low growth, or hairy leaves are a few amongst many external features which tend to reduce the rate of water loss from the leaf surface (transpiration) and thus enable their possessors to occupy drier areas than would be possible for them in their absence. Such features are often accompanied by a microscopical internal structure also tending to check the rate of water loss, and plants having an aggregate of such feature are often termed *xerophytes,* from their capacity to grow in arid situations. Many plants, on the other hand, are entirely devoid of such transpiration checks and even exhibit features which tend to promote water loss, and often possess means of secreting liquid water. Such plants are quite unsuited to dry situations, but are admirably adapted for the humid situations in which they flourish.

Some species owe their success to a remarkable capacity for vegetative spread, as, for example, *Mercurialis perennis* and *Epilobium angustifolium,* others to a copious seed output, as, for instance, the foxglove *(Digitalis purpurea*), of which one plant may produce a million seeds in a single season. Contrast this with the seed output of another woodland species, *Allium ursinum,* which often does not exceed 40 seeds per annum. The rosebay willowherb (E. *angustifolium*) will often spread at the rate of 60cm. a year by means of its rhizomes and at the same time produce some 50,000 seeds, whereas its congener, *E. montanum*, only produces from 4,000 to 13,000 seeds in a season and spreads vegetatively about 1·1cm. per annum. The equipment of species in the struggle for existence is thus very unequal.

Seed Dispersal. — Many seeds and fruits are dependent on wind action for their distribution, and some, such as the parachute-like fruits of the goatsbeard *(Tragopogon)*, the plumed seeds of the willows and willowherbs, or the winged seeds of the tropical *Bignoniaceae*, are wonderfully fitted for this mode of dispersal. Others, such as the burr-fruits of the goose-grass *(Galium aparine)*, enchanter's nightshade *(Circaea)* and herb bennett *(Geum urbanum)*, become attached to the coats of animals by means of their hooked appendages, whilst the seeds of many berries are swallowed by animals and deposited in their droppings. often at great distances from their source. Here, however, it should be noted that the crops of birds on migration are usually empty and their plumage remarkably clean, so that bird carriage is not so important an agent as might be supposed. Still other seeds or fruits, like those of many waterside plants, have a buoyant structure and are carried to new habitats by means of streams and ocean currents. The efficacy of this means of dispersal is shown by the carriage of seeds of *Entada scandens* from South America by ocean currents, which frequently deposit them along the west European seaboard in a viable condition.

The Social Life of Plants (Synecology).—The foregoing considerations lead naturally to the conception of definite communities of plants, and it is the study of these social groupings which is the particular domain of *synecology*. The largest groupings that can be recognized are related to the broad climatic features of the earth's surface; such are termed *formations* and are well represented by the tropical *rain forest*, a community characteristic of areas within the tropics with high and continuous rainfall, consisting of a luxurious vegetation in which there are a great variety of broad-leaved evergreen trees, numerous woody climbers *(lianes)*, and epiphytic plants, the whole presenting a great complexity of structure. Other examples of formations are the deciduous forests of temperate regions, the grassland formations of the American prairies and the African veld, or the deserts of arctic and tropical regions. These formations can be further subdivided, according to the species which play the major rôle in the plant community, into *associations*, where several species take a leading rôle, or *consociations*, where there is one predominant species. Since even in these the subordinate species vary from one part to another, *societies* within the association can be recognized.

The deciduous forest formation of America presents in Indiana and Missouri associations in which oak and hickory are the chief features, whilst in the region of the great lakes it is represented by an association of birch and maple. In central Europe the same formation is represented by the very mixed forests of beech, hornbeam oak, etc., of the Danube region, by the Mediterranean chestnut forests, by the oak forests of Austria and other types. In Britain consociations are the rule, each characterized by a single dominant tree and associated with particular soil conditions. Thus the ashwoods are chiefly found on limestone soils, where the conditions are moist; beechwoods on dry soils, particularly those derived from chalk; birchwoods constitute the uppermost zone of woodland in mountain districts and also occur as a temporary phase on felled areas; alderwoods occupy the wettest soils; oakwoods of *Quercus Robur* are a feature of the moister and more fertile clays and loams, and oakwoods of *Q. sessiliflora* of the less fertile, acid, and usually drier non-calcareous soils, especially on the valley slopes of the west. Within an English oakwood some areas are covered with a carpet of *Mercurialis perennis* and *Scilla nutans*, others with *Anemone nemorosa* or *Ficaria verna*, furnishing examples of societies within the consociation. Such illustrations serve to indicate the use of these synecological terms; but for an account of the plant communities of the world the reader is referred to the works cited on p. 18.

Every plant community has something of the attributes of an organic unit, in that it possesses a more or less definite structure and has a life history in which juvenile, adult, and senile phases can be recognized. The structural organization is well illustrated in the temperate deciduous woodland, where three definite strata are usually present, respectively consisting of trees, shrubs and herbs, whilst beneath the lowest tier or ground flora there is often a carpet of mosses and the surface soil is rich in fungi and bacteria. Although less conspicuous, these flowerless plants are just as important a part of the community and have as definite a floristic composition. Beneath the surface the root systems of the higher plants exhibit a stratification comparable to that of the aerial organs, and the differing depths to which the roots of different species penetrate, as also the different periods at which they make their maximum demands on the food supply in the soil solution, are features which tend to reduce the competition between species and render possible that dense intermingling which results in the succession of seasonal changes. It must, however, be realized that the architecture of any community necessarily connotes different conditions in its various parts so that the environment occupied for example by the ground flora of a tropical or temperate forest, or by the lowest stratum of a fen is markedly different, as to humidity and illumination, from that of the tree layer in the one or the tall reed; in the other.

The different associations in a plant formation show an analogous structure often built up by very diverse species, and no better example of this could be furnished than by the desert vegetation of Texas and Mexico, characterized by succulent Cactaceae, and that of Africa, characterized by succulent Euphorbiaceae. Some of the members of these totally unrelated groups are so similar when not in flower as to be most readily distinguished by wounding, since the euphorbias possess milky juice which the cacti do not. Each association is distinguished by the presence and relative abundance of certain species and the absence of others. Those which are almost invariably present in a community are termed *constants*, but their diagnostic value is often low owing to their constancy in more than one association. Examples are furnished by *Mercurialis perennis* in the beechwoods of Britain and *Viola sylvestris* in the oakwoods. Of greater significance are the *characteristic* species which occur more or less exclusively in a particular community, as *Hordeum sylvaticum* and *Monotropa hypopitys* in the beechwoods of Britain or *Psamma arenaria* on European sand-dunes. Such characteristic species may be at the same time constants but are often of local occurrence. Many of the subordinate or accessory species are found in a variety of communities but have their characteristic frequency in each.

Succession. — Careful observation shows that, quite apart from the periodic rhythm of the seasonal changes, no community is stable. The physical environment itself is slowly altering, partly as a consequence of climatic action, partly through the influence of the living covering. Commonly, these changes are too secular in character to be readily appreciated, and it is only where the alterations in the physical environment are unusually rapid that the existence of a definite life-history in the plant community can be easily observed. In general, the tendency is for communities characterized by extreme conditions, as of dryness or wetness, to approach the mean. The process is well illustrated by the formation of sand-dunes, where the early stages consist of sandy accumulations around plants of marram grass (*Psamma*) or other pioneer species; these by their continued growth, as fresh layers of sand are added, not only stabilize the sand but by the decay of their older parts add organic material and so materially increase the water-retaining capacity of the soil. With the consequent amelioration of the extreme desert conditions species less specialized than the first colonizers can become established, and so there is a cumulative increase in the stability and quality of the habitat. The original dune-units increase in size and coalesce. so that the "yellow dune" gives place to the "grey dune," carpeted with continuous vegetation, and ultimately comes to bear scrub or even forest. Similarly the first occupation of the submerged mud in some estuary by almost microscopic seaweeds is the vanguard of a sequence of plants which progressively raise the level of a salt-marsh till it becomes pasture often of high economic value. The zones of vegetation which can be seen bordering the margin of a shallow lake present a sequence in space from within outwards which corresponds closely with the sequence of changes in time which led to the present condition of the outermost. Another familiar example is the passage of enclosed pasture to scrub and finally woodiand. In such *successions,* as these sequences are termed, each phase is distinguished by the presence of certain species, and the number and size of these tends usually to increase as the succession proceeds. Frequently in the final stages, however, one or two species again come to predominate, and since these often determine the physiognomy of the community they are frequently referred to as the *dominants.* Successions have been extensively studied by American ecologists and F. E. Clements has utilized this aspect as the basis for a classification of plant communities.

Competition.—Except perhaps in the so-called "open" communities such as those of deserts, where the individual plants are separated by bare soil, there is probably always direct competition between the constituent members. The conditions of the habitat exert a selective action, stimulating the development of certain species and depressing the vigour of others. If protected from competition many species can grow in habitats where they do not occur naturally. Many aquatics can survive under terrestrial conditions, and a large proportion of alpines succeed under cultivation in the lowlands. It is thus commonly not a question of whether or not a species can grow, but whether it can grow well, and competition often resolves itself into a capacity to obtain the requisite share of such essentials as light, air, water and mineral salts. In competition for light the naturally taller species is at an advantage; it can grow above and shade its competitor. Thus, wherever soil and climate can support forest vegetation, this tends to be the end phase or "climax" in the succession. So, too, trees which cast a deep shade are usually successful in competition with those having a light canopy. The birch, which by reason of its light wind-born fruits readily colonizes denuded woodland areas, eventually gives place to trees of heavier canopy such as the oak. Large size, however, is usually associated with delay in reproductive activity and the prolonged life-history renders the arboreal habit less successful than the herbaceous under the stress of conditions imposed by the presence of man. This is reflected in the steady diminution of the area occupied by natural forests.

Almost any feature in the organization or life-history of the individual which fits it for its particular habitat is at the same time a passive agent in its survival; but amongst the features which may be regarded as of importance in aggressive competition may be mentioned especially the rate of vegetative spread, the annual output of seeds, the efficiency of the mechanism of dispersal, and the extent and character of the root and shoot systems.

Economic Aspects.—Finally, mention should be made of the importance of the study of plant communities and their successions for the proper control and exploitation of forests and the maintenance of high yielding pastures. The naturally occurring species of an area serve as a valuable guide to agricultural practice, since their presence is in effect a product of the complex built up of soil and climate. A study of the natural relations of species is, moreover, a useful guide to their artificial juxtaposition in the practice of agriculture, forestry and horticulture (*qq.v.*).

BIBLIOGRAPHY.—0. Drade, *Handbuch der Pflanzengeographie* (1890, floristic distribution); J. C. Willis, *Age and Area* (1922); A. C. Seward, "Present and Past Distribution of Certain Ferns," *Journ. Linn. Soc.* 219 (1922); A. De Candolle, *Géographie Botanique* (1855); *Die Pflanzenareale* (Jena, 1926); E. J. Salisbury, "The Geographical Distribution of Plants in Relation to Climatic Factors," *The Geographical Journal,* 312–342 (1926, critical review and bibl.); E. J. Russell, *Soil Conditions and Plant Growth* (1927, copious bibl.); E. J. Salisbury, "The Stratification and Hydrogen-ion Concentration of the Soil," *Journ. Ecology,* 220–240 (1922); H. B. Guppy, *Plants, Seeds and Currents in the West Indies and Azores* (1917); E. Warming, *Oecology of Plants* (Eng. ed., Oxford, 1909, extensive bibl); F. E. Clements, *Plant Succession* (Carnegie Inst. Washington Publ. 290, 1916, extensive bibl.); A. W. Schimper, *Plant Geog. on a Physiological Basis* (Eng. trans., Oxford, 1903, best gen. account of vegetations of world); Ch. Flahault, "Les progres de la Géographie botanique depuis 1884," *Progressus Rei Botanicae,* 243–318 (Jena, 1907, bibl.); A. G. Tansley, *Practical Plant Ecology* (1923, an elementary introduction to field methods, with bibl.); F. E. Clements, *Plant Indicators* (Carnegie, publ. 290, 1920). (E. J. S.)

PHYSIOLOGY OF PLANTS

The physiology of plants deals with the functions of the living plant as morphology and anatomy deal with form and structure. Physiology aims to explain the functions of an organism in terms of physical and chemical processes. Physiology thus considers the living organism solely from the mechanistic standpoint, *i.e.,* from the standpoint that the organism is a machine albeit a very complex one. In this attempt to explain the organism in the terms of a machine the physiologist is supported by the fact that the organism appears to obey so-called physical laws in much the same way as does dead material. The living organism for example obeys the law of the conservation of energy, the amount of energy given out by the organism being equal to the amount taken in in food; again the plant or animal conforms also to the second law of thermodynamics which relates to the use of free energy.

Characteristics of Living Organisms.—Although it is impossible to give an exact definition of a living organism some of its characteristics may be pointed out. Whether one is dealing with a plant or animal of a single cell, or of a large organism such as an elephant or a tall tree, it is evident that it is a machine constructed to carry on certain processes, such as the absorption or building up of food; the process of respiration (*see* below) and the processes of growth and reproduction. One great difference between the living machine and any other machine is that the living machine is infinitely more complex than any man-made machine. Then again the processes going on in the organism are not independent of one another but are to a high degree, what is called, *integrated.* All the processes are interlinked or related, the finished material of one process being often the raw material of the next, and all being so closely associated as to lead to movement or growth or reproduction or some other activity of the organism. Another marked characteristic of the living machine which distinguishes it from all other machines is its power, to put it colloquially, to build itself up as it goes along. In other words the growing organism is a functioning unit which adds to itself and increases the size of the machine by its own functicnal activity. Another characteristic of the plant or animal is its constant reaction to the environment and its constant adaptation to changes in the environment. It is true that a carefully dried seed kept at a low temperature may appear to be quite inert, though still alive as is shown by its power of germination under suitable conditions; yet all active organisms show a constant interchange with their environment. Even in the case of the seed it is probable that some interchange, such as respiration, is still going on though at such a slow rate that our present methods of analysis are too coarse to recognize it. Another characteristic of the organism is that any apparent steady state or equilibrium is not a *static* but a *dynamic* one. If the normal organism appears to be in an inactive state it is simply that the constructive processes just balance the destructive processes, not that the processes are at a standstill. The living organism is like a battery which is constantly running down and requires constant recharging, though the recharging goes on at the same time as the discharging. The majority of cells require oxygen for their mere continued existence even in a resting condition and additional oxygen when in a state of activity. This need of oxygen even during quiescence indicates that a quiescent state of the cell is only an apparent quiescence, a state of dynamic not static equilibrium. Again the giving out of heat by all living organisms even when apparently inactive indicates the dynamic equilibrium of chemical processes going on in the cells. These exceedingly intricate processes continue unceasingly throughout the life-period of every cell in the simplest as well as in the most complex organisms.

Organization of Cell.—A11 living cells contain, or consist of, a viscous, glairy material (somewhat akin in consistence to unboiled white of egg) known as protoplasm. Protoplasin is not of course a single substance but a very complex system; it has been described as the "physical basis of life" since life as far as we know, does not appear to exist apart from protoplasm. An analysis of an active plant tissue, like lettuce or beet leaves, shows that it contains about 90% water. Of the dry material we should find carbon 38·19%, hydrogen 5·1%, oxygen 30·8%, nitrogen 4·5% and ash 21·5%. Similar results would be found for most plant material in the dry state though resting materials such as the potato tuber and the wheat grain would have only 2–4% of ash. Active protoplasm, and living material generally, is characterised by a high percentage of carbon owing to the large amount of organic matter, and in plants by a high percentage of oxygen owing to the large amount of oxygen-rich materials as carbohydrates (sugars, starch). A small proportion of nitrogen is also always present in living material. In ordinary analyses of plant material the protoplasm is only a small proportion of the material, a large proportion is dead cell-wall material, the contents of the cell vacuole (see above, Cytology), and protoplasmic inclusions. The nearest approach to an analysis of protoplasm is that which has been made of certain myxomycetes (see FUNGI) which exist as naked masses of protoplasm. Kiesel (1925) has examined Reticularia lycoperdon. He finds in a hundred parts of the dry weight.—protein, 29·1, other nitrogenous substances, 12·0, nucleic acid, 3.7, oil 19·1, carbohydrates generally 9 9, glycogen 15·2, also lecithin and cholesterol. This analysis is of course very incomplete; 6% of the material was not determined and a large number of substances present in small quantities only must have been overlooked. We note, however, the large amount of protein and this is a general phenomenon; just as we find life associated with protoplasm so we find protoplasm associated with protein.

It is clear that protoplasm must be a material, or rather a system of materials of very special nature since the enormous number of chemical reactions associated with life processes go on within it, and are apparently controlled and brought by it into proper co-ordination. Protoplasm also is concerned with the hereditary process, with the handing on to the male and female cells and from cell to cell in the body of the plant or animal, of the special qualities which cause the offspring to resemble their parents. (*See* CYTOLOGY)

The modern theory of the special peculiarities of protoplasm associated with its life activities may be termed the *physico*-chemical theory. In this view stress is laid not so much on any special organization of the protoplasm as on its peculiar physico-chemical condition.

It is pointed out that proteins are colloidal in nature or rather exist in the colloidal state (see COLLOIDS) and that, on one hand, many of the peculiarities which distinguish chemical processes in the living organism from the same processes occurring in the laboratory, and the peculiar co-ordination of processes which marks the living cell—and indeed of the whole organism for the harmony of the working of the plant or animal body is a commonplace—are related in some way with the colloidal nature of the protoplasmic substratum in which they occur. It cannot be said, however, that the colloidal theory carries us very far. We know that material in the colloidal state exhibits an enormous extension of surface and that substances may accumulate on this extended surface (by a process known as adsorption) and react together at a much faster rate than would otherwise be the case. The theory, however, does not explain how the numerous chemical processes going on in the cell are on the one hand kept from interfering with one another, and yet on the other hand are brought into close interrelationship and co-ordination. Still less can a colloidal theory explain the even more complicated processes of growth, of *differentiation* (the development of new and different parts as the plant or animal develops), and of heredity. It is clear also that the protoplasm is not a simple colloid of two phases, such as are found in gamboge in water where the particles of gamboge are the one phase and the water surrounding them the other phase. In the protoplasm there is not only protein material but oily material (so-called lipin material) appears to be essential and probably also carbohydrates play a part. We know furthermore, that various salts (of potassium, calcium, etc) are necessary. The physical relationship of the colloidal protoplasm must therefore be far more complex than that of any colloidal material studied in the laboratory. Any attempt to explain the peculiar relationship of the processes occurring in living organisms by reference to the behaviour of a complicated, dead, colloidal medium is largely speculation since the behaviour of such a medium is unknown.

Enzymes.—When dealing with the colloidal organization of the cell reference must be made here to the substances known as enzymes (*q.v.*). These are substances of unknown nature which can be extracted from dead cells whether plant or animal, and they must certainly play a very large part in the chemical processes going on in the living cell. They have three marked characteristics; they can act as catalytic agents, *i.e.,* they cause many chemical processes to go on at a much faster rate than would otherwise be the case; in chemical language they accelerate; they can thus cause rapid changes to occur which in their absence require a high temperature or the action of strong acids or alkalis. Secondly they act in very minute quantities and do not themselves appear to be used up in the process which they accelerate, for example invertase can break down 1,000,000 times its weight of cane sugar. Thus they partake of the nature of chemical catalysts Thirdly they are usually sensitive to heat (thermolabile) their activity being usually destroyed by temperatures well below that of boiling water. It is to be noted that the processes they accelerate may be either breaking down processes or building up (synthetic) ones, and that they can accelerate both such processes. Enzymes have been very actively investigated of late years especially by Willstatter and his pupils, but their nature is still obscure. They seem to be a part of the mechanism of the living cell by which the rate of various chemical processes are controlled. These enzymes seem to be of colloidal nature, or to have a colloidal carrier, though apparently they are not of protein nature; and furthermore their action is markedly specific, that is, the enzyme which affects the rate of one chemical process is unable to affect the rate of another process of marked chemical similarity. For example, sugars closely related in chemical composition require different enzymes to bring about changes in them. This is one of the puzzling aspects of cell physiology for it seems difficult to believe that the cell has a battery of enzymes to carry on the very numerous chemical processes with which it is concerned. Enzymes can, of course, only be studied outside the cell and it may be that the conditions in the living cell are different.

In relation to the cell organization it must be pointed out that many of the processes going on in the cell are *balanced* or reversible reactions, that is reactions which are capable of going in either direction; a good example of this is the formation of fats. These substances consist of glycerol (glycerin) combined with a fatty acid. In the presence of a special enzyme, lipase (found in castor oil seeds and in the animal body), this reaction is capable of going either way, the fat may be split up into glycerol and acid, or the acid and glycerol may be combined to form fat; the lipase accelerates both these processes. Whether the reaction goes in the direction of synthesis or analysis depends not on the lipase but on the concentration of the substances taking part, *i.e.,* fat, glycerol, fatty acid and water. It is probable that by controlling the amount of water available for particular reactions the cell is able to control the direction in which such a reversible process shall go.

WATER RELATIONS OF THE PLANT

It is well known that water is essential for all life processes. A seed may be thoroughly dried and still be capable of germination but it is in a dormant state; for its germination and ordinary activities water is necessary. It seems essential that the colloids of the protoplasm should be swollen (imbibed) with water in order that it may be active. Furthermore all the chemical processes of the cell go on in a watery medium and water is necessary for the solution and reaction of the substances concerned. The more active tissues of the plant generally contain particularly large quantities of water as was seen in the case of the green leaf; in the older and less active parts the percentage of water is less because many of the cells have been reduced to dead husks of cell wall material.

WATER RELATIONS OF THE CELL

As is shown above, under the heading of Cytology, the mature cell consists of a cell-wall lined inside with a thin layer of protoplasm, which itself encloses a central space, the *vacuole,* filled with cell sap. *(See* above, *Cytology.)* The sap contains various dissolved substances, sugars, nitrogenous materials, a variety of inorganic salts and other substances which are sometimes of colloidal nature. Curiously enough the majority of the substances are highly soluble in water and yet if a slice of beetroot is placed in water the amount of material passing out from the sap of the living cells is comparatively small as long as the cells remain alive; the cells on the other hand are capable of taking up water. We have then a peculiar condition of affairs in which water can enter the cell but the passage out of soluble substances present inside the cell is hindered. This effect is due, not to the cell wall which appears on the whole to be dead and inert, but to the living layer of protoplasm which is often known as the *plasma membrane.* This exhibits when living a condition of *semipermeability* since it lets water readily pass in and out, but hinders the passage of certain dissolved substances such as those in the sap. Water is attracted into the cell by the dissolved substances inside just as it would be into a sugar solution enclosed within a pig's bladder, which also roughly is semipermeable allowing water to enter freely but being more or less impermeable to the sugar. As a result of the entry of water the cell becomes swollen up and turgid and exerts what is known as *osmotic pressure* on the elastic cell wall or membrane which is thus stretched. Whole tissues of the plant are thus given a rigidity which is not due to their actual mechanical strength. The dependence of this rigidity on plentiful supplies of water is well seen in the case of leaves and the stems of herbaceous plants which often wilt, *i.e.,* become soft and flaccid, on a hot summer's day. Directly so much water is lost that the wall is no longer expanded, the rigidity of the cell must completely disappear.

Plasmolysis.—That the cell allows water to pass both ways and that the plasma membrane hinders not only the exit but also the entry of various substances into the cell is shown by the action on the living cell of a solution of cane sugar or of some salt such as potassium nitrate, or calcium chloride. If 'the living cell is placed in a solution of one of these substances of a concentration greater than that of the cell sap, water is drawn out of the cell and the cell collapses; this process is known as plasmolysis. It gives a convenient method of measuring the osmotic pressure of the cell. We find that concentration of cane sugar which brings about what is called "incipient plasmolysis," that is, the stage at which the plasma membrane has just begun to be withdrawn from the cell wall at one point. In this condition the osmotic pressure inside and outside the cell must be the same and since the osmotic pressure of the sugar solution can be determined the pressure of the cell sap is known. Osmotic pressure is generally expressed in terms of atmospheres; if a cell has an osmotic pressure of 5 atmospheres, the pressure exerted on a given area of the cell wall is five times as great as the downward pressure exerted by the atmosphere on the same area, which is about fourteen pounds to the square inch. Pressures of 5 to 40 atmospheres are common in plant cells and those of the order of 150 atmospheres have been observed. These pressures seem large but owing to the very small size of the cell the actual forces concerned are small.

Osmotic Pressure, Turgor Pressure and Suction Pressure.—When a cell is supplied with water it goes on absorbing and at the same time expanding with the result that the *backward* pressure of the stretched and elastic cell wall becomes greater and greater, until finally it equals the osmotic pressure of the cell contents; this backward pressure of the cell wall is known as *turgor pressure.* The cell is then fully expanded and fully imbibed and can absorb no more water. If on the other hand the cell is not fully imbibed the osmotic pressure is greater than the turgor pressure and the cell will tend to suck or draw water into the cell. When the cell is flaccid, as in the plasmolysed condition, there is no turgor pressure. It is clear that the difference between the osmotic pressure and the turgor pressure measures the pull with which the water is drawn into the cell; this difference is known as *suction pressure.* The term water absorbing power is sometimes employed but the first is by far the more satisfactory term since we arc dealing with a pressure and not a power. If P=the osmotic pressure of the cell sap, T= the turgor pressure, and S the suction pressure, then $P-T=S$. We see then that the suction pressure is that fraction, if any, of the osmotic pressure left over from balancing the turgor pressure (backward pressure of the wall). When the cell is fully imbibed with water then $P=T$ and so $P-T=0$ and there is no suction pressure. When the cell is flaccid $T=0$ and therefore $P=S$, *i.e.,* the suction pressure is equal to the full osmotic pressure.

As the suction pressure is such an important quantity the question arises as to its measurement. As it represents the pressure with which water is drawn into cell from outside it is evident that if we just balance this pressure inside the cell by an equal pressure outside, the cell will neither take in nor give out water, and therefore will neither expand nor contract, *i.e.,* will remain unaltered in volume. This consideration is the basis of the method of measurement. The cell, the suction pressure of which is to be determined, is placed in purified paraffin oil under the microscope and its volume measured; this gives its normal volume since it does not absorb the oil nor does it lose water while immersed in the oil. The cell is then removed and placed in various strengths of cane sugar solution or some other plasmolysing agent until a concentration is found at which the volume is the same as measured in the oil. If the cell does not change in volume while lying in a watery solution it must be that its suction pressure is opposed by an equal pressure in the opposite direction. This counter pressure must be the osmotic pressure of the-cane sugar solution which just keeps the cell at its original volume. The osmotic pressure of this solution thus gives the suction pressure of the cell in the state in which it was investigated; like the osmotic pressure it is usually expressed in atmospheres.

ABSORPTION OF WATER BY THE PLANT BODY

Water plants are surrounded by a very dilute solution of salts, as in the case of fresh water or a somewhat stronger solution in the case of sea water. Being surrounded by a watery medium the loss of water, and accordingly the need for absorption of water, does not play any very large part in their economy. The conditions are very different with land plants which, in the case of higher plants, often expose very large surfaces to the air and consequently lose great quantities of water in the form of vapour, which passes through the pores in their leaves in the process of *transpiration (see* below). Such land plants must therefore take up larger quantities of water from the soil and the rate at which they can take up water will depend upon the forces with which the water is held in the soil for it is these forces which the *suction pressure* of the cells in contact with the soil have to overcome.

Soil Conditions. — The soil is a very complex material consisting of (a) mineral particles of various sizes and varied chemical composition, *(b)* of organic matter usually in the form of a dark brown material known as *humus* which is derived for the most part from the decomposition of remains of dead plants which formerly grew upon the soil, *(c)* water, which is held by colloidal adsorption in films on the mineral and humus particles and also, to a certain extent, within spaces of the soil, (d) air which is found in the spaces between the soil particles. The air can, of course, be displaced by water, as in the case of a water-logged soil where all the pore spaces of the soil are filled with water. Soils differ very much in what is called their *mechanical* composition, *i.e.,* in the relative amount of particles of large and small size. A sandy soil has a large proportion of large particles, a clay soil has a large proportion of small particles, and to this is due their great difference in behaviour both in relation to water-retention and their response to mechanical treatment (*e.g.,* ploughing) and to fertilizers. The relation of size of soil particles to the water holding power of the soil is particularly important in reference to the physiology of the water absorption of the plant from the soil, and attempts have been made to estimate the relative forces with which the water is held by different soil constituents. Briggs and McLane working in America determined the amount of water held back by various soils when they were whirled round with enormous rapidity in a centrifuge;

the centrifugal force resulting from the rapid rotation at first causes water to be thrown off but it is finally balanced by the water retaining forces of the soil particles. By comparing the behaviour of a number of different soils of different compositions they deduced that if the water holding capacity (moisture equivalent) of the particles of size 2.0 to 0·05 mm. diam. (*i.e.,* coarse and fine sand) be taken as unity, the corresponding equivalent for the particles of below 0·05 to 0·005 mm. diam. (silt) is 12, while that for the particles of less than 0·005 mm. (*i.e.,* clay) is 57. The silt is partly colloidal, and the clay highly colloidal, and the high water-holding power is due to the colloidal properties. The humus also is of colloidal nature and of marked water-retaining power and its capacity in that respect may be taken as about the same as that of the colloidal clay. The forces with which the water is held in different soils and in the same soil with different amounts of water has been investigated by Shull by what may be termed a biological method. It is well known that dry seeds will take up water actively and often with considerable force, the amount they can take up depends upon the force with which the water is held in the medium from which it is being taken. The method consists then in placing dry seeds in different soils with different content and determining the amount of water taken up after a given period, say 48 hours. Similar seeds are then placed at the same temperature, (a) in concentrated solutions of lithium chloride and sodium chloride of high osmotic pressure, or (b) over sulphuric acid of different concentrations. If the seed takes up in the same time the same amount of water from a given soil as from the salt solution or from the moist air over sulphuric acid the water retaining power of the materials in which the seed is placed should be the same. Now the osmotic pressures of the solutions—which represent the forces against which the water-absorbing forces of the seeds are acting—are known and so the water holding power of the soil can be expressed in atmospheres. The results show that the water absorbing power of the seeds is very high, for they will take water from a saturated solution of lithium chloride which has an osmotic pressure of nearly a thousand atmospheres. They show also, as was to be expected, that in an ordinary loam soil the forces with which the water is held go up markedly as the water becomes reduced in amount. In a silty loam investigated the forces holding water were negligible when there was 20% of water in the soil, but when it was reduced to 15% the forces were several hundred atmospheres and when reduced to about 10% of the order of 1,000 atmospheres pressure. With sand the condition is very different for the material is non-colloidal and the water is only loosely held; only when the water content is reduced to a very small amount does the pressure become considerable.

Dynamic Relations of Water Absorption.—The observations which have been described above only gives us a picture of static equilibrium between the plant and the soil. They show what the conditions are when there is a balance between the forces pulling water into the seed (or root of the plant) and the forces holding the water in the soil, that is they show us the condition when water is no longer taken up. This, however, though helpful, as giving some measure of the forces which the root has to overcome, gives us a very imperfect picture of the relationship to the plant. The plant is continually giving off water in the process of transpiration and unless the rate of absorption keeps pace with the rate of loss of water the water content of the plant will begin to fall. The plant will flag when this difference in the two rates has existed for a short period and the plant will be dead long before the rate of absorption has fallen to zero. The equilibrium between absorption on the one hand and loss of water by transpiration on the other is thus, like the equilibrium in the living cell, a dynamic not a static one.

TRANSPIRATION

The term transpiration is applied to the process of loss of water vapour from the aerial part of a land plant; it is of the nature of controlled evaporation. The transpiratory losses take place mainly from the leaf surface since these organs expose a large surface for evaporation and are supplied on the epidermal surface with pores known botanicaiiy as stomata. (See above, *Anatomy.*) These pores interrupt the otherwise continuous layer of *cuticle* which covers the surface. In its absence the loss of water from the leaf surface would be very large and uncontrollable. The cuticle is, however, not completely waterproof so that we can distinguish cuticular transpiration and *stomatal* transpiration. The second is very much the larger, being usually 80–97% of the whole, though under special conditions, as in a tropical rain forest, the cuticular transpiration may be as high as the stomatal.

Measurement of Transpiration.—That transpiration occurs can be shown by the loss of weight of a potted plant, when the pot and surface of the soil are protected from water-loss by rubber sheeting; this gives a convenient method for measuring the rate of transpiration. It is not applicable to plants growing in the ground; for such plants paper dipped in a cobalt chloride solution, dried and applied to the leaf may be employed. On the absorption of the water vapour coming from the leaf the colour of the cobalt chloride paper changes from pink to blue, and the rate of this change gives some measure of the rate of transpiration.

Size and Arrangement of Stomata.—The stomata are more commonly confined to the lower surface of the leaf—the cuticle on the upper surface being then continuous, though leaves with stomata on both sides frequently occur. The stomata are very small pores, those of the sunflower leaf being about $\frac{1}{100}$ of a millimeter (*i.e.,* about $\frac{1}{2500}$ of an in.) in diameter. They are very numerous, varying from 40 to 300 per square mm.; a sunflower leaf may thus bear 13,000,000 of them. The pore is bounded by two special cells known as guard cells (as described in the anatomy of plants) and open below into a chamber which is bounded by the walls of the green cells (*mesophyll*) of the leaf. These cells are full of water and from their wet cell walls water naturally evaporates into the space, and by the physical process of gaseous diffusion passes out of the stomatal pore into the drier air outside. As the stomata occupy a very small proportion of the total surface it might be supposed that the rate of passage of a gas or vapour out or in would be very slow. It was shown, however, by Brown and Escombe in 1900 that such very small pores allow of a much greater rate of diffusion than might be expected. It is found that provided the pores are not too close to one another the rate of diffusion is proportional to their diameter and not to their area.

Effect of *Various* Conditions on the Rate of Transpiration.—Transpiration like most physiological processes is markedly affected by external conditions. Since the process is essentially one of evaporation, one of the most important factors (the term factor is applied to a particular condition affecting the rate of a process) is the humidity or relative dryness of the air to which the plant is exposed. The drier the air the more rapid, on purely physical grounds, will be the rate of diffusion of the water vapour through the stomatal pore. This is due to the big difference of the water content (humidity) of the air below and above the pore. The proper measure of the evaporating power of the air is not the actual relative humidity (or percentage saturation of the air) but the saturation deficit and this is markedly affected by temperature. Air 70% saturated at 10° C has only about half the saturation deficit of air 70% saturated at 20° C, and so its evaporating power is only half. Temperature itself has very little effect on transpiration or evaporation except in so far as it affects the evaporating power of the air. Atmospheric pressure has only a slight effect since evaporation tends to go up with a fall in barometric pressure but it is so small that it can under ordinary conditions be neglected Wind is a very important factor in transpiration. It is well known that plants suffer very much in windy situations and "wind-breaks" are often put up for plant protection. The ill effect is mainly due to the enhanced rate of transpiration, which is the direct physical effect of the removal by the wind of the layers of air in contact with the leaf.

Effect of Light.—If the rate of transpiration is measured, say by weighing a potted plant under appropriate conditions, it is found that the water loss is much greater by day than by night and this occurs even if the evaporating power of the air and the temperature are kept constant. It is a well known effect of light upon the higher terrestrial plants. This effect occurs in an ordinary diffused light so it cannot be due to the heating effect of the rays, for in such circumstances such effect is practically negligible. The effect produced by the light must be due to some change in the leaf itself since the factors affecting evaporation have remained unaltered. As the transpiratory water loss is through the stomata we should expect some change in the size of the pore, and it is found that in the majority of leaves light causes a widening of the stomatal pore and darkness a partial closure.

Stomatal Action.—As already stated the stomatal pore is bounded by two guard cells and it is by changes in their shape that the alteration of the pore is brought about. Their shape, the relative thickness of their inner and outer walls, and their attachment to the epidermal cells are such that when they become more turgid their inner walls—those facing the pore—move apart and so the pore widens, while on a reduction of turgor these walls approach one another and the pore becomes less in size. When the cells become collapsed, as in drying or by plasmolytic agents, the size of the pore is very much reduced though probably not to zero.

The mechanism by which light brings about alterations of turgor in the guard cells has been much disputed. It has often been held that the stomata open in light owing to the increased turgor due to the accumulation of sugars produced by the assimilatory activity of the chloroplasts of the guard cells. This view is quite untenable for the guard cells open in the light in the absence of external supplies of carbon dioxide. Lloyd (1908) also has shown that guard cells containing only leucoplasts behave similarly to normal ones. It was shown also by the same observer that the guard cells in the early morning, when the pore is closed, show much starch, which disappears during the day to reappear again in the evening when the stoma closes. This led to the view that the light affected the starch-sugar ratio in the guard cells. In the day insoluble starch would change into soluble sugar and the turgor of the cell rise, in the night the sugar would change back to starch and the turgor fall. The turgor changes would bring about the corresponding changes in the size of the stomatal pore. This view received support from the observations of the osmotic pressure of guard cells. In *Rumex* patientia, for example, it was found that the osmotic pressure of the guard cells is 23 atmospheres when they are fully open, about midday, while only 13–14 atmospheres when the pore is closed at night. It is found that in addition to light other factors such as neutral salts and acids and alkalis affect the starch-sugar relation and so stomatal movement. This is rather what might be expected since the change from starch to sugar and the reverse is almost certainly an enzymic one. Further work by G. W. Scarth in 1926 indicate that acetic acid and ammonia, *i.e.*, both acid and alkali, will cause the opening of the stomata; in an intermediate range where there is slight acidity the guard cells remain closed. This suggests that what the guard cells respond to is a change in the concentration of free hydrogen ions (*i.e.*, the free hydrogen parts of the acid molecule when it is dissociated in water) of the solution. In this view light affects the "acidity" of the leaf as a whole either by altering the content of organic acids in the cells, or the concentration of carbonic acid by affecting the rate of assimilation. There are indications that the effect is more complex and that the change in the starch-sugar ratio is too slow to explain the rapid turgor changes that occur. It is probable that there is present in the cell sap of the guard cells some colloidal material which absorbs water and that the amount of water the colloid takes up is altered by changes in the concentration of the hydrogen ions of the cell.

Control of *Transpiration* by *Stomata*.—The question of the control of the rate of transpiration by the stomata has also been much debated. The older view was that the opening and closing of these pores had an important controlling effect. This view was abruptly called in question by Lloyd in 1908 who denied the regulation of water loss of leaves through stomatal closure. It is clear from later work that the stomatal aperture may vary widely while the rate of transpiration shows no corresponding change; thus the stomata may go on opening in the middle of the day while the transpiration rate falls. The matter is again complicated by the fact that the rate of loss of water vapour by the stomata is also affected by the accumulation of moist layers of air upon the surface of the leaf. If the stomata open more widely when such layers are present there may be little possibility of any faster diffusion of water vapour through the pores. Calculations indicate that in still air the layers of moist air on the leaf exert the most effect, and it is only when the stomatal pores have become very narrow that the pores can have a controlling action. In wind, however, these moist layers are removed and the stomatal pore can exert a controlling action at any degree of opening. It must be borne in mind however that the stomata are very sensitive to light but their response to losses of water by the leaf are slow, so that they cannot keep the water content of the leaf constant by controlling the stomatal pore.

Direct Action of Light on Leaf Cells.—As already described light markedly increases transpiration by causing the stomata to open, but the question arises as to any possible direct effect on the mesophyll. It was claimed by Francis Darwin (1914) that in a leaf which had been vaselined on both sides, to block the stomata, and then slit so that the mesophyll cells transpired directly into air, light still increased the rate of water loss by as much as 36% in the case of the leaf of ivy. Such a huge increase seemed very unlikely, so the matter was again investigated by Henderson (1926), who showed that, when all allowances were made for possible changes of temperature, light did produce an increased rate of evaporation from the mesophyll cells of the leaf to the extent of about 5%. The exact mechanism of this is obscure; it is probably some effect on the resistance of the protoplasm to the passage of water through it to the surface of the cell. In the light the cell wall would be more fully imbibed, *i.e.*, wetter than in the dark.

Advantages and Disadvantages of Transpiration.—This question is often debated, the extreme positions being (1) that the process is an *unavoidable* evil, (2) that it is a physiological necessity. The idea of its physiological necessity is mainly based on the view that the water and the inorganic salts that the plant requires are taken in together in the form of the very weak solution which occurs in the soil, and that the excess water must be got rid of in transpiration. This view is based on the erroneous assumption that water and salts enter the plant together. As a matter of fact the forces bringing about the entry of water and the entry of dissolved salts into the root cells are of an entirely different nature; the two must enter quite independently. Whether transpiration is an "evil" may be debated but it is perfectly clear that given the necessity of taking in gases from the air, the loss of water by plants is quite unavoidable. The same pores which allow the entry of gases must also allow of the passage out of water vapour. The plant could only stop such water loss by having a continuous cuticle, and then the supply of carbon dioxide for the manufacture of sugar and starch would almost completely be cut off. The loss of water by transpiration is a necessary result of the construction of the plant. It has been suggested that a rapid stream of water rising in the wood (see below) is necessary to convey the salts to the leaves, but it is found that a reduction of transpiration does not necessarily reduce the accumulation of salts in plants. It may be that some *minimum* rate of upward water flow is necessary to transport the salts to the higher parts of the plant. Transpiration may also play some small part in keeping down the temperature of plants exposed to the direct rays of the sun.

MOVEMENT OF WATER IN THE PLANT BODY

The water that enters the plant from the soil ultimately escapes from the leaf surface passing through the stomatal pores in the form of water vapour. The question arises as to the path taken by this water. It has been known a long time that the main body of the water passing through the vascular plants travels by way of the xylem, *i.e.*, the wood. (See above, Anatomy.) The evidence for this is various. It is found that if the trunk of a tree is "ringed," *i.e.*, cut through right down to the wood throughout the circumference of the tree, water continues to pass up the tree for a long time and apparently unhindered. Again if cut shoots are placed in a solution of a dye such as eosin, the wood alone is deeply stained showing that the dye solution has travelled up through this tissue. The frequent occurrence in the wood of wide open tubes containing no protoplasm also indicate its function as a conducting channel.

Passage of Water Across the Root.—The root as anatomical studies show, usually exhibits elongated outgrowths from certain of its superficial cells. These outgrowths are known as *root-hairs* and serve to increase the surface of the root available for absorption. These hairs are in contact with the films of water on the soil particles and they can withdraw water from the soil if their suction pressure *(see* above) is greater than the imbibition forces of the soil, *i.e.,* the forces tending to retain the water in the soil. The water thus absorbed, if it is to reach the leaves, must pass across the root to the xylem strands and the question arises as to the mechanism of this transport. It has been shown by the work of Ursprung and Blum that there is a *gradient of increasing pressure* from the root hair to the endodermis; by this means the water will pass from cell to cell across the cortex. At the endodermis there appears to be some abnormal condition for in the absorbing root of the broad bean it is found that while the suction pressure rises from outside to the sixth cortical cell from 0·7 to 3·0 atmospheres, yet at the endodermis it falls to 1.7 atmospheres; as a result the direction of movement of the water should be reversed and the water pass back again; this cannot be the case so the matter requires further investigation.

Ascent of Water in the Wood.—That the water rises in the wood to supply the needs of transpiration is well established, but the mechanism of this rise has been much disputed. It is clear that any explanation must meet the extreme case of the tall leafy tree. Now a single tree may lose many gallons of water a day in transpiration and a blue gum tree (Eucalyptus) of Australia or a Sequoia of N. America may reach a height of 300 ft. or more. A mechanism has thus to be found which will not merely hold up a column of water at a height of 300 ft.—this is merely a problem in statics—but one that will drive (or pull) many gallons of water a day to this height. Many different forces have been invoked to explain the rise. The force of capillarity has been called in but measurements of the size of the wood vessels show that capillarity will not explain the rise of water to the height of a tall tree, let alone the continued movement of the water upward. Then again atmosphere pressure has been suggested as concerned in the movement, but such a pressure would only explain the rise of water to a height of a little over 30 ft. "Root pressure" has been called in as the motive power for the rise of the transpiration stream. When the stem of a wood plant is cut across near the ground a flow of sap under considerable pressure may occur from the wood of the cut stump; the pressure bringing about this flow is known as root pressure. Unfortunately for this explanation no pressures have been observed which are adequate to explain the rise of water to the top of a tall tree. Again root pressure is found most active in the spring, while the transpiration stream flows most actively in the summer. Then again we have the so-called *vital theories* of the cause of the ascent of sap in all trees. In these theories the living parenchyma cells which are so characteristic of the wood are supposed to exert a pumping action. They are assumed to take water from a lower wood vessel and pump it into a higher vessel with which they are in contact.

The objections to these vital theories are mainly twofold; they are inconsistent with experimental data and also with the known structure of the wood. The strongest experimental evidence against vital theories is obtained from the results of poisoning experiments. E. Strasburger carried out in 1893 some classical experiments with an oak tree over 70 ft. high and with tall climbers like wistaria and hop. The oak was cut off at the base and the cut end placed in a tub of picric acid, a highly poisonous yellow solution, which was found to be taken up in considerable quantities. After three days in this fluid the trunk was placed in a solution of a reddish dye (fuchsin) and there left for another six days. The oak trunk was then split down the middle when it was found that the yellow poison had been drawn up to 70 ft., and among the yellow stained wood were red patches showing that the dye had been drawn up *after* the picric acid, *i.e.,* through the *dead* wood. In the case of the two climbers lengths of 30–40 ft. were killed by heat when it was found that, as in the oak, coloured solutions were drawn up through the stems in spite of the killing of the living cells. These experiments seem to show clearly that fluids will rise in the wood of tall plants without the intervention of the living cells of the wood.

Cohesion Theory of the Ascent of Sap.—It is evident that in the absence of a pumping mechanism in the wood itself the water rising must *either be pushed from below or pulled from above.* Since water will rise even in tall trees when they are severed at the base some pulling force from above would appear to be acting and it can be demonstrated that a cut leafy shoot does exert a pulling or sucking force on a column of water. If a glass tube is fixed with an airtight junction to the lower end of a small leafy branch of a tree (the wood being bared at the point of junction), water will naturally rise in the tube. If the tube is filled with boiled water and the lower end placed in a dish of mercury, the mercury will be drawn up after the water. Under favourable conditions when no air bubbles develop in the system the mercury column will be raised *to a height above that of the barometric column.* This demonstrates that the cut branch exerts a definite sucking force on the water column. The same fact could be demonstrated without mercury using water alone in the tube, if the space above the water in which the tube dipped was exhausted of air. More elaborate experiments of this type show that a transpiring branch will exert a pull of 7 to 8 atmospheres. Such experiments demonstrate not only the sucking force exerted by *a* cut leafy shoot but also a peculiar physical property of a fluid such as water and mercury, namely, its cohesion or tensile strength. If a column of water or mercury is held up in a vertical tube without being supported from below, it must evidently be held by a pull from above. If, however, the fluid is transmitting a pull its particles must cohere together like the particles of a steel wire. Now it is found that if a fluid, like water, be free from air bubbles and is enclosed in a rigid tube to the wall of which the fluid *adheres,* it can then transmit a very considerable tension, owing to the attraction of the water particles for one another which is spoken of as their *cohesion.* Under conditions spoken of, with the fluid adhering to the walls of a rigid tube, the fluid is unable to change its shape and hence, as the result of its cohesion, is able to transmit a pull like a steel wire. By experiment it has been shown that in the case of water this cohesion or tensile strength is very great, for it requires over 200, and probably over 300, atmospheres to rupture a column of water.

The cohesion theory of the ascent of sap asserts that the water threads in the water channels of the wood are adhering to the wet walls of these vessels (and of the tracheids) and that these water threads can transmit any pull exerted on them at the top. Any cross-walls in the wood channel do not interfere with the practical continuity of the water columns since these walls are fully soaked with water. As has already been explained transpiration losses take place from the cells abutting on the intercellular spaces in the leaf, with a consequent increase in their suction pressure. As a result they take water from neighbouring cells and those with rising suction pressure will take water from the tracheids found in the fine vascular bundles (veins) of the leaf. The water columns in these dead tracheids are continuous with those in the rest of the wood channels in the plant, and the result of the withdrawal of water by the leaf cells is that these columns fall into a state of tension which is transmitted throughout the plant and thus down to the roots. The pull of the mesophyll cells in the leaf is thus felt by the cortical cells of the absorbing root, and water is drawn from them into the wood and their suction pressure goes up. This leads to water being taken from cells farther and farther towards the outside of the root, and so to loss of water from the root-hair which takes water from the soil; thus the chain of cohering particles extending from the soil to the leaf is complete.

Difficulties in the Cohesion Theory.—The cohesion theory certainly provides the most satisfactory explanation of the rise of the transpiration stream in tall trees. There are one or two difficulties, however, presented by the theory, one of which is in respect of air bubbles in the woody tracts. If sections of the wood are cut with great precaution a certain number of the wood channels are always found to contain air bubbles and therefore to be out of action. If the number of these air-containing channels went on increasing from year to year the proportion of blocked channels might be very high, though the new ring of wood laid down each year would start without air bubbles. It is suggested by Dixon that root pressure which develops in the spring would compress the air bubbles, by pushing the columns from below, and so cause their solution. It is doubtful, however, if root pressures occur of the magnitude necessary to bring about the solution of the bubbles at the top of a tall Sequoia tree. On the other hand the bubbles found in sections of the wood may be artefacts, *i.e.,* produced in the cutting of the sections. From the observations of H. R. Bode it seems doubtful if bubbles exist at all in the water-conducting tracks of herbaceous plants under normal conditions, and the case may be the same in woody plants, though the bubbles seem to develop very easily; this question of air bubbles in the wood requires further investigation. Another difficulty lies in the behaviour of dead leaves. The cohesive theory it must be remembered is a *purely* physical theory. All it requires is one membrane evaporating into dry air, another membrane in contact with a water supply, and the two connected by a continuous water thread under such conditions that it can support a tensile stress. Accordingly if we kill a leaf with chloroform vapour while still attached to the plant it should continue to draw up water as its cell walls are still directly continuous with the water supplies of the stem. One would expect the leaf cells to collapse owing to the loss of osmotic pressure but not to dry up; we find, however, that such a dead leaf soon dries. This suggests that though the cohesion theory rightly envisages the main factors in the rise of water there are other subsidiary factors which play a part.

ABSORPTION OF SALTS AND PERMEABILITY

As is well known the plant contains considerable quantities of inorganic salts of sodium, potassium, calcium, magnesium and iron and the only source of these is the soil from which nitrates, sulphates and phosphates are also obtained. The water in the soil is not pure but is a weak solution of inorganic salts known as the *soil* solution. The exact composition of the soil solution is doubtful. It must vary much from soil to soil and from time to time in the same soil and it is a matter of great difficulty to separate it from the soil. Estimations give a concentration of total solids in the soil solution from a wet soil of 0·1 to 0·025 per cent or less; a manured soil gives a stronger soil solution than an unmanured one. It is from the soil solution that the ordinary land plant takes up the salts necessary for its growth; unless the essential salts can be supplied in sufficient quantity growth will suffer. It must be added however that a sufficient supply of water and appropriate salts together with a sufficient aeration of the root system are not in themselves sufficient; in addition, the reaction of the soil must be suitable. The soil must be neither too acid nor too alkaline, or to put it more accurately, the concentration of hydrogen ions in the soil must be correct. Olsen (1923) in studying Swedish vegetation demonstrated a remarkable agreement between the concentration of hydrogen ions in the soil and the distribution of various plants. The presence of lime or chalk in the soil is of great importance in relation to soil reaction since lime neutralizes acidity. The addition of lime will often raise an infertile "sour" soil to a fertile level. The striking response of some plants to lime-rich or lime-poor soils may be related to the hydrogen ion concentration of the soil.

The Essential Salts.—Plants which normally grow in the soil can be grown successfully in water cultures, *i.e.,* in a solution of salts, or in quartz sand watered with such a solution. A solution of this kind may consist of water 1,000 grams, potassium nitrate 1 gm., calcium sulphate 0·5 gm., magnesium sulphate 0·5 gm., calcium phosphate and ferric phosphate each 0·25 gm. In this or similar solutions plants may be grown successfully for many generations. If any of the elements, nitrogen, sulphur, phosphorus, potassium, calcium, magnesium and iron are absent, the plant suffers, indicating that these elements are essential to the plant. The sodium and chlorine which plants absorb from the soil do not seem to be essential for plant growth. Moreover, small quantities of boron are absolutely necessary for the proper growth of such a plant as the broad bean. We know, in addition, most of the essential salts appear to be poisonous when given alone and that salts have an antagonistic action to one another, each neutralizing the toxicity of the other. The culture solution has thus to be a balanced solution in which the various toxicities cancel out.

Absorption of Salts.—When the water relations of the cell were discussed it was pointed out that the plasma membrane of the cell was of a semi-permeable nature, in that it held back soluble substances in the cell sap while showing a permeability to water. The fact that plants contain inorganic salts which they have taken up from the soil shows that the cell is not completely impermeable to dissolved substances, as does the fact that such substances as sugar travel about the plant. It is found, as we should expect that when salts (such as potassium nitrate or sodium chloride), or even cane sugar, are used as plasmolysing agents that the substance enters sooner or later and plasmolysis disappears. The entry of salts into the cell raises the whole question of the nature of the living plasma membrane and the forces which are concerned in bringing about the passage of substances in and out of the living cell. The subject, however, is as yet a very confused one and has recently been reviewed by Stiles. On simple physical principles a salt should go on entering and accumulating in a cell until the concentration inside and outside the cell is the same. If, however, a slice of carrot is placed in a solution of potassium chloride the salt goes on accumulating in the cell until the concentration inside is apparently many times (even 25 times) that outside. Again as Osterhout has shown, if the sap of the large cells of the seaweed Valonia is analysed it is found that the concentration of potassium inside the cell is over 40 times that of the sea water outside. On the other hand the concentration of sodium is five or six times as great in sea water as it is in the cell sap. The fact that the living plasma membrane can keep permanently between its two sides so great a difference of concentration as that of potassium shows that it must be of very peculiar nature.

Changes of Permeability.—As might be expected from the fact that the accumulation of substances in a cell is a fluctuating quantity one finds that the permeability of a cell is not constant; in other words the rate of entry or exit of a given substance may be changed by external conditions. For example the permeability of a cell to a particular dye may be markedly affected by the nature and concentration of a neutral salt in the dye solution. Since the plasma membrane contains a high percentage of protein and the physical condition of such substances is altered by many salts, the change in permeability is not unexpected. Then again we find that the rate of entry of one salt into a cell is altered by the presence of another salt. Weak solutions of sodium chloride and calcium chloride, which by themselves do not plasmolyse a cell, will do so when mixed. The effect seems to be due to the calcium ion altering the membrane in such a way as to hinder the entry of the sodium ion—another example of antagonistic action. Again it has been claimed that light increases the permeability of the cells in the leaf of the lime. Illumination has been definitely shown (Brooks, 1927) to increase the rate of entry of a dye into the *Valonia* cell, and also to increase the rate of diffusion of the salts from the cut surface of a tissue, such as that of the swelling at the base of the leaf-stalk in the sensitive plant (Mimosa). We have probably to view the permeability of active cells as constantly varying, though how the changes in permeabilities of neighbouring cells are related so as to cause material to travel in any particular direction in a tissue is still obscure.

Transport of Salts and of Organic Substances.—The mechanism of the transport upward of mineral salts and the transport downwards of organic substances (such as sugar from the leaves), is still imperfectly known. Owing to the apparent slowness of diffusion of salts from cell to cell the supplies of salts required by the leaves would seem necessarily to move in the transpiration stream. There are, however, no data available showing that the rate of the stream and the concentration of salts in it are sufficient to transport the necessary supplies. A reduction of the rate of the transportation stream by shading leaves does not appear to reduce the salt content of the plant, at least in the herbaceous plants investigated. It may be that a certain critical rate of the stream is required and that in the experiments mentioned the rate was always above this.

GENERAL METABOLISM OF THE PLANT

The term metabolism is applied to the whole complex of chemical changes going on in the plant, the building up of more complex organic substances from simpler ones being spoken of as anabolism, and the breaking down of complex to simpler ones being termed Katabolism. It has already been noted that very many of the chemical reactions in the plant are balanced or reversible ones, so that according to the conditions (*e.g.,* the concentration of the reacting substances) the process may at one time be anabolic, another time katabolic. A balanced reaction ultimately reaches an equilibrium point where the rate of the process iii one direction is equal to the rate in the other; the equilibrium is thus a dynamic one. In those balanced reactions in which there is an energy exchange, *i.e.,* heat is taken in or given out, the equilibrium point is altered by a change of temperature. Experiment in the laboratory shows that the rate of many chemical processes is markedly affected by a rise of temperature, the rate of many of them doubling for each rise of 10° C. The marked effect of temperature on the metabolism of plants is no doubt partly one of acceleration, and partly a shifting of the equilibrium points of reversible reactions. There is a further point in relation to balanced reactions; if such a reaction is proceeding in a particular direction and material A is being converted into material B, then the mere accumulation of B tends to slow down the reaction and ultimately brings it to a standstill; should then the amount of B be increased further the reaction will proceed in the other direction, *i.e.,* from B to A. A similar result is very common in reactions caused by enzymes, the accumulation of the products of the reaction tending to bring the reaction to a standstill.

Stress must be laid on the fact that the chemical processes going on in the living plant take place not in a simple homogeneous medium like water but in the protoplasm, which is what is called a heterogeneous system, having many colloid phases. (See above.) The enzymes which seem to play so large a part in metabolism also appear to be colloidal at least in part; thus many of the reactions may take place on their surfaces and on the surfaces of the protoplasmic medium. The system in which the chemical changes occur being thus heterogeneous and of so complex a nature, we should naturally expect that a variation of conditions (such as of temperature, illumination, etc.) would affect differently the processes in the plant and similar processes occurring in the laboratory.

The metabolism of the green plant, to which our brief review must be confined, shows two main anabolic processes, (a) the manufacture of carbohydrates in the process of photosynthesis (carbon *assimilation*), (b) the building up of complex nitrogenous substances such as proteins from nitrates absorbed from the soil and from organic material such as carbohydrates. In addition there is a main metabolic process, that of *respiration,* which is akin to the process of alcoholic fermentation by yeast.

PHOTOSYNTHESIS (CARBON ASSIMILATION)

The whole life of the globe is dependent on this photosynthetic power of green plants for they alone are able to manufacture food material for themselves. The green plant may be described as the great alchemist which alone of living things has mastered the secret of converting the sun's rays into food material. The process of assimilation is associated with certain pigments which absorb the incident light; the energy so obtained is employed in the building up of complex organic substances from carbon dioxide and water, oxygen being at the same time evolved. In the case of the higher plants the pigments of the green Ieaf, as we know mainly from the work of Willstätter and his collaborators, are four in number—*Chlorophyll* a, $C_{55}H_{72}O_5N_4Mg$, a blue-black crystalline substance, greenish blue in solution; *Chlorophyll* b, $C_{55}H_{70}O_6N_4Mg$, a green-black substance, green in solution; *Carotin,* C_4OH_{56}, an orange-red substance found also in carrots, and *Xanthophyll,* $C_{40}H_{56}O_2$, a yellow substance. The two first are the green pigments and are often termed "chlorophyll," the other two are the yellow pigments. The amounts of these do not vary greatly in different leaves. The average amounts are given below:—

	Percent of fresh weight	Percent of dry weight
Chlorophyll a	0·2	0·63
Chlorophyll b	0·075	0·24
Carotin	0·017	0·05
Xanthophyll	0·033	0·09

In green algae the same four pigments are present; in the brown and red algae and blue-green algae chlorophyll is present in association with other pigments which give these plants their peculiar colour. The assimilating pigments are not dissolved generally in the cell but are associated with denser portions of the protoplasm of definite form, known as plastids; it is apparently in these plastids that the special physical and chemical processes characteristic of photosynthesis occur. It is generally accepted that the two green pigments are the most important in the process of photosynthesis. One of the functions of the green pigments is clearly that of absorbing the necessary energy for the decomposition of carbon dioxide, and their solutions show very characteristic absorption bands, particularly in the red-orange and the violet end of the spectrum. Whether in addition the chlorophyll reacts chemically with the carbon dioxide is still in doubt. Willstatter and Stoll hold that the carbon dioxide combines with the chlorophyll to form a definite compound on which light acts; it is thus converted into a substance of the nature of a peroxide which can be acted upon by an enzyme.

Products of Photosynthesis.— Sachs (1862) was the first to relate the carbohydrates appearing in the leaf to the process of assimilation; he was responsible for the dictum that starch was the "first visible product of assimilation." This was based on the fact that in the case of many plants starch appeared in the plastids of the leaf in the light and disappeared again in the dark. It is now generally agreed that carbohydrates of some kind are the main products of photosynthesis, though many monocotyledons form little or no starch, but much sugar in the form of glucose, fructose and cane sugar. Which carbohydrate is first formed is a matter in dispute. In green leaves exposed to light cane sugar accumulates markedly; this has led to the view that it is the first formed sugar. A much more plausible hypothesis would seem to be that hexose sugars (glucose and fructose) are first produced, and that when these reach a certain concentration cane sugar is formed from them; this view is supported by the work of Weevers (1924). The starch arises in all probability from glucose and it would seem likely that there is a critical concentration of sugar in the chloroplast above which starch is formed from the sugar, and below which the starch is converted back into sugar. This is confirmed by the fact that by floating leaves on sugar solutions of high concentration even those which are normally starch-free will produce that substance in their chloroplasts.

Effect of Various Conditions on the Rate of Photosynthesis.—The rate of this process is affected by the concentration of carbon dioxide available, by the amount of water, by the intensity of the light and by its wave length, by the chlorophyll content, by the supply of oxygen and of mineral salts, and also by many other internal conditions, or factors as they are called. It used to be supposed that all these factors acted independently, but it was shown by the work of F. F. Blackman (1905), that the factors are closely interrelated. He put forward the "theory of limiting factors," that in any set of conditions the rate of a physiological process was determined by the factor present at the lowest intensity. The view that under any set of conditions it was only by the increase of the intensity of one factor that the rate of the process could be increased requires some modification in the light of recent work. It is clear, however, that if any factor A is present at very low intensity it will prevent an increase of another factor B having the marked effect upon the rate of the process which it would have produced if the factor A were acting at a higher intensity. Bearing this relationship of the factors in mind, we find that with increasing concentration of carbon dioxide the rate of assimilation goes up proportionally, if the concentration is not too high and light and temperature are sufficient. Similarly with increasing light-intensity the rate of assimilation goes up proportionally if the temperature and concentration of carbon dioxide are sufficient. With high light intensities there is probably a falling off in the rate, as with higher concentrations of carbon dioxide. With a moderate temperature, if other conditions are favourable, the rate of assimilation obeys the Van't Hoff rule, approximately doubling for each rise of temperature of 10° C. At higher temperatures, somewhere in the neighbourhood of 25° C, with some plants, the injurious effect of high temperature appears and the rate begins to fall off. The process of assimilation is little sensitive to the concentration of oxygen, reduction to $\frac{1}{100}$ of the normal amount having no effect, but complete absence of oxygen acts injuriously. A number of *internal* factors must markedly affect the rate of photosynthesis, but the only one that has been closely investigated is that of the chlorophyll-content, by Willstatter and Stoll. It was found that the photosynthetic rate per unit of chlorophyll (the "assimilation number") varied markedly in different plants and even in the same plant. Leaves of yellow varieties were found to show very high rates in proportion to the amount of chlorophyll present, though the rate in these leaves is less influenced by temperature than is that of fully green leaves. Clearly there is some internal factor (or factors) other than chlorophyll content which is controlling the rate. This may be termed the "protoplasmic factor"; Willstatter and Stoll conclude that this factor is enzymic.

Quality of Light and Photosynthesis.— The question of the effectiveness in photosynthesis of light of different wave lengths has been hotly debated by physiologists for many years. The question is a complicated one since in white light there are great differences in the energy-value of the rays of different wave lengths, and the different rays are absorbed to a very different degree by the chlorophyll and the colourless parts of the leaf. In the case of the leaf there is little doubt that with equal intensity of incident light the red rays are more effective than the blue. The work of Warburg and Negelein quoted below indicates also that for equal quantities of light-energy *absorbed* by *the chloroplast,* the red rays are considerably more effective than the blue.

Efficiency of the Photosynthetic Process.—It is known that the green leaf is comparatively inefficient as a producer of assimilation material. Brown and Escombe (1905) attempted to determine the efficiency of the green leaf by comparing the energy of the light absorbed with the absorption of carbon dioxide, the assumption being made that glucose was produced in the leaf from the carbon dioxide. Their results are only very approximate but they indicate that the efficiency is only about 1%, increasing however with low intensities of light to about 4%. A large proportion of the energy absorbed is used in transpiration, and with the higher intensities of light the concentration of carbon dioxide in nature is too low to allow of the light being fully effective. The most accurate experiments on the efficiency of the photosynthetic process are those of Warburg and Negelein (1922 and 1923) with the minute unicellular fresh water alga, *Chlorella.* With such a plant there is no question of transpiration, and the experimental arrangements were such that practically the whole of the light received was absorbed by the chloroplasts of the cells; in the case of the leaf a considerable amount of the light passes through it and a certain amount is reflected. Warburg and Negelein show that with decrease in the intensity of the light the efficiency goes up, *i.e.,* a larger proportion of the light absorbed is made use of in photosynthesis, the rate of the latter process being measured by the production of oxygen. In their earlier experiments they obtained an efficiency of 71% when using yellow and yellow-red rays; the methods employed for calculating this were, hcwever, not altogether satisfactory. In their later work they obtained results of 59% for red light, and 34% for blue light. Whether these percentages are the maxima that can be obtained is not yet certain.

Cosmic Relations of the Photosynthetic Process.—As already stated this process is the fundamental chemical process on which the life of all animals and plants depend. A study of the land plant's relation to the sun shows it as a machine of comparatively low efficiency, since only a small part of the sun's energy is stored by the plant, crops such as cereals and potatoes retaining only 2 to 3% of the energy received. This uneconomical working is in part due to the fact that so much of the sun's energy consists of invisible heating rays which the plant cannot use for food production. Furthermore the plant is somewhat more efficient than first appears as part of the material manufactured during the day is burnt up again in respiration and so lost. The proportion so lost is very variable, depending largely on the temperature at night; it may be taken as 20–50 per cent. Another cause of the low efficiency of the plant, as has already been pointed out, is the low concentration of the raw material (the carbon dioxide) available for the process. It has been suggested that in early Carboniferous times when coal was formed, the concentration of this gas was higher. However this may be it is clear that the energy available from our rapidly lessening stores of coal and oil is really the energy of sunlight received by the earth many thousands of years ago.

RESPIRATION AND FERMENTATION

Respiration and fermentation are closely allied processes. Both consist in the breaking down, generally by an oxidation, of complex organic compounds, commonly sugar, into simpler ones with a liberation of energy. In respiration oxygen is usually necessary and the breakdown is complete, carbon dioxide and water being formed. In the second oxygen is not necessary and the chemical degradation is not complete, some organic substance such as alcohol being the end product. As is to be expected the release of energy for a given amount of sugar consumed is much greater in respiration than in fermentation, the first being a much more economical process than the other. By means of these two processes the plant gains supplies of available energy from the food material consumed. Such supplies of energy are necessary to maintain the dynamic equilibrium of the cell and to carry on various chemical processes in which energy is absorbed. In the higher plants some of the energy is also used in mechanical work.

Aerobic Respiration.— As has already been stated absorption of oxygen and the production of carbon dioxide are characteristic of the majority of plants as they are of animals. The carbon dioxide is not the only product for if sugar is oxidized an equal number of molecules of carbon dioxide are formed together with a certain amount of heat. The term *aerobic* respiration is applied to this process in contrast with the one in which oxygen is not necessary, which is termed *anaerobic* respiration and is akin to fermentation. Various substances appear capable of being oxidized in respiration, sugars, fats, proteins, sulphur, ammonia, nitrites, methane, (CH_4) hydrogen, etc., but in the higher plants sugar seems to be the substance most commonly consumed. The action is an oxidation and may be expressed thus:—

$$C_6H_{12}O_6+6O_2=6CO_2+6H_2O$$

together with a release of 674,000 calories of energy.

The intensity of respiration varies enormously in different plants and different organs of the same plant. Actively growing tissues such as meristematic tissues show the most intense respiration, in some cases as in the developing spadix of arum *(see* ARACEAE) the rate is as high as in warm blooded animals and the heat generated is sufficient to raise perceptibly the temperature of the inflorescence. Developing seeds also show active respiration; poppy seeds at 16° C give out in 24 hr. 122 cc. per gram of *dry* weight. Leaves pressed together in a receptacle where heat losses are small may in the process of respiration raise the temperature so much as to bring about their death. When sugar is used in respiration the amount of carbon dioxide given out is equal to the amount of oxygen taken in; the *respiratory quotient* (CO_2/O_2) is then one. In other cases it is widely divergent from unity especially when fats or proteins are being consumed.

Effect of Conditions on Respiration.— The rate of this process is markedly affected by various external and internal conditions. Temperature is one of the most active as is to be expected, since a rise of temperature tends to accelerate chemical processes generally. The effect on respiration is very similar to that on assimilation *(see* abovr) and again markedly depends on the duration of exposure to higher temperatures. The respiration rate is very low round about the freezing point, but rises with increase of temperature, being very approximately doubled for a rise of temperature of 10° C. After a time, however, an injurious effect with rise of temperature sets in—no doubt an effect on the protoplasmic mechanism, since high temperatures affect colloids.

The rate of respiration is also affected by the amount of the available material. Increase in the concentration of sugar supplied tends to raise the rate, as can be shown by adding or subtracting sugar from the food supply of a fungus in culture. A reduction of the amount of oxygen in the air has not much effect on respiration until the amount is considerably reduced. On the other hand the accumulation of carbon dioxide—a product of respiration—has a definitely depressant effect on the rate of both aerobic and anaerobic respiration.

Anaerobic Respiration and Fermentation.— Green plants which normally show aerobic respiration are still able to give out carbon dioxide when kept in an atmosphere free from oxygen; at the same time alcohol is produced in small quantities indirectly showing kinship between fermentation and this type of respiration. The alcoholic respiration of yeast has been the subject of much investigation and is known to be associated with an enzyme-zymase, and the production of a compound of sugar and phosphoric acid (known as hexosephosphate) and an enzyme which acts on this compound. *(See* FERMENTATION.) The work of Neuberg and his collaborators indicates that pyruvic acid is an intermediate product between sugar and alcohol.

Mechanism of Respiration.— The peculiarity of respiration as a chemical process lies in the fact that the plant (and animal) is able to oxidize at quite ordinary temperatures such a substance as sugar, which in the laboratory can only be burnt at high temperatures. The question arises as to the peculiar conditions in the plant responsible for this. Oxidizing enzymes have been claimed as the key to the problem, but while these will readily oxidize certain aromatic compounds they will not act on the respiratory substances such as sugars. Wieland has brought forward an entirely different theory of physiological oxidation in which water is the real source of the oxygen used. In this view the first step in the process is the combination of the respiratory material with water, which is followed by a process of *dehydrogenation,* probably under the action of an enzyme, in which hydrogen is split off leaving the material oxidized. The hydrogen is in an active state and in ordinary aerobic respiration combines with the oxygen of the air to form water; the oxygen of the air thus acts as a *hydrogen acceptor* as it is called. In the absence of air other substances, such as methylene blue or hydroquinone, can take its place. Thus the oxidation of acetic acid to alcohol can go on without oxygen•if methylene blue is present. Glucose also can give carbon dioxide at ordinary temperatures when water and some catalyst, such as palladium black, are present and some acceptor of hydrogen is available. Another theory is that of O. Warburg, who holds that respiration is essentially a surface reaction. He has shown that various substances such as oxalic acid, amino acids, and even sugars are respired in the living organism. The effect of narcotics on the "respiration" of the surface is very similar to that on the respiration of the living organism. Quastel's theory of the activation of the respiratory substances and the discovery by Sir Frederick G. Hopkins of the important sulphur-containing substance glutathione must be referred to. The various theories of oxidation are discussed in the English edition of Kostychev's book on plant respiration *(see* references).

GROWTH

The term growth is generally applied to the increase in size of an organism, In unicellular organisms it applies only to the inciease of the single cell; in multicellular organisms it is generally associated with the formation of new cells as well as with the increase in size of cells already existing. In the growth of the cell we may find an increase in all the cell constituents, cell-wall, protoplasm, etc., though frequently an increase in volume is brought about by the enlargement of the volume of the cell without any increase of protoplasm. Of the manner of growth of protoplasm we know very little. Bacteria (which are unicellular and consist of little else than a mass of protoplasm) when placed under the more favourable conditions of temperature and food supply will multiply so rapidly that each cell divides into two new ones every 20 minutes. The protoplasm thus grows at such a rate that its mass becomes multiplied *eight times every hour.* This shows that the production of protoplasm from non-living material may go on at an astonishing rate, but of the details of this production we are quite ignorant. In cells invested with a cell wall the growth of the latter is due to the activity of the protoplasm. The new wall which divides the parent-cell into two new ones is formed across the nuclear spindle. *(See* above, *Cytology.)* There has been considerable dispute as to the method of thickening of a wall already formed, whether it is by the addition of new layers, *i.e.,* apposition, or by the intercalation of new particles of cell wall material among the old—the so-called *intussusception.* It is probable that the first process is the more common but that both occur.

Effect of External Conditions on Growth.—It is found that on the whole light has a retarding effect on growth. When illuminated the actual length attained by the organ and the rate of growth are both less than in the dark. Dicotyledonous plants grown in the dark have generally much elongated stems and also small leaves but the actual amount of light required to prevent the *etiolated* condition is very small. Light is of course indirectly necessary for the growth of the green plant, as without it the leaves are unable to build up the food material. *Temperature* is the factor which has the most marked effect on the rate of growth, as is to be expected since the temperature so largely controls the rate of the processes on which growth depends. There is a *minimum* temperature below which the growth of the plant or organ does not occur at all, a *maximum* above which the growth stops as a result of injury to the plant, and an *optimum* temperature, the one at which the rate is greatest. These, however, are not absolute terms for, as with all effects of temperature, the degree of temperature cannot be separated from its duration. This is so particularly in relation to higher temperatures which may be injurious only when the duration is prolonged. In the case of the roots of the cress plant, which have been closely investigated, the minimum is found about freezing point, 0° C; the optimum, however, was found to vary with the duration of the exposure. If the roots were tested by means of an exposure of $3\frac{1}{2}$ hours to various temperatures, the optimum was at 30° C; with an exposure of 7 hr. at 29° C, while with an exposure of 14 hr. the optimum was pushed back to 27° C. The maximum also was found to fluctuate in a similar manner being higher with shorter times of exposure. Both light and temperature have also a *formative* effect on the plant in that these factors may affect the shape of plant organs; plants grown at high temperatures in weak lights are noticeably different in appearance from plants grown at a lower temperature and a higher light intensity. The formative effects of chemical substances is also often marked at least in the case of the lower plants. Another external condition necessary for the growth of most plants is a supply of oxygen.

Periodicity of Growth.—Organs of limited growth usually show what is called a "grand period of growth," the rate of growth being at first slow then gradually increasing to a maximum and then slowing down again to zero. This may be illustrated by a zone on the main root of a bean seedling which in *successive days* showed the following increases, the results being expressed in millimetres, 1·8, 3.7, 17·5, 16·5, 15·5, 14·5, 7·0, 0·0. If we express the total length of the root section graphically we have an S shaped curve; the organ or plant body starts as a small structure, grows at first slowly and then with increasing rapidity, and then the rate of growth begins to slow down and finally stops.

Correlation of Growth.—One of the most striking phenomena in the growth of the plant body is the correlation of growth. The thickness of the trunk is related to the size of the branches which it bears, and the size of the root-system is correlated with that of the shoot-system. A good example of correlation is seen in the bending up in a side-shoot to replace the loss of the top of the main stem in the tree trunk of a conifer. It has been known for some time that in the animal body hormones (chemical messengers) are produced by certain glands and that these hormones circulating about the body may control growth and other processes. It has of recent years been demonstrated that the plant possesses growth-promoting substances which can diffuse through the plant and so control growth at some distance from the point of production of the substances.

IRRITABILITY

The term irritability is often applied to the visible reactions which the plant makes to its environment. The particular action of the environment is known as the stimulus, and irritable responses as responses to a stimulus. The stimulus may, for example, be some change in the intensity of light or temperature or gravity or electricity. Some stimuli are necessary for the normal growth of the plant such as a suitable degree of temperature, light, etc.; without such conditions acting more or less continually on the plant body as a whole the organism would not be in a state to react to stimuli. The term stimulus is to a large extent a term serving as a cloak for our ignorance. We do not speak of the stimulus of light causing assimilation because we have some physio-chemical picture of this process. When a shoot turns in response to unilateral light we speak of the light as a stimulus, largely because we are unable to picture the course of events which cause difference of illumination to bring about curvations of the shoot or root. Stimuli have, however, usually one point in common that the stimulus does not itself supply the energy employed in the response to the stimulus, but the energy used in the response comes from a store pre-existing in the plant. The stimulus seems thus to be a releasing mechanism, in which the amount of energy employed has no relation to the energy released. The firing of a gun is a good example where the energy used in pulling the trigger has no relation at all to the amount of energy released in the explosion; irritable mechanisms of this kind are therefore sometimes called trigger mechanisms.

GEOTROPISM

It is well known that the plant body takes up a definite position in space. The main stem of a tree usually stands quite vertically and its branches stand out more or less horizontally. The main or tap root also grows vertically downwards and the rootlets at various angles. It is well known also that if a seedling is placed with its stem and its root horizontal the stem proceeds to curve upwards and the root downwards.

Geotropic Response.—This response is known as a geotropic response. that of the stem being negatively geotropic and the root positively geotropic. We note that the curvature is usually confined to the tips of the organs, *i.e.*, to the growing points of the stem and the root. That the curvature is due to the action of gravity was shown as long ago as 1806 by Knight, the English experimenter. He fixed a number of seedlings in different positions on the edge of a wheel rotating in a vertical plane, that is, on a horizontal axis. The wheel was rotated at a considerable speed so that at its edge there was considerable centrifugal force. The result he observed was that the roots, in whatever direction they had started growing, soon grew outwards at right angles to the direction of the axis. The stems, however, grew in the opposite direction to that in which the centrifugal force was acting and they soon all met in the centre of the wheel. This experiment shows that plants do not distinguish between gravity and centrifugal force, and that the root grows in the direction of the force while the stem grows in the opposite direction. About 70 years later Sachs invented his *klinostat*, an apparatus by which plants are rotated on a disc in a vertical plane, but the speed of rotation is very slow, once in 10–20 minutes. As a result centrifugal force is negligible but the one-sided action of gravity is abolished as every side of the organ in turn faces downwards; the effect of gravity is not annulled but the curving (*tropistic*) effect is abolished. It is evident that the curvature results from the difference in the elongation of the two sides.

Geotropic Curvature is not confined to plant organs which are still in active growth. It may occur in organs which have normally ceased to grow as in the case of the stems of grasses. If a short piece of wheat or barley stem is placed in a horizontal position, the base of the node, to the growth of which the elongation of the node is mainly due, will start into growth again as a result of the stimulus of gravity and the stem turns upward. That such curvature is not a simple weight effect on the plant is shown by the *upward* curvature of the stem, and by the fact that the root often will grow downwards into mercury although in such a dense fluid the root tends to be forced upwards.

Reaction and Presentation Time.—As we are dealing with a stimulus we should expect the effect to be related to the duration, intensity and direction of the force; this we find to be the case When a stem or root is laid horizontal the time taken for the organ to show a visible curvature is 10 to 20 minutes, according to the sensitiveness of the object and the external conditions, such as the temperature. This period is known as the reaction *time*. It is found that this length of time is not necessary to produce a curvature. If after a much shorter time the plant is removed from the horizontal position and placed on a klinostat, the curvature follows later. The minimum time to which the plant must be exposed to the gravitational stimulus in order to show later a curvature is known as the *presentation* time. This is much shorter than the reaction time and varies from as short a period as 2 min. for the inflorescence stalk of the plantain and the hypocotyl of the sunflower, to 25 minutes for some other plants. There is naturally a marked difference in the presentation times exhibited by individuals of the same species. In the oat shoot, for example, the mean time was 32 minutes, but some reacted in less than 14 minutes, while others required more than 49 minutes. It is found that the stimulation applied during the presentation time need not be given all at once. A series of short exposures, each less than the presentation time, may by summation become effective. If the pauses between stimulation are only five times as large as the periods of stimulation the presentation time is not lengthened by the intermittent nature of the treatment. Thus, if the normal presentation time of a shoot is 10 minutes, it will react if placed horizontal for five successive 2 minute periods, with a period of 10 minutes in the vertical position in between. If, however, the period between one stimulation and the next is 20 minutes, then more than 5 of the two-minute periods will be required. The effect of the stimulation thus slowly weakens during the pauses.

The presentation time and reaction time are naturally affected by the intensity of the applied stimulus. We cannot alter the effect of gravity, but we can use instead a centrifugal force which can be increased at will and to which, as has been shown above, plants respond as to gravity. The table below gives the intensity of the centrifugal force measured in terms of gravity (G), the presentation time, and the products of the time by the intensity.

Intensity	Presentation time	Product
46 G	7 secs.	322
24 ,,	12 ,,	287
4·84 ,,	60 ,,	290
0·76 ,,	415 ,,	315
0·14 ,,	2·230 ,,	322
0·04 ,,	7·800 ,,	312

We see from the third column that the geotropic reaction obeys what is called the product *law*—the time of stimulation is inversely proportional to the intensity of the stimulus, so that the product of the two is constant. This product law is also clearly shown when the root or stem is placed at various angles with the horizontal. The horizontal position is found to give the most intense stimulus, the intensity being proportional to the sine of the angle with the vertical at which the organ is placed.

PHOTOTROPISM

The fact that plants growing near a window will bend their shoots towards the light is familiar to everyone. This reaction is known as *phototropism*, which means a turning towards light; the term has replaced *heliotropism*, which means a turning towards the sun, since the reaction is shown in relation to almost any light. As in the case of geotropism there are two types of response, *positive* and *negative*, where the turning is towards or away from the source of light respectively. The first is found strongly marked in most shoots of the higher plants and is also found in a few roots. The positive phototropism of most roots is to be expected, since without some such response the light needs of the plant could hardly be satisfied. It is also to be noted that with the ordinary diffuse light of the sun the phototropic reaction is much more powerful than the geotropic. A seedling developing from a seed underneath a stone in a position to which light reaches, will not, under the influence of gravity, push its shoot fruitlessly against the stone above, but will show a phototropic curvature and so reach the light. Negative phototropism is found in some underground roots but markedly in the aerial roots found in many orchids. There are also plant organs which tend to set themselves at right angles to the direction of the incident light; these show *transverse* phototropism. The phototropic reaction is usually a growth reaction like the geotropic one. The side which becomes convex grows faster than the normal, and the concave side less fast. Also, as in the case of geotropism, unilateral light may cause a curvature in a mature organ by starting growth in length afresh. All light curvatures are, however, not due to growth changes but in the case of some leaves to the turgor changes of special cells.

Phototropism and the Product Law.—As with geotropism we find that the product law holds; the effect depends on the amount of light received, *i.e.*, on the product of the intensity of light multiplied by the time of illumination. The time required with different intensities of light to start a reaction, *i.e.*, the *presentation time*, is given below for the coleoptile (the seedling sheathing leaf) of the oat:—

Presentation time	Intensity (metre-candles)	Product
6 (hours)	0·00085	18·6
1	0·00477	17·2
4 min.	0·0898	21·6
4 (seconds)	5·46	21·8
1/100 (second)	1,902	19·0

It is seen that the product varies about the number 20, which means that the oat coleoptile will respond to 20 metre-candle-seconds. The principle of summation is also found with phototropism; stimuli too weak to cause a reaction will act if repeated. The intensity of the light required to produce an effect for a given time is found to vary with the colour, in other words, with the wave-length. It is found that *visible* light of all wave lengths will act, but the violet light is the most effective.

Conduction of Stimulus.—Charles Darwin showed as long ago as 1881 that the light stimulus might be perceived at one place and the curvature result at quite another place, showing that the stimulus was conducted. This is well seen in certain grass seedlings (such as those of *Setaria*), where the apical cotyledon soon stops growing, while the hypocotyl below continues to elongate for some time. Illumination of one side of the *cotyledon alone* will bring about a marked curvature of the hypocotyl below. In the same way unilateral illumination of the *tip* of the coleoptile of the cereal seedling, such as oat, will cause a curvation of the *lower* part. In relation to the conduction of the phototropic stimulus in this plant a very surprising result was obtained by Boysen-Jensen in 1913. He found that if the tip of the coleoptile be cut off and stuck in again with a thin layer of gelatine and the tip be then exposed to one-sided light a curvature will ensue in the darkened lower region. Later this was shown to be true for other grasses and also for the conduction of a stimulus due to injury. Snow in 1923 was able to show that the same held for the geotropic response of bean roots. If the tip is cut off and is fixed on again with gelatine the roots curve when placed horizontal. This suggests something which can pass a layer of gelatine, *i.e.*, very definitely a soluble growth-promoting substance which differs from the illuminated tip and causes the curvature. It has also been found that the slowing of the growth of a vertical coleoptile caused by decapitation can be largely removed by replacing the coleoptile in position. Such observations as these have led to a large amount of work, particularly in Holland and Germany. The most striking of the results obtained has been that of F. Went (1927), who has shown that by placing cut off illuminated coleoptile tips on small blocks of agar (a gelatine-like material obtained from seaweed) the growth-promoting substance diffuses into the agar. Blocks of this agar when placed on the cut surface of the coleoptile are able to cause curvatures.

Nature of Phototropic Reaction.—The earlier view of the positive response of stems to unilateral light was that the side towards the light being more highly illuminated had its growth rate reduced more than did the other side, with the result that the stern bent towards the source of light. Later, however, when the negative response of other plant organs was observed, and the response of transparent structures like root hairs and fungal hyphae, the view was widely held that the plant responded to the *direction* of the incident light. A. H. Blaauw was the first to return to the simpler theory; he showed that simple unicellular structures like the sporangiophone of *Phycomyces* and the complex hypocotyl of the sunflower exhibited a complicated but definite "light-growth reaction" when equally illuminated all round, the rate of growth being increased in *Phycontyces* and reduced in the sunflower. Light *apart from direction* has thus an accelerating effect in the one case and a retarding effect in the other. The turning of the hypocotyl of the sunflower towards the light is easily explicable as the side towards the light would be more illuminated and so grow more slowly. In *Phycomyces*, however, a negative phototropism might be expected, since the "light-growth reaction" is one of retardation, but in fact the curvature is towards the light. Blaauw, however, pointed out that the glass-like cylindrical structure of the sporangiophore acts like a lens and focuses the light on the further side, which is thus more intensely illuminated than the nearer. As a result of his work Blaauw put forward the view that in general the phototropic reaction is simply a growth response to differences of light intensity on the two sides of the organ.

The chemotactic movements of antherozoids and bacteria and the chemotropic movements of roots cannot here be dealt with, but a few words must be said on the so-called *nastic* movements of plant organs. These are movements which may be called out by a change in external conditions, but, as already stated, the nature of the movement is not determined by the stimulus from outside. The perianth leaves of the tulip exhibit a *thermonastic* movement, for when the temperature is raised these leaves open as a result of the greater growth of the upper sides. Many flowers show *nyctinastic* movements, opening and closing in response to changes of light intensity. Similar movements, the so-called *sleep movements*, are also known in leaves, especially in the leaves of Leguminosae.

Photoperiodism.—A very interesting reaction to light, which is in no sense a phototropic response, has been discovered of late years. It is a familiar fact that at least in temperate climates many plants flower only at certain periods of the year; there are so-called spring flowers, autumn flowers and plants which flower in the summer. This marked seasonal effect must be due to some varying external condition or set of conditions. It has often been supposed that, temperature plays a large part in the development of flowers, and a certain degree of warmth is essential for growth, yet altering the temperature alone will not markedly alter a plant's flowering period. Asters and chrysanthemums cannot be made to flower in summer by lowering the temperature, nor irises in winter by putting them in a greenhouse.

Apart from temperature there is one regular cyclical change associated with the march of the seasons and that is the change in length of the day and night, the day in the latitude of London varying from $16\frac{1}{2}$ hours in June to a little under eight hours in December. It was shown by Garner and Allard that in the case of many plants it is the length of the day which is the decisive factor in fixing the season of flowering. The discovery was made in the United States, where the behaviour of a valuable variety of tobacco, known as Maryland Mammoth, was being studied. It had been found impossible to obtain seeds from this variety since it went on growing steadily through the season, sometimes reaching a height of 12 ft., being eventually cut down by frost before it had formed flowers. One autumn a specimen was transplanted to a greenhouse, where it promptly flowered and set seed. This was at first thought to be an effect of temperature, but further investigation showed that it was impossible to cause the plants to flower in summer. It was soon found that the *dominating factor was length of day;* if growth conditions were favourable it would flower in the short days of late autumn or winter but not in the long days of summer. By artificially shortening the day to 12 hours, by placing the Maryland Mammoth plants in the dark during some of the daylight hours, flowering could be brought about at any time of the year. Following up this discovery Garner and Allard investigated at Washington the behaviour of a large number of plants. These were grown in pots which were borne upon light trucks running on lines so that the pots could be run in and out of sheds and thus be illuminated for various fractions of the daylight period. Many plants, such as the tobacco variety mentioned above, soya beans, asters, chrysanthemums, poinsettia, were found to be "short day" plants, and would only flower when the period of daylight was reduced to 12 hours or less. If the time of illumination is suitably adjusted the plants will flower and fruit when they are quite diminutive, while other individuals exposed to full daylight grow to a large size without any trace of flower production. Other plants such as grasses have been shown to be "long day" plants, which require a long daily period of illumination for the initiation of flowering.

BIBLIOGRAPHY.—Pfeffer, *Plant Physiology* (1890); Benecke-Jost, *Pflanzenphysiologie* (1924) (Eng. trs., 1st ed., 1907); V. O. Palladin, *Plant Physiology* (1923); S. Kostytschew, *Lehrbuch der Pflanzenphysiologie* (1906); H. Lundegårdh Klima und Boden, *Pflanzenleben* (1925); W. M. Bayliss, *Principles of General Physiology* (1921); J. F. McLendon and G. Medes, *Physical Chemistry in Biology and Medicine*, and J. F. McLendon, *Physical Chemistry of Vital Phenomena* (1917); O. Meyerhof, *Chemical Dynamics of Vital Phenomena* (1927); P. Haas and T. G. Hill, *Chemistry of Plant Products* (1928); S. A. Waksman and W. C. Davison, *Enzymes* (1926); R. Chambers, *Amer. Journ. Anat.* 35 (1925); G. W. Scarth, *Protoplasma* II. (1927); W. J. V. Osterhout, *Journ. Genl. Physiol.* XI., 391 (1928); C. A. Shull, *Botan. Gazette* 62 (1916); E. J. Russell, *Soil Conditions and Plant Growth* (1927); Brown and Esscombe, *Phil. Trans. Roy. Soc.* B. 193 (1900); F. E. Lloyd, *Physiology of Stomata* (1908); Darwin and Pertz, *Proc. Roy. Soc.* B. 84 (1911); Darwin, Proc. Roy. Soc. 87 (1914); F. V. Henderson, *Annals of Bot.*, 40 (1926); J. G. V. Loftfield, *The Behaviour of Stomata* (1921); G. W. Scarth, *Protoplasma* II. (1927); H. H. Dixon, *Transpiration and the Ascent of Sap* (1914), and *The Transpiration Stream* (1921); H. H. Bode, *Beiträge zur Dynamik der Wasserbewegung, Gefässpflanzen, Jahrb. f. wiss. Botanik*, 62, 92 (1923); W. Stiles, *Permeability* (1924); W. J. V. Osterhout, *Journ. Gen. Physiol.* VII., 561 (1925); M. M. Brooks, *Protoplasma* I., 305 (1927); V. H. Blackman and S. G. Paine, *Annals of Bot.*, XXXII. (1918); C. Olsen, *d. Trav. Labor. Carlsberg*, 15, 1 (1923); E. J. Salisbury, *Journ. Ecol.* 8, 202 (1920), and 9,220 (1921); W. E. Brenchley and K. Warrington, *Annals of Bot.* XLI., 167 (1927); H. H. Dixon, *The Transpiration Stream* (1921); O. F. Curtis, *Annals of Bot.*, XXXIX., 573 (1925); T. G. Mason and E. J. Maskell, *Annals of Bot.*, XLII., 1 and 571 (1928); H. A. Spoehr, *Photosynthesis* (1926), and W. Stiles, *Photosynthesis—the Assimilation of Carbon by Green Plants* (1925); R. Willstätter and A. Stoll, *Untersuchungen über Chlorophyll* (1913), and *Untersuchungen über die Assimilation der Kohlensäure* (1918); T. Weevers, *Kem. Akad. Wetensk*, Amsterdam, *Proc.*, 27 (1924); F. F. Blackman, *Annals of Bot.*, 19 (1905); H. T. Brown and Escombe, *Proc. Roy. Soc.* B. 76 (1905); O. Warburg and E. Negelein, *Zelt für physikalische Chem.* 102 (1922) and 106 (1923); O. Warburg, *Über die Katalytischen Wirkungen der lebendigen Substanz* (1928); F. G. Hopkins, *Biochem. Journ.* 15 (1921); Quastel, *Biochem. Journ.* 20 (1926); S. Kostytschew, *Plant Respiration* (1927); D'A. W. Thompson, *Growth and Form* (1917); T. Brailsford Robertson, *Chemical Bases of Growth and Senescence* (1923); R. Snow, *Annals of Bot.* XXXVIII. (1923); Buder, *Ber. d. deutsch. bot. Ges.* 36 (1918) and 38 (1920); W. W. Garner and H. A. Allard, *Journ. Agric. Res.* 18 (1920) and 23 (1923); K F. Kellerman, *Quart. Review of Biology* I. (1926).

(V. H. B.)

PATHOLOGY OF PLANTS

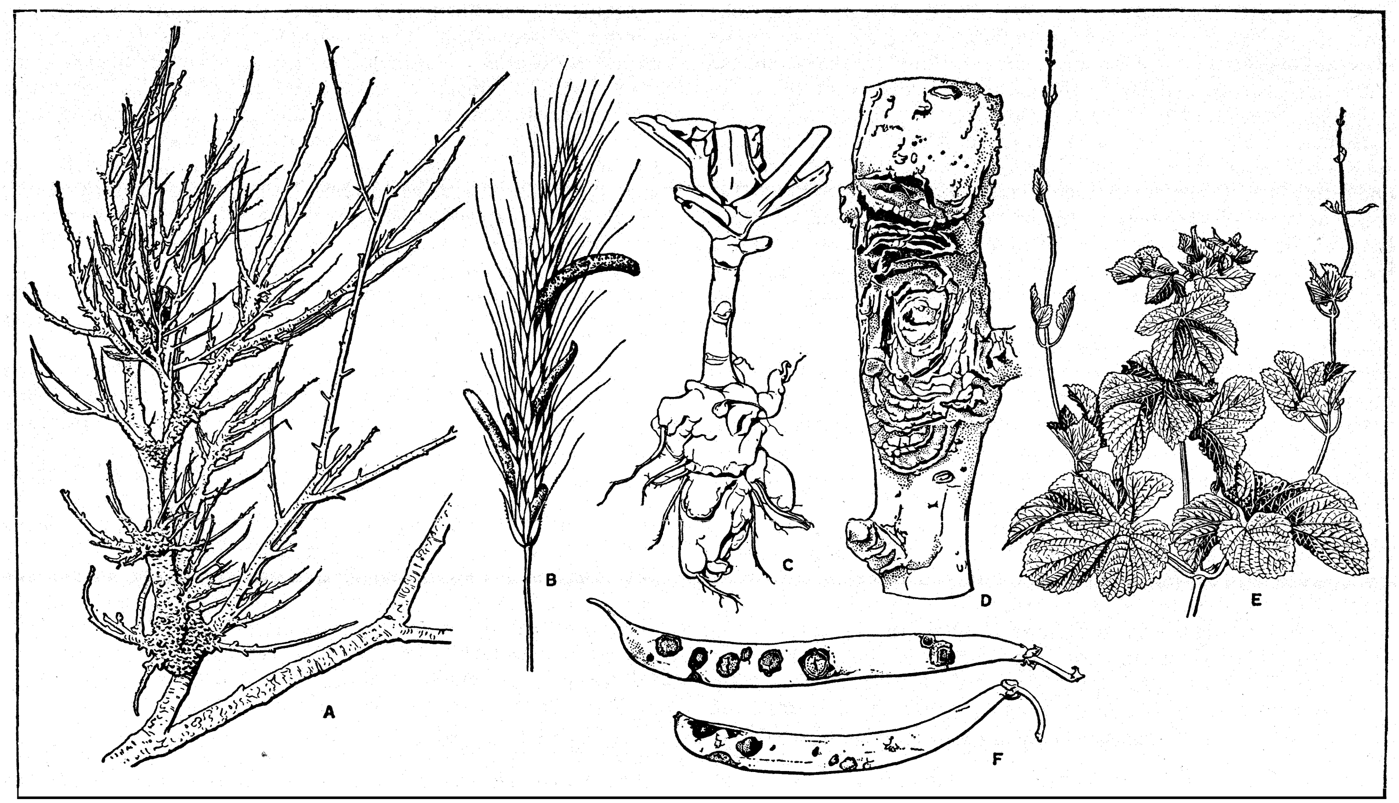
Plant pathology (or Phytopathology) is that branch of biological science which treats of the diseases of plants. While there can be no doubt that diseases of plants, and in particular of cultivated plants, have manifested themselves from time immemorial, it is only within comparatively recent years that their study has been taken up in an organized and scientific manner. The application of the scientific method generally to the study of practical agricultural problems is a development scarcely older than the 19th century.

Historical.—In view of the devastating effects of plant disease, especially when the particular plant attacked is of primary importance as food for mankind or his domestic animals, it is not surprising to find that references to epidemics of disease are not uncommon in historical writings, even of remote times. The earliest records are to be found in the Old Testament (*e.g.*, Deut. xxviii., 22, 1 Kings viii., 37) under such terms as "blasting" and "mildew." The precise nature of the diseases referred to cannot now be determined but there is little doubt that some of the epidemic diseases of cereals, such as rust or mildew, are indicated. The ravages of insects are frequently noted, such as for instance plagues of locusts, caterpillars and canker-worms.

In Greek literature we find references to plant diseases in the writings of Aristotle, and more particularly in those of his pupil Theophrastus, the father of botany. The latter describes diseases of a number of cultivated crops, such as various legumes, cereals, fig, olive, etc., and observes that varieties of the same crop may show different degrees of resistance to disease. This is probably the first mention of the idea of "resistant varieties" which figures so largely in present day writings on the subject. Among Roman writers the younger Pliny, who flourished in the 1st century of our era, devotes some attention to the subject and makes a number of well-founded observations regarding the incidence of certain plant diseases.

The middle ages were for plant pathology, as for all other sciences, dark ages and we have to come down to the Renaissance, with its general quickening of interest in all intellectual pursuits, to find evidence of further progress. The 17th and 18th centuries witnessed considerable activity in the study of plant diseases. The new studies proceeded in the main from two different directions. The practical gardener or agriculturalist was chiefly concerned in describing the various diseases to which his crops were subject and in attempting to evolve methods of treatment. On the other hand, the student of human pathology was interested in the diseases of plants from the possible analogies to his own problems which such a study might offer. The whole science of botany had in the old days a distinct medical bias. It is not surprising, therefore, that the study of plant diseases has been to a large extent modelled upon the older science of human pathology, the terminology of which has been freely borrowed.

The elucidation of the real nature of plant disease, from the point of view of the causal agent, is mainly dependent upon the perfection of the microscope. But even the extended powers of observation which the use of that instrument brought to bear on the subject did not at once lead to a correct appreciation of the true nature of plant disease. Various structures were observed and accurately figured in detail as being associated with the diseased parts, but they were interpreted as portions of the plant which had become changed by the disease and not as belonging to a distinct organism which was responsible for the disease. The first incontestible proof that a specific plant disease was due to the invasion of the tissues of the plant by a definite parasitic organism was furnished by the German scientist, De Bary, whose pioneer researches prepared the way for a host of other workers, at first chiefly in Germany, and later in all civilized countries. The 20th century has witnessed an extraordinary activity in the study of problems of plant disease, most strikingly, perhaps, in the U.S.A. The economic importance of the subject, as a branch of scientific agriculture, has become increasingly recognized and the prosecution of plant disease researches is being more and more taken up by Government departments in all countries possessing a progressive agriculture



FROM (A, B, C, D) DUGGAR, "FUNGOUS DISEASES OF PLANTS" (GINN & CO.), (E) SALMON & WARE IN JOURNAL OF MINISTRY OF AGRICULTURE (H M. STATIONERY OFFICE), (F) WILTSHIRE IN "STUDIES ON THE APPLE CANKER"

FIG. 1. —TYPES OF PLANT DISEASES

A. Abnormal development of buds on branch of cherry giving rise to "witches' broom." B. Ergot of rye, showing replacement of grain by a fungal structure (Sclerotium). C. Finger-and-toe or club root disease of cabbage. D. Canker of apple tree. E. Spike disease of hop (Central branch diseased, lateral climbing branches healthy). F. Spotting of fruit disease "Anthracnose" of bean

Definition and Scope.—While it is true that the distinction between a healthy and a diseased plant is often perfectly obvious, it is not easy to frame a definition of the diseased condition which will meet all cases. The border line between health and disease is not always sharply marked. It will be shown below that the majority of plant diseases result from the invasion of the plant tissues by a definite organism, the parasite. Nevertheless, the presence of a parasite does not always necessarily mean disease in the common acceptation of the term. For example, the root-nodules of leguminous plants (pea, bean, clover, etc.) are produced by the attack of an organism—a bacterium—and far from producing damage, the presence of the bacterium is essential to the proper development of the plant. The important part played by certain fungi in the germination and subsequent growth of many plants, such as orchids and heaths, is a further illustration. The living together of two organisms does not necessarily produce injury to either partner, in which case one speaks of a symbiotic relationship. Every gradation may be traced from the purely symbiotic type, in which the two partners are benefited or not obviously injured, to the distinctly parasitic type in which one partner thrives at the expense and to the detriment of the other. In fact both types of relationship may be shown between the same two partners—that is, a symbiotic or harmonious relationship is at first set up, but by and by one of the partners suppresses the other and the relationship becomes one of parasitism. There is thus a gradual transition from a condition of health to one of disease.

So far reference has only been made to the diseases of parasitic nature. Over and above these there is a class of diseases in which no parasite is present at all, viz., the so-called plzysiological diseases. The existence of the latter increases the difficulty of defining disease in terms of the causal agent.

Perhaps the most adequate definition is obtainable by considering the normal development of a plant. Over a certain range of conditions, which one reckons as normal, a particular species of plant develops in a certain way—*e.g.,* has a certain appearance, reaches a certain size, and so on—all of which are the reflection of a normal physiology or functioning of the plant. If now a particular individual diverges from the normal and if the abnormality impairs the functioning and more especially imperils the life of the plant, that plant may be considered as being diseased.

From the purely practical or economic point of view, a satisfactory definition of disease presents no great difficulties. Any given crop is grown in the expectation of a certain yield, both as regards quality and quantity. Disease in its economic aspects may therefore be defined as a condition of the crop in consequence of which it fails to give a satisfactory yield.

General Classification.—Diseases, whether of plants or animals, may be classified on the basis of the symptoms produced or of the causal agent concerned. For reasons given more fully below, the latter system of classification is more generally adopted in connection with plant diseases, and it is convenient to give at this point a general classification along such lines in order to limit the scope of the present article. Classified on the basis of the causal agency, plant diseases are as follows:—

(1) Diseases due to the non-living environment.

(2) Diseases due to so-called internal causes.

(3) Diseases due to living agencies, which may be plants or animals.

The first two groups constitute the plzysiological diseases. In group (1) the disease symptoms can be related to certain physical or chemical features of the environment. In group (2) no such association has yet been demonstrated, nor has it been possible to explain the symptoms as being due to the presence of a parasite. The second group is thus defined on purely negative characters, and is in fact a kind of limbo into which are put all diseases the cause of which is still obscure. Some of these may prove, with advancing knowledge, to be referable to either of the other groups.

The members of the third group constitute the parasitic diseases. The plant, technically termed the host, is attacked by another organism called the parasite. The animal parasite may be various—mammal, bird, snail, insect, eelworm, etc. The attack of a crop by such an animal as a rabbit is not usually described as a disease, though there is no difference in kind between such attack and that produced by mites or greenflies. Economically the most important diseases of animal origin are those produced by insects, and these constitute in the main the province of the entomologist. (See ENTOMOLOGY: Economic.)

Plant parasites may be bacteria, algae, fungi (including slime-fungi) or higher plants. Plant diseases of bacterial origin were at one time believed not to exist, on account of the supposed fact that the acidity of plant juices is inimical to bacterial growth. Many bacterial diseases of plants are now known, some of great economic importance. The recorded cases of parasitism due to algae are few and unimportant. Diseases caused by higher plants, some of which will be cited later, are on the whole of greater scientific interest than of economic importance. The fungi (*q.v.*) are by far the most important group of disease-producing organisms, so far as plants are concerned.

Broadly speaking, therefore, the plant pathologist is by training either an entomologist or a mycologist. As far as diseases of parasitic type are concerned, only those caused by plants, and therefore chiefly of fungal origin, will be dealt with in the present article. At the same time it is important to note that the two aspects of the study of plant disease, the entomological and the mycological, cannot in practice always be separated.

Symptoms of Disease.—The study of symptoms is the first step in the examination of a disease problem. By symptoms one means the total of the modifications shown in the plant as the result of disease. In the majority of plant diseases of parasitic type the true symptoms are accompanied at one stage or other of the disease by certain appearances such as the fructifications of the parasite.

A very important difference between the typical plant disease and the typical animal disease is as regards the definiteness of the symptoms shown. In animals and especially in man disease symptoms are usually very characteristic, so that it is often possible to identify (or diagnose) a particular disease from a study of the symptoms alone. With plants this is not generally possible. Disease symptoms in the latter are much more generalized, *i.e.,* the same or approximately the same symptoms can be produced by a great variety of causes. Wilting of the foliage, for example, is a symptom of disease in plants and its cause may be most varied—damage to the roots by fungal or insect attack, damage to the stem, presence of injurious salts in the soil, scarcity of water, and so on. Hence it follows that while a study of the symptoms may give valuable indications of the nature of a particular plant disease, it is in general necessary to discover the cause or aetiology of the disease before the latter can be definitely identified. Determination of the causal agent may be difficult and usually involves considerable expense of labour and time.

While the main symptoms of plant disease are of a rather generalized nature, a number of different types may be distinguished. The more important of these are given in the following list:

(a) Change of colour, such as paleness, silvering, reddening, blackening of leaves. The change of colour may be shown over the leaf or even over the whole plant, or it may be limited to spots, streaks or patterns, such as the well-known "mosaic" appearance.

(b) General wilting of the shoot, as when the plant suffers from drought, or from "damping off" disease, or from the effects of a parasite which destroys the roots or is present in the water-conducting system.

(c) Premature shedding of leaves, blossoms, fruits, etc.

(d) Abnormal *retention* of leaves, which is especially well shown in certain diseases of deciduous trees. The autumnal shedding of leaves is a vital or physiological process, due to the action of a definite absciss or cutting-off layer at the base of the leaf. If this layer is prevented from functioning, as for example by the killing action of a parasite which has invaded it, the leaves cannot be shed in the normal way.

(e) Dwarfing or *stunting,* which may be general to the whole plant or may only be shown in particular organs.

(f) Abnormal enlargement or multiplication of parts (hypertrophy) resulting in the formation of such structures as galls, turnours, knots, warts, etc. (fig. 1). Hypertrophy is generally accompanied by distortion or malformation as in the rolling or puckering of leaves and the twisting of shoots. Frequently it takes the form of an abnormal development of buds, the majority of which would normally have remained dormant. The structures called "witches' brooms" (fig. 1) which are common on certain trees (*e.g.,* willow, birch) are produced in this way.

(g) Replacement of one organ by another, as for example the change of petals into foliage leaves. Some changes of this type, though properly speaking malformations, may be economically desirable and are therefore not considered as diseases. An example is the "doubleness" of some flowers.

(h) Change of habit of growth, *e.g.,* from the prostrate to the erect, from the climbing to the non-climbing type of growth (fig. 1).

(i) Change in the periodicity relationships of the plant, as for example the premature flowering ("bolting") of a biennial plant in its first year of growth, or the opening of foliage or Aoral buds at the wrong time of year.

(j) Replacement of parts of the plant by structures belonging to the parasite, such as the conversion of the rye grain into the resting organ (sclerotium) of the Ergot fungus (fig. 1). "Mummification" of certain fruits is another example of this type.

(k) More or less rapid killing (necrosis) of the plant or parts of it. Killing is often accompanied by more or less pronounced rotting, as in the decay of fruits, buds, etc. (fig. 1). Localized killing of leaves results in the formation of dead spots The killed tissue may remain as such or may dry up and fall out, thereby producing a "shot-hole" effect.

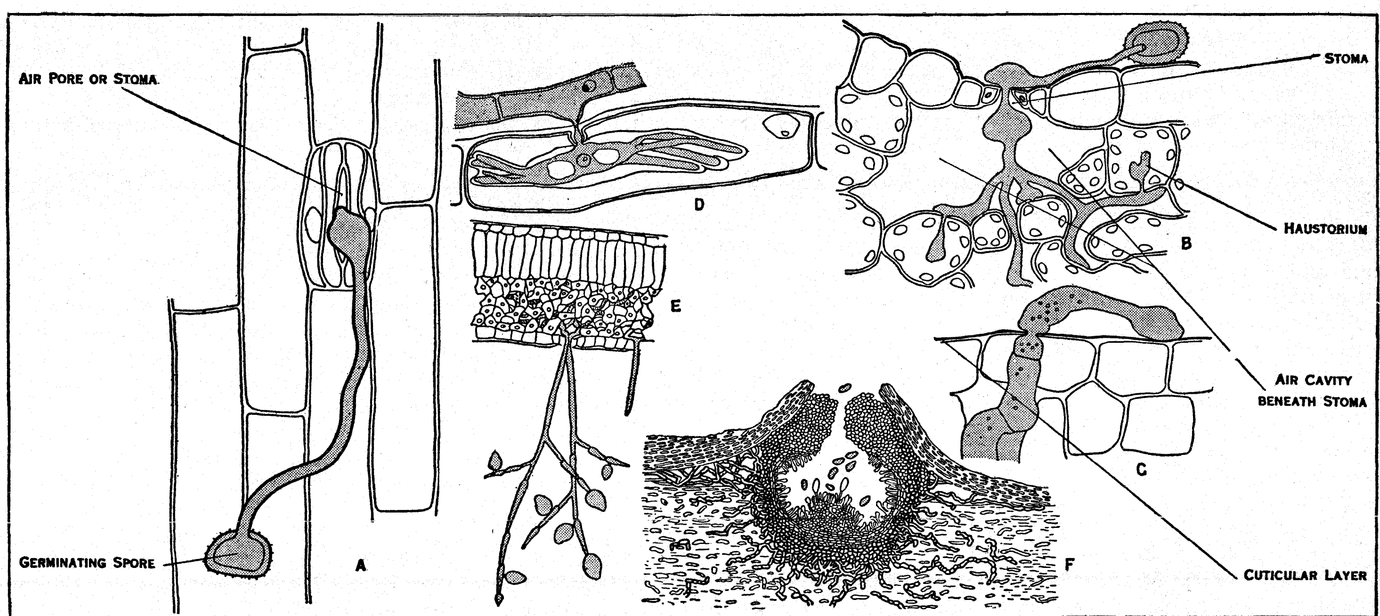
(*l*) Formation of deep-seated wounds or cankers (fig. 1). In a canker, the parasite slowly eats into the plant tissue, the part invaded being killed and to a large extent disappearing. Associated with this type of wound there is usually a certain amount of hypertrophy of the tissue which still remains alive round the margin of the invaded part.

(*m*) Various kinds of exudations, as in the gumming of plum trees or the abnormal flow of resin in certain conifers.

METHOD OF STUDYING PLANT DISEASE

Though the investigation of a plant disease is a matter for the specialist, a short account of the methods adopted will serve to indicate the type of problems encountered. The parasitic type of disease is in practice the one most frequently met with, and therefore in actual study it is usually assumed in the first instance that the disease under investigation is of parasitic origin.

Identification of the Parasite.—The first problem which arises is the determination of the nature of the parasite (assuming that such is actually present). The tissues of the plant which show the symptoms of disease are examined, after suitable preparation, under the microscope and if the disease is actually due to a parasite it is usually not difficult to demonstrate its presence. Definite indications of its nature and identity may also be obtained at this stage. In a number of cases, the parts of the plant which show the symptoms of disease may appear to contain no parasite, even though further study may confirm that the particular disease is of truly parasitic nature. Thus the parasite may be so small as to be beyond the range of microscopic vision (see Virus diseases, below), or, as occasionally happens, the parasite is located elsewhere but is able to produce symptoms in parts of the plant remote from it. The mere presence of a fungus or bacterium within the diseased part (or lesion) is not, however, a certain indication that the disease is caused in that way. Direct proof can only be obtained by inoculating healthy plants of the species showing the disease with the organism in question and observing whether the disease is thereby produced. The details of the procedure involved in the carrying out of such artificial inoculations will vary much in different cases. In general it is necessary, as a first step, to prepare "pure cultures" of the organism, that is, to grow the latter in such a way that no other organism is present. These pure or unmixed cultures of the organism are then tested separately by inoculations on the host plant, and by this means evidence is obtained as to which is the active parasite concerned. The active parasite being isolated and its pathogenicity



FROM (A) PHILOSOPHICAL TRANSACTIONS, BY COURTESY OF THE ROYAL SOCIETY, (B, C) ANNALS OF BOTANY, (D) BOTANICAL GAZETTE (UNIVERSITY OF CHICAGO PRESS), (E, F) DUGGAR, "FUNGOUS DISEASES OF PLANTS" (GINN & CO.)

FIG. 2.—THE FINER STRUCTURE OF SOME PARASITIC FUNGI (MAGNIFIED)

A. Surface view of plant leaf, showing rust spore germinating, B. Section of leaf showing entrance of rust fungus through a stoma, C. Penetration of cuticular layer of plant by fungus, D. Haustorium or abortive process of mildew within plant cell, E. Fructification of potato blight fungus with egg-shaped spores, F. Fructification of Black Rot fungus embedded in the tissue of an apple, rupturing outer skin of the fruit

(or capacity to produce disease) proved, one is now able to identify the particular disease in terms of the parasite which is responsible for it.

Identification of the disease is of value inasmuch as it enables the investigator to correlate his work with similar work done elsewhere, and of which a record is obtainable in the scientific literature. But mere identification is not the most important part of the study. It is essential to work out the *life-history* of the fungus—*i.e.,* to know where and in what form it occurs throughout the year. The same fungus may exist in a variety of forms in different situations or at different times of the year, and it is essential to connect up the various stages. In particular it is very important to establish the manner in which the fungus passes the winter (or equivalent) season. In temperate climates, for example, a summer growing season alternates with a period of dormancy during the winter. Often it is only on the actively growing crop in summer that the disease is observable. It reappears each spring, spreads during the summer, and becomes more or less latent during winter, The considerations which arise in this connection vary much in the different cases. A few examples will illustrate this. Annual crops pass the winter season in the form of seed. Is the disease therefore carried over the winter by means of the seed, and if so is it present within the seed, or is it carried on the surface? Or does it persist in the soil, or is the new crop infected afresh from dead remains (stubble, trash, etc.) of the preceding year's crop? Or again, do various perennial plants, such as certain weeds, serve to carry the disease through the winter? With perennial crop plants such as fruit trees, there is the further possibility that the disease may overwinter in a resting form on or in the plant itself. The determination of the exact method of overwintering which obtains in any particular case is obviously of the greatest practical importance.

The further examination of a disease problem from the point of view of the parasite would take into consideration the geographical range of the latter. Plants showing the particular symptoms would be obtained from different localities and the parasites isolated and compared. Thus a general idea would be obtained of the geographical distribution of the parasite and of the range of host plants which it could parasitize.

The complete elucidation of a plant disease involves much more, however, than the determination of the existence and habits of a parasite as outlined above. The presence of the parasite is only one of the conditions essential for the appearance of a specific parasitic disease. The more important factors and the manner in which they operate will now be indicated.

Temperature.—First as regards temperature. This factor determines in large measure the rate of growth and general vigour both of parasite and host. There is a certain temperature *(minimum)* below which an organism will not grow, a *maximum* above which it will not grow, and an *optimum* at which it grows best. These three temperatures constitute the so-called *cardinal points* for the particular organism. The cardinal points for the parasite are not in general the same as for the host plant, and the cardinal points for the disease itself are not the same as those of either host or parasite. Usually the range of temperature over which disease takes place is distinctly narrower than that over which either of the two organisms concerned will grow. The optimum temperature is well known in many cases to be different for host and parasite, and thus it is clear that the possibility exists of finding a temperature at which the host plant grows well but which is unfavourable for the development of the disease. The precise relationships are somewhat complex and have been fully worked out for a limited number of diseases only, but it is possible in general terms to classify diseases into the two main types, high temperature and low temperature diseases. An example of each will show the difference. The root-rot disease of tobacco is one of the low temperature type. Susceptible varieties of tobacco when grown in infected soil are badly diseased if the temperature rules low, whereas in the same soil the disease would not occur at a higher temperature. The wilt disease of cabbage is of the high temperature type, and only occurs in seasons when the general ground temperature is high.

Water.—The water-relationships of the crop are of equal importance with those of temperature and are to be studied in terms of the amount and distribution of rainfall, the water-retaining capacity of the soil, drainage, etc. Two factors which are of great importance in the initiation of parasitic attack are the relative humidity of the air surrounding the plant and the percentage of moisture present in the soil. The parasite requires the presence of a certain amount of moisture to start its growth processes. So it will often be possible for the plant pathologist to explain the occurrence of disease at one time or place and not at another in terms of these factors. The percentage of moisture in the soil affects not only the capacity of the parasite to grow but also the growth of the roots of the plant. It may therefore also influence the capacity of the roots to resist the attacks of the parasite.

Light.—Light is also a factor which influences the susceptibility of a plant to disease. The quantity of light received by the plant determines in large measure its vigour of growth, not merely as regards the amount of new tissue formed, but also as regards the mechanical strength and to a certain extent the chemical composition of the tissues of the plant. These qualitative differences influence the degree of resistance which the plant can offer to the attack of a parasite. For example the weak, pale, rather juicy, "forced" type of growth which results when plants are grown under conditions of feeble illumination — as when plants are grown in glasshouses during winter or when they shade each other by standing too closely together — predisposes them to attack by a variety of fungi ("damping-off" diseases). On the other hand, certain fungi (*e.g.,* some of the rusts) attack their hosts with vigour only when the latter are growing under conditions of good illumination. Again, the symptoms of certain diseases (*e.g.,* some mosaics) will only appear when the plant is exposed to light of a certain range of intensity.

The three fundamental factors, temperature, humidity and light are, in the open field, to a large extent beyond control. Nevertheless, it is often possible, in agricultural practice, materially to modify their action. By suitable methods of cultivation — draining, subsoiling, ridging, manuring — the amount of soil water can be regulated. By the provision of shade trees — as is usual in many tropical cultivations — or by suitable spacing of the crop itself or by pruning, the intensity of light or humidity of the air can be adjusted so as to approximate to the needs of the plant.

Soil Factors. — Reference has been made to soil moisture as a factor of importance in connection with plant diseases. This is merely one of the many soil factors which influence plant growth and which therefore require to be considered in dealing with the liability of plants to disease. The physical texture of the soil and the presence or absence of certain chemicals are of importance mainly inasmuch as they influence soil humidity. But there are in addition a number of soil factors which act otherwise. Thus the amount of certain constituents present in the soil (*e.g.,* nitrogen, potash, phosphate) influences not only the quantity of plant growth but also, to an appreciable degree, its quality — and in particular its susceptibility to disease. The presence or absence of lime, by controlling the reaction of the soil, is in some cases the factor which determines whether a particular disease will develop or not. Soil aeration is a factor in itself, though in practice it is often difficult to separate its effects from those due to soil humidity.

Internal Factors. — So far the discussion of the factors which influence plant disease has been limited to the environment. The latter, however, merely modifies the result which is in the main conditioned by the structure and physiology of the host plant itself. These "internal" factors are more elusive than those already discussed and in their fundamental aspects are practically unmapped. A few examples of internal factors and of their manner of functioning will be given in the following section. Nevertheless, though very little is known of the underlying factors which determine immunity or susceptibility, certain phases of the problem are open to direct observation and experiment.

From the foregoing sketch it is clear that the complete investigation of a plant disease may ramify into various branches of agricultural science. The plant pathologist is thus much more than a mycologist, or student of fungi, though in practice the two names are often used as equivalent. Plant disease investigations may call for the joint work of the mycologist (or entomologist), the soil chemist, the physicist and the practical agriculturalist, and lastly — as will be shown more clearly later — the co-operation is required of the geneticist for the breeding of resistant varieties, and of the pure chemist for the preparation of chemical means of combating the disease.

NATURE OF DISEASE; PHYSIOLOGY OF PARASITISM

The discussion under this heading will be confined almost wholly to diseases of parasitic nature. The problems presented in parasitic disease are simpler inasmuch as the interactions of parasite and host plant can be studied under the microscope, and to a certain extent at least are amenable to chemical and physical analysis. For simplicity, the description will be confined to a disease of fungal origin.

The earliest phase of such a disease is the entrance of a fungal thread or *hypha* (see FUNGI for account of fungal structure). The fungus, usually in the form of a spore, germinates on the surface of the plant, or otherwise comes in contact with the latter. It then enters, either by naturally occurring openings (stomata, water pores) (fig. 2) on the surface or by boring directly through the skin or cuticle of the plant (fig. 2). Certain parasites, known as *wound* parasites, are only able to enter through openings or wounds which have been made by other agencies; *e.g.,* insect bites, bruises due to processes of cultivation, frost cracks, wind damage, pruning wounds, etc. Then again dispute exists as to whether the actual process of penetration is effected by purely mechanical means or by the agency of some chemical substance which softens or dissolves the cuticular layer of the plant. Once inside the plant, the fungus progresses by sending hyphae through the tissue, either between the cells (*intercellular*) or into the cells (intracellular). The particular relationship shown — *i.e.,* whether the hyphae are between or actually in the host cells — is more or less characteristic of individual diseases. In many cases the hyphae of the fungus ramify between the cells of the host and here and there send characteristic outgrowths (haustoria) into the cells themselves (fig. 2). These outgrowths are clearly the organs which enable the parasite to abstract its nutriment from the host cells.

While the fungus is progressing through the plant, the cells of the latter in the neighbourhood of the parasite, or even at some distance from it, show a number of more or less characteristic changes. The total sum of these changes, it should be noted, constitute the symptoms of the disease. The details of the changes shown vary much from one disease to another, but broadly speaking one can distinguish two main types of disease, each with a characteristic set of host changes associated with it.

Generalized Parasites. — In the first type, the fungus pours out certain chemical substances into the surrounding host cells, with markedly destructive effects to the latter. The living contents (protoplasts) of the cells are killed and the walls which separate the individual cells (and which form the mechanical skeleton of the living plant) are softened or partially dissolved. The destructive principle exuded by the fungus is able to diffuse out into the host tissue and thus bring about killing of the latter well ahead of the growth of the fungus. Fungi of this type are therefore not parasites in the strict sense of the term, inasmuch as they are growing all the time, not on the living plant, but on parts of it they have previously killed.

This type of parasitism is relatively simple and crude. The fungus, so to speak, is in the nature of an assassin who kills and then plunders his victim. The essential part is the killing and this merely entails that the fungus must possess the necessary battery of substances for carrying out this process. In these respects such fungi and the diseases to which they give rise stand in marked contrast to the type which will now be described.

Specialized Parasites. — In the second type of disease, there is no rapid killing or rotting effect produced by the parasite on the host cells in the neighbourhood. The cells of host plant and parasite live side by side for a considerable time with no apparent damage to the former. Indeed it frequently happens that the presence of the parasite stimulates the host cells to unusual growth and activity. Thus the cells in the neighbourhood of the parasite, some of which are actually penetrated by the food-absorbing processes of the latter, are often found on examination to be more richly supplied with food reserves than are the normal cells removed from the zone of influence. If the part of the plant affected is a leaf or other green part, the stimulating effect produced by the parasite may often be seen in the more intense green round the margin of the invaded spot than elsewhere. The stimulating action in many cases takes the form of renewed growth on the part of cells which normally would not have grown further. In this way are produced the tumours, galls, warts, witches' brooms, etc., frequently associated with diseases of this type. Such parasitism illustrates the **symbiotic** relationship to which reference has already been made. The symbiotic relationship may persist for a considerable time, but by and by injurious effects supervene, leading to more or less extensive destruction of the host tissue.

The second type of parasitism is much more subtle in nature than the first. The method of attack adopted has no resemblance to that of the assassin but savours rather of the blackmailer whose interests would not be well served by the premature death of his victim. Up to a point the interests of blackmailer and victim are identical, and if the association leads to unusual industry on the part of the latter the final harvest is all the richer. In diseases of the second type an analogous behaviour is shown. The analogy can in fact be pressed more closely still. Fungi which produce the first type of disease are, like the assassin, not selective in their action. In diseases of the second type, on the other hand, a high degree of selectivity is typically shown.

Fungi which produce this specialized type of disease show specialization in other respects. Their food requirements are of a very particular nature, and on this account it is generally impossible to cultivate them on any medium other than the living plant to which they are specialized. The symbiotic relationship is apparently necessary, and if this is not developed, no effective parasitism ensues.

As fungal attack progresses, one usually finds that the parasite makes provision for its further distribution by the development of a fruiting or sporing stage. The spores may be formed within the tissue of the parasitized plant and are disseminated only when the latter is decomposed, as for example by rotting on the surface of the soil. More generally the fructifications of the fungus are developed on or towards the outside of the plant, either emerging from the stomata or bursting through the outer skin (fig. 2). Many fungal parasites develop two kinds of spore. One of these is produced in profusion during the growing period and serves to spread the disease rapidly to new plants. This is the so-called summer spore, which is usually short-lived and germinates with great readiness when the environmental conditions are suitable. The second type of spore is usually produced later in the season. This is a resting form which typically will not germinate until after a certain interval has elapsed, and which in some cases requires exposure to winter cold before it is capable of germination. The resting spore is usually provided with a thick protective wall, and is capable of enduring long exposure to atmospheric conditions. Its function is to carry the fungus over the winter.

Immunity. — The preceding sketch of the progress of a successful parasitic attack would be incomplete without some reference to those features of the plant which confer resistance or immunity to disease. These are the "internal" (as apart from environmental) factors to which reference was made above. It was also pointed out that immunity to certain highly specialized fungi was really due to over-susceptibility.

It may be noted in the first instance that a plant may be immune in the practical sense for the reason that it merely *escapes* disease. Internally it may be just as susceptible as other plants which become badly diseased. The presence of water-drops on the surface, which enable germination of the fungal spores, is a necessary antecedent to attack. Many plants are enabled to escape attack on account of a property of their outer surface which prevents the adherence of water.

With fungi which penetrate the cuticle, the strength of the latter is obviously of importance, at least if the mechanical view of penetration is accepted. In many cases there is definite evidence that this factor comes into play. Thus certain fungi are only able to attack the young leaves in which a mature, fully thickened cuticle is not yet present.

When the fungus has actually entered the tissues of the plant, it must, if parasitism is to be effected, be able to live in the sap with which it comes into contact. Attempts have therefore been made to explain the susceptibility or resistance of a tissue in terms of the properties of the plant juices. Certain difficulties of a technical nature are met with in such investigations; *e.g.*, it is not certain how far an extract which is pressed out from a plant is a true representation of the ceii-sap originally present in the cells. Up to the present it has been possible only in a few cases to correlate the resistance of the host tissue to fungal attack with the anti-fungal properties of the plant juice.

The method by which the "killing" type of fungus breaks down the resistance of the host tissue is by excreting certain enzymes which partially dissolve the cell walls and kill the protoplast. These ferments are highly specific in action; *i.e.*, they are active on some tissues and not on others. The main factor in this connection seems to be the chemical composition of the cell walls.

So far we have dealt with possible chemical measures of defence. Many plants adopt a mechanical means of defence by laying down a protective layer of cork in advance of the parasite. The corking-over of an exposed or wounded surface is a common reaction of plants, and the same often takes place in response to the wound caused by a parasite. One or more layers of corky cells are formed somewhere along the line of separation between diseased and healthy tissue, and these act as a mechanical barrier to further progress. Any condition of the invaded plant which tends to accelerate this formation of cork increases the resistance to attack, and conversely. Similarly it has been shown in one case (the "silver leaf" disease of plum trees) that resistance depends on the formation, as a wound response, of a layer of hard gum which mechanically shuts off the parasite.

No reliable evidence exists as yet of any formation of antibodies such as play a fundamental part in the arrest of certain animal diseases. Here we meet with another illustration of the essential difference between plant and animal diseases.

ECONOMIC IMPORTANCE OF PLANT DISEASES

The number of known plant diseases is very great, and even if those occurring on non-economic plants are ignored, there is still a large residue. A glance at the disease lists of economic crops, such as are published from time to time by departments of agriculture and other bodies, will show as many as twenty or more diseases occurring on particular species of cultivated plants. The majority of these appear, for the present at any rate, to be of little economic importance, but one may say generally that more or less all cultivated plants are subject to two or three diseases of major importance, which at various times or places interfere seriously with their profitable cultivation. Thus in the case of the potato, one may cite four important diseases, blight, wart, common scab and virus disease, all of which afford serious problems to the grower. Of the many diseases reported on the apple, one may mention mildew, scab, canker, brown rot, bitter pit and scald as of the greatest economic importance; and so on, for other crop plants. In any one year and in a given locality, certain of these diseases may do little damage or may even appear to be absent, but over a wide area and over a period of years the aggregate loss is very great. One might forecast that the seriousness of the losses due to plant disease will tend to become greater as the gradual increase in the world's population makes it less possible for the supply of any product to outstrip the demand.

Though the farming class as a whole may in certain cases reap an advantage from the prevalence of plant disease, to the individual farmer the occurrence of disease in his crops can only bring loss. He therefore adopts certain measures with a view to protecting his crops and submits to various legislative restrictions, the object of which is to prevent or limit the spread of plant diseases. All these measures have as their ultimate result an increased cost of production of the article concerned, and this in the long run represents a loss to the community.

Epidemics. — It is, however, when plant disease comes on in epidemic form that the most striking damage is produced. The general public which is unaware of the widespread and ever-continuous frittering away of plant products as a result of disease, sees then the disease in its most concentrated form. Such epidemics have at one time or other produced enormous losses. They have profoundly influenced the economic development of certain countries, and have led frequently to acute distress and famine. The following examples will serve to illustrate these statements.

The rust diseases of cereals are present in all cereal-producing countries and the annual loss in many of them runs into millions of pounds sterling. The estimated loss from the stem-rust disease of wheat in 13 of the northern United States for the ten-year period 1915–24 is given as about 550 million dollars, half of which loss was incurred in a single "rust" year, 1916. The rust epidemic of 1891 cost Prussia about three-quarters of the whole cereal crop. Similar disasters have occurred in India, Australia, South Africa and other wheat-growing countries. It is simply the fact that wheat is cultivated in so many widely separated countries—in all of which a rust epidemic is not liable to occur in any one year—which acts as a safeguard against a serious bread famine.

The coffee disease, also caused by a rust, is a striking example of the effect which a disease may have on the economic history of a country. In the earlier part of the second half of the 19th century, the coffee industry was the mainstay of the prosperity of Ceylon. About 1870 a hitherto unrecorded leaf disease appeared on the coffee bushes. As with many important plant parasites, the seriousness of this disease was not recognized at first. Within a few years the fungus had spread over the whole island and the coffee industry soon disappeared from Ceylon.

Perhaps the most outstanding instance of distress caused by a fungal disease is afforded by the great Irish potato famine in 1845 and 1846. The potato disease ("blight") had only appeared in Europe a few years previously, the causal fungus being, like the potato itself, a native of South America. The disease spread like wildfire over western Europe and in the seasons 1845 and 1846 almost completely destroyed the potato crop in Ireland. As the potato at that time constituted the staple food of the peasant population, the result of the epidemic was a famine of unprecedented severity.

The story of the coffee leaf disease in Ceylon has in recent years found a very close parallel in that of the chestnut blight in the United States. This disease first appeared in 1904 on a few trees in the neighbourhood of New York. Subsequent investigation showed that the causal fungus was a native of Eastern Asia where it occurs on certain native species of chestnut, but without causing appreciable damage. It had apparently been introduced into the United States on a consignment of chestnuts from the East, and there is every probability that if its importance had been recognized, the disease could have been stamped out in the early stages. As it was, the disease began to spread over the New England States and it soon became apparent that the fungus was much more destructive to the American sweet chestnut (*Castanea* dentata) than to the Asiatic forms. Control methods of the most elaborate nature were put in operation, but too late to be effective. At the present time, this disease has destroyed practically all the native chestnuts in the United States. (See CHESTNUT.)

Records of the complete extermination of an industry by fungal disease are fortunately not numerous. On the other hand it would be possible to multiply examples in which fungal diseases are an ever-present menace to particular cultivations. The most important single factor in the cultivation of many economic plants is the liability to certain fungal diseases.

METHODS OF CONTROLLING PLANT DISEASE

The checking of a plant disease, so that if not actually eliminated it is reduced to manageable proportions, is spoken of as its "control." This may be complete or partial. The methods of control may be divided into two main groups, first those which are put into practice by the grower himself, and second those which are enforced upon him by legislation. In the following discussion these will be considered separately.

Voluntary Control.—The adoption of control measures by the grower is subject to a number of severe restrictions. It is only with a certain number of crops that individual treatment of plants is possible, and in all but exceptional cases the economic consideration of cost is all-important. It is idle for the plant pathologist to suggest measures of control if the requirements of time and labour involved in the treatment are such as cannot be satisfied or if the ultimate gain to the grower is not obviously greater than the cost of the measures adopted. The control methods adopted may be directed to increasing the resistance of the plant to disease, or in the case of a parasitic disease may also be directed against the parasite. The former will be dealt with first.

Resistance.—For every plant there is a certain range of environmental conditions within which it grows best. If the conditions vary widely in any important respect from those which are ideal, the plant grows badly. A weakly growing plant is in general more susceptible to parasitic attack than is a strongly growing one, and the abnormal condition of the plant resulting from the unfavourable environment may in itself be so pronounced as to be called diseased. Good cultivation, therefore, which aims at giving the plant the optimal conditions for its growth, is the first line of treatment to be adopted with a view to lessening the incidence of disease.

The most approved methods of husbandry will not however guarantee freedom from plant diseases, nor are they always practicable. More special methods must therefore be adopted. In recent years it has become increasingly recognized that the main line of defence against many important diseases consists in the development of *immune* or resistant varieties of the host plant.

To obtain varieties of a crop plant which are resistant to a particular disease is in many cases not difficult. These may in fact exist among the varieties already in cultivation. If the resistant forms possess high merits in other respects—*e.g.,* in yielding power, in quality of product, etc.—then the problem of the particular disease is in large measure solved. Often, however, the resistant varieties which are already known to occur show certain disadvantageous features, and these may be so great as to outweigh the benefits conferred by the high disease resistance shown.

One method of obtaining a resistant strain from a commercial variety consists in growing the plants under conditions in which they are exposed to infection and selecting out for propagation those individuals which stand up successfully against the disease. This method has been adopted with great success in the development of strains resistant to some of the important wilt diseases (cotton, cabbage, etc.).

A more elaborate method consists in the artificial crossing of parents of known characteristics, followed by the sorting out of the different types which occur among the progeny. (See PLANT BREEDING.) This is the application to problems of disease of the principles of Mendelism (*q.v.*). Resistance to disease behaves as a single or multiple Mendelian factor, and is usually dominant in the immediate offspring.

Destruction of the Parasite.—The control of plant diseases by the adoption of measures against the fungus is best considered with reference to the life-history of the fungus and in particular to the manner in which it reinfects the growing crop after each period of winter dormancy.

If the fungus is a soil parasite, it may be possible to starve it out by ensuring that it does not come in contact with the particular crops on which it grows and multiplies. This involves a system of rotation of crops. The practice of crop rotation is justified for other agricultural reasons and is of great value in that it tends to check the multiplication of specific soil (and other) parasites. Some soil parasites however are able to live indefinitely on the humus material of the soil so that they cannot be starved out (*e.g.,* some wilt diseases), others may persist so long in the dormant form that the interval required between successive susceptible crops is too long to be economically practicable (*e.g.,* wart disease of potato).

The elimination of a parasite from the soil by any process of sterilization is generally impracticable on account of the expense involved. In greenhouse cultivation or in those cases where the main source of infection is the seed-bed, soil sterilization may be attempted. For this purpose, heat (*e.g.,* steam-heat as obtained from a boiler) or a fungicidal chemical such as formalin is generally used.

Preventive Measures.—If the disease is carried by the seed, the practical method of control consists either in the selection of seed known to be free from contamination or in some process of seed treatment devised to destroy the parasite without appreciably affecting the germinating capacity of the seed. If the fungus is present merely on the surface of the seed, treatment is generally simple. This consists in steeping the contaminated seed in solutions of various chemicals—formalin, copper sulphate, mercuric chloride, organic salts of mercury, etc.—for a suitable time. The fungus is killed by this treatment whereas the seed is little damaged on account of the protection afforded by its seed coat. Dusting the seed with various chemical powders is similarly effective.

A general palliative measure in the treatment of plant disease is to reduce the amount of infective material available. If the fungus overwinters on the dead remains of the previous year's crop, the latter should be disposed of, either by burning or by digging into the ground. Crop rotation, by segregating to some extent the current year's crop from last year's, is likewise useful.

One of the most important methods of protecting plants against the attack of air-borne parasites is by the use of fungicidal chemicals which are sprayed or dusted over the plants. The object aimed at here is to coat the surface of the plant with a thin but more or less continuous film of the fungicidal substance so that, when the air-borne spores of the parasite arrive, they are unable to initiate attack. Spraying or dusting, if properly carried out, prevents attack but is ineffective if the disease has already established itself. Thus an intimate knowledge of the life-history of the fungus with special reference to the date at which it emerges from its winter resting stage is of the greatest importance for success in spraying operations. The leaves and young shoots of the plant are readily injured by the action of poisonous chemicals, so that great care is necessary in the preparation and use of fungicides, otherwise greater damage may be done than that which it is intended to prevent. The spray, which consists of a very fine suspension in water of the fungicidal substance, is discharged under pressure in the form of a mist so that as far as possible the whole plant surface is covered. In practice various inert substances ("spreaders") are added in order to facilitate wetting of the leaves and adhesion of the spray. The basis of most sprays in commercial use is either copper or sulphur. To the former class belong the well known Bordeaux and Burgundy mixtures, prepared by adding solutions of copper sulphate to lime and soda respectively. To the latter belong such preparations as "liver of sulphur," "lime sulphur" and "colloidal sulphur."

Legislative Control.—The legislative enforcement of certain measures for the control of plant diseases actually dates back for several hundred years. Witness for example the Rouen act of 1660 for the control of wheat rust by the eradication of barberry bushes (see later). The full development of these measures however has only come about within the last twenty years. The Destructive Insects and Pests Act was passed by the British parliament in 1907 and a similar law, the National Plant Quarantine Act came into force in the United States in 1912. Practically all civilized countries adopted the same type of regulations and at much the same time.

Restriction of Imports.—As between one country and another, the effect of these enactments is to limit free trading in such plants or plant products as are considered likely to bring dangerous parasites into the importing country. The restrictions may amount to a complete embargo, as applies for instance to the import of English potatoes into the United States (on account of the wart disease) or of American gooseberry bushes into England (on account of mildew). In other cases import is allowed provided the material has been inspected by a responsible authority in the exporting country and warranted free from certain diseases. Such material is subjected to further inspection at the port of entry and if found contaminated may be destroyed. From the port it may be liberated directly to the trade or may be sent to a quarantine station, where it is grown in an isolated situation for such time as enables its freedom from disease to be fully established. These restrictive regulations may also be in force between different parts of the same country, as for instance, between the different states of the United States.

Domestic Control Measures.—Within the limits of any one country, legislative control may take the form of compulsory notification of certain diseases. The latter will then be inspected, and the appropriate measures—such as destruction of the infected material—enforced. A further measure is the placing of restrictions on the kind of crop which may be grown within certain infected areas. The legislation against wart disease of potato in England is an illustration of this type of control measure. Within an infected area (called a "scheduled" area) only immune varieties of potatoes may be grown. The enforcement of this kind of measure is very difficult unless suitable immune varieties or other substitute crops are available.

Legislative control of the type outlined above has naturally led to the creation of an inspection service, and further to a wide extension of facilities for advisory work and for the carrying out of research. This increased interest in problems of plant disease, arising from government intervention, is perhaps the most striking development in plant pathology which the 20th century has produced.

CLASSIFICATION OF PLANT DISEASES AND SPECIAL ACCOUNT

In the present section a brief account will be given of some of the more important plant diseases and under the following headings—

(a) Physiological Plant Diseases.
(b) Plant Diseases due to Bacteria.
(c) Plant Diseases due to Viruses.
(d) Plant Diseases due to Fungi and Slime-Fungi.
(e) Plant Diseases due to Higher Plants.

Physiological Plant Diseases.—Plants, like animals, may show deficiency diseases due to the lack of some important chemical constituent in their food supply. Thus a lack of iron salts in the soil produces the condition called "chlorosis," in which the green pigment of the plant, chlorophyll, fails to develop. Lack of potash, such as often occurs in poorly manured soils or in light soils leached by heavy rainfall, produces very characteristic symptoms of disease in certain plants, *e.g.*, potato, tobacco and cereals. Similarly for other essential food elements such as magnesium, phosphate and nitrogen. Conversely disease conditions may result from the presence of an excess of certain chemicals in the soil. To this class belong various kinds of chlorosis, due to excess of lime or manganese in the soil. The most important diseases of this type are those associated with the accumulation of soil alkali. These are met with in irrigated regions where they often constitute the chief agricultural problem.

Among diseases due to unsuitable environmental conditions may be cited those caused by too high temperature, such as sunscorch of leaves, heat canker, etc. The effects of too low temperature are familiar as frost injury to leaves, young shoots, fruit, etc., but a more important illustration is seen in the winter killing of trees in those countries which experience severe winter freezing. The development of "winter-hardy" varieties of cultivated plants is of great importance in countries possessing the continental type of climate.

Injuries due to noxious chemicals in the air are well shown by plants growing in industrial areas. The more important chemicals in this connection are gases, such as coal gas and sulphur dioxide, fumes such as sulphuric acid, and dusts such as soot and cement dust. The latter act by choking up the breathing pores of the plants, but this action is often accompanied by the poisonous effects of gases associated with the dust. In this connection should also be mentioned the injuries which arise from the injudicious use of chemical protective agents such as sprays.

Plant Diseases Due to Bacteria.—The most important diseases of this type are the fire blight (Bacillus *amylovorus*) of apples, penrs and similar fruits; the angular leaf spot or black-arm disease of cotton (*Pseudomonas malvacearum*); the olive tubercle (P. *Savastanoi*); citrus canker (P. cifri); various wilt diseases (*Bacillus tracheiphilus* in cucurbits, *B. solanacearum* in tomato, potato, etc.); soft rots of a number of vegetables (B. *carotovorus* and allied species); two leaf spot diseases of tobacco (*Bacterium angulatum* and B. tabaci); and crown gall (P. *tume*faczens) on a large variety of herbaceous and woody plants.

Plant Diseases Due to Viruses.—This important group was formerly placed among the physiological diseases, but it is now known that they are of infectious or contagious nature. Detailed investigation has failed to show the presence of a visible parasite, but in other respects the resemblance to the parasitic type of disease is very close. The disease can in many cases be transmitted by the inoculation of the juice of a diseased plant into a healthy one. Where this simple method of transmission fails, infection of a healthy plant can be obtained by grafting on it a shoot of a diseased plant. In certain cases it has been proved that the juice of a diseased plant is able to convey infection after it has been filtered through a porcelain cup, whence the current view with regard to these diseases is that they are caused by filter-passing organisms. The symptoms of virus disease are confined to the shoot portions of the plant, and take the form typically of mottling ("mosaic") of the leaves, with as a rule a certain amount of puckering, distortion or inrolling. The habit of growth may aiso be affected, and often there is dwarfing, premature death, and a marked diminution in the yield. The chief agents of transmission are various leaf-biting or leaf-sucking insects, particularly aphides. The number of crop plants which are known to show virus diseases is very large and includes potato, tomato, tobacco, cucumber, clovers, spinach, hop, sugar cane, sugar beet, peach and many others. Certain kinds of ornamental variegation are also infectious and are thus not distinguishable from virus disease.

Diseases Due to Fungi and Slime-fungi.—These constitute by far the most numerous group of plant diseases. The species of fungi which cause plant disease are to be numbered by thousands and occur in all the main divisions into which fungi are classified (see FUNGI). In the majority of text books on plant pathology, these diseases are classified according to the systematic relationship of the causal fungus, but in some cases a grouping according to the crop plant affected or according to the type of symptom produced may offer certain advantages. In the present article, any systematic review of even the more important diseases is impossible. Ail that can be attempted is to indicate some of the more important groups or types.

The Slime-Fungi. (Myxomycetes) are responsible for a few diseases of economic importance. The best known example is the finger-and-toe or club root of crucifers (turnip, swede, cabbage, etc.) due to the organism *Plasmodiophora* brassicae. This disease is remarkable for the large size of the hypertrophies produced on the roots of the affected plants.

The group of the Lower Fungi (Phycomycetes) includes two important disease-producing families. The more important of these is the *Peronospora* family or downy mildews which cause important diseases of a great number of crops, potato, vine, hop, lettuce, several grasses and many others. The downy mildew of the potato (Phytophthora infestans) produces the most important disease of all, the potato blight, to which reference has already been made. Many-seedling diseases ("damping off") also belong here. The most important member of the second family is the organism *Synchytrium* endobioticum, the cause of the black scab or wart disease of potato.

Within the group of the Ascomycetes there are numerous important parasites. Species of *Sclerotinia* produce the brown-rot or "mummy" diseases of apple, plum and similar fruits, being among the most destructive orchard parasites. The family of the Erysiphaceae comprises the powdery mildews. These fungi cause the abundant formation on the plant of a powdery mass of summer spores, whence the name of the group. Crops of economic importance which are attacked by powdery mildews include cereals, clover, vine, hop, gooseberry, stra berry, apple, rose and oak. Species of Exoascus produce the leaf-curl disease of peaches and almonds and a number of interesting if economically unimportant diseases such as witches' brooms on cherry and birch. To the group of Ascomycetes also belong such important diseases as ergot of grasses (Claviceps *purpurea*), apple canker (*Nectria galligena*), wheat scab (*Gibberella* saubinetii), black knot of plum (*Plowrightia* morbosa), chestnut blight (Endothia *parasitica*), and apple scab (Venturia *inaequalis*). The group Basidiomycetes includes three families of parasites of very great economic importance: the smuts, the rusts and the bracket fungi.

The smuts (Ustilagineae) are a peculiar group of parasites which live almost wholly within the host plant and usually direct their attack to the developing flower and fruit. The latter in the typical case is converted into a black powdery mass of spores which constitute the "smutted" head so characteristic of this type of disease. The most important examples are met with among the grasses—viz., the loose and covered smuts of barley, wheat, oats, rye, rice, maize, etc.

The rusts (Uredineae) include perhaps the most important of all plant parasites. The cereal rusts (*Puccinia graminis* and allied forms) are the best known and economically the most serious, but important parasites occur on apple, plum, coffee, Weymouth pine, and many others, especially herbaceous plants. A striking feature in the life history of some of these rusts is that they pass from one host species to another. Thus some forms of the wheat rust parasite have a stage on the barberry; the Weymouth pine blister rust passes to various species of currant. The elimination of the so-called "alternate host" offers a means of control for certain of these rusts. Hence the "barberry eradication campaign" which is being actively prosecuted in certain wheat-growing countries.

The bracket fungi (Polyporaceae) are a• group which attack living trees and timber. These are generally wound parasites which gain entrance through broken branches or other injuries, destroy the wood of the tree, and from time to time produce the well-known bracket-like fructifications on the surface. Species of Polyporus and Fomes attack a large variety of growing trees.

Diseases due to Imperfect Fungi make up an enormous and miscellaneous list, including such as the following: many fruit rots (Botrytis, *Penicillium*), wilts (Fusarium), stripe disease of cereals (*Helminthosporium*), and an almost infinite number of leaf, stem and fruit spots (Phoma, *Septoria, Gloeosporium*, etc.).

Diseases Due to Higher Plants.—Parasites of this type are of great botanical interest, but as a rule of little economic importance. Well known examples are the mistletoe (which is a semi-parasite only, being able to manufacture its carbonaceous food from the air by means of its green leaves) and the dodder or love vine. These attach themselves to and parasitize the stems of other plants.

BIBLIOGRAPHY.—F. D. Heald, *Manual* of Plant Diseases (New York and London, 1926), gives a full bibliography (pp. 20–24) of general and specialized text-books. Current literature: Phytopathology (American Phytopathological Society, 1911 onwards); Journal of Agricultural Research (Washington, D. C.. 1913 onwards); *Annals* of Applied Biology (London, 1914 onwards); *Zeitschrift* fur *Pflanzenkrankheiten*, (Stuttgart, 1891 onwards); Review of Applied Mycology (Kew, England, 1922 onwards). The journal last mentioned gives full abstracts of all the current plant pathological literature. (W. BRO.)

PLANUDES, **MAXIMUS** (c. 1260–1330), Byzantine grammarian and theologian w-ho flourished during the reigns of Michael VIII. and Andronicus II. Palaeologl, spent the greater part of his life as a monk in Constantinople. On entering the monastery he changed his original name Manuel to Maximus. Possessing a knowledge of Latin remarkable for 'his time he was sent by Andronicus II. in 1327 on an embassy to remonstrate with the Venetians for their attack upon the Genoese settlement in Pera. Planudes, especially by his translations, paved the way for the introduction of the Greek language and literature into the West.

He is the author of a Greek grammar, a biography of Aesop and a prose version of his fables, certain scholia, various original poems. His numerous translations from the Latin included Cicero's Somnium *Scipionis* with the commentary of Macrobius: Caesar's Gallic War; Ovid's *Heroides* and Metamorphoses; Boetius, De *consolatione philo*sophiae; Augustine, De *trinitate*. He also edited a supplement to the Anthology known as Appendix *Planudea*.

See Fabricius, Bibliotheca graeca, ed. Harles, xi. 682; theological writings in Migne, *Patrologia* graeca. cxlvii.; correspondence, ed. M. Treu (1890), with a valuable commentary; K. Krumbacher, *Geschichte* der byzantinischen *Literatur* (1897); J. E. Sandys, *Hist.* of Class. *Schol.* (1906), vol. i.

PLAQUE, a small flat plate or tablet, applied particularly to rectangular or circular ornamental plates or tablets of bronze, silver, lead or other metal, or of porcelain or ivory. Small plaques, called plaquettes, in low relief in bronze or lead, were produced in great perfection in Italy at the end of the 15th and beginning of the 16th centuries, and were usually copies of ancient engraved gems, earlier goldsmith work and the like.

PLAQUEMINE, a city of southeastern Louisiana, U.S.A., located on the Mississippi river 14 mi. S.W. of Baton Rouge. It is the parish seat of Iberville parish. Pop. (1940) 5,049, a decrease of 75 from the 1930 figure. Plaquemine is served by the Texas and Pacific railroad and by state highways 30 and 168. Its principal industries include sugar, lumber and oil. The town's chief importance, however, derives from the fact that it is the site of the Plaquemine locks, constructed in 1909. The locks are located in a channel which connects the Mississippi with the Grand river, the Grand in turn being connected with the Atchafalaya, which flows into the Gulf of Mexico.

The function of the channel was at one time assumed by Plaquemine bayou, no longer navigable. The name Plaquemine, given first to the bayou and later to the town, is said to be a derivation of the Indian word for persimmon, a fruit which thrives in the vicinity.

Plaquemine was incorporated in 1838 and became the parish seat four years later.

PLASSEY (Palāsi), village of Bengal, scene of Clive's victory on June 23, 1757, over the forces of the namab Suraj-ud-Dowlah. Clive, with 1,100 European and 2,100 native troops, and 10 field-pieces, took the field against the nawab, who had 50,000 men, 53 heavy guns, and some French artillery under M. de St. Frais.

Only the river Bhagirathi separated Clive's little force from the entrenched camp of the enemy, when the English leader, for once undecided, called a council of war.' Clive and the majority were against fighting, Major Eyre Coote, of the 39th Foot, and a few others for action.

Coote's soldierly advice powerfully impressed Clive, and after deep consideration he altered his mind and issued orders to cross the river.

After a fatiguing march, the force bivouacked in a grove near Plassey early on the 23rd. The nawab's host came out of its lines and was drawn up in a huge semi-circle almost enclosing the little force in the grove, and St. Frais's gunners on the right wing opened fire.

Clive replied, and was soon subjected to the converging fire of 50 heavy guns. For hours the unequal fight was maintained, until a rainstorm stopped it. The English covered up their guns, but the enemy took no such precaution.

Mir Mudin, the only loyal general of the nawab's army, thinking that Clive's guns were as useless as his own, made a disastrous cavalry charge upon them; he lost his own life, and his colleagues then had the game in their hands. Mir Jagar persuaded the nawab to retire into the entrenchments. St. Frais stood fast until one of Clive's officers, Major Kilpatrick, successfully drove him in. Clive followed up this success by cannonading the camp at close range.

But the rank and file of the native army, ignorant of the treachery of their leaders, made a furious sortie. For a time Clive was hard pressed, but his cool generalship held its own against the undisciplined valour of the enemy, and, noticing Mir Jagar's division in his rear made no move against him, he led his troops straight against the works.

After a short resistance, made chiefly by St. Frais, the whole camp fell into his hands. At a cost of 23 killed and 49 wounded this day's work decided the fate of Bengal. Although the historic grove has disappeared, a monument has been erected to commemorate the victory.

PLASTER OF PARIS, $2CaSO_4, H_2O$, a hemihydrated variety of gypsum (dihydrated calcium sulphate, $CaSO_4, 2H_2O$) which forms a cement when treated with water (see CEMENT). It obtained its name in consequence of being manufactured by the calcination of gypsum in the neighbourhood of Paris.

PLASTER-WORK. Piastering is one of the most ancient of handicrafts employed in connection with building operations, the earliest evidence showing that the dwellings of primitive man were erected in a simple fashion with sticks and plastered with mud. Soon a more lasting and sightly material was employed to take the place of mud or slime, and that perfection in the compounding of plastering materials was approached at a very remote period is proved by the fact that some of the earliest plastering which has remained undisturbed excels in its scientific composition that nhich is used at the present day. The pyramids in Egypt contain plaster-work executed at least 4,000 years ago (probably much earlier) and yet existing. hard and durable. Indeed the principal tools of the plasterer of that time were practically identical in design, shape and purpose with those used to-day. For their finest work the Egyptians used a plaster made from calcined gypsum just like the plaster of paris of the present time, and their methods of plastering on reeds resemble in every way our "lath, plaster, float and set" work. Hair was introduced to strengthen the "stuff," and the whole finished somewhat under an inch thick.

Very early in the history of Greek architecture we find (*e.g.*, at Mycenae) the use of plaster of a fine white lime stucco. The art had reached perfection in Greece more than five centuries before Christ, and plaster was frequently used to cover temples externally and internally, in some cases even where the building was of marble. It formed a splendid ground for decorative painting, which at this period of Grecian history had reached a very high degree of beauty. The temple of Apollo at Bassae, built of yellow sandstone about 470 B.C., is an excellent example. Pavements of thick, hard plaster, stained with various pigments, were commonly laid in Greek temples. In England the walls of large houses were formerly plastered above the wainscoting and coloured, while the ornamented plaster ceilings of the time of Henry VIII, Elizabeth and James I, are still the admiration of lovers of the art. Still earlier specimens of the plasterer's skill are extant in the pargeted and ornamented fronts of half-timbered houses. With regard to the smaller buildings, comprising small dwelling houses and cottages, the general application of plaster is of comparatively late date; for wainscoted walls and boarded ceilings or naked joists alone are frequently found in houses of not more than a century old both in England and on the continent.

Wood and Metal Lathing.—Wood laths are narrow strips of some straight-grained wood, generally Baltic or American fir, in lengths of from two to four or five feet to suit the distances at which the timbers of a floor or partition are set. Laths are about an inch wide, and are made in three thicknesses; "single" ($\frac{1}{8}$ to $\frac{3}{16}$ in. thick), "lath and a half" ($\frac{1}{4}$ in. thick), and "double" ($\frac{3}{8}$ to $\frac{1}{2}$ in. thick). The thicker laths should be used in ceilings, to stand the extra strain, and the thinner variety in vertical work such as partitions, except where the latter will be subjected to rough usage. Laths are nailed with a space of about $\frac{3}{8}$ in. between them to form a key for the plaster, and they must be nailed so as to break joint in bays three or four feet wide with ends butted one against the other. By breaking the joints of the lathing in this way, the tendency for the plaster to crack along the line of joints is diminished and a better key is obtained. Every lath should be nailed at each end and wherever it crosses a joist or stud. All timbers over three inches wide should be counterlathed, that is, have a fillet or double lath nailed along the centre upon nhich the laths are then nailed. This is done to preserve a good key for the plaster. Walls liable to damp are sometimes battened and lathed in order to form an air cavity between the damp wall and the plastering.

Lathing of metal, either of wire or in the form of perforated sheets, is extensively used on account of its fireproof and lasting quality. There are very many kinds of this material made in different designs under various patents. A lathing has been introduced formed of thin wooden rods wired together at $\frac{1}{4}$-in. intervals. This can be fixed around curves, and economizes plaster.

Lathing nails are usually of iron, cut, wrought or cast—and in the better class of work they are galvanized to prevent rusting. Zinc nails are sometimes used, but are costly.

Materials for Plaster.—The lime principally used for internal plastering is that calcined from chalk or other nearly pure limestone, and is known as fat, pure, chalk or rich lime. Hydraulic limes (see BRICKWORK and MORTAR IN BUILDING) are also used by the plasterer, chiefly for external work. Perfect slaking of the calcined lime before use is very important as, if used in a partially slaked condition, it will "blow" when in position and blister the work. Lime should therefore be run as soon as the building is begun, and at least three weeks should elapse between the operation of running the lime and its use.

Hair is used in plaster as a binding medium, and gives tenacity to the material. Ox-hair, which is sold in three qualities, is the kind usually specified; but horsehair, which is shorter, is sometimes substituted in its stead or mixed with the ox-hair in the lower qualities. Good hair should be long, strong, and free from grease and dirt, and before use must be well beaten to separate the lumps. In America, goats' hair is frequently used, though it is not so strong as ox-hair. The quantity used in good work is one pound of hair to two or three cubic feet of coarse stuff.

Manila hemp fibre has been used as a substitute for hair. As a result of experiments to ascertain its strength as compared with that of other materials, it was found that plaster slabs made with Manila hemp fibre broke at 195 lb., plaster mixed with sisal hemp at 150 lb., jute at 145 lb., and goats' hair at 144½ lb. Another test was made in the following manner. Two barrels of mortar were made up of equal proportions of lime and sand, one containing the usual quantity of goats' hair, and the other Manila fibre. After remaining in a dry cellar for nine months the barrels were opened. It was found that the hair had been almost entirely eaten away by the action of the lime, and the mortar consequently broke up and crumbled quite easily. The mortar containing the Manila hemp, on the other hand, showed great cohesion, and required some effort to pull it apart, the hemp fibre being apparently quite uninjured. Sawdust has been used as a substitute for hair and also instead of sand as an aggregate. It will enable mortar to stand the effects of frost and rough weather. It is useful sometimes for heavy cornices and similar work, as it renders the material light and strong. The sawdust should be used dry.

Some remarks are made on the ordinary sands for building in the articles on BRICKWORK and MORTAR IN BUILDING. For fine plasterer's work special sands, not hitherto referred to, are used, such as silver sand, which is used when a light colour and fine texture are required.

In England this fine white sand is procured chiefly from Leighton Buzzard.

External Work.—For external work Portland cement is undoubtedly the best material on account of its strength, durability and weather resisting properties. The first coat or rendering is from ½ to ¾ in. thick, and is mixed in the proportions of from one part of cement to two of sand to one part to five of sand. The finishing or setting coat is about $\frac{3}{16}$ in. thick, and is worked with a hand float on the surface of the rendering, which must first be well wetted.

Stucco is a term loosely applied to nearly all kinds of external plastering, whether composed of lime or of cement. The principal varieties of stucco are common, rough, trowelled and bastard. Common stucco for external work is usually composed of one part hydraulic lime and three parts sand. The wall should be sufficiently rough to form a key and well wetted to prevent the moisture being absorbed from the plaster. Portland cement is used for all but the commonest external work. White Portland cement, made in the United States and France, is very successfully used with white sand to give an excellent stucco closely resembling stone and very durable.

Rough stucco is used to imitate stonework. It is worked with a hand float covered with rough felt, which forms a sand surface on the plaster. Lines are ruled before the stuff is set to represent the joints of stonework. Trowelled stucco, the finishing coat of this work, consists of three parts sand to two parts fine stuff. A very fine smooth surface is produced by means of the hand float. Bastard stucco is of similar composition, but less labour is expended on it. It is laid on in two coats with a skimming float, scoured off at once, and then trowelled. Stucco may be executed in colours, the desired tints being obtained by mixing with the lime various oxides. Black and grays are obtained by using forge ashes in varying proportions, greens by green enamel, reds by using litharge or red lead, and blues by mixing oxide or carbonate of copper with the other materials.

Rough-cast or Pebble-dash plastering is a rough form of external plastering in much use for country houses. In Scotland it is termed "harling." It is one of the oldest forms of external plastering. In Tudor times it was employed to fill in between the woodwork of half-timbered framing. When well executed with good material this kind of plastering is very durable. Rough-casting is performed by first covering the wall or laths with a coat of well-haired coarse stuff composed either of good hydraulic lime or of Portland cement. This layer is well scratched to give a key for the next coat, which is also composed of coarse stuff knocked up to a smooth and uniform consistency. While this coat is still soft, gravel, shingle or other small stones are evenly thrown on with a small scoop and then brushed over with thin lime mortar to give a uniform surface. The shingle is often dipped in hot lime paste, well stirred up, and used as required.

Sgraffito (Italian for "scratched") is scratched ornament in plaster. Scratched ornament is the oldest form of surface decoration, and at the present day it is much used on the continent, especially in Germany and Italy, in both external and internal situations. Properly treated, the work is durable, beautiful and inexpensive. The process is carried out by applying a first coat or rendering of Portland cement and sand, in the proportion of one to three, laid on about ½ in. thick; then following with the colour coat, which is sometimes put on in patches of different tints as required for the finished design. When this coat is nearly dry, it is finished with a smooth-skimming, $\frac{1}{12}$ to ⅛ in. thick, of Parian, selenitic or other fine cement or lime, only as much as can be finished in one day being laid on. Then by pouncing through the pricked cartoon, the design is transferred to the plastered surface. Broad spaces of backgrbund are now exposed by removing the finishing coat, thus revealing the coloured plaster beneath, and following this the outlines of the rest of the design are scratched with an iron knife through the outer skimming to the underlying tinted surface. Sometimes the coats are in three different colours, such as brown for the first, red for the second and white or gray for the final coat. The pigments used for this work include Indian red, Turkey red, Antwerp blue, German blue, umber, ochre, purple brown, bone black or oxide of manganese for black. Combinations of these colours are made to produce any desired tone.

Internal Plastering.—Lime plastering is composed of lime, sand, hair and water in proportions varying according to the nature of the work to be done. In all cases good materials, well mixed and skilfully applied, are essential to a perfect result. When brickwork is to receive plaster, it is all-important that its surface should be rough enough to form a key, or, alternatively, that the joints should be well raked out. Plaster is applied in successive coats or layers on malls or lathing, and gains its name from the number of these coats. "One coat" work is the coarsest and cheapest class of plastering, and is limited to inferior buildings, such as outhouses, where merely a rough coating is required to keep out the weather and draughts. This is described as "render" on brickwork, and "lath and lay" or "lath and plaster one coat" on studding. "Two coat" work is often used for factories or warehouses and the less important rooms of residences. The first coat is of coarse stuff finished fair with the darby float andscoured. A thin coat of setting stuff is then laid on, and trowelled and brushed smooth. "Two coat" work is described as "render and set" on walls, and "lath, plaster and set," or "lath, lay and set" on laths. "Three coat" work is usually specified for all good work. It consists, as its name implies, of three layers of material, and is described as "render, float and set" on walls and "lath, plaster, float and set," or "lath, lay, float and set," on lathwork. This makes a strong, straight, sanitary coating for walls and ceilings. The process for "three coat" work is as follows: For the first coat a layer of well-haired coarse stuff, about ½ in. thick, is put on with the laying trowel. This is termed "pricking up" in London, and in America "scratch coating." It should be laid on diagonally, each trowelful overlapping the previous one. When on laths the stuff should be plastic enough to be worked through the spaces between the laths to form a key, yet so firm as not to drop off. The surface while still soft is scratched to give a key for the next coat, which is known as the second or "floating coat," and is $\frac{1}{4}$ to $\frac{3}{8}$ in. thick. In Scotland this part of the process is termed "straightening" and in America "browning," and is performed when the first coat is dry, so as to form a straight surface to receive the finishing coat. Four operations are involved in laying the second coat, namely, forming the screeds; filling in the spaces between the screeds; scouring the surface; keying the face for finishing. Wall and ceiling screeds are plumbed and levelled. Screeds are narrow strips of plastering, carefully plumbed and levelled, so as to form a guide upon which the floating rule is run, thus securing a perfectly horizontal or vertical surface, or, in the case of circular work, a uniform curve. The "filling in," or "flanking," consists of laying the spaces between the screeds with coarse stuff, which is brought flush with the level of the screeds with the floating rule.

The "scouring" of the floating coat is of great importance, for it consolidates the material, and, besides hardening it, prevents it from cracking. It is done by the plasterer with a hand float which he applies vigorously with a rapid circular motion, at the same time sprinkling the work with water from a stock brush in the other hand. Any small holes or inequalities are filled up as he proceeds. The whole surface should be uniformly scoured two or three times, with an interval between each operation of from six to twenty-four hours. This process leaves the plaster with a close-grained and fairly smooth surface, offering little or no key to the coat which is to follow. To obtain proper cohesion, however, a roughened face is necessary, and this is obtained by "keying" the surface with a wire brush or nail float, that is, a hand float with the point of a nail sticking through and projecting about $\frac{1}{8}$ in.; sometimes a point is put at each corner of the float. After the floating is finished to the malls and ceiling, the next part of internal plastering is the running of the cornice, followed by the finishing of the ceiling and walls.

The third and final coat is the "setting coat," which should be about $\frac{1}{8}$ in. thick. In Scotland it is termed the "finishing," and in America the "hard finish" or "putty coat." Considerable skill is required at this juncture to bring the work to a perfectly true finish, uniform in colour and texture. Setting stuff should not be applied until the floating is quite firm and nearly dry, but it must not be too dry or the moisture will be drawn from the setting stuff.

The coarse stuff applied as the first coat is composed of sand and lime, usually in proportions approximating two to one, with hair mixed into it in quantities of about a pound to two or three cubic feet of mortar. It should be mixed nith clean water to such a consistency that a quantity picked up on the point of a trowel holds well together and does not drop. Floating stuff is of finer texture than that used for "pricking up," and is used in a softer state, enabling it to be worked well into the keying of the first coat. A smaller proportion of hair is also used. Fine stuff mixed with sand is used for the setting coat. Fine stuff, or lime putty, is pure lime which has been slaked and then mixed with water to a semifluid consistency, and allowed to stand until it has developed into a soft paste. For use in setting it is mixed with fine washed sand in the ratio of one to three.

For cornices and for setting when the second coat is not allowed time to dry properly, a special compound must be used. This is often "gauged" stuff, composed of three or four parts of lime putty and one part of plaster of paris, mixed up in small quantities immediately before use. The plaster in the material causes it to set rapidly, but if it is present in too large a proportion the work will crack in setting.

The hard cements used for plastering, such as Parian, Keene's and Sirapite, are laid generally in two coats, the first of cement and sand $\frac{1}{2}$ to $\frac{3}{4}$ in. in thickness. the second or setting coat of neat cement about $\frac{1}{8}$ in. thick. These and similar cements have gypsum as a base, to which a certain proportion of another substance. such as alum, borax or carbonate of soda, is added, and the whole baked or calcined at a low temperature. The plaster they contain causes them to set quickly with a very hard smooth surface, which may be painted or papered within a few hours of its being finished.

Mouldings. — Plain, or unenriched, mouldings are formed with a running mould of zinc cut to the required profile. Enrichments to suit a scheme may be added after the main outline moulding is set. being cast in moulds of gelatine or plaster of paris. For a cornice moulding two running rules are usual, one on the wall, the other on the ceiling, upon which the mould is worked to and fro by one workman, while another man roughly lays on the plaster to the shape of the moulding. The mitres at the angles are finished off with joint rules made of sheet steel of various lengths, three or four inches wide, and about $\frac{1}{8}$ in. thick, with one end cut to an angle of about 30°. In some cases the steel plate is let into a "stock" or handle of hardwood.

Cracks in plastering may be caused by settlement of the building, and by the use of inferior materials or by bad workmanship, but apart from these causes, and taking the materials and labour as being of the best, cracks may yet ensue by the too fast drying of the work, caused through the laying of plaster on dry walls ahich suck from the composition the moisture required to enable it to set, by the application of external heat or the heat of the sun, by the laying of a coat upon one which has not properly set the cracking in this case being caused by unequal contraction, or by the use of too small a proportion of sand.

For partitions and ceilings, plaster slabs (often of fibrous plaster) are in very general use when work has to be finished quickly. For ceilings they require simply to be nailed to the joists, the joints being made with plaster, and the whole finished with a thin setting coat. In some cases, with fireproof floors. for instance, the slabs are hung up with wire hangers so as to allow a space of several inches between the soffit of the concrete floor and the ceiling. For partitions the slabs frequently have the edges tongued and grooved to form a better connection; often. too, they are holed through vertically, so that, when grouted in with semifluid plaster, the whole partition is bound together as it were, with plaster dowels. Where very great strength is required the work may be reinforced by small iron rods through the slabs. This forms a very strong and rigid partition which is at the same time fire-resisting and of light weight, and when finished measures only from two to four inches thick. The slabs may be obtained either with a keyed surface, which requires finishing with a setting coat when the partition or ceiling is in position, or a smooth finished face, which may be papered or painted immediately the joints have been carefully made. Partitions are formed with one or other of the forms of metal lathing referred to, fixed to iron uprights and plastered on both sides.

Fibrous Plaster. — Fibrous plaster is given by plasterers the suggestive name ('stick and rag," and this is a rough description of the material, for it is composed of plaster laid upon a backing of canvas stretched on wood. It is much used for ceilings, partitions, mouldings, circular and enriched casings to columns and girders, and ornamental work, which, being worked in the shop and then nailed or otherwise fixed in position, saves the delay often attendant upon the working of ornament in position.

Desachy, a French modeller, took out in 1856 a patent for "producing architectural mouldings, ornaments and other works of art, with surfaces of plaster," with the aid of plaster, glue, wood, wire and canvas or other woven fabric. The modern use of this material may be said to have started then, but the use of fibrous plaster was known and practised by the Egyptians long before the Christian era; for ancient coffins and mummies still preserved prove that linen stiffened with plaster was used for decorating coffins and making masks. Cennino Cennini, writing in 1437, says that fine linen soaked in glue and plaster and laid on wood was used for forming grounds for painting. Canvas and mortar were in general use in Great Britain up to about 1850. This work is also much used for temporary buildings.

It is a notable fact that after World War I the rise of plasterers' wages in Great Britain and the United States, combined with the great scarcity of skilled workmen and other considerations, led to a considerable increase in the use of substitutes for plaster-work.

Various "boards," made of woodpulp and other materials, plywood and asbestos-cement sheets, have come largely into use for the finishing of walls and ceilings.

See G. R. Burnell, *Limes, Cements, Mortars and Mastics* (5th ed., 1865); F. M. Simpson and others, *Building Construction* (1910 and 1913); Rivington's *Notes on Building Construction* (new ed., 1915), Part III; W. Millar, *Plastering, Plain and Decorative* (4th ed., 1927); and the works on architecture of Robert and James Adam. *See* also E. C. Eckel, *Cements, Limes and Plasters* (1922); M. Jourdain, *English Decorative Plaster Work* (1926); A. H. Telling, *A.B.C. of Plastering* (1927). (X.; L. C. M.)

PLASTICS. The beginnings of the plastics industry have been variously ascribed to widely divergent geographical points—early developments are associated with Henri Braconnot, a Frenchman, C. F. Schonbein, a German, and Alexander Parkes, an Englishman, who all worked independently in the middle of the 19th century toward the development of a cellulose nitrate material. For all practical purposes however, it might be safely stated that the first real plastic was evolved by a young U.S. printer, John Wesley Hyatt. In 1863 the great elephant herds began to be decimated, and the excess demand for natural ivory was causing the price of all commodities made from ivory to rocket sky-high. It was then that Phelan and Collander, manufacturers of ivory billiard balls, sponsored a $10,000 award for the person who could develop an adequate substitute for the rapidly disappearing ivory. John Wesley Hyatt determined to win this award (an ambition which ironically was never realized), and thus started the plastics industry on its way. For it was in pursuit of the substitute billiard ball that Hyatt, working with his brother Isaiah, discovered cellulose nitrate plastic, later to be called by the trade name Celluloid. Hyatt did succeed in developing some very acceptable billiard balls coated with a collodion solution, and on April 6, 1869 the brothers were granted their first patent for the making of a solid collodion with very small amounts of solvent, dissolving the pyroxylin under pressure and thus securing great economy of materials and a saving of time. Improvements in the process of mixing the pyroxylin and camphor mere noted in patents issued in 1870 and 1872 to the Hyatts. Subsequent patents, 75 in all, were taken out as they developed progressive improvements in their process for mixing pyroxylin and camphor to produce cellulose nitrate plastic, the material which became the base for the plastics industry. In 1870 the Albany Dental Plate company was organized by Hyatt to handle the first commercial applications of cellulose nitrate plastic, and this venture was followed in 1871 by the formation of the Celluloid Manufacturing company, immediate predecessor of the Celanese-Celluloid corporation.

The far-reaching effects of the discovery of this material, its contribution to the plastics industry, and its influence upon many phases of American life, were manifold and enduring. Its principal use, immediately following the billiard ball era, was for dental plate blanks. One of the most important of the early applications was its use in sheet form for automobile side curtgins, not to mention that nostalgic symbol of a way of life—the famous celluloid collar.

Flexibility and resistance to wear were significant virtues of cellulose nitrate plastics, but its susceptibility (in the transparent form) to ultra-violet light resulted in rapid discolouration and deterioration. It was later used as the first bonding material for laminated "safety" glass, and although it was subsequently superseded by the more light-stable plastic materials, it served as an invaluable factor in establishing the importance of safety glass to the automotive industry. Cellulose nitrate was also used as a pigmented lacquer to provide both protection and colour to automobile bodies until the development of more suitable resins. Large quantities of the material were used for early photographic film. The miscellaneous applications cover a wide range of uses from spectacles, frames, buttons, combs, brush handles, heel coverings for ladies' shoes, typewriter and adding machine keys, radio and automobile dials to babies' rattles, and endless novelty and decorative items.

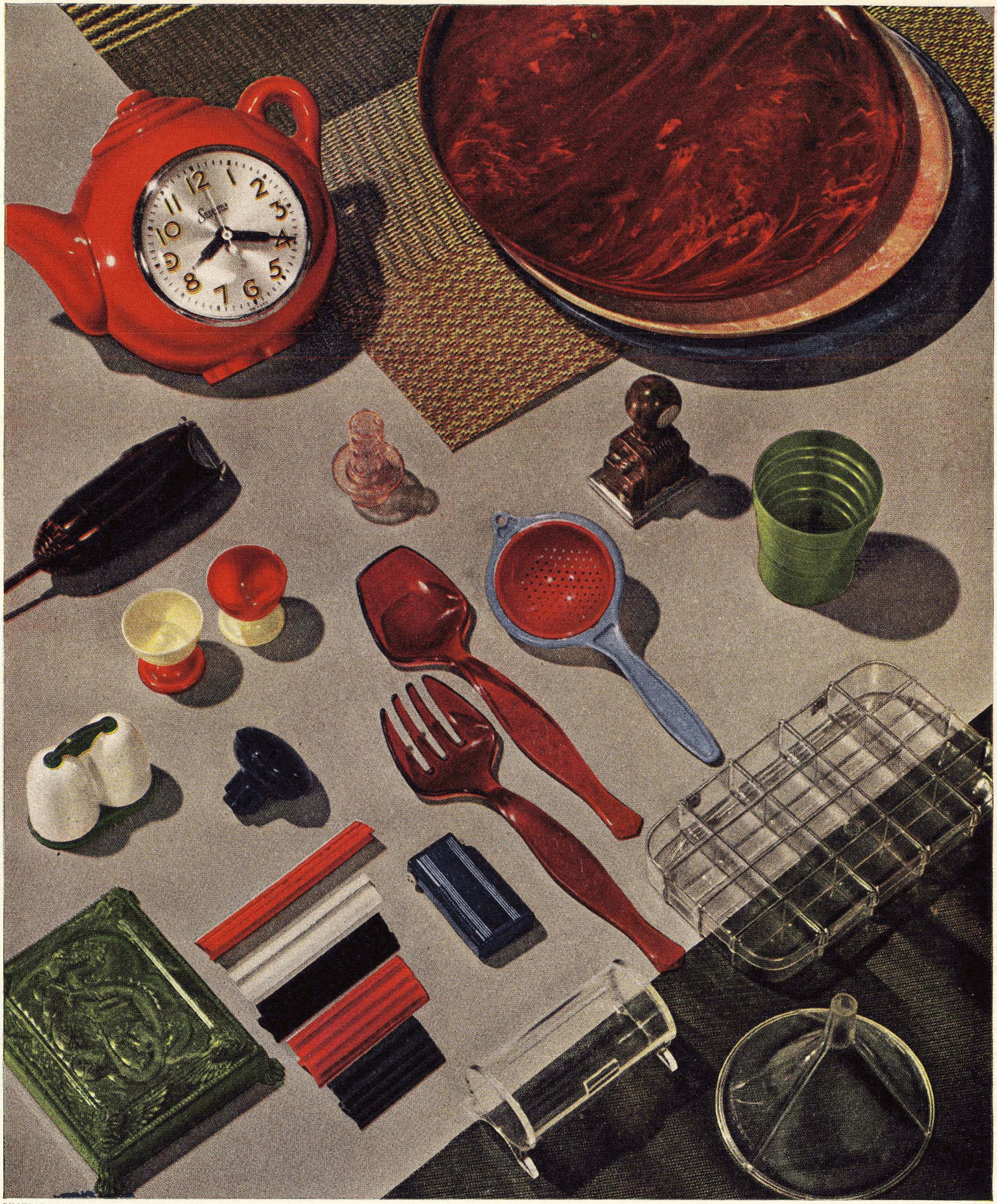
The cellulose nitrate or pyroxylin plastics are available in a wide range of colours and decorative effects. They may be moulded, extruded into rods, tubes and other uniform shapes, or sliced into sheets. By means of dyes and pigments which can be incorporated in the plastic mass by kneading, rolling, pressing, sheeting, restacking and re-sheeting, a wide variety of transparent and opaque colours as well as mottled and variegated effects may be produced. Its toughness, ease of fabrication, excellence and variety of colours, water resistance and good chemical resistance to solvents other than alcohols, ketones and esters contributed to the widespread and continued use of this earliest plastic. One of its chief drawbacks was its flammability, and the fact that light and heat tend to decompose and discolour it. Its use, however, was an important factor in paving the way for advances in the formulation and pigmentation of all thermoplastics, and for the pioneering in the mechanical and operative means of manufacture and fabrication of other plastic materials. Most important of all, it was in the vanguard of developments which created the later market for plastics, and indicated the direction for so many of its uses.

From the first, the search for a thermoplastic material, with the properties of cellulose nitrate but without its high degree of flammability, was pursued diligently. Strictly speaking, the discovery of such a material actually preceded Hyatt's, with Paul Schutzenberger's record of its preparation in 1865, and more fully in 1869. But it wasn't until 1894 that a patent was granted to C. F. Cross and E. J. Bevan for a process of preparation of a high acetyl chloroform soluble type of material. The first mention of a *plastic* of the cellulose acetate type occurred in 1903 in a patent issued to A. Eichengrun and T. Becker. Its first Practical commercial use was for safety photographic film in 1909, and for 17 years (through 1926) this new material was confined almost exclusively to the photographic field. Late in 1926 the work of the Dreyfus brothers in collaboration with the Celanese-Celluloid corporation bore the fruits of success, and cellulose acetate began to be used extensively as a base for the manufacture of commercial thermoplastics.

The same basic process that produced cellulose nitrate plastics is employed in the manufacture of cellulose acetates with the important difference that acetic acid and acetic anhydride instead of nitric acid is used to treat the cotton linters. For two years following its introduction for commercial consumption, cellulose acetate plastic material was available only as sheets, rods and tubes supplied for fabrication by the established method used for pyroxylin plastics. But general mass production from this material was given new impetus with the development in 1929 of a cellulose acetate moulding powder. The advent of the injection moulding press at that time greatly increased the speed with which moulded articles could be produced from this new thermoplastic material.

The products available from this material became legion, and the cellulose acetate plastics and moulding powder soon outstripped cellulose nitrate materials both in over-all quantity and dollar value of annual production. It became widely used in the automotive industry for interior accessories, such as knobs, handles, switches, escutcheons, steering wheels, instrument panels, dials, etc. Its high resistance to impact made it an ideal material for protective goggles, workmen's lanterns, gas mask lenses and plane parts. Its mechanical toughness suited it admirably for tool handles, pen and pencil containers, oil gauges, etc. Excellent electrical properties made it a first-rate insulating material for winding wires, laminating insulations, and for all types of telephone equipment including telephone bases and handles. Cellulose acetate became one of the outstanding materials in laminated or "safety" glass development because of its superiority to cellulose nitrate as a glass binder by virtue of its resistance to ultra-violet light and general weathering. Its toughness, light weight and transparency made the acetate materials a primary component in the aircraft industry, and during World War II these plastic materials assumed the importance of war essentials used extensively for cockpit enclosures, windows and numerous other parts of planes where visibility and strength are important.

Shellac, Phenolic and Bituminous Plastics.—It might be fitting in a chronicle of plastic development, to begin with a



PHOTOGRAPH BY PAGANO INCORPORATED; ARTICLES ASSEMBLED THROUGH COURTESY OF MODERN PLASTICS MAGAZINE

COMMON SMALLER ARTICLES OF PLASTICS

From left to **right,** top to bottom: kitchen clock (acetate), fabric (saran), trays (acetate), electric shaver (phenol and urea), small juice extractor (styrene), date stamp (phenol), measuring cup (urea), egg holders (acetate), salad spoon and fork (acetate), strainer (acetate and urea), salt and pepper shaker (acetate), doorknob (styrene), keyhole flashlight (below salad fork) (urea), fishing tacklebox (to right of salad spoon and fork) (acetate), card box (acetate), strips of extruded moulding (acetate and butyrate), cigarette holder (acrylic), transparent funnel (polystyrene)

discussion of shellac, the source of which is a humble and natural one. It is a little red bug, the *laccifer lacca,* which thrives in India and southern Asia and is directly responsible for the production of shellac, a product known and utilized for centuries as a constituent of sealing wax, varnishes, lacquers, etc. However, the first practical efforts directed toward developing this material for commercial use as a plastic was by a contemporary of John Wesley Hyatt's, John Merrick, who obtained the first patent for shellac in 1868. In the same year a second patent was issued to John M. Gardner, but it was not until 1895 that Emile Berliner developed the use of shellac moulding composition for phonograph records, still one of its chief outlets today.

Its first important use for moulded electrical insulation came in 1900, and shellac is still widely employed today for the manufacture of high-voltage insulators. One of its early functions mas in the ignition system of motor cars, but its low softening point and tendency to distortion from heat, led to its replacement in this application by thermosetting resin compositions. Later developments were primarily in connection with its use as a resinous binder for cloths, paper, silk, mica and other insulating components. It is also a first-rate binder for laminated sheets and for tubing, to which it imparts a good bond and high-quality electrical insulation.

Its ease of mouldability, toughness, hardness, fidelity of reproduction, low cost and possibility of re-use as scrap are outstanding properties of shellac. It has both thermosetting and thermoplastic properties, and may be used for both types of work. The long heating required during the curing cycle to utilize its thermosetting properties increases its electrical quality.

It was the "fruitless" quest for a substitute for natural shellac that resulted in the discovery by Dr. Leo H. Baekeland of one of the most versatile of all plastic materials, the first phenol formaldehyde resin, Antedating Dr. Baekeland's discovery in 1907, was the work of Adolf von Baeyer, who reported in 1872 that the union of phenols and aldehydes led to the formation of a resin, but it was his inability to control the reaction as well as the failure of successive investigators to recognize the implications of the "insoluble" mass that resulted from the union of these ingredients, that prevented industrial development and exploitation of this plastic. In 1909 Baekeland was granted a patent in which it was recorded that a heat hardened resin could be produced by using an alkaline catalyst. A heat and pressure patent subsequently granted Dr. Baekeland attested to the technique for converting this resin in a relatively short time into a moulded article of excellent mechanical and electrical properties. The manufacture of Bakelite, as Dr. Baekeland called his discovery, was begun in 1907 in his Yonkers laboratory. In 1910 the General Bakelite company was organized which subsequently merged with two other companies to form the Bakelite corporation. After 1926, following the expiration of the basic patent, many other firms marketed phenolic resins under a variety of trade names to supply the enormous demands.

To Dr. Baekeland, for his outstanding contribution of this general utility plastic material, belongs much of the credit for the amazing growth of the radio and automotive industries, not to mention the field of plastics itself. For it was the discovery of this insulating material that made possible the growth of radio as a mass production item. The most general application of phenolic plastics in automotive vehicles is in those parts of the electric system where material with good dielectric properties is required—in distributor heads, coil parts, switches, junction boxes, etc. These parts must be held to close tolerances, must be impervious to intense heat, and must be tough enough to withstand the abuse of normal service conditions. They were made possible in a large measure by this phenolic resin. Other applications of this plastic in the automotive field are for the impregnation of brake linings, and in phenolic resin-bonded grinding wheels. Magnetos, switches, instrument housings, terminal sleeves and conductor terminals are a few of the aircraft uses of this material, as are plane radio sets, panels, tubes, sockets, condensers, mountings, coils, binding posts, knobs and dials. Moulded canvas base phenolic material is used for cable pulleys, bushings, pilot seats and helmet liners. Phenolics are also used for radio parts, photographic equipment, closures, telephone parts, corrosion resistant apparatus, electrical insulating materials, heavy industrial units, etc.

Not the least important of uses for phenolic resins are in laminates. A laminated structure is formed from layers of sheet material which are bonded together into a solid substance. The synthetic resins perform the function of bonding individual layers into single, fused pieces of laminated material. When unusual hardness, dielectric strength, chemical resistance and low thermal conductivity are desirable factors, the laminates perform invaluable functions. Power transformers, automobile timing gears, cams, clutches, industrial fan blades and heavy indoor truck wheels are all made from laminates using phenolic resins. Laminated materials have terrific impact resistance, and are usually impervious to mineral or vegetable oils and to most acids, alcohol, benzol and gasoline. (See also RESINS: *Synthetic Resins.*)

In 1909, at the same time that Dr. Baekeland was working on his formula for shellac, a third plastic material, the bitumen or cold-moulded type, was launched by Emile Hemming, one of the earliest pioneers in the field. Asbestos, asphalts, coal tar, stearin, pitches, natural and synthetic resins and oil are the raw materials used in the preparation of this plastic. Because of the presence of volatile solvents and drying oils in the composition, the conditioning and storing of this plastic, prior to moulding, must be closely supervised.

Early applications of this material were chiefly in the field of electrical devices, and for use in moulding automotive products. However, reductions in the cost of phenolic materials and in the cost of moulding phenolics limited the use of cold-moulded materials to situations where the high temperature and flame-resisting properties could not be matched by the phenolics. Their chief uses are for electrical switch parts which may be subjected to open flame or arc when the circuit is broken, and for cooking utensil handles placed inside the oven or subjected to an open flame in use. These products will not burn at cooking temperatures. Battery boxes are one of the chief automotive products made from this material, and wire connectors, valve wheels and cores for high heat-resistant units are other products. Low cost and rapid moulding cycle are outstanding properties.

Casein.—At the end of the 19th century, Dr. Adolf Spitteler was working in Hamburg to develop a "white blackboard." Toward this end he united sour milk with formaldehyde and achieved a tough, insoluble hornlike mass, which led to the first patent grant for casein in 1900 to Dr. Spitteler and a colleague, W. Krische. Production of this material began almost immediately in Germany and France under the trade name of Galalith, which means milkstone, and manufacture began in England soon after, in 1914. In the United States, the first successful casein plastic development was undertaken by the Aladdinite company in 1919.

Casein plastics are largely used to manufacture such items as beads, buttons, ornaments and similar novelties and accessories. The limitations on its more extensive use are imposed by its hygroscopicity or poor moisture resistance.

Urea Formaldehyde Resins.—Although it was known as early as 1897 that urea could combine with formaldehyde to form a resinous product, few advances in the direction of a practical development of this material were recorded until the granting of the Hanns John patents in 1920. This first patent was for a transparent urea formaldehyde resin product which had the appearance but not the fragility of glass. Fritz Pollak and Kurt Ripper investigated this material further, and patents for their developments were issued in 1923. In 1928 this "synthetic organic glass" appeared on the U. S. market under the trade name Aldur, but it soon proved to have little practical value because of a tendency to crack. It was demonstrated by Carleton Ellis, however, that the addition to the resin of a slightly hygroscopic filler such as wood flour, or bleached pulp or alpha cellulose resulted in a moulding composition that could be formed into stable articles. In 1929 two such moulding powders were introduced, one known as Beetle and the other as Aldur. In 1931 Plaskon was placed on the market.

From the first, this plastic enjoyed immediate acceptance and widespread usage. The unlimited range of permanent colours, dimensional stability, handiness, absence of taste and odour, excellent insulating qualities, lightness of weight and shock resistance made it a highly desirable material for lighting fixtures, tableware, bottle closures, scales, illuminated dials, piano keys, reflectors, toys, novelties, dress accessories and a aide variety of other products. Laminated sheet materials using urea formaldehyde resins are used for doors, wall panelling, table tops, decorative murals and a wide variety of interior and architectural applications, also as a resin for impregnation of fibres.

Cast Phenolic Resins.--In 1928 there appeared a new phenolic resinous product, known as the cast phenolic, which differed from the earlier phenolic resins in appearance, processing and range of applications. These new resins were prepared in the form of a viscous syrup which was poured into a lead or rubber mould and hardened by heating. Since these resins are produced in liquid form, it is possible to mix two or more colours which flow together. Cast phenolic products are machined and polished after casting to give them brilliance and depth. Although a considerable portion of their popularity was established on aesthetic grounds, their expanded use was also attributed to their ease of fabrication, smooth finish, low thermal conductivity, electrical insulating qualities, hardness and durability. Developments which resulted in a heat-resistant, nonabsorbent, nonreactive grade of cast phenolic resin extended its use to the manufacture of corrosion-resistant equipment such as impeller parts, rotor parts of pumping and piping, and forming tools or dies for aircraft parts.

Vinyl Resins.—These resins were known as early as 1838. but their commercial development in the U.S. dated from 1928. nhen the Carbide and Carbon corporation began to work with polyvinyl ester resins, and introduced them commercially as a product called Vinylite. The most important of these resins. estimated by industrial values, are the polyvinyl acetates, polyvinyl chloride, co-polymers of vinyl chloride, vinyl acetate and the polyvinyl acetals. At about the same time, Shawinigan Chemicals Ltd. in Canada began the manufacture of polyvinyl acetate under the trade name Gelva. The extraordinary superiority of polyvinyl butyral for use as a plastic binder for laminating safety glass resulted in the establishment of three plants for its manufacture in 1937. In 1940 the Dow Chemical company entered the vinyl field with its vinylidene chloride resin for chemically resistant applications and coating, and for synthetic products known as Saran. The vinylidene chloride plastics in extruded form are used as tubing or piping to replace copper, and as extruded fibres for furniture and household upholstery fabrics.

Polyvinyl acetate plastics achieved great success as coatings. as adhesives for all types of materials, including paper, metal, mica, glass, plastic sheets, wood and porcelain.

Polyvinyl chloride plastics are endoned with considerable resistance to chemicals and moisture. They are used widely for gaskets and protective coatings, and as an insulating material for uires. The vinyl resins assumed new importance during World War II as insulation, and substitutes for rubber and other scarce materials.

Polystyrene.——More than 100 years before it was produced commercially in the United States, polystyrene mas known in England. Cognizance nas taken of the valuable properties of this plastic, but methods of producing styrene economically and with a sufficiently high degree of purity to achieve the necessary transparency and durability were not perfected until 1937, when the Dow Chemical company and the Bakelite corporation started the manufacture of styrene resins in clear transparent form

Polystyrene plastics are characterized by unusual properties outstanding among which are their low power factor and water absorption, high chemical resistance and physical strength at lon temperatures. These properties combine to make polystyrene exceptionally well suited to radio frequency insulation, parts of refrigeration equipment, and caps and closures for bottles containing fairly strong acids. Polystyrene is also used for transparent dials and indirect lighting of amperage, oil, temperature. fuel, mileage and other indicators in aeroplanes and automobiles.

Acrylic Resins.—The acrylic resins, with their crystal clarity. edge-lighted beauty, and inherent sparkle and brilliance, became perhaps the most popular of plastics. Dr. Otto Rohm, a German. is credited with having initiated the fundamental research on the synthesis and polymerization of this material in 1901. The development and research which resulted in its widespread use mas done by Imperial Chemical Industries Ltd., in England. The two United States suppliers were Rohm and Haas and du Pont. They were first offered for sale in 1931 as materials for coatings and laminated glass binders under the trade names Acryloid and Plexigum. In 1936 methyl methacrylate resin was introduced in transparent sheet form by Rohm and Haas company as Plexiglas, and du Pont offered both the sheet and the moulding powder under the trade name Lucite in 1937. Rohm and Haas moulding powder, originally called Crystalite, became available in 1938. The company now refers to both their sheet material and moulding powder as Plexiglas.

The optical qualities of these plastics are principal considerations in the manufacture of surgical instruments, spectacle lenses, camera lenses, edge-lighted advertising signs, and reflectors for highway illumination, as well as radio and automobile dials, etc. The material is practically impervious to moisture, and that factor, combined nith its lightness, toughness, dimensional stability and colourability make it an ideal material for lifelike, realistic dentures. Because of strength, weather resistance and clarity, acrylics are used extensively in aircraft as landing light covers, gun turrets, cockpit enclosures, windows and aindshields.

Cellulose Acetate **Butyrate and** Ethyl Cellulose.—One of the most serious drawbacks of the cellulose acetate plastics is their poor resistance to moisture and weathering. The determined effort on the part of researchers to overcome this disadvantage led to the development of cellulose acetate butyrate, in which the cotton linters of the base are treated with butyric acid in addition to the acetic acid and acetic anhydride used for the regular cellulose acetate. The Hercules Ponder company introduced cellulose acetate butyrate in 1932 as Hercose for use in protective coatings and followed it in 1937 with Hercose Acetate Propionate made in collaboration with Tennessee-Eastman company. The latter company brought out a cellulose acetate butyrate moulding composition in 1938 which they called Tenite II. Such applications as automobile headlights, fender guides and outdoor furniture (in place of reed materials) profit from the toughness, weathering qualities and fine colours available in this material, which is also used as a base for aeroplane "dope" to replace the more hazardous and dangerously flammable cellulose nitrate.

Ethyl cellulose was the first cellulose ether made commercially in the United States, having been introduced by Hercules Ponder in 1935 and by Dow Chemical in 1937. A second cellulose ether. methyl cellulose, was made available by Dow Chemical in 1939 under the trade name Methocel. Both came into general use for moulding purposes. Ethyl cellulose has low flammability, high dielectric properties. good acid and alkali resistance, resistance to moisture and humidity, and excellent insulation Chief uses have been for protective coatings, adhesives, paper and fabric coatings and for wire insulation. The ethyl cellulose lacquers were remarkably successful, displaying unusual toughness and flexibility under widely varying temperature conditions.

These same cellulose derivatives have properties uhich make them auitable for use in the production of less rigid plastics. a fact which had special significance during the acute scarcity of natural rubber in World War II. Cellulose derivatives such as ethyl cellulose may be compounded with chemical arid oil plasticizers to yield compositions which have many of the qualities that have made rubber applicable to a wide variety of uses. These compositions can be made tough and pliable, flexible and thermoplastic, although they must be handled differently from rubber in the manufacturing process. Some of the cellulose derivative., can be fabricated into products with qualities equal or even superior to rubber compositions, although their resilience and stretching properties are limited as compared with rubber. They can, however, be made to show only minor deformations when subjected to stress at room temperatures, and their water resistance is comparable to that of compounded rubber. These compositions have good pliability at low temperatures, good chemical resistance, and they may even be made oil-, gasoline-, or flame-proof with proper addition of modifiers or plasticizers.

Lignin.—In the 1930s, men began to search patiently for a means to utilize waste wood and sawdust as a possible component of a moulding composition. Wood contains approximately 25% lignin, a resin which forms the natural bond for wood cellulose fibres. It is possible to soften this resin to separate the wood fibres. In 1937 the Masonite company succeeded in developing a lignin plastic which they called Benaloid. This material was manufactured in sheet form about 4 by 12 ft. for laminating. The sheets may be drilled, turned, sawed, tapped and nailed, and are superior to natural woods both by virtue of their uniformity, and the fact that they are almost entirely unaffected by moisture and immersion in water. Both thermoplastic and thermosetting lignin moulding compositions were made available in 1939 by the Marathon Chemical company.

Experiments demonstrated that lignin can be added to phenolics to make a highly satisfactory moulding compound for such items as closures and a whole variety of industrial parts.

Similar experiments were conducted with the use of lignin as an extender for urea formaldehyde and thermoplastic materials.

Other Resins and Plastics.—An outstanding commercial use of synthetic resins is as a protective coating material; the automotive industry has used enormous quantities of the alkyd resins for this purpose. Originally cellulose nitrate lacquers were used for coating. After the alkyd resins were made available by General Electric in 1926 and subsequently by American Cyanamid, du Pont, and Resinous Products and Chemicals company, they were mixed with the cellulose nitrate lacquers for better adhesion, and to lessen the porous qualities of the cellulose nitrate lacquers. Later developments, however, led to use of the all-resin lacquers which, although they require a longer drying period, produce a fine lustrous surface, excellent adhesion, a durable finish and first-rate insulating qualities.

The coumarone indene resins have their source in the light coal-tar oils, and are polymerized by the addition of sulphuric acid to form resins. Work was begun on this development as far back as 1890, but manufacture was not started in the United States until 1919, when the Barrett company began its commercial presentation under the name of Cumar. This type of resin became one of the most important and widely used in the market. Its brittleness and low softening point prevented use as a binder for moulding compounds, but it was used extensively as a modifier of the properties of other resins and as a plasticizer with various organic binding materials, particularly to soften rubber during milling operations. In the automotive industry, the coumarone indene resins are used as a softening material for rubber in tire compounds, and in combination with rubberlike resins in hose, gasket and similar parts. They are also used for composition floor tiling and other industrial applications.

Another resin which expanded rapidly in use is melamine, which became commercially available in the U.S. in 1939. Only a few years before, it had been considered a rare chemical, available in minute quantities at $40 a pound. The cost was rapidly lowered with increased production and melamine became the base of a large group of plastic products. In combination with formaldehyde, it demonstrates arc-resisting properties, and it may be combined with alkali fillers such as asbestos to produce heat-resistant materials with unusually high arc resistance, or with alkali-curing resins for the production of laminated parts. Melamine resins may also be combined with cotton or rag fillers for the production of impact-resistant moulding materials, the chief characteristics of which are high flexural strength, very low water absorption and general inertness. In solution this material may be used to impregnate paper, canvas, asbestos cloth and paper, glass cloth and wooden veneers for laminating purposes.

Alpha cellulose-filled melamine moulding material was adopted for tableware by U.S. airlines because of its resistance to boiling water, fruit juices and similar agents. It was also used as a button material by the U.S. army because of its durability and wide range of colours. Mineral-filled melamine moulding compounds fulfilled important functions in World War II because of their high dielectric strength; they were used in ignition systems of aircraft, tanks, tractors, etc.

A new material produced during World War II under the name of C R 39, with its chemical composition a closely guarded secret, mas described as a colourless liquid of low viscosity, containing only carbon, hydrogen and oxygen. Reputed to be 40 times harder than other clear plastics, notably the acrylics, it is stable at ordinary temperatures, but upon heating in the presence of a catalyst such as benzoyle peroxide, passes through an induction period, then gradually increases in viscosity and finally jells. Upon application of further heating, the jell hardens and finally becomes a strong, hard, insoluble, infusible, crystal clear solid plastic.

Resin Bonds for **Plywood.**—A great improvement in plywood techniques took place during World War II. The use of resin-bonded plywood for aircraft, small boat construction, pontoons, housing developments and other large-scale industrial enterprises became entirely practical not only as a materials-saving expedient, but as a means for increasing the strength and efficiency of such constructions with no corresponding increase in time or labour costs.

Wood is one of the oldest structural materials known to man, and its use in aeroplane construction had begun in World War I, at which time its excellent strength-weight ratio was established. However, the best adhesives then' available were albumen and casein, which had only limited uses because of their inability to combat the effects of moisture, fungus and mould growth. It was not until the early 1930s that developments in Europe demonstrated the fact that the phenol formaldehyde resins are endowed with the properties necessary to overcome the limitations of the earlier adhesives. They are waterproof, boilproof, heatproof and highly resistant to fungus and mould attack. By 1935 phenolic resins became commercially available and the value of plywood as a prime structural material for the aircraft industry, as well as for others, was on its way to becoming a reality.

The relatively high cost of the phenolic resins limited their use to high-cost fields where durability and service requirements transcended price considerations. The need for a resin that could be used in outlets where standards were less severe, and where the cost factor could be controlled, led to the development of the urea formaldehyde resins in 1937. Although this latter type of adhesive does not quite achieve the bonding strength of the phenolic resins, it is far superior to the animal-vegetable glues formerly used in such products as radios and furniture.

Keeping pace with the perfection of the phenolic and urea resins were the fabricating developments in the construction of plywood. One of the most notable of these developments was the rubber-bag moulding process used extensively in the manufacture of large aircraft parts. A wood mould is constructed with the exact contours and specifications of the part to be fabricated—fuselage, wing, pilot seat, etc. The wood veneers are then wrapped around the wooden die or form, and between each layer a resin solution is sprayed or brushed onto the wood plies. Ribs or other reinforced parts may be made integral parts of the moulded structure by placing them into slots in the wooden form before covering it with the veneers. The part is then placed into a rubber bag or composition membrane which is deflated by a vacuum pump so that the veneers are held rigidly in place against the wood mould. The rubber bag with its contents is then placed into an autoclave, where the heat converts the resin into an infusible state, thus fixing the veneers permanently into the desired shape. The steam pressure within the tank assures uniform application of heat and pressure over the surface of the rubber bag, and when the resin-bonded structure is removed from the wood mould after the curing treatment in the autoclave, the moulded parts are ready for assembly with only a limited amount of finishing necessary. This process made possible the speedy construction of completely formed fuselages, wing sections and other large aircraft parts.

MOULDING PROCESSES

Any basic definition of a plastic establishes one incontrovertible fact—that a plastic must be capable of being moulded. Upon the success of the moulding process and upon the efficiency of the essential equipment for the process is predicated the successful development of plastics.

The basic principle for the operation of the hydraulic press is believed to have been conceived as far back as 1653, but the adaptation of the principle to a practical machine was not achieved until about 1795. Not until approximately 1839, with Goodyear's discovery of the vulcanization of rubber, did the hydraulic press begin to be an industrial reality. At that time the simplest hand-type of hydraulic press, constructed on the rod principle, was developed for the manufacture of rubber products, and it was subsequently used for moulding the early thermoplastics, pyroxylin and shellac. This type of press was used for nearly 70 years without any startling changes, and in fact was still employed in the 1940s for some types of moulding operations in which only limited quantity is required and the mould is sufficiently light to warrant manual handling.

With the advent of the phenolic thermosetting resins, impetus was given to the improvement of the compression moulding press in a manner calculated to increase the output from a given mould. Semi-automatic presses were then developed in which moulds were mounted on platens, thus providing for mechanical opening and closing. Pins were also incorporated in the design which made possible automatic ejection of pieces. Later improvements brought about automatic regulations of the degree of pressure, as well as of the timing of the pressing operation, and such semi-automatic presses became standard equipment for compression moulding.

The modification of the semi-automatic moulding press was introduced in 1918 in order to facilitate the handling of moulds with metal inserts. This was achieved by the development of a movable upper platen which presents the top die in a vertical, accessible position and which makes the placing of inserts a relatively simple and efficient operation.

Fully automatic compression moulding presses were later developed to perform all the operations of routine moulding of thermosetting plastics, including measuring the charge of moulding powder, preheating it, loading it into cavities, closing and opening the mould, ejecting finished pieces and repeating the cycle indefinitely. These presses succeeded in reducing the human element and margin of error to a minimum.

Injection moulding was a still later development in plastic production. Originally conceived in 1865 as a die-casting machine for forcing molten metal into a die by mechanical or hydraulic means, the method did not make much progress until 1872, when the Hyatt brothers were granted a patent for a machine to extrude celluloid. The design of the heating cylinder of this machine embodied many of the principles incorporated into subsequent models, and although the Hyatts had to abandon its use for the purpose intended, it left its mark on injection moulding equipment. Later developments in the manufacture of injection moulding presses took place in Germany and were adapted for U.S. models. The first such units to be introduced into the U.S. market had an injection capacity of only ½ to 1½ oz. per cycle, and were suitable for moulding small articles like buttons, combs and costume jewellery. To meet the demands of U.S. moulders for machines of increased capacity, sturdier construction and more efficient design, domestic manufacturers improved the presses until they attained a capacity of 36 oz. By 1935 there were about 75 injection moulding presses in the United States, mostly importations from Germany. By Dec. 1939, the number had increased to 574, and by 1943 to an estimated 1,300.

Transfer Moulding.—Thermosetting resins remain plastic at high temperatures for a relatively short interval before the resin hardens to an infusible mass. Therefore the heating chamber must be loaded with a quantity of compound sufficient for each cycle, and the maximum plasticizing heat must be restricted only to this amount.

This moulding of thermosetting resins by their injection in a plastic state into a hot mould is called transfer moulding. The press is similar to that of injection moulding of thermoplastics except that the mould itself is kept hot constantly to effect the transformation of the resin to the cured or hardened state.

The special advantage of this process is that erosion of dies, breakage of small pins and damage to inserts can be avoided. Because the material flows into the mould cavity as a liquid, no large stress is built up to break the mould or displace fragile inserts; glass and fine metal parts can be used without danger of distortion or breakage. Higher and more uniform density can be produced, and separation of the resin from the filler is minimized. Small holes and deep holes which are impractical in compression moulding are easily accomplished by the transfer process. For impact materials which produce a heavy flash in compression moulding, and for decorative pieces, the process is particularly well adapted. Greater strength, more uniform density, freedom from gas pockets and extremely close tolerances are possible.

Extrusion.—The process of continuous extrusion was known and used for many years in the rubber industry and in connection with pyroxylin fabrication before it was adapted for thermoplastics. The extrusion process is a technique of continuous production analogous to squeezing toothpaste out of a tube to form a strip or ribbon unit. The plastic materials in powder, granular or cube form, are forced through a die to produce a strip of material that takes the shape of the die opening. The extrusion machine is a fairly simple and inexpensive mechanism. The plastic material is fed into a heated cylinder and is extruded through nozzles to produce rods and tubing of various shapes and sizes. Continuous canvas or rubber belts are frequently used to move the strip along as it emerges from the die, and harden it by cooling. Sometimes the belt is shaped to fit the extruded form, thus reducing possible distortion to a minimum.

PRODUCTION IN THE UNITED STATES

Total production of synthetic resins and plastics in the U.S. during 1941 was approximately 438,000,000 lb., or 219,000 tons—almost half the estimated world production in that year. Complete figures of production in the United States were not revealed after that country entered World War II, but it was known that cellulose ester plastics production for the first six months of 1942 showed an increase of approximately 25% over the same period in 1941. Cellulose nitrate sheets, rods and tubes were produced at the rate of 8,515,000 lb. for the first half of 1942—substantially the same as for the like period in the preceding year. Cellulose acetate sheets, rods and tubes produced remained almost constant for the first half of 1942, but later suffered because of restrictions on some of the plasticizers.

Cellulose ester moulding powders showed an increase of over 30% up to July 1942, an increase which was purely due to wider use of cellulose acetate butyrate moulding powder. There were approximately 21,000,000 lb. of cellulosic moulding powder sold in six months of 1942 as compared to approximately 31,000 lb. in all of 1941.

USE OF PLASTICS IN WORLD WAR II

Practically all plastic materials were directed into essential war uses in the United States during World War II. Their inherent physical properties, such as lightness, strength, insulation (both heat and electrical), resistance to acids and alkalis, weathering, ease of mouldability and fabrication made them excellent material for military uses. Such materials must be so stable that they will withstand extremes of temperature (–40 to 160° F.) and rapid humidity changes without distortion. Close tolerances and absolute uniformity must be maintained in moulding because there is very small margin for error in any war application.

Phenolic formaldehyde plastics were perhaps the most widely used during World War II, because of their light weight, stability under rapid temperature changes, good insulating qualities, imperviousness to weathering and high impact resistance. In planes, phenolic materials were fabricated into pulleys, fairleads, for control cables to every part of the structure, cabin air controls, propellers and propeller parts, aileron control quadrants, illuminated dials and name plates for night flying. These same materiais were incorporated into warships—in elevators, gun turrets, gun light switches, radios, pumps, junction boxes, etc.

The need for moulding materials of exceptional mechanical strength to replace strategic metals greatly stimulated the use and further development of compounds known as high or medium impact phenolics. Plastic of this type successfully passed the test for 37-mm. dummy-fuses, and for the 60- and 81-mm. mortar shell fuse. In the Browning machine gun it replaced the black walnut used for grip handles. Booster tubes for demolition bombs were made of phenolics. Even the traditional duck of army tents was treated with phenolic formaldehyde resins, to increase the life of the material, improve its water impermeability and protect the fire-resistant finish against weathering or deterioration in storage. Melamine resins were used for buttons and as the basis of a treatment for paper pulp, for such uses as clothing, army tents, sandbags, etc.

World War II saw a vast increase in the manufacture of acrylic plastics, as well as the expansion of the facilities for fabricating aircraft parts. The aircraft industry used a large percentage of the sheet production, turning out more planes per month and using a larger area of acrylics per plane. Another development was an acrylic power turret which could be revolved mechanically. Blackout lights on army trucks and jeeps were made from acrylics. Tank sight windows were cut from sheet acrylics. Navy PT boats were equipped with acrylic machine-gun housings, as well as acrylic windows. Dials and gauges were protected from the effects of salt water by moulded or fabricated acrylic covers.

The vinyl resins became vital as rubber substitutes. The Baruch report on the U.S. rubber situation after Pearl Harbor pointed out that vinyls saved the equivalent of 22,000 tons of crude rubber per year.

Wartime applications for polyvinyl compounds were numerous. Polyvinyl butyral, long used only as the plastic sandwich for laminated safety glass in automobiles, coated the fabric from which lightweight army raincoats were made for soldiers ($1\frac{3}{4}$ lb. of crude rubber were saved for each coat). Polyvinyl alcohol was moulded into heat-resisting tubing and gaskets for trucks. Polyvinyl acetate was used instead of rubber latex in mid-soles for shoes. Polyvinyl butyral was also used in bags for transporting drinking water, hospital sheeting for military and civilian use, life belts for the navy and merchant marine, food bags and waterproof, oil-resistant suits for seamen. In extruded form, polyvinyl butyral replaced rubber in tubing, in clamps to prevent vibration of fuel lines in aircraft and in a host of other military applications.

Cellulosic materials were extensively employed in gas mask parts, including lenses, knobs, starter buttons, blackout lenses and protective surfaces for maps and documents. Cellulose acetate sheeting found a large war use in windows for trainer aeroplanes and gliders, and for windshields for motorcycles. Fluorescent cellulose acetate sheeting was used for lighting fixtures in war equipment, where visible lighting could not be used. The butyrate and the high acetic acid content cellulosic plastics were used for applications requiring improved water resistance and dimensional stability. Among such uses were gas mask lenses, hoze nozzles, pistol grips, flashlight cases, first-aid kits, stirrup pump parts and shaving brush handles.

Polystyrene was employed in enormous quantities during the war. In 1942 productive capacity for the manufacturing of monomeric styrene for polymerization into the plastic was a fortuitous circumstance, since this product became available for the manufacturing of the Buna-S type of rubber, which was applied to battery boxes, radio insulations, coaxial cable insulation, resin modifiers for wire coating, etc.

Like other plastics, ethyl cellulose was placed under strict allocation by the War Production board because of its adaptation to military uses, including coating for braided ignition cable, fire and waterproofing dyes, artificial leather, etc. In sheeting form it mas made into transparent face shields for gas masks, goggles and envelopes for shop prints. Ethyl rubber, made of ethyi celiuiose combined with an oii plasticizer, proved to be flexible and elastic and showed better resistance to abrasion, ozones and gasoline than natural rubber, but less resilience, elongation or resistance to permanent deformation. It was used instead of natural rubber for gun covers, electrical or junction tape, water tubing to replace brass, raincoats, hospital sheeting, gloves, footwear, etc.

Plastic plywood also became increasingly important as a major structural material for war use, in lightweight training planes, assault boats, floating ramps, pontoons and for the famous PT motor torpedo boats. Pilot seats of plastic plywood were an important development.

After their introduction in 1940, the vinylidene chloride resins (Saran) aroused considerable interest because of their unusual properties—water, chemical and solvent resistance combined with toughness, durability and appearance. It found its way into such varied products as piping for use in plumbing fixtures, to replace brass and copper in defense housing, for electric fixtures and installations.

The laboratories of the plastics industry by 1943 had established as many as 5,000 different formulations of plastics, each with characteristics of its own, mostly for wartime uses. (See also SYNTHETIC FIBRES.)

BIBLIOGRAPHY.—E. Hemming, *Plastics and Molded Electrical Insulation* (1923); Carleton Ellis, *The Chenzistry of Synthetcc Resins* (2 vol., 1935); G. M. Kline, "Organic Plastics," National Bureau of Standards *Circular* C411 (1936); H. Barron, *Modern Rubber Chemistry* (1938); C. D. Clarke, *Molding and Casting* (1939); J. T. Marsh and F. C. Wood, *An Introduction to the Chemistry of Cellulose* (1939); A. J. Lockrey, *Plastics in the School and Home Workshop* (1940); R. Cherry, *General Plastics* (1941); D. A. Dearle, *Plastic Molding* (1941); Herbert R. Simonds, *Industrial Plastics* (2nd ed., 1941); G. B. Thayer, *Plastics Mold Designing* (1941); J. Delmonte, *Plastics in Engineering* (2nd ed., 1942); J. H DuBois, *Plastics* (2nd ed., 1942); John Sasso, *Plastics for Industrial Use* (1942); Herbert R. Simonds and Carleton Ellis, *A Handbook of Plastics* (1943); *Plastics Catalog* (issued annually). (C. A. BN.)

PLATA, RIO DE LA or **RIVER PLATE,** a funnel-shaped estuary, on the east side of South America. extending west-northwest from the sea about 170 miles. The discovery of the South sea by Balboa, then governor of Castilla del Oro, of which Darien formed a part, created a lively desire to learn something of its coastline, and the year following (in 1514), the Spanish monarch concluded a navigation contract with Juan Diaz de Solis, then Piloto Mayor, to search for a strait connecting the Atlantic with the newly found ocean. De Solis set sail from the port of Lepe on Oct. 8, 151j, reached the Bay of Rio de Janeiro on Jan. 1, 1516, and continuing southward to lat. 3j° entered the great estuary now known as the Plata, which, for a short period of time, was called the de Solis and the Mar Dulce. Ascending it to the vicinity of the island of Martin Garcia. near the mouth of the Paraná river, de Solis was ambushed and killed early in 1516 by Guarani Indians. In 1520 Magellan explored the Rio de la Plata, and discovered and navigated the straits which bear his name. In 1526 Cabot ascended the Mar Dulce, discovered the Paraná river and reached a point on the Paraquay near the site of the present city of Asunción. Here he obtained by barter from Guarani Indians silver ornaments. The receipt of these silver baubles caused the name of Rio de la Plata to be applied to the third greatest river of the western continent.

The extreme breadth of the river at its mouth is 138 miles. It narrows quickly to 57m. at Montevideo, and to 25m. at its head, where it receives the Paraná and Uruguay rivers. Its northern or Uruguayan shore is somewhat elevated and rocky, while the southern or Buenos Airean one is very low. The whole estuary is very shallow, and in no place above Montevideo exceeds 36ft. in depth at low water. The bottom generally consists of sand covered with from 10 to 20ft. of water. A dredged channel of about 22ft. in depth leads from the port of Buenos Aires 20m. east to deep water. Winds and tides considerably affect the depth of the channel. The Plata is simply the estuarine receptacle of two mighty streams, the Uruguay and Paranb which drain the Plata basin. This has an area of 1,198,000sq.m., or over two and one-half times that of the Pacific slope of the Andes, and comprises the most fertile, healthiest and best part of Brazil, a large portion of the Argentine republic, the whole of Paraguay and south-eastern Bolivia, and most of Uruguay.

The Uruguay and **Affluents.**—The Uruguay river has a length of about 1,000 miles. Many small streams from the western slope of the Brazilian Serra do Mar unite, in about 27" 45' S., to form this river, which then flows W.N.W., serving as the boundary between the States of Santa Catharina and Rio Grande do Sul, as far as 52° W., near which it receives a considerable tributary from the north, called the Pepiri-guazú. Between 27° 58′ and 33° 34' S. three important tributaries join it from the east—the Ipui-guazli, the Ibicui and the Negro.

The Pepiri-guazú in its lower course is about 250ft. wide, but higher up it narrows to about 30ft., and runs with great violence between high wooded banks. It is navigable for canoes for about 70m. above its mouth, as far as its first fall. The Rio Negro has a delta of several large islands at its confluence with the Uruguay. Its head-waters are in the southern part of Rio Grande do Sul, but the main river belongs entirely to the State of Uruguay. Its lower reaches are navigable for craft of moderate draught.

From its source in the coast range of Brazil the Uruguay runs through open, hilly country, and then enters a forest belt of high lands. At the river Pepiri-guazú it turns suddenly to the south-west, and continues this course to its junction with the Paraná and Plata. Near Fray Bentos, 61m. before reaching the Plata, it forms a great lake, about 56m. long and from 4 to 6m. wide. At Punta Gorda, where it debouches into the Plata, it is about 1m. wide, but is 90ft. deep. From the Pepiri-guazú junction its banks are high and covered with forest as far down as 27° 30' S., where the river is 2,300ft. wide and from 10 to 40ft. deep. The Uruguay is much obstructed by rocky barriers. Four miles below its confluence with the Pepiri-guazú it has a cataract, about 8m. long, with a total fall of 26ft. at low water. The river near the Pepiri-guazú is 1,550ft. wide, but about $1\frac{1}{2}$m. before reaching the cataract its width is reduced to 600ft. Along the cataract it is closed in between high precipitous walls of black rock only 70ft. apart. Above Punta Gorda, 212m., is the Salto Grande, which has a length of 15m. of rapids, the greatest single fall being 12ft., and the difference of level for the entire length of the reefs 25ft. Nine miles below the Salto Grande is the Salto Chico, which bars navigation during six months of the year, but in flood-time may be passed in craft drawing 5ft. of water. The Uruguay can be navigated at all seasons by vessels of $4\frac{1}{2}$ft. draught as far up as the Salto Chico, and of 14ft. up to Paysandú for a greater part of the year. Fray Bentos may be reached all the year round by any vessel that can ascend the Parana. Above the navigable lower river there is launch and canoe navigation for many hundreds of miles upon the main artery and its branches, between the rapids which are met with from time to time. The Uruguay has its annual floods, due to the rains in its upper basin. They begin at the end of July and continue to November, attaining their maximum during September and October. Except in floods, it is a clear-water stream, and even at its highest level carries comparatively little silt.

The **Paraná** and Its **Affluents.**—The Paraná (the "Mother of the Sea" in Guarani) drains a vast area of southern Brazil. It is formed by the union of the Rio Grande and Paranáhyba, and is about 1,600m. long from its source in Goyaz to its junction with the Paraguay, and thence 600 more to the Plata estuary. Its average width for the latter length is from 1 lo 3m. Its Rio Grande branch descends from the slope of the Serra da Mantiqueira, in the region where the orographic system of Brazil culminates near the peak of Itatiaia-assu, almost in sight of Rio de Janeiro. It is about 680m. long, but only navigable in the stretches between the many reefs, falls and rapids which interrupt its regular flow.

Besides these rivers, the Paranb has many long and powerful affluents from the Brazilian States of São Paulo and Paraná. Most of them, although obstructed by rapids, are navigable for launches and canoes. Among the eastern tributaries are the Tiété, the Paraná-panema, formerly known as the Anemby, and the Iguazu. The Paraná-panema is about 600m. long, and rises in an offshoot of the Serra Paranápicaba which overlooks the Atlantic ocean. It is navigable for only 30m. above its mouth.

The Iguazú, also called the Rio Grande de Curutiba, has its sources on the slopes of the Serra do Mar of Brazil, and flows nearly west, through thick forests, along the line of 26" South. Its navigation is difficult even for small craft, as it is full of reefs, rapids and cataracts. Sixteen miles above its mouth is the magnificent Salto del Iguazú, sometimes called the Victoria Fall, round which canoes have to be transported 37m. before quiet water is again reached. The width of the falls, measured along their crest or edge, is $2\frac{1}{2}$m.; part of the river takes two leaps of about 100ft. each, but a portion of it plunges down the whole depth in unbroken mass. Its mouth is about 800ft. wide, and the depth in mid-river 40ft.

The Paraná has unobstructed navigation for about 400m. between the Falls of Urubuponga and the Falls of Guayra, in 24" 3' S., where it forms a lake $4\frac{1}{2}$m. long and $2\frac{1}{2}$m. wide, preparatory to breaching the Serra de Mbaracayú, which there disputes its right of way. It has torn a deep gorge through the mountains for a length of about 2m., where it is divided into several channels, filled with rapids and cataracts. It finally gathers its waters into a single volume, to plunge with frightful velocity through a long cañon only about 200ft. wide. From these so-called falls of Guayra or "Sete Quedas," as far as its confluence with the Paraguay river, the Paraná has carved a narrow bed through an immense cap of red sandstone, along which it sometimes flows with great rapidity, occasionally being interrupted by dangerous narrows and rapids, where the banks in some places close in to a width of 450 to 600ft., although the average is from 1,200 to 1,600 feet. At the south-east angle of Paraguay the Paraná is turned westwards; but before escaping from its great sandstone bed it is obstructed by several reefs, notably at the rapids of Apipé, which are the last before it joins the placid Paraguay, 130m. farther on.

The Paraguay.—The river Paraguay, the main affluent of the Paranb, rises in Matto Grosso, in the vicinity of the town of Diamantino, about 14° 24' South. It flows south-westwards, as far as Villa Maria, along the foot of the high plateau which divides it from the Cuyabá river to the east, and then, turning southwards, soon reaches the morass expansion of Xarayes, which it traverses for about 100m. A few miles below Villa Maria it receives an affluent from the north-west, the Jaurá, which has its source nearly in contact with the head-waters of the Guaporé branch of the river Madeira. From the junction of the São Lourenço (or Cuyabá) with the river Paraguay, the latter, now a great stream, moves sluggishly southwards, spreading its waters, in the rainy season, for hundreds of miles to the right and left, as far south as 20°, turning vast swamps into great lakes—in fact, temporarily restoring the region, for thousands of square miles, to its ancient lacustrine condition.

On the west side of the upper Paraguay, between about 17° 30' and 19° S., are several large, shallow *lagunas* or lakes which receive the drainage of the southern slopes of the Chiquitos sierras, but represent mainly the south-west overflow of the vast morass of Xarayas. The principal of these lakes, naming them from north to south, are the Uberaba, the Gaiba, Mandioré and the "Bahia" de Caceres. The Uberaba is the largest. It is in great part surrounded by high ground and hills, but its southern coast is swampy and flooded during the rainy season. The west shore is historic. Here, in 1543, the conquistador, Martinez de Irala, founded the "Puerto de los Reyes," with the idea that it might become the port for Peru; and from Lake Gaiba several expeditions, in Spanish colonial days, penetrated 500m. across the Chaco to the frontier of the empire of the Incas. At the Puerto de los Reyes Bolivia laid out a town in Dec. 1900, in the forlorn hope that the "Port" may serve as an outlet for that commercially suffocated country, there being no other equally good accessible point for Bolivia on the Paraguay river.

South of the São Lourenqo, the important rivers entering the Paraguay from the east are the Taquary, which rises in the Serra Cayapó, on the southern extension of the Matto Grosso tableland; the Mondego, with many branches, draining a great area of extreme southern Matto Grosso, and the Apb, which forms the boundary between Paraguay and Brazilian Matto Grosso.

The **Pilcomayo.**—The Pilcomayo rises among the Bolivian Andes north of Potosi and north-west of Sucre, races down the mountains to their base, crosses the Chaco plains, and pours into the river Paraguay near Asunción. It does not receive any branch of importance until it reaches about 21° S., where it is joined from the south-west by the river Pelaya, upon which Tupiza, the most southerly city of Bolivia, is situated. Just below the junction is the fall of Guarapetendi, 23ft. high. From this point to the mouth of the Pilcomayo the distance in a straight line is 480m., although by the curves of the river, which is extremely tortuous, it is about double that distance. According to Storm, who quotes Captain Baldrich, the river bifurcates at 21° 51′ S., but again becomes a single stream at 23° 43′, the right channel being the greater in volume. It is probable that between 23" and 24" S. it throws three great arms to the river Paraguay, the upper portions of which have yet to be explored, but the lower parts have been examined for 100 to 200m. up from the Paraguay. From 180 to zoom. above its mouth the Pilcomayo filters through a vast swamp about 100m. in diameter, through which there is no principal channel. This swamp, or perhaps shallow lagoon, is probably partly drained by the river Confuso, which reaches the Paraguay between the Pilcomayo and Macá. A northern branch of the Pilcomayo, the Fontana, the junction being at 24° 56′ S., is probably also a drainage outlet of the same great swamp.

For the first 100m. below the Fall of Guarapetendi the Pilcomayo is from 600 to 1,000ft. wide, but it so distributes its waters through its many bifurcations, and loses so much from infiltration and in swamps, and by evaporation from the numerous lagoons it forms on either side of its course, that its channel is greatly contracted before it reaches the Paraguay. From Sucre to the Andean margin of the Chaco, a distance of about 350m. by the river, the fall is at least 8,000ft.—a sufficient indication that its upper course is useless for purposes of navigation. Its lower course is of little value for commercial purposes.

The **Bermejo.**—The Bermejo river flows parallel to the Pilcomayo, and enters the Paraguay a few miles above the junction of this with the Paranb. Its numerous sources are on the eastern frontage of the inland Andes, between the Bolivian town of Tarija and the Argentine city of Jujuy. In 23" 50′ S. the Bermejo receives its main affluent, the San Francisco, from the south-west. The latter has its source in about 22° 30′ S., and, under the name of Rio Grande, runs directly southwards, in a deep mountain valley, as far as Jujuy. It then turns eastwards for 50m., and is joined by the Lavayen from the south-west. These two streams form the San Francisco, which, from their junction, runs north-eastwards to the Bermejo. From its junction with the latter stream the Bermejo flows south-eastwards to the Paraguay with an average width in its main channel of about 650ft., although narrowing at times to 160 and even 100. In its course, however, it bifurcates and ramifies into many channels, forming enormous islands, and frequently leaves old beds for new ones.

Since the exploration of the Bermejo by Patiño in 1721, it has often been examined from its sources to its mouth, with a view to ascertaining its navigability. Like the Pilcomayo, the Bermejo is of little use owing to swift currents, shoals, quicksands, snags and fallen trees.

The **Salado.**—The Salado, about 250m. south-west of and approximately parallel to the Bermejo, is the only great tributary which the Paranb receives from the west below its confluence with the Paraguay. Its extreme head-waters, the Santa Maria and Calchaqui, which unite near the town of San Carlos and form the river Guichipas, drain a much broken Andean region lying between 24° and 26° 30′ S. in the Argentine province of Salta. Having received the Arias, the Guáchipas runs north-eastwards about 50m., and then it changes its name to the Juramento, which is retained until the river reaches the Chaco plains at the base of the foot-hills of the Andes. Here it becomes the Salado. It joins the Paraná near Sante FC in 31° 39' S. and 60° 41′ West. Explorers of the Salado, inclusive of Captain Page in 1855, claim that its lower half is navigable, but the many efforts which have been made to utilize it as a commercial route have all resulted in failure.

The Pilcomayo, the Bermejo and the Salado erode quantities of the Pampean material, dissolve it into silt and pour it into the Paraguay and Paranb rivers. The engineer, Pelleschi, estimates that "the soil annually subtracted from the territory of the Chaco by the Bermejo alone equals 6,400,000 cubic yards."

Lower Course of the Paran&.——From 31° 30' south to the Plata estuary the western bank of the Paraná is a precipitous bluff of reddish clay, varying from 25 to 75ft. above mean river level. It is being gradually undermined, and tumbles into the water in great blocks, adding to the immense volume of silt which the river carries. The Paranb is lowest in December; it rises in January, February and March, reaching its greatest height in March. It is steady in April, May and June, but falls and rises irregularly during the next three months. The difference between low and high river is generally about 12ft., depending upon the varying quantity of rains in Brazil and the melting of the Andean snows. Below its junction with the Paraguay the Paraná has an average current of 2½m. an hour, and the river varies in width from 1 to 3m., at low water; but in floods it seems almost a continuous lake, broadening to 10 and 30m. and burying many of its numerous islands and marginal swamps under a vast sheet of water, and obliterating its many parallel lateral channels and connecting canals.

Islands of Parank.—In the middle Paraná, from the mouth of the Iguazú to the mouth of the Paraguay river, there are many islands, some of them large, rocky and high above the river. From Paraguay to the city of Rosario, islands are numerous, many of them of great area; and again below Rosario they soon increase in number and size until the Plata estuary is reached. In flood-time the upper portion of the trees being out of water, they have the appearance of floating forests. Then the river often makes wild work with its banks, and builds up or sweeps away entire islands, leaving deep channels instead. The lower delta of the Paraná does not share in these phenomena; its islands and main channels appear more fixed. This probably is due to the less elevation attained by the waters in flood-time, and the numerous branches which distribute them into the Plata estuary. This must have extended, in a very recent geological period, inland from its present head to at least 32° S.; but the enormous quantity of silt which the Paraná receives from its Paraguay affluent, and from the tributaries which reach it from the Andes, has filled this length of about 220m. with these muddy islands, which rest upon a sandy bed of great depth.

Paraná Delta.—The frontage of the Paraná delta is 40m. across, almost in a straight line from north to south. Through this the river finds its way to the Plata by 11 outlets, large and small, the two principal ones being the Paraná-Guazú and the Paraná de las Palmas. The Paraná is navigable to the São Lourenqo river by craft drawing 3ft. of water, and to within a few miles of Asunción, the capital of Paraguay, by vessels drawing 9ft. The city of Paraná may always be reached with a draught of 12 and Rosario with 1jft. of water.

The commercial development of the Plata basin promises to become gigantic. The Andes on the west, the interior of South America on the north, great rivers, and the Brazilian mountains on the east of the Plata basin are obstacles which compel the rich and varied products of at least 1,500,000sq.m. of fertile country to seek access to the ocean by a single avenue—the Plata estuary. (G. E. C.)

During the 20 years ending in 1928 many of the ports, cities and towns located on the Plata-Parani-Paraguay river system have made marked progress. Millions of dollars have been spent in extending and improving shipping facilities by Montevideo, La Plata. Buenos Aires, Rosario—all of them ports of call for ocean-going steamships. Many of the smaller ports like Santa Fé, Paraná, Corrientes, Posadas and Asunción, have also improved their facilities, and have increased their exports of grain, hides, meat, quebracho wood and extract, maté and lumber.

Improved Communications.—The completion, in 1916, of a 37m. railway around the Falls of Guayra, on the Alto Paranb river, opened a new river and rail gateway to the heart of Brazil, the principal outward shipments being yerba-maté and dried beef. A new hotel at Iguazú River falls and a motor-car service from Puerto Aguirre to the falls, 10m. distant, provide modern accommodation, and, aided by better steamboat service on the Alto Paraná have brought more tourists to the cataracts. The Rondon, the Roosevelt (1913–14) and other expeditions of recent years; the colonization schemes of European and American companies in Paraguay and Bolivia; the completion of a Brazilian railway from São Paulo nearly to the Paraguay; petroleum investigations in eastern Bolivia; larger areas planted with cotton in Argentina and Paraguay have combined to arouse wider interest in the vast region watered by the Plata river system. On the Uruguay river the cities of Mercedes, Paysandú and Salto have new water systems, improved streets and extended sanitation. A packing plant at Fray Bentos has increased operations there. The Argentine Navigation company, the Lloyd Brazileiro and local steamboat lines operate La Plata services to Corumbb, Brazil, 1,800m. from the Atlantic. Ocean-going vessels ascend as far as Rosario and Santa FC 200m. and 300m. above Buenos Aires. Throughout the Plata region the gradual introduction of modern agricultural implements has increased output, and, consequently, river traffic.

BIBLIOGRAPHY.—W. J. Holland, *To the River Plate and Back* (1913); *G.* Ross, *Argentine and Uruguay* (1916) ; A. Boerger, *Sieben la Plata-Jahre* (1921); *Review of the River Plate* (Buenos Aires, weekly). (W. A. R.; G. E. C.)

PLATAEA or **PLATAEAE,** an ancient Greek city of Boeotia, situated close under Mt. Cithaeron, near the passes leading from Peloponnesus and Attica to Thebes, and separated from the latter city's territory by the River Asopus. Though one of the smallest Boeotian towns, it stubbornly resisted the centralizing policy of Thebes. In 519 B.C. it invoked Sparta's help against its powerful neighbour, but was referred by king Cleomenes to Athens (for the date, *see* Grote's *History of Greece,* ed. 1907, p. 82, note 4). The Athenians secured Plataea's independence, and thus secured its enduring friendship. In 490 the Plataeans sent their full levy to the assistance of the Athenians at Marathon, and during the invasion of Xerxes they joined eagerly in the national defense. At Artemisium they volunteered to man several Athenian ships, and subsequently abandoned their town to be burnt by Xerxes. In 479 they fought against the Persians under Mardonius in the decisive battle which bears the name of the city. (For an account of the battle *see* GRAECO-PERSIAN WARS.) Their great victory was celebrated by annual sacrifices and a Festival of Liberation (*Eleutheria*) in every fourth year at Plataea, whose territory moreover was declared inviolate.

In spite of this guarantee Plataea was attacked by Thebes at the beginning of the Peloponnesian War (431) and formally besieged by the Peloponnesians (429–27). The garrison after capitulating was put to death, and the city razed by the Thebans. The remaining Plataeans received a qualified franchise in Athens, and in 421 were settled on the territory of Scione. Expelled by Lysander in 404 they returned to Athens, until in 387 Sparta restored them in their native town as a check upon Thebes. The city was again destroyed by Thebes in 373, and the inhabitants once more became citizens of Athens. Plataea was rebuilt by Philip and Alexander of Macedon, and during the rest of antiquity enjoyed a safe but obscure existence. It continued to flourish in Byzantine and Frankish times. The walls of the town, which at various periods occupied different portions of the triangular ledge on which it stood, remain partly visible. Recent excavations have discovered the Heraeum; but the temple of Athena the Warlike, built from the Persian spoils and adorned by the most famous artists, has not been identified.

AUTHORITIES.—Strabo p. 411; Pausanias ix. 1–4; Herodotus vi. 108, viii. 1, ix. 25–85; Plutarch, *Aristides,* 11–21; Thucydides ii. 1–16, 71–78, iii. 20–24, 52–68; Isocrates, *Plataicus;* G. B. Grundy, *The Topography of the Battle of Plataea* (London, 1894) and *Great Persian War* (London, 1901), ch. xi.; W. Woodhouse in *Journal of Hellenic Studies* (1898), pp. 33–59; H. B. Wright, *The Campaign of Plataea* (New Haven, 1904); R. W. Macan, *Herodotus,* vii.–ix. (London, 1908), appendix; W. M. Leake, *Travels in Northern Greece,* ch. xvi., pp. 323–367 (London, 1835); *Amer. Journ. of Archaeology,* 1890, *pp.* 445–475; 1891, pp. 390–405. (M. C.)

PLATE, the common name for the electrode from which the current flows through the vacuous space in a radio vacuum tube.

PLATEAU, JOSEPH ANTOINE FERDINAND (1801–1883), Belgian physicist, was born at Brussels on Oct. 14, 1801, and died on Sept. 15, 1883 at Ghent, where he had been professor of physics from 1835. The more original investigations of Plateau refer chiefly to physiological optics and molecular forces. We owe to him the "stroboscopic" method of studying the motion of a vibrating body, by looking at it through equidistant radial slits in a revolving disk. In 1843 Plateau became permanently blind. He published an analytical catalogue of memoirs from the earliest times to the end of the 18th century on his favourite theme of subjective visual phenomena. This blind man's investigations on molecular forces, embracing hundreds of novel experiments whose results he saw only with others' eyes, are described in his great work *Statique expérimentale et théorique des liquides soumis aux seules forces moléculaires* (2 vols., 1873).

PLATED WARE: *see* SHEFFIELD PLATE and ELECTRO-PLATING

PLATE GLASS: *see* GLASS MANUFACTURE.

PLATE GLASS INSURANCE: *see* INSURANCE, MISCELLANEOUS.

PLATEN-HALLERMUND, AUGUST, GRAF VON (1796–1835), German poet and dramatist, was born on Oct. 24, 1796, at Ansbach, and entered the Bavarian life guards in 1814. He took part in the short campaign in France of 1815; he then obtained a long leave of absence, and after a tour in Switzerland and the Bavarian Alps, entered the University of Wurzburg in 1818 as a student of philosophy and philology. In 1819 he removed to Erlangen, where he sat at the feet of F. W. J. von Schelling. As a result of his Oriental studies he published a little volume of poems—*Ghaselen* (1821), each consisting of from ten to twenty verses, in which he imitates the style of Ruckert; *Lyrische Blätter* (1821); *Spiegel der Hafis* (1822); *Vermischte Schriften* (1822); and *Neue Ghaselen* (1823).

Though Platen was at first influenced by the school of Romanticism, and particularly by Spanish models, yet the plays written during his university life at Erlangen. *Der gläserne Pantoffel, Der Schatz des Rhampsinit, Berengar, Treue um Treue, Der Turm mit sieben Pforten,* show a clearness of plot and expression foreign to the Romantic style. His antagonism to Romanticism became more and more pronounced, and he attacked its extravagances in the witty "Aristophanic" comedies *Die verhängnisvolle Gabel* (1826) and *Der romantische Oedipus* (1828). In 1826 he visited Italy, which he henceforth made his home, living at Florence, Rome and Naples. *Der romantische Oedipus* earned for him the bitter enmity of Karl Immermann and Heinrich Heine, but he retained many staunch admirers, who delighted in the purity of the subject matter of his productions and their beauty of form and diction. In Naples were written his last drama *Die Liga von Cambrai* (1833) and the delightful epic fairy-tale *Die Abbassiderz* (1830; 1834), besides numerous lyrical poems, odes and ballads. He died at Syracuse on Dec. j, 1835. Platen's odes and sonnets, to which must be added his *Polenlieder* (1831), expressing his sympathy for the Poles in their rising against the rule of the Tsar, rank among the best classical poems of modern times.

Platen's *Gesammelte Werke* were first published in one volume in 1839, and have been frequently reprinted; a convenient edition is that edited by K. Goedeke in Cotta's *Bibliothek der Weltiteratur* (4 vols., 1882). His *Tagebuch* (1796–1825), was published in its entirety by G. von Laubmann and L. von Scheffler (2 vols., 1896–1900). *See* P. Besson, *Platen, étude biographique et littéraire* (1894); A. Fries, *Platen-Forschungen* (1903); E. Petzet, *Platens Verhältnis zur Romantik in sein italien Zeit* (1911); R. Schlosser, *August Graf von Platen. Ein Bild seines geistigen Entwicklungsganges und seines dichterischen Schaffens* (Munich, 1910–13).

PLATERESQUE, the earliest of the styles of Spanish Renaissance, so called, either because the Renaissance found its first popular Spanish expression in silverware (*platero*, silversmith), or because its rich and delicate ornament resembled silversmith work. It is characterized by the application to forms structurally simple, of extremely rich ornament, distantly based on Italian Renaissance forms, using pilasters, entablatures, carved rectangular panels, shallow niches, much heraldic ornament and rich pierced, scrolled cresting. Its courtyards, usually with two or more openings on the upper floor, above a single opening below, are famous for their decorated columns, sometimes simulating balusters, their bracketed capitals and their graceful delicacy Owing to Moorish influence, there is a common tendency to carry the decoration around the door over the full height of the wall above. Decorative ironwork, as in the church *rejerías* (*q.v.*), or open metal screens, was highly developed. The style embraces, generally, the first half of the 16th century, but its decorative ideals influenced not only the classic period which followed, but the Baroque as well. Characteristic examples are the hospital of Santa Cruz, Toledo, by de Egaz (1504–16), the college at Alcalá de Henares, by Gumiel (1500–17), the university and Irish college at Salamanca, the Casa de las Conchas at Salamanca and the Infantada at Guadalajara. (See RENAISSANCE ARCHITECTURE.)

(T. F. H.)

PLATERSPIEL, BLATERPFEIFE, a mediaeval simplified bagpipe, consisting of an insufflation tube, a bladder and a chaunter; the double reed in its socket at the top of the chaunter being concealed within the bladder. In the platerspiel we recognize the early mediaeval chorus (*q.v.*) a word which in mediaeval Latin was frequently used also for the bagpipe, while in its later forms it was practically identical with the cromorne (*q.v.*).

PLATINUM, a very heavy steel-grey metal of great usefulness in the chemical and mechanical arts.

Platinum was probably known in the impure state from very early times, but because of its physical properties and especially its high melting point it was impossible to work it by any of the arts then known and it therefore remained as an unnamed substance. (Symbol Pt, atomic number 78, atomic weight 195·23.) It was probably the metal alluded to in the early part of the 16th century by Scaliger, who refers to a metal incapable of being fused obtained from the mines in Mexico and Darien. About the middle of the 18th century it was introduced into Europe in small quantities and attracted the notice of various chemists. Scheffer, in a paper read before the Stockholm Academy entitled "On white gold or the seventh metal, termed in Spanish platina del Pinto" (1752), showed that it was insoluble in nitric acid but soluble in aqua regia, was precipitated from its solutions by mercury, and was infusible at the highest temperature of the furnace. He also dealt with some of its alloys and discovered that it was fusible when mixed with arsenic. Platinum was melted by Macquer and Baumé in 1758 in the focus of a powerful burning glass. Count von Sickingen in 1772 prepared the metal in the form of foil and wire and showed that it was soluble in nitric acid when alloyed with a large quantity of silver. For the later history of platinum, its occurrence and separation from the other metals, see PLATINUM METALS and RUTHENIUM, RHODIUM, PALLADIUM, OSMIUM and IRIDIUM.

Platinum in the massive state is a greyish-white metal having a specific gravity of 21·4 and is exceedingly malleable and ductile. It melts at about 1,755° C and volatilizes readily in the electric furnace. Its latent heat of fusion is 27.18 calories It is a bad conductor of heat and electricity. When pure it is a soft metal and on this account is not suitable for some purposes, but on alloying it with iridium in small amounts the hardness is greatly increased. It is capable of being welded at a temperature near its melting point, but for easier working at a lower temperature gold is used as a solder in repairing damaged crucibles and other articles. It alloys easily with all the other metals of its own group, likewise with gold, silver and lead, but is scarcely acted upon by metallic mercury. It has been obtained in the crystalline condition by distillation in the electric furnace or by heating the fluoride to a red heat (Moissan). Spongy platinum is readily produced by ignition of the double chloride $(NH_4)_2PtCl_6$; it possesses a much greater surface area than the massive metal and hence is more active when employed in catalysis. Platinum black is best prepared by warming a solution of any of the chlorides or double chlorides of platinum in caustic alkali with alcohol or some similar reducing agent, or by dissolving the lead in nitric acid from a not very rich lead–platinum alloy. It has an enormous surface area and hence is the most usual form in which platinum is employed in catalytic reactions. The platinum black, for convenience in handling and also to minimize loss, is usually deposited upon some suitable material such as asbestos or barium sulphate. Colloidal platinum can be obtained in solution by passing an electric arc between platinum terminals under pure water.

Uses.—Platinum is used in the laboratory in the form of dishes, crucibles and weights, although a small amount of iridium is generally added to increase its hardness and hence its durability. Platinum vessels, however, should never be used for heating caustic alkalis, as they undergo corrosion producing platinates, and no metal of low melting-point should ever be heated in them. At one time platinum vessels were almost exclusively used in concentrating sulphuric acid (*q.v.*) made by the chamber process; this use has been abandoned as sulphuric acid made by the contact process is already concentrated, and the chamber acid is now concentrated in cheaper vessels.

Platinum is the best catalyst for the manufacture of sulphuric acid by the contact process; at a temperature below a red heat it is capable of causing the reaction $2SO_2+O_2=2SO_3$ to be nearly completed. The resulting SO, is dissolved in water till an acid of the required strength is obtained (see SULPHURIC ACID). Its use for this purpose has been partly given up, as some cheaper catalysts such as the oxides of iron and chromium, although less efficient, have been found more economical. In this process platinum is always used as platinum black. The material to be platinized (asbestos, pumice, brick, barium sulphate, etc.) is dipped in a dilute solution of platinum chloride, dried and ignited, an enormous catalytic surface of platinum black being thus produced. Another large and rapidly extending use for platinum is in the catalytic production of nitric acid from ammonia by oxidation. A mixture of ammonia gas and air (or oxygen) in the right proportion is passed in a very rapid stream over a network of heated platinum gauze. Either ammonium nitrate or nitric acid can be produced according to the proportions of oxygen and ammonia in the reaction mixture. The reaction is exothermic, and by adjusting the rate of flow of the mixed gases the reaction temperature can be kept constant.

Platinum or, better, iridium-platinum alloy is the most suitable anode material for electrolysis of all kinds. It remains unattacked under practically all conditions, but owing to the initial expense, some form of carbon, especially Acheson graphite, is now generally used for this purpose. Two methods of measuring high temperatures depend upon the use of platinum; the first is the platinum resistance thermometer, which depends upon the change of resistance of a platinum coil with temperature when a constant current is passing through it; the second is the use of a platinum and rhodium–platinum thermocouple. By careful calibration either of these instruments is capable of giving a very exact measurement of high temperatures. As platinum is not oxidized by air at the temperature of the electric spark, it is very suitable in electro-technics for contact-points of magnetos and induction coils and the armatures of electric beils; it can also be used when caused to glow by the passage of an electric current as a heating-element; for some of these uses it has now been displaced by cheaper materials, one of the best being a chromium–nickel alloy known as nichrome.

Platinum is extensively used for some surgical instruments such as needles for hypodermic syringes, for the metal can be sterilized even in the flame of a match; it is also used in the incandescent state as an electric cautery. Unfortunately it cannot be hardened sufficiently to make a good cutting edge. In dentistry platinum was formerly used extensively for making dental plates, etc., as an alloy of 2 parts of silver to one of platinum possesses the same coefficient of expansion as the hard porcelain-like material of which artificial teeth are composed. Owing to the rise in the price of platinum, gold or gold alloys have now almost entirely displaced it for this purpose. The use of platinum in jewellery is considerable; during the World War palladium replaced it to a large extent and now an alloy called white gold, which consists chiefly of gold alloyed with a small quantity of either palladium or platinum, is largely displacing it. Another use for platinum is the production of photographic prints by the platinotype process. These prints are of great beauty owing to the variety of tones that can be thus produced, and have the advantage over silver prints of being absolutely permanent.

Platinum Compounds. — Platinum does not combine directly with oxygen at any temperature, although in the molten state it absorbs several times its volume of this gas, which, however, is released when the metal cools. Four oxides of platinum are obtainable by indirect methods, viz., PtO, Pt_3O_4, PtO_2 and PtO_3. Of these, PtO and PtO_2 are important as they are the bases of the platinous and platinic salts. *Platinous oxide,* PtO, is obtained by gentle ignition of the corresponding hydrate, $PtO,2H_2O$, which is obtainable by precipitating either PtCl, or K_2PtCl_4 with caustic alkali. It is a black powder, soluble in acids when freshly prepared. *Platinic oxide,* PtO_2, is known in the hydrated form $Pt(OH)_4$, but only a portion of the combined water can be removed before deeper decomposition begins to take place. The hydroxide is obtained by adding excess of caustic soda to a boiling solution of PtCl,, which gives a yellow solution of sodium platinate, and then precipitating the cold solution with acetic acid. It is a white or yellowish solid soluble both in dilute acids and in alkalis when freshly prepared, but after losing water on heating it becomes black and insoluble. The peroxide, PtO_3, is obtainable by electrolyzing an alkaline solution of $Pt(OH)_4$ at 0° C. It is a red-brown unstable solid which readily parts with some of its oxygen at ordinary temperatures.

Two well-defined chlorides of platinum are known — platinous chloride, PtCl,, and platinic chloride, PtCl,. *Platinous chloride* is formed by heating chloroplatinic acid to 300° C or evaporating a solution of the same substance with absolute alcohol to dryness several times. It is a greenish or sometimes brownish substance insoluble in water but soluble in hydrochloric acid or alkali chloride solutions, with which it forms double chlorides of the form M_2PtCl_4; these are the alkali salts (platinochlorides) of chloroplatinous acid, H_2PtCl_4. This acid, which is known only in solution, can be obtained also from either its barium or silver salt by exact precipitation by means of sulphuric or hydrochloric acid respectively. The best known salt of the acid is the potassium compound, which is easily produced by reducing a boiling solution of potassium chloroplatinate with sulphur dioxide. It crystallizes in dark red prisms easily soluble in water, and in the case of certain unfortunate persons, traces of it act as a violent irritant to the mucous membrane of the eyes and nose. Platinous chloride combines with various unsaturated substances to form double compounds; it combines directly with carbonic oxide at 250° C to form three compounds, $PtCl_2,CO$; $(PtCl_2)_2,3CO$; and $PtCl_2,2CO$; with phosgene to form $PtCl_2,2COCl_2$; with ethylene to produce $PtCl_2,2C_2H_4$; and with phosphorus trichloride to form compounds $PtCl_2,PCl_3$ and $PtCl_2,2PCl_3$.

Platinic chloride, $PtCl_4$, is formed by the action of chlorine on platinum at a temperature below 500°. If platinum is dissolved in aqua regia or in hydrochloric acid in a stream of chlorine and the solution is evaporated with hydrochloric acid till free from nitric acid, reddish-brown crystals of chloroplatinic (platinichloric) acid, $H_2PtCl_6,6H_2O$, are produced: these if ignited in a stream of hydrogen chloride gas at 165° give a residue of $PtCl_4$ as a reddish-brown, very hygroscopic, crystalline mass. The pure chloride, however, is rarely met with, and the platinic chloride of commerce is the compound $H_2PtCl_6,2H_2O$ formed by heating the hexa-hydrated compound to 100° C. Chloroplatinic (platinichloric) acid is a weak acid, it reddens litmus paper and decomposes metallic carbonates producing the corresponding platinichlorides. It forms potassium and ammonium compounds which are nearly insoluble in water and quite insoluble in a mixture of alcohol and ether; the corresponding sodium compound is soluble in this mixture, and this circumstance affords the best method of separating potassium from sodium quantitatively. Chloroplatinic (platinichloric) acid forms compounds with organic bases which are usually difficultly soluble in water.

Platinum is not attacked by fluorine at a low temperature, and advantage of this was taken by Moissan when he first isolated that element and by Moissan and Dewar when they first liquefied this gas. At higher temperature (500°–600° C) Moissan obtained two fluorides, PtF_2 and PtF_4. Platinum does not readily form stable salts with oxy-acids. A sulphate $Pt(SO_4)_2$ is said to have been produced by dissolving platinic hydroxide in sulphuric acid but no nitrate of platinum is known. A series of salts known as platino-nitrites having the general formula $M_2Pt(NO_2)_4$ is well known, and another series, the platino-oxalates of the composition $M_2Pt(C_2O_4)_2$ has also been recorded. Two sulphides of platinum, PtS and PtS_2, are definitely known, and the existence of various intermediate ones has been announced from time to time. PtS and PtS_2 are produced by acting upon solutions of corresponding platinum compounds with sulphuretted hydrogen. Both sulphides are black powders; PtS_2 must be dried without access of air as it readily undergoes oxidation.

Platinous cyanide, $Pt(CN)_2$, is best produced by precipitating a solution of potassium platinochloride, K_2PtCl_4, with mercuric cyanide. It is of importance as it combines with cyanides of the alkali and alkaline-earth metals to produce a series of salts known as platinocyanides which are remarkable for their wonderful colours and for their use in radiography. They are derived from platinocyanic acid, $H_2Pt(CN)_4$, which can be prepared by decomposing the mercury or copper salt with sulphuretted hydrogen. The acid crystallizes from water in deliquescent prisms but is better crystallized from an ether–alcohol mixture. Potassium platinocyanide, $K_2Pt(CN)_4,3H_2O$, is easily produced by dissolving spongy platinum in a solution of potassium cyanide, preferably in the presence of air, or by the interaction of a solution of platinous chloride with excess of potassium cyanide; in the latter method recrystallization is necessary to remove the potassium chloride simultaneously produced. It crystallizes in rhombic prisms which are yellow by transmitted light but have a blue metallic lustre by reflected light. The magnesium salt, $MgPt(CN)_4,7H_2O$, crystallizes in beautiful red tetragonal prisms with metallic moss-green reflex. Its solution in water is colourless. Barium platinocyanide, $BaPt(CN)_4,4H_2O$, is the compound used for X-ray screens. It occurs in citron-yellow monoclinic prisms with a green reflex.

Platinum salts combine with ammonia in various proportions to form two series of bases, platinous and platinic ammines (see AMMINES). In the platinous series there are two compounds having the formula $PtCl_2,2NH_3$; they are probably cis- and trans-isomerides. A polymeride having the formula $(Pt,4NH_3)$ $PtCl_4$ has long been known as the "green salt of Magnus," and is made by the action of ammonia upon platinous chloride. These compounds, although of great interest theoretically, are of little practical value. A complete account of these interesting compounds may be found in Gmelin-Kraut's *Handbuch.* (F. E. *M.)*

See L. Duparc and M. N. Tikhonovich, ***Le Platine et les*** *gftes platanifères de l'Oural et du Monde* (1920); C. Janin, *World's Outlook for Platinum* (1928).

PLATINUM METALS. Although generally found in nature in the metallic condition, native platinum is never chemically pure. With it in varying proportions five other metals are generally associated, and to this group of six elements the name "platinum metals" has been given. The six metals in the order of their atomic numbers and weights are as follows:—

Metal	*Symbol*	*Atomic No.*	*Atomic Wt.*	*Metal*	*Symbol*	*Atomic No.*	*Atomic Wt.*
Ruthenium	Ru	44	101·7	Osmium	Os	76	190 8
Rhodium	Rh	45	102·91	Iridium	Ir	77	193·1
Palladium	Pd	46	106·7	Platinum	Pt	78	195 23

Although certain properties are common to the whole group, yet very great chemical and physical differences are found between the various members. It will be noticed that the atomic numbers of the first three and second three members are consecutive and that a common difference of 32 separates them. This common difference in atomic number corresponds to similarity in chemical properties between members differing by this constant number; at the same time similarities, more especially physical, are noticed amongst the members of each group.

One property common to the whole of the platinum metals is the high temperature of their melting points. The most easily fusible of them, palladium, only assumes the liquid condition at about 1,550° C; platinum comes next with a melting point of about 1,750° C and the other metals fuse at temperatures intermediate between these and the melting point of osmium, which is about 2,700° C. Another property common to this group of metals is the valuable one of resisting chemical action and especially oxidation (the particular cases of ruthenium and osmium as regards oxidation will be dealt with when those metals are considered in detail).

Another property common to all members of the group is their great catalytic action, that is, the power of bringing about chemical action between other substances without themselves undergoing any alteration. In small chemical operations platinum and palladium are extensively used, but for large-scale or commercial working these metals, on account of their high cost, are not suitable unless the wastage is very small or negligible. Thus platinum and palladium are most efficient catalysts in the hydrogenation of oils and fats for the production of edible glycerides (*q.v.*); they are, however, seldom used for this purpose since the inevitable wastage would cause the process to be too costly. Metallic nickel or certain of its compounds are used instead, with the result that the operation has to be carried out at a considerably higher temperature, resulting in the destruction of some of the important vitamins which would have survived had palladium been used instead of nickel.

As regards density or specific gravity, the platinum metals resolve themselves naturally into two groups: the three members of lowest atomic weight have specific gravities of 11–12, *i.e.*, somewhat higher than, but not far removed from, that of silver, 10–11; the three higher members, however, are much denser and their specific gravities range from 21·4 for platinum to 22.5 for osmium which is the heaviest massive substance known under terrestrial conditions. As the specific gravity of platinum is near to that of gold, 19·4, an alloy of platinum with some base metal is easily prepared possessing the same density as gold.

Being bad conductors of electricity, platinum and its allied metals in the form of wire easily become incandescent when an electric current is passed through them. Incandescent lamps with very luminous filaments for electric lighting could be made without any danger of fusing of these metals. The first practical success was attained with filaments of metallic osmium, which was found to glow more vigorously and thus give better illumination than the other platinum metals. This fact is perpetuated in the name "Osram" which is still a trade-mark of certain lamp manufacturers, although the use of osmium for this purpose has long been discontinued. Although the platinum filaments for lamps was soon displaced by tantalum and tungsten, yet for a considerable time platinum entered into their construction, as some material had to be used, which could be fused into the glass without cracking, to carry the necessary leading-in wires. The only suitable substance then known was platinum, which has a coefficient of expansion almost the same as that of glass, and for a considerable time this was the only available material. This wasteful use of platinum has now been obviated by the production of alloys of much cheaper material having the same coefficient of expansion as ordinary glass.

Occurrence.—The platinum metals appear to be widely distributed in nature, although generally in very small quantities. Localities in which they occur are Brazil, Colombia, Peru, Russia, Australia, Borneo, Tasmania, California and South Africa. Alluvial deposits have hitherto been the usual sources, but platiniferous reefs have now been found in the Transvaal and Natal. Alluvial platinum was reported in 1927 from Sierra Leone over an area of 40sq. miles. The first definite recognition of crude platinum as a separate metal occurs in the 18th century, when chemists obtained samples of platinum ore from Carthagena.

In 1803 and 1804 four new metals were obtained from platinum. Osmium and iridium were discovered and isolated by Smithson Tennant and palladium and rhodium by W. H. Wollaston. The remaining platinum metal, ruthenium, was not discovered till 1828 when Osann succeeded in isolating it from the platiniferous ore of the Ural mountains, a deposit discovered in 1819. The platinum ores obtained from various localities differ greatly in composition. Platinum is generally found as the chief metal and the other metals of the group occur in relatively small and variable quantities. Occasionally, however, and especially in Australia and South Africa, small nuggets or grains of osmiridium are found, and recently considerable amounts have been found in Tasmania which is now its chief source. This mineral consists chiefly of the metals osmium and iridium, and also usually of a certain amount of ruthenium, the other platinum metals occurring to a small extent only. In addition to the six platinum metals, platinum ores contain other elements, the most common being gold, copper, silver, iron, chromium and nickel.

Separation.—The methods in general use for the separation of the six platinum metals are here outlined, detailed accounts of their purification being shown under the headings of the several metals. A platinum ore which has been freed from base metals and other impurities is treated with aqua regia (*q.v.*); osmium, most of the iridium and a small amount of ruthenium remain undissolved. The solution, containing platinum, palladium, rhodium and small amounts of ruthenium and iridium, is evaporated to dryness, when the metals are obtained as chlorides. These chlorides are then heated to about 150° C whereby the chlorides of palladium and iridium are partly decomposed giving lower chlorides. The residual mass is dissolved in very dilute hydrochloric acid, and ammonium chloride is added to precipitate most of the platinum and iridium as double chlorides, the other metals remaining in solution. This solution is then treated with metallic iron (technically termed "footing"), which throws all the metals completely out of solution; this precipitate, like all others similarly obtained, is technically called "foots." The precipitate after thorough washing is again dissolved in aqua regia, the solution is concentrated and again treated with ammonium chloride to remove further amounts of platinum and iridium and then treated with ammonium hydrate, when nearly all the palladium is thrown out as a difficultly soluble ammine, $Pd(NH_3)_2Cl_2$. The solution now containing rhodium and ruthenium is evaporated to dryness and strongly ignited, leaving the metals themselves. These are fused with potassium bisulphate, when the rhodium forms a soluble double sulphate leaving the ruthenium unattacked.

The foregoing residues containing osmium, iridium and some ruthenium are heated in a tube in a stream of air or preferably oxygen. Osmium and ruthenium form volatile oxides which are deposited in the cold parts of the tube. The residue, iridium with some ruthenium and small amounts of other platinum metals, is purified by suitable methods. A method of treating crude platinum ores, particularly useful in concentrating the platiniferous portion, is to heat the ores with metallic lead or to make a mixture of the ores with galena, scrap iron, glass and borax, the last two materials serving as a flux. The platinum metals, except most of the osmiridium, are dissolved in the lead which is removed by ordinary cupellation, the platinum metals remaining ready for subsequent treatment. In modern reef-mining, the platiniferous ores are concentrated after grinding by methods of oil flotation.

Another method of opening up platinum ores is to treat a heated mixture of the substance and common salt with chlorine. All the platinum metals are attacked by this process giving double chlorides of the metal with sodium. As these double chlorides differ in stability, variations of the temperature of treatment give different products. Even if the double chloride is decomposed at or below the temperature of formation, the metal resulting from this decomposition remains in a finely divided condition and subsequent treatment is facilitated, and at the same time some of the stable double chlorides, especially that of iridium, are soluble in water and are easy to treat subsequently. It is obvious that with ores of different compositions some of the foregoing methods are more suitable than others in particular cases. Furthermore, all firms engaged in the refining of these metals have their own special secret methods. (F. E. M.)

BIBLIOGRAPHY.—E. A. Smith, *Platinum Metals* (1925); A. D. Lumb, *The Platinum Metals* (1920).

PLATO (c. 428 B.C.–*c.* 348 B.C.), Greek philosopher, son of Ariston and Perictione, was born in the year 428–427 B.C. and died in 348–347 at the age of over 80. His family was, on both sides, one of the most distinguished of Athens. Ariston is said to have traced his descent through Codrus to the god Poseidon; on the mother's side, the family, that was related to Solon, goes back to Dropides, archon of the year 644 B.C. Perictione apparently married as her second husband her uncle Pyrilampes (Parm, 126 C) a prominent supporter of Pericles, and Plato was probably chiefly brought up in his house: Critias and Charmides, leading men among the extremists of the reactionary Terror of 404, were respectively cousin and brother of Perictione; both were old friends of Socrates, and through them Plato must have known the philosopher from boyhood.

His own early ambitions as he tells us in the seventh Epistle (324 *b.*–326 b.) were political. The reactionaries urged him to enter public life under their auspices—at the age of 24—but he wisely held back till their policy should declare itself. He was soon repelled by their violences, particularly by their attempt to implicate Socrates in the illegal execution of their victim Leon. He hoped better things from the restored democracy, but its condemnation of Socrates finally convinced him that there was no place for a man of conscience in active politics. Hermodorus, an immediate disciple, is the authority for the statement that, on the execution of Socrates in 399 B.C., Plato and other Socratic men took temporary refuge with Eucleides at Megara. The later Lives represent the next few years as spent in extensive travels in Greece, Egypt, Italy. Plato's own statement is only that he visited Italy and Sicily at the age of 40 and was disgusted by the gross sensuality of life there, but found a kindred spirit in Dion, brother-in-law of Dionysius I. of Syracuse.

The Academy.—About or soon after 387, Plato founded the Academy as an institute for the systematic pursuit of philosophical and scientific research. He presided over the society for the rest of his life, making it the recognized authority alike in mathematics and in jurisprudence. From the allusions of Aristotle we gather that Plato lectured without manuscript, and we know that "problems" were propounded for solution by the joint researches of students. On the political side there are traces of tension between the Academy and the rival school of Isocrates.

The one outstanding event in Plato's later life is his intervention in Syracusan politics. On the death of Dionysius I. in 367, Dion conceived the idea of bringing Plato to Syracuse as tutor to his successor, whose education had been neglected. Plato himself was not sanguine of results, but as both Dion and the philosopher-statesman Archytas of Tarentum thought the prospect promising, he felt bound in honour to risk the adventure. The project was by training Dionysius II. in severe science to fit him for the position of a constitutional king who might hold Carthaginian encroachment in Sicily at bay. The scheme was crushed by his natural jealousy of the stronger Dion, whom he drove into virtual banishment. Plato paid a second and longer visit to Syracuse in the year 361–360, in the hope of still effecting an accommodation, but failed, not without some personal danger. When Dion captured Syracuse by a coup-de-main in 357, Plato wrote him a short letter of congratulation and warning against his own lack of tact and graciousness. After the murder of Dion in 354 the philosopher drew up the important seventh and eighth Epistles, reviewing and justifying the policy of Dion and himself and making proposals, unsuccessfully, for a conciliation of Sicilian parties.

The prejudice which led students in the 19th century to discredit the Epistles, in spite of the favourable opinion of scholars such as Bentley, Cobet, Grote, Blass, E. Meyer, worked havoc with their accounts of Plato's life. It is safe to say that at present the authenticity of the two letters of chief biographical importance, VII. and VIII., is established. I. and perhaps XII. are admittedly unauthentic; on the rest opinion is divided. It seems to be inclining (rightly, as the present writer thinks), in favour of acceptance. The best recent account of the events in Sicily is in E. Meyer, *Geschichte des Altertums*, vol. 5.

To us Plato naturally is important primarily as the greatest of philosophical writers, but to himself the foundation and organization of the Academy must have appeared his chief "work." In the seventh Epistle he utters on his own account the same comparatively unfavourable verdict on written works, in contrast with the contact of living minds, as a vehicle of "philosophy," which he ascribes to Socrates in the Phaedrus (Ep. VII. 341 *b.–e.*, 344 c.). It can hardly be doubted that he regarded his dialogues as intended in the main to interest an educated outside world in the more serious and arduous labours of his "school."

All the most important mathematical work of the 4th century was done by friends or pupils of Plato. Theaetetus, the founder of solid geometry, was a member of the Academy, as were also the first students of the conic sections. Eudoxus of Cnidus, the author of the doctrine of proportion expounded in Euclid's Elements, inventor of the method of finding the areas and volumes of curvilinear figures by exhaustion, and propounder of the astronomical scheme of concentric spheres adopted and altered by Aristotle, removed his school from Cyzicus to Athens for the purpose of cooperation with Plato. Archytas, the inventor of mechanical science, was a friend and correspondent. The Academy is thus the connecting link between the mathematics of the 5th century Pythagoreans and those of the geometers and arithmeticians of Alexandria.

Science.—Nor were other sciences neglected. Speusippus, Plato's nephew and successor, was a voluminous writer on natural history; Aristotle's biological works have been shown to belong largely to the early period in his career immediately after Plato's death, before the breach between the younger philosopher and the Academy. The comic poets found matter for mirth in the attention of the school to botanical classification. The Academy was particularly active in jurisprudence and practical legislation. "Plato sent Aristonymus to the Arcadians, Phormion to Elis, Menedemus to Pyrrha. Eudoxus and Aristotle wrote laws for Cnidus and Stageirus.

"Alexander asked Xenocrates for advice about kingship; the man who was sent to Alexander by the Asiatic Greeks and did most to incite him to his war on the barbarians was Delius of Ephesus, an associate of Plato." (Plutarch, against Colotes, 1126 *c.–d.*) The creation of the Academy as a permanent society for the prosecution of both exact and humane sciences was, in fact, the first establishment of a University.

Socrates.—The most important formative influence to which Plato's mind was exposed in youth and early manhood was that of Socrates. But it does not appear that Plato, whose first ambitions were political, belonged to the innermost circle of the old man's intimates, or regarded himself as a "disciple." In *Ep.* VII. he is careful to speak of Socrates not as a "master" but as an older "friend" (*ἑταῖρος*) for whose character he had a profound respect, and has recorded his own absence (through indisposition) from the death-scene of the Phaedo. It would seem that his own vocation to philosophy only dawned on him afterwards, as he reflected on the moral to be learned from the treatment of Socrates by the democratic leaders. Aristotle incidentally ascribes to him an early familiarity with the Heracleitean Cratylus, a younger man than Socrates and apparently an admirer of the philosopher. This may be only Aristotle's Inference from the existence of the diaiogue

Cratylus. It is more important to remember Plato's connection with Pyrilampes and Critias. Pyrilampes was a Periclean politician, and Critias was known as a democrat until his moral balance was upset by the collapse of the Periclean system in 404. Early upbringing in a family of Periclean politics having connection with Solon may explain why Plato's own estimate of democracy in the *Politicus* and *Laws* is much less unfavourable than that which he ascribes to Socrates in the *Gorgias* and *Republic.*

Beyond this, we can say only that Plato in early life must have been exposed to the same influences as his contemporaries. His early experiences covered the disastrous years of the Deceleian War, the shattering of the Athenian Empire and the fierce civil strife of reactionaries and democrats in the year of anarchy 404–403. He was too young to have known anything by experience of the imperial democracy of Pericles and Cleon, or of the full tide of the "sophistic" movement. It is not from memory that he depicts Protagoras or even Alcibiades, as they were in their great days.

The Works. — The canon and text of Plato appears to have been fixed by two scholars, Dercylides and Thrasylus, either shortly before or shortly after the Christian era. Thrasylus is uncertainly identified with a grammarian of the name who flourished in the reign of Augustus and was "heard" by Tiberius. By reckoning the *Epistles* as one item, the list was made to consist of 36 works, arranged in nine "tetralogies," or groups of four. (Aristophanes of Byzantium had already attempted an arrangement in "trilogies," or groups of three, which, however, he did not carry through.)

Textual **Problems.**—No genuine work of Plato has been lost, but there is a general agreement of modern scholars to reject a number of small items from the text. Their verdict may be said to have gone definitely against the following, *Alcibiades I., Alcibiades II.* (suspected by some even in ancient times), *Theages, Erastae, Clitophon, Hipparchus, Minos.* Most or all of these are probably early Academic work, and possibly not all later in date than Plato's death. Most, though not all, contemporary scholars also regard the *Epinomis*—in the present writer's opinion wrongly—as an appendix to the *Laws* added *de suo* by the mathematician Philippus of Opus, who is recorded by Diogenes Laertius (III. 37) to have transcribed the work for circulation. The *Greater Hippias* and *Menexenus* are still regarded as doubtful by some, though Aristotle used both, and expressly quotes the latter, in a way which seems to prove that he regarded them as Platonic. (The wild negative criticism of German scholars of the middle of the 19th century, which received its death-blow in 1867 from L. Campbell's proof of the genuineness of *Sophistes* and *Politicus,* is now universally recognized to have been an aberration.) Plato's will, preserved by Diogenes (III. 41–43), is pretty certainly authentic. Some of the 32 epigrams ascribed to him in the *Anthology,* may conceivably be genuine.[1]

Order **of Dialogues.**—Plato's literary career extended over the greater part of a long life. The *Apology* must have been written while the memory of Socrates' appearance before his judges was still fresh; the *Laws* is confessedly the work of an old man with a long experience of life behind him, and the state of its text fully bears out the tradition, preserved by Proclus, that its aged author never lived to give it final revision. Some half a century or more must have elapsed between Plato's last and his earliest composition.

This of itself would prove that Schleiermacher, with whom modern critical study of Plato begins, went astray in assuming that Plato started his career with a ready-made complete "system" to be disclosed. We must expect to find in his writings evidence of the development of his mind. But if we are to read the development aright we must have some trustworthy way of determining the order of the dialogues. Plato himself has only given us the scantiest indications of the order He has linked the *Sophistes* and *Politicus* externally with the *Theaetetus* as professed continuations of the conversation reported in that dialogue; he has also, as most students recognize, linked up the *Timaeus* in the same way with the *Republic.* Aristotle adds one other piece of information, that the *Laws* were written after the *Republic.* Further investigation of the problem opens in 1867 with L. Campbell's edition of the *Sophistes* and *Politicus,* and the work thus begun was continued by others, notably W. Dittenberger, C. Ritter and W. Lutoslawski.

By consideration of numerous independent stylistic criteria (for which *see* the works named at the end of this article), it has been definitely established that the dialogues *Sophistes, Politicus, Philebus, Timaeus* (with its fragmentary sequel *Critias), Laws,* form a distinct linguistic group, which must belong to the later years of Plato's life, as we might have presumed from the consideration that Socrates, the central figure of other dialogues, becomes, in those of this group (with a solitary exception for the *Philebus,* the one member of the group which is wholly preoccupied with ethics), a secondary personage, and disappears altogether from the *Laws.* The whole group must therefore be later than the *Sophistes,* which professes to be a sequel to the *Theaetetus.* Now the *Theaetetus* can be dated with some accuracy, since it commemorates the recent death of the eminent mathematician after whom it is named from disease and injury contracted in a campaign before Corinth, which, as elaborately proved by Eva Sachs (*de Theaeteto Atheniensi*, Berlin, 1914), must be that of 369 B.C. The dialogue may thus be safely ascribed to 368–367, the eve of Plato's departure for Syracuse, and the marked change of style visible in the *Sophistes* is best explained by the supposition that there was a break in Plato's literary activity during the years 367–360 when he was specially occupied with Sicilian affairs. So much may be regarded as fairly certain.

The Earlier Dialogues. — It is not so easy to reach definite conclusions about the order of composition of the more numerous earlier group of dialogues. It is generally recognized, on linguistic and other grounds, that the series ends with the *Theaetetus* and the closely related *Parmenides.* Attempts have been made by C. Ritter, Lutoslawski and others, to determine the internal order of the group on linguistic evidence, but there are obvious reasons for doubting whether the methods which have been successful in establishing the distinction between the two great groups of earlier and later dialogues can be applied with the same confidence to works belonging to the same general period of their author's life and composed probably at no great distance of time from one another.

In point of fact, there is not complete agreement between the arrangements proposed by different "stylometrists," and their advocates have usually eked out the strictly philological argument by more or less dubious assumptions about the development of Plato's thought, though it is very questionable whether any real development can be traced before the *Theaetetus* and *Parmenides.*[2] Perhaps all that can be said with certainty is that the great outstanding dialogues, *Symposium, Phaedo, Republic* (and the writer of this article would be inclined to add *Protagoras),* in which Plato's dramatic power is at its highest, mark the culmination of this first period of literary activity. The comparative decline of dramatic power, accompanied by compensating maturity of critical acumen is the most striking contrast between the dialogues of the second and those of the first period.[3] A good account of the work done by the "stylometrists" will be found in H. Raeder, *Platons philosophische Entwickelung* (1905).

The **Socrates of** the Dialogues. — The great initial difficulty which besets the modern student of Platonic philosophy is that created by the dramatic form of Plato's writings. Since Plato

[1]The most dubious are also the best known. That on Agathon (imitated by Shelley, "Kissing Helena") and that on Alexis and Phaedrus are condemned by the occurrence of the names Agathon and Phaedrus. They are obviously suggested by the parts played by the tragic poet Agathon and Phaedrus of Myrrhinus in the *Symposium* and *Phaedrus.* The author has forgotten that both were grown men in Plato's childhood. This suggests suspicion of all the "amatory" verses. The syntax of the first of the epigrams on Aster is also singular.

[2]*See* in particular the important study of P. Shorey, The *Unity of Plato's Thought* (1903).

[3]In *Ep.* VII. *326a* Plato seems to refer to Rep. VI. 499 *b.-c.* as already written before his first visit to Sicily in 387. It has been argued that the *Symposium* must be later than 385 since Aristophanes, who died in that year, is introduced into the dialogue. But it is not clear that Plato made it an absolute rule never to introduce living speakers. It is hard *e.g.,* to believe that Eucleides must have died while the *Theaetetus* was being written

never introduces himself into his own dialogues, he is not formally committed to anything which is taught in them. The speakers who are formally bound by the utterances of the dialogues are their protagonists, Socrates, Parmenides, the Pythagorean Timaeus, and all these are real historical persons. The question thus arises, with what right do we assume that Plato means us to accept as his own the doctrines put into the mouths of these characters? Is his purpose dogmatic and didactic, or may it be that it is mainly dramatic? Are we more at liberty to hold Plato responsible for what is said by his *dramatis* personae than we should be to treat a poet like Browning in the same fashion?

It is tempting to evade this formidable issue in one of two ways. One is that of Grote, who held that Plato allows himself freely to develop in a dialogue any view which interests him for the moment, without pledging himself to its truth or considering its compatibility with other positions assumed elsewhere in his writings. Thus, according to this theory, Plato can make Socrates advocate hedonistic utilitarianism in the Protagoras, or denounce it in the Gorgias, can assert the so-called "ideal theory" through the mouth of Socrates in the Phaedo, or refute it in the character of Parmenides in the dialogue of that name, with equal gusto and without pledging himself in either case. His championships are purely dramatic, or, at most, reflect his passing mood at the moment of composition.

The more common assumption of the 19th century was that scme of Plato's characters, notably Socrates and Timaeus, are "mouthpieces" through whom he inculcates tenets of his own, without concern for dramatic or historical propriety. Thus it was, and often still is, held that the most famous philosophical doctrines of the Phaedo and *Republic,* the "ideal theory," the doctrine of "recollection" and of the tripartite soul, were actually originated by Plato after the death of Socrates, to whom these speculations were entirely unknown, and consciously fathered on the older philosopher by a mystification too glaring to deceive any one seriously. Careful study of the dialogues should satisfy us that neither of these two extreme views is tenable.

The Thought of the Earlier and Later Dialogues.—There is undeniably a real difference between the thought of the dialogues which are later than the Theaetetus and those which are earlier, and this difference will have to be accounted for. But there are no serious discrepancies of doctrine between the individual dialogues of the same period.[1]

Now Plato seems to announce his own personal conviction of certain doctrines of the second group of dialogues by a striking dramatic device. In the Sophistes and Politicus the leading part is taken by an Eleatic and in the Laws by an Athenian who are the only anonymous, indeed almost certainly the only imaginary, personages in the whole of Plato's writings.[2] It can hardly be doubted that the reason why these two characters have been left anonymous is precisely that the writer may be free to use them as "mouth-pieces" for his own teaching. Plato thus takes on himself the responsibility for the logic and epistemology of the Sophistes and Politicus and the ethics and educational and political theory of the Politicus and Laws in a specially marked way, and by doing so compels us to face the question how far he means the utterances of Socrates in his earlier dialogues to be taken as expressions of a philosophy of his own.

"Forms."—It may be regarded as an established result of the inquiries of Dr. Henry Jackson and others that there is a definite philosophical doctrine running through the earlier dialogues which has as its main ieatures the theory of "Forms" (the "ideal" theory), the theory that knowledge is "recollection," and the theory of the "tripartite soul." In the dialogues of the second period these tenets, as we have learned to know them from the earlier dialogues, appear only in the mouth of Timaeus, a 5th century Pythagorean older than Socrates, and the most important of them all, the theory of "Forms" is actually made the object of what looks like a refutation in the Parmenides.

The problem is to find an explanation of this puzzling fact. Are we, with Dr. Jackson[3] and others to distinguish two philosophies, both originated by Plato after the death of Socrates, an earlier and a later? Or are we to suppose that in the main the object of the first group of Plato's dialogues is to preserve the memory of Socrates and that the philosophy expounded is in the main what it professes to be, the thought of Socrates, coloured, no doubt, unconsciously but not consciously distorted, in its passage through the mind of Plato? On the second view we should have to say that, strictly speaking, Plato had no distinctive Platonic philosophy until a late period in his life, much as we can say that, though Kant was all through his life a prolific writer on philosophy, there was no distinctive Kantian philosophy before the Critique of *Pure* Reason. Most Platonic scholars are still unwilling to accept this interpretation of the facts, though there are weighty considerations which plead strongly for it.

Socrates and Plato.—It is significant that the only dialogue not earlier than the Theaetetus in which Socrátes takes a leading part is the Philebus, the one member of the second group which deals exclusively with those ethical problems on which the thought of the historical Socrates had been specially concentrated. This is most naturally explained by supposing that Plato, from regard to fact, was unwilling to make Socrates the exponent of doctrines which he knew to be his own property, though it is hard to understand his misgivings if he had already for years been employing him in that very capacity.[4] (If, as is most probable, *Ep.* II. is authentic, the question would be definitely settled by the sentence of the latter [314 c.] "there is not, and never will be, a work of Plato; the works which now go by that name belong to Socrates embellished and rejuvenated.")

It is notable, too, that Aristotle apparently knew nothing of an earlier and a later version of Platonism. He attributes a definite doctrine to Plato which is quite unlike anything to be found in the first great group of dialogues, and seems to be known to him from oral communications in the Academy, though something like it can, by looking hard, be read between the lines in the *Philebus.* It was also the view of Neo-Platonic scholars like Proclus that the "ideal theory" expounded in the great earlier dialogues really originated with Socrates and that something of the same kind was also held by contemporary Pythagoreans in Italy (Proclus in *Parmenidem* ed. Stallbaum 562, 610), and the fact that Proclus does not find it necessary to argue the point seems to show that this had been the standing tradition of the Academy. Similarly Galen, in the early 3rd century of our era, has preserved the definite statement of the learned Stoic Poseidonius that the doctrine of the "tripartite soul," often said in modern times to be another invention of Plato's, is as old as Pythagoras (Galen de *placit. Hipp.* et Plat. 425, 478).

Moreover, as Burnet has argued, it is very hard to believe that any writer would introduce a far-reaching novel speculation of his own to the world in the curious fashion which Plato is supposed to have adopted in the Phaedo, where Socrates is made to describe the "ideal theory" as something quite familiar which he has for years constantly canvassed with his intimates (nearly all, if not all, of whom, were certainly living when the Phaedo was circulated). It is not necessary here to determine the historical question. We may be content to turn to the Platonic dialogues, carefully distinguishing the successors of the Theaetetus from its predecessors, and attempt a summary of their contents. The general doctrine of the first period will be described without any more or less arbitrary attempt to say how much of it may be actually "Socratic." We may then consider how far this doctrine is modi-

[1]As there would be betweeh the Protagoras and the Gorgias or Phaedo if the Protagoras really said that the pleasure is the good. What it actually says is only that "the many," "most men," hold this view (353 *d.–e.*), and ought not therefore to regard the doctrine that "goodness is knowledge" as paradoxical, since on their own theory, virtue will amount to right computation of pleasures and pains.

[2]Except the two minor personages of the Laws, a Spartan and a Cretan, who have really nothing to do except to say "Yes." "Yo," in the appropriate places.

[3]*Journal* of Philology X.–XII.

[4]It might be said that if the principal doctrines of the Platonic Socrates were known by Plato to be his cwn peculiar property, he might feel a difficulty about putting a new and more critical philosophy into the mouth of the speaker who had been used as the exponent of his "earlier" teaching. Rut this would not wholly explain why Socrates might not have been made to teach the logic of the *Sophistes.*

fied in later dialogues, or in the version of Platonism presupposed by Aristotle's criticisms.

No attempt will be made here to describe the personality or temperament of Plato which is, in fact, as elusive as that of Shakespeare and for the same reason. He is often credited with a strongly "mystical" and "erotic" temperament. He does ascribe such a temperament to Socrates, but it is puerile to treat his picture of Socrates as evidence about himself, though the mistake is constantly committed.

It should therefore be noted that the "mysticism" is confined to dialogues of the first period, in which Socrates is its exponent, and that the "erotic" language in which Plato's Socrates speaks of his devotion to his young friends was also used by the Socrates of Aeschines to describe his relations with Alcibiades (Fr. 4, Krauss). There is no evidence that Plato personally ever fired the imagination of gifted boys as Socrates did. Apart from the Epistles, the most valuable light we possess on Plato's personality is afforded by Aristotle's description of him as a man "whom it is blasphemy in the base even to praise" (ὅν οὐδ' αἰνεῖν τοῖσι κακοῖσι θέμις).

THE EARLIER DIALOGUES

In the Republic, the greatest of all the dialogues which precede the Theaetetus, there may be said to be three main strands of argument deftly combined into a consummate artistic whole, the ethical and political, the aesthetic and "mystical," and the metaphysical. Other major dialogues belonging to this period give special prominence to some one of these three lines of thought; the Phaedo to the metaphysical theme, the Protagoras and *Gorgias* to the ethical and political, the *Symposium* and Phaedrus to the aesthetic and "mystical," though in none does Plato make an artificially rigid separation of any one of the great ideal interests of human life from the rest.

The shorter dialogues deal with more special problems, usually of an ethical character, and mostly conform to a common type. A problem in moral science, often that of the right definition of a "virtue," is propounded, a number of tentative solutions are considered and are all found to be vitiated by difficulties which we cannot dispel; we are thus left, at the end of the conversation, aware of our discreditable ignorance of the very things it is most imperative for man to know. We have formally "learned" nothing, but have been made alive to the worthlessness of what we had hitherto been content to take for knowledge and the need of seeking further enlightenment.

The effect of these "dialogues of search" is thus to put us in tune with the spirit of Socrates, who had said that the one respect in which he was wiser than other men was just his keen realization of his own ignorance of the most important matters. We learn the meaning of his ruling principle that the supreme business of life is to "tend" the soul (to "make it as good as possible") and his conviction that "goodness of soul" means first and foremost, knowledge of good and evil. The three dialogues directly concerned with the trial of Socrates have manifestly a further purpose. They are intended to explain to a puzzled public why Socrates thought it stuff of the conscience neither to withdraw from danger before trial, nor to make a conciliatory defence, nor, finally, to avail himself of the opportunity of flight after conviction. Even well-wishers like Xenophon, as we know, were puzzled by what had seemed his wilfully defiant attitude; it was therefore a debt of honour to his memory to put the matter in the true light. In the remarks which follow, we will consider these shorter dialogues in an order adopted simply for purposes of convenience.

Hippias I. and II.—In these dialogues Socrates has as "respondent" the well-known polymath Hippias of Elis, whose self-complacency is sharply satirized. In the *Hippias Maior* the question propounded is "What is the fine" (καλόν)? "Fine" is a predicate by which we are constantly expressing both aesthetic and moral approval; do we really know what we mean by it? We discover that we do not, though incidentally we also learn that "fine" or "beautiful" is certainly not a synonym for either "useful" or "pleasant." *Hippias* Minor deals directly with the famous Socratic paradox that "wrong-doing is involuntary." It is commonly held that it is much worse to tell a wilful untruth than to blunder into an unintentional false statement. Yet the analogy of the arts and professions seems to show that the man who errs intentionally, if there is such a person, is a better man than he who errs unintentionally. (The suggested thought, of course, is that there "is no such person." The man who knows what is good will always aim at this and at nothing else,—the familiar doctrine of Socrates.)

Ion, Menexenus.— Both these are "occasional" works. Socrates had said that he found the poets, who as a class are commonly reckoned "wise," quite unable to explain to him how they came to say their best things, or what they meant by them. (*Apol.* 22 *a.–c.*) The *Ion* develops this thought into the theory that neither the poet, nor his interpreter the "rhapsode," produces his effects "by science," *i.e.*, as a result of conscious "artistry"; the effect in both cases is due to a non-rational "inspiration," or, as we now say, "native genius." (The importance of this is that it rules out appeal to the poets as specially competent authorities on the conduct of life.)

The *Menexenus*, which professes to repeat a "funeral oration" learned from the famous Aspasia, is apparently meant as a satire on "patriotic" distortion of history. Apparently the "discourses" satirized are those of Pericles in Thucydides, Lysias (Lysias II.) and Isocrates (the Panegyricus). The singular anachronism by which Socrates (and Aspasia) are represented as commenting on the events of the Corinthian War down to the year 387 must be intentional, whatever its object.

Charmides, Laches, **Lysis.**—These are typical "dialogues of search." The question of the Charmides, which contains a particularly delightful picture of the way of Socrates with a promising lad, is what is meant by sophrosyne, the virtue which is shown alike in graceful and easy command of one's appetites and passions, in dutiful behaviour to parents, elders, official "superiors," in balance and sanity amid the ups and downs of fortune. We seem to be in a fair way to identify this virtue with "knowledge of self"—the self-knowledge Socrates had valued so highly—when we are confronted with an ambiguity. "Self-knowledge" might be taken to mean a knowledge which has knowledge itself for its object, in fact for "epistemology." But it is hard to be sure that there is any such science as "the knowledge of knowledge," and harder still to see how such knowledge could be directive of conduct.

In the Laches we are concerned with valour, the soldier's virtue. Here again we are on the point of defining the virtue as knowledge of what is and what is not really to be dreaded. But this is tantamount to saying the true knowledge of evil and good, and the resultant definition, "valour is knowledge of good" would identify valour with the whole "goodness of man." That is, the definition is only possible if we can meet the popular objections to the Socratic thesis of the "unity of virtue."

The *Lysis* examines in the same tentative way, friendship, the relation in which self-forgetting devotion most conspicuously displays itself. The crux of the problem is that after many false starts, we seem to have reached a promising result in the view that each friend is really "a part of" the other in "soul or temper or body," and yet it is hard to reconcile this position with the facts which seem to show that "unlikeness" is a potent source of attraction. Aristotle has taken up and discussed the issues raised in the dialogue in his own treatment of the same subject (E.*N.* VIII.–IX.).

Cratylus.—The question here, one much agitated in the age of Socrates, is whether names are significant by "nature" or "convention." Is there some special appropriateness of the sounds of names to the objects called by them, or is there no bond between the thing and its name but that of the "usage of the community"? The absurdity of attempts to get metaphysics out of etymologies is humorously exposed by showing that the method can be used at pleasure to prove either that the "giver of names" agreed with Heracleitus that motion is the sole reality or that he held, with Parmeaides, that motion is an illusion. Yet there are real analogies between "vocal gestures" and the things signified by them, which are pointed out with a good deal of insight. The main purpose of Plato, however, is to dwell on the point that language is an instrument of thought; the test of its rightness is not mere "social usage," but its capacity to express true thought accurately.

Euthydemus.—The dialogue is, in large part, broad satire on "eristics" who misapply the logic of Zeno for the purpose of entangling anyone who commits himself to any assertion in fallacies due to the ambiguity of language. (Aristotle has drawn freely upon it in his own essay on Fallacies, the de *Sophisticis* Elenchis.) Its more serious purpose is to contrast this futile contradiction-mongering with the "protreptic" of Socrates. The lad Clinias is simply bewildered by the questions of the two professors of "eristic"; those of Socrates have the purpose of convincing him that the happiness we all desire is not guaranteed by the possession of the things the world accounts good, but depends on our making the right use of them. If we would attain happiness we must "tend" our "souls," and that means that we must acquire the "royal" science which ensures that we shall make the right use of all the gifts of mind, body and fortune, in other words, the knowledge of true and absolute good.

Gorgias.—The Gorgias is a much greater, as well as a much longer work than any of those we have considered, and has always been a prime favourite with serious moralists. Beginning ostensibly as an enquiry into the nature and worth of "rhetoric," the art of advocacy professed by Gorgias, it develops into a plea of sustained eloquence and logical power for absolute right, as against expediency, as the sovereign rule of life private and public, and ends with an imaginative picture, on Orphic lines, of the eternal destinies of the righteous and the unrighteous soul. Literature has no more impressive presentation of the claim of conscience to unqualified obedience and the impossibility of divorcing the politically from the morally right.

Gorgias holds that "rhetoric" is an "art," the application of knowledge to practice, and the queen of all "arts," since it gives its possessor the abject of man's highest ambition, power to enforce his will on society. The statesman, who is the man of men, is just a consummate advocate speaking from a brief. If he is clever enough he will, though a layman, carry the day with an audience of laymen, even against the expert specialist. To his audience he will seem, though he is not, the superior of the real expert. Socrates declares. that "rhetoric" is not an "art," a matter of native principles, but a mere "empiric knack" (τριβή) of humoring the prejudices and pleasing the tastes of an audience. It is a subspecies of κολακεία, "parasitism."

There are two genuine "arts" conducive to the health of the body, those of the trainer and the physician; each has its parasitic counterfeit, the one in the profession of the "beautifier," the other in that of the confectioner. So there are two "arts" conducive to "health of soul," those of the legislator, who lays down the rule of morally sane life, and of the judge, who corrects moral disorders. The "sophist" counterfeits the first, as the "rhetorician" the second, by taking the "pleasant" instead of the "good" as his standard The "rhetorician" is thus not the wise physician of the body politic but its "toady" (κόλαξ). This severe judgment is disputed by Polus, the ardent admirer of Gorgias, on the ground that the successful "rhetorician" is virtually the autocrat of the community; every man's life and property are at his mercy.

To be such an autocrat is the summit of human happiness; even if, like Archelaus of Macedonia, the aspirant only reaches the position by a series of shocking crimes, he is the most enviable of mankind, because he is above law and can do "whatever he likes." Socrates denies this. The autocrat always does "as he pleases," and for that reason never does "what he wishes"; like all mankind, he wishes for true happiness or good, but no act which is immoral ("unjust") ever leads to happiness. To suffer a wrong is an evil, but to inflict one is much worse. And if a man has committed a wrong, it is much worse for him to go unpunished than to be cured of his moral malady by the sharp but wholesome medicine of punishment. If "rhetoric" is of real service to men, it should be most of all serviceable to an offender. If he knew his own interest, he would employ all his powers of persuasion to move the authorities to inflict the penalties for which the state of his soul calls. Polus is unable to meet this reasoning, because he had at least conceded to current morality that it is more disgraceful, though not more evil to inflict wrong than to suffer it.

This is denied by Callicles of Acharnae, an otherwise unknown politician, who proceeds recklessly to develop the doctrine of the "will to power." It may be a convention of the herd that unscrupulous aggression is discreditable and wrong, but "nature's convention" (the νόμος τῆς φύσεως, a phrase which appears here for the first time in literature) is that the strong are justified in using their strength as they please, while the weak "go to the wall." Callicles and Socrates thus appear as champions of two contrasted moralities of private and public life. Callicles stands for self-assertion in ethics and aggressive "Imperialism" in politics. Socrates opposes both. In his judgment the creators of the imperialistic Athenian democracy were no true statesmen, because they were content to give Athens a navy and a commerce without creating a morally sound national character. They may have been capable "domestic servants" of the democracy for whose tastes they catered; they were not its physicians. The one true statesman of the past was the "just" Aristeides; in the present, Socrates himself is the one man who shows a statesman-like mind, though it is perfectly true that he might at any moment have to pay with his life for refusing to call that good which pleases the public fancy. It is not true, as Callicles supposes it to be, that the secret of happiness is to have strong and vehement passions and be able to gratify them to the full. That would be a condition like that of the fabled sinners who are punished in Hades by being set to spend eternity in filling leaking pitchers. The truly happy life is that of "measure" in which the gratification of desire is strictly regulated by regard for justice and *sophrosyne.* If we may believe the Orphic doctrine of judgment to come, the votary of "passion" and injustice has a heavy reckoning to await hereafter.

Meno.—The *Meno* is nominally concerned with the question what virtue is and whether it can be taught, but it is further interesting for two reasons. It states clearly the doctrine, which we have not met so far, that knowledge is "recollection"; it also introduces as a character the democratic politician, Anytus, the main author of the prosecution of Socrates. It seems plain that Plato wishes to indicate his opinion that it was Socrates' severe criticism of the great figures of the history of Athenian democracy which led to the prosecution.

Can virtue be taught or learned (as must be the case, if the professional sophists can really do what they profess)? That depends on what virtue is. We are on the way to define it as "ability to secure good things by honest means," when we reflect that honesty itself is a "good thing," and the definition consequently is circular. This reminds us of the current dilemma that all such inquiries are futile because it is idle to inquire into what you already know, useless to inquire into what you do not know (since you could not recognize the unknown, even if you found it). This difficulty would vanish if it were true that the soul is immortal and has long ago learned all truth, so that it needs now only to be "reminded" by sense-experiences of truths it once knew and has forgotten. This (Orphic) doctrine seems to be supported by the experience that a lad who has never studied geometry can be brought to recognize mathematical truths by merely showing him a diagram and asking him appropriate questions about it. He produces the right answer "out of himself." (The point thus is the presence of an a *priori* element in mathematical truth)

In any case, we may say that if "virtue" is knowledge, it can be taught; if it is not knowledge, it cannot. But is it knowledge? If it is, one would suppose that there must be professional teachers of it. But Anytus assures us vehemently that the sophists, who claim to be such professionals, are mischievous impostors, and we can be sure that the ordinary decent citizen cannot "teach virtue," as Anytus maintains, since the "best men" of the democracy, Themistocles and the rest, have been unable to teach it to their own sons. Perhaps, then, we must say that the "best men" of Athens have no genuine knowledge of good; their successes have been due not to knowledge, but to mere "correct opinions." Still, for practical purposes a correct opinion will serve as well as knowledge. The trouble is that you cannot depend on its permanency unless you fasten it down by thinking out the reason why of it (αἰτίας λογισμῷ). Then it becomes knowledge. If a man should arise who could actually teach statesmanship to others, he would be one who really *knew* what good is; the virtue of such a scientific statesman would he to that of other men as substance is to shadow.

Protagoras. — This finely dramatic dialogue gives us the completest presentation to be found in Plato of the main principles of the Socratic morality, and is the direct source of Aristotle's statements about the teaching of Socrates in the *Nicomachean* Ethics.

Socrates meets, in the house of Callias, the eminent sophist Protagoras, who is very attractively drawn and represented as a great admirer of the younger man's ability. Protagoras explains that his profession is the "teaching of goodness," and that by "goodness" he means the art of making a success of one's own life, that of one's household and that of one's "city." (Thus he teaches "the conduct of life, private and public," and has done so for years with success.) Socrates urges that there are two considerations which make it look doubtful whether this art can be taught. The Athenians have a high reputation for intelligence, but it is notorious that the Ecclesia requires no evidence of expert knowledge in a speaker who discusses the niorality of a proposed course of action.

Also the eminent democratic statesmen have never taught their own "goodness" to their sons. Public opinion and the practice of the eminent few alike suggest that the "conduct of life" is not teachable. Protagoras, to be sure, thinks that the absence of special teachers only proves that every citizen of a civilized city can, in his degree, act as teacher, exactly as he can teach his children his native language or his trade. Goodness depends on δίκη and αἰδώς; the sense of right and conscience, and the whole of life in a civilised society, is a process of education in these. His exposition at once raises the problem of the unity of virtue. Are the various commonly recognized "virtues" really different, so that a man may be strong in one but weak in another? Protagoras is at first inclined to say that they are, but on reconsideration is ready to identify all of them but one with wisdom or sound judgment.

An exception must be made for courage, a virtue which is popularly regarded as having something conspicuously non-rational about it. The dialogue culminates in an argument by which Socrates attempts to show that there is no need to make this exception. The general public, the party which insists so much on the non-rational character of courage, would be ready to accept the identification of the good and the pleasant, and to grant that the goodness of courage means that by facing pain and danger one escapes worse pain or danger. On their own theory, then, courage, and the rest of virtue, can be reduced to prudent computation of pleasures and pains. The humour of the situation is that Socrates and Protagoras have thus changed places. Socrates, who had raised a difficulty about the teachability of virtue, is left satisfied that virtue must be knowledge; Protagoras, who claimed to be able to teach it, ends by declaring that, whatever virtue may be, it cannot be knowledge. It is important to observe that the dialogue does not teach Hedonism. The equation good=pleasant is advanced 'only as one which would be accepted by "the mass of men," and should forbid them to find a paradox in the identification of virtue with knowledge; it is expressly repudiated by Protagoras as unworthy of a man of high character.

All that Socrates asserts is that virtue is knowledge and wrong-doing consequently involuntary. There is no disagreement in moral principle between the *Protagoras* and the *Phaedo* or *Gorgias.* If the "mass of men" are ready to accept the Hedonist formula, that is because they are votaries of the body-loving life (βίος φιλοσώματος); this is why we are told in the *Phaedo* that "popular" virtue is illusory. The true explanation of Socrates' doubts is that though he holds that true virtue, being knowledge, is teachable, he does not believe that what Protagoras is trying to teach is true virtue. "Success" depends on personal "tact" and "tact" cannot be learned from an instructor.

Euthyphro, Apology, **Crito.**—The main purpose of these three works, which deal with the bearing of Socrates before, during and after his trial, is to obviate possible serious misunderstandings of the Master's position and motives; the theme of all three may be said to be the true meaning and importance of "care" or "tendance" of the soul.

The problem of the *Euthyphro* is what is religion (τὸ ὅσιον). The respondent Euthyphron is certainly meant to be a kind of Orphic sectary, not, as has been fancied, a representative of ordinary Athenian belief and practice. Socrates had associated with such men and was known to hold unusual beliefs about the soul; hence it was important to make it plain that he was something different from a fanatic. The dialogue, interesting also from its well-developed logical terminology, enables Socrates to repudiate immoral mythology and to reject the conception of "religious duty" as fulfilment of purely arbitrary commands. Its central thought, which, however, is not formally asserted as a conclusion, is that the "service" (θεραπεία) of God which is religion means co-operation with God and under God in the production of a "noble work" (πάγκαλον ἔργον), the nature of which is not further defined, though it is sufficiently clear that the "work" meant is the "tendance of the soul."

Consideration of the *Apology* and *Crito* in detail belongs rather to the study of Socrates (*q.v.*) than to that of Plato. Of the *Apology* we must be content to say here that the real defence of Socrates is contained in the pages which explain that the mainspring of his life has been his conviction that he has a mission from God to spend his life in "philosophy," the endeavour to "make his own soul as good as possible," and to incite mankind to do the same; to this mission it is his duty to be strictly faithful, even if faithfulness means condemnation as a traitor by the democracy. The *Apology* thus depicts Socrates as carrying out in his own practice the ethical programme of the *Gorgias.* The actual accusation is treated with contempt and satirical humour. *(See* article SOCRATES.)

The point of the *Crito,* though simple, is often missed. Was Socrates wantonly throwing away a valuable life by refusing to escape from prison? Why did he make this refusal? Because, though the conviction was materially iniquitous, it was the verdict of a legitimate court, which could not be disregarded without real disloyalty. Socrates has been wronged not by the law, but by politicians who have abused the law. If he disregarded the conviction, he would be directly doing a wrong against the whole social system.

Foundation **of** Plato's Doctrine — In the works so far considered we have the foundation of a moral and political doctrine based on Socratic principles, from which Plato never departed. The main underlying thought is that the great concern of man, a concern not limited to this earthly life, is the development of a rational moral personality (the "tendance of the soul"). Our felicity depends wholly on our success in this task (to use Butler's language, on "our conduct," not on "our condition"). And this success, again, depends on rational insight into the true scale of good. Men do not miss felicity because they do not desire it; on the contrary no man ever really desires anything else. The reason why men forfeit felicity is that they mistake apparent good for real, the conditionally for the absolutely good. If a man ever knew with assurance what absolute good is, he would in practice never pursue anything else. It is in this sense that "all virtue is knowledge" and that "all wrong-doing is involuntary" (*i.e.,* consists in the pursuit of what is falsely supposed to be good).

"Popular morality" is confused in theory and unreliable in practice because it does not rest on any assured insight into absolute good; "philosophic morality," just because it does rest on such certain insight, is a morality of absolute and unconditional obedience to conscience, such as Socrates had shown. Since the task of the statesman is simply the task of "tending the soul" extended to the "national" soul as its object, the "philosophical" moralist is also the only true statesman. True statesmanship means the promotion of national character as the one thing which matters, and is therefore simply the application, on the grand scale, of the principles of absolute morality; what falls short of this is opportunism masquerading as statesmanship.

These convictions clearly imply a far-reaching metaphysic as their foundation and justification. The principles of this metaphysic, though they are frequently hinted at in passages of dialogues alrrady reviewed, are put before us more explicitly in those we have now to consider; in connection with them we shall also observe an explicit theory of knowledge and scientific method.

Phaedo.—The Phaedo is often treated as though its object were to provide a demonstration of the immortality of the soul. It does not really profess to do this. The object is to justify faith in immortality as a rational faith by showing that it follows naturally from a fundamental metaphysical doctrine (the "ideal theory" or "doctrine of Forms"), which seems to afford a rational clue to the structure of the universe, though it is expressly said at the end of the whole discussion that this doctrine itself still requires further examination. At the same time, it is made fully clear that the writer accepts this metaphysical doctrine, with the reservation just mentioned, and is passionately sincere in the faith in "personal immortality" which he brings into connection with it. To be strictly accurate, indeed, we ought to say that the faith to be defended goes beyond belief in "immortality." What is being maintained is the "divinity" of the soul; its survival of death is a consequence of this inherent divinity.[1]

The argument is briefly as follows. A true philosopher may naturally look forward to death without dismay. For death is the separation of soul from body, and the philosopher's whole life has been spent in trying to liberate the soul from dependence on her body. In life, the body is always interfering with the soul's activity. Its appetites and passion interrupt our pursuit of wisdom and goodness; its infirmities are perpetually hindering our thinking. Even in our scientific work, we only attain exact and certain truth in proportion as we detach ourselves from reliance on sense-perception and learn to depend on pure thinking.

Death, then, only completes a liberation which the philosopher has been "rehearsing" all through life—if, that is, the soul continues to exist after death, as there are reasons for thinking. For:

I. There is a belief that the soul has a succession of many lives, and that when it is born into this world, it has come back from another. And there are two considerations to be urged on behalf of this belief. (a) The processes of nature in general are cyclical. The hot becomes cold, the cold hot; the waking go to sleep, the sleeping wake. It is reasonable to suppose that this applies to the case of dying and coming to life, so that the dead return to life, just as the living die. If this were not so, if the process of dying were not reversible, life would ultimately vanish from the universe. And (b) we may appeal to the doctrine that what we call "learning" is really "recollection," "being reminded" of something. This certainly seems to be the case, for in all our science we are perpetually being "put in mind of" precise ideal standards, mathematical or moral. We reason about exact quality, absolute justice and the like. Sense or experience never presents us with such perfect equality or justice; it only suggests them or "reminds us of them." We must therefore have become acquainted with them before we were confined to our bodies, and therefore must have existed before our birth. Now *(a)* and (b) together would prove what we want to prove, the soul's survival of death, though our "dread of the dark" makes us demand a more convincing argument.

II. We may consider the antithesis between the divine and eternal and the temporal and mutable, which runs through the universe. The body is certainly temporal and mutable. The soul is relatively immutable, like the fixed ideal standards or norms which she contemplates in her scientific thinking. Her thought is concerned with eternal objects and she herself has the likeness of that which she contemplates. If, then, some constituents of the body are nearly indestructible how much more should one expect the divine element in us, the soul, to resist destruction, as the traditions about re-birth assert that it does.

There are two grave "scientific" difficulties still to face. It may be argued: *(a)* that the soul is an "epiphenomenon," the "tune" (ἁρμονία) given out by the body, and if so, its superior "divinity" will not protect it from vanishing when the instrument which makes the music is broken; (b) that though the soul actually makes its own body, and perhaps can make a long succession of bodies, it cannot do so without "expending energy"; a time will come when it can no longer make a fresh body, and then it will itself disappear. We must not be driven into misology, antipathy to science, by this apparent clash between science and a faith to which we are attached.

The answer to (a) is that there are good souls and bad ones, and the good soul is "more in tune" than the bad one. But that which can be more or less "in tune" is clearly not itself a "tune." And if the soul were the "tune" resulting from the functioning of the body, its character at any moment would be a resultant of the condition of the body. How then could we have the experience, characteristic of the moral life, of the conflict between the soul with its aspirations and the body with its carnalities? The answer to (b) can only be given as part of a whole theory of the causes of "coming into being and passing out of being." Socrates had been led, early in life, to frame a tentative theory of the matter in consequence of his dissatisfaction with the chaotic state of physical speculation, and in particular with the failure of Anaxagoras to make any satisfactory use of his apparently teleological principle that "mind is the cause of all order and structure." He fell back on the method of "hypothesis."

What distinguishes this method from all others is that it begins by making an undemonstrated "postulate" (ὑπόθεσις). It then proceeds from this point to consider the truth or falsehood of the consequences which follow logically, from the initial postulate; the question of the truth of the postulate is, for the present, left unasked. Socrates' own fundamental unproved postulate has always been that usually, but loosely, called the "theory of Ideas." The postulate is that there really is a single determinate and immutable something (εἶδος, ἰδέα) answering to every significant "general term," and apprehended only by pure thought. The sensible things of which we predicate general terms temporarily "partake in" or "communicate with" the Idea or Form (ἰδέα, εἶδος). When we say that a thing becomes *e.g.,* beautiful, what we mean is that the Form (ἰδέα) "beauty" begins to be "present to" that thing, the thing begins to "partake of" the Form. When we say that a thing ceases to be beautiful, we mean that this relation of "presence," "participation," "communication" (παρουσία, μέθεξις, κοινωνία) is dissolved. This is the true account of the cause of "coming into and passing out of being," and if we accept it, we may proceed to our final argument for immortality.

III. There are Forms which are mutually incompatible, such as warmth and cold. Heat is never cool, and cold is never warm. But there are also certain sensible things of which it is an essential character to "partake of" a given Form. Such things will never admit an incompatible Form. Thus it is an essential character of snow to "partake of" cold. It will never, therefore, "partake of" the Form "heat." Similarly it is an essential character of a soul to be alive, to "partake of" the Form "life." It refuses to "partake of" the Form "death." At the approach of death, the soul must either retire or be annihilated (the metaphors are military). What we have said of its divinity forbids us to think that it is annihilated; we must therefore assume that it "retires" to some other region. The proof of immortality is thus hypothetical; it is shown to be involved as a consequence by the doctrine of Forms. This doctrine has been stated as a fundamental unproved postulate and it is admitted that it demands fuller consideration.

But our enquiry has at least satisfied us that the hope of immor-

[1]Plato's belief in immortality ought never to have been disputed. It is re-affirmed in the most unqualified way in the seventh *Epistle* (335*a–b*) and his very latest work, the Laws (904*c*–905*d*), though the particular arguments of the *Phaedo* do not re-appear there. Aristotle, too, in his early days as a member of the Academy, had taught the doctrine in his *Eudemus* (*Fragmenta,* ed. Rose 37–48). This consideration is really decisive. The characteristic argument of the Law, from the "self-moving" nature of the soul had already been used in the *Phaedrus* (245*c*). *Timaeus* 41*a*, where the final appeal is to the goodness of the Creator, formally applies not to men but to the stars.

tality Is a reasonable one. (To distrust it would be to call the foundation of our whole philosophy into question.) The discourse ends with an imaginative cosmological myth depicting the future of the just and the unjust respectively.

In this statement of the theory of Forms (ἰδέαι, εἴδη) we may note the following points: (1) The doctrine is a piece of "realist" metaphysics. It is assumed that a universally predicated "general term" denotes or stands for an individual reality, apprehensible by thought, though not by sense. (2) There are a plurality of such Forms, standing in various logical relations with one another; whether they constitute a system with a definite structure the *Phaedo* does not tell us. (3) They are at once the objects known in all genuine science and the formal causes of all the temporal processes of the sensible world. (4) The sensible things which have the same names as Forms are said to owe their character to their "participation" (μέθεξις) of the Forms, or, equivalently, to the "presence" (παρουσία) or "communication" of the Forms to them. The precise character of this relation of "participation" is admitted to need further explanation. So far as the language of the *Phaedo* goes, a sensible thing would seem to be thought of as a temporary "complex" or meeting-place of universal characters and as nothing more.

Symposium, **Phaedrus.**—It is by no means clear that these two dialogues are closely connected in point of date, but they may be considered together as both presenting the Forms in a special light, as objects of mystical contemplation and excitant of mystical emotion.

The argument of the *Symposium* cannot be reproduced here as a whole. The immediate object of the dialogue, which professes to record the discourses made in eulogy of Eros by a group of eminent speakers at a banquet in honour of the tragic poet Agathon, in the year 416–5, is to find the highest manifestation of the "Love" which controls the world in the mystic aspiration after union with the eternal and super-cosmic Beauty, to depict Socrates as the type of the aspirant who has reached the goal of "union," and to set in sharp opposition to him the figure of Alcibiades, who has sold his spiritual birthright for the pleasures and ambitions of the world. The centre of philosophical interest lies in the discourse of Socrates, which he professes to have learned a quarter of a century ago from the priestess Diotima of Mantineia.[1]

The main argument may be summarized thus. Eros, *desirous* love, in all its forms, is a reaching out of the soul to a good to which it aspires but has it not yet in possession. The desirous soul is not yet in fruition of good. It is on the way to fruition, just as the "philosopher" is not yet in possession of wisdom but is reaching out after it.

The object which awakens this desirous love in all its forms is Beauty, and Beauty is eternal. In its crudest form, love for a beautiful person is really a passion to beget offspring by that person and so to attain, by the perpetuation of one's stock, the *succedaneum* for immortality which is all the body can achieve. A more spiritual form of the same craving for eternity is the aspiration to win immortal fame by combining with a kindred soul to give birth to sound institutions and rules of life. Still more spiritual is the endeavour, in association with chosen minds, to enrich philosophy and science with "noble discourses and thoughts."

But the goal still lies far ahead. When a man has followed the pilgrimage so far, he "suddenly descries" a Supreme Beauty which is the cause and source of all the beauties he has discerned so far. The true achievement of immortality is finally effected only by union with this. The philosopher's path thus culminates in a supreme "beatific vision." It is clear that the object of this vision, the "Beauty sole and eternal" of the dialogue, means what the *Republic* calls "the Good" or "Form of Good," which by its presence actually causes the goodness of everything else to which the name of good can be given. The Forms are thus thought of as a hierarchy with a supreme Form at their head, though no attempt is made at a rational theory of the way in which the supreme Form unites the rest into the system.

The immediate subject of the *Phaedrus* is the principles of "rhetoric" or, as we should say, prose composition. The *Gorgias* had told us that "rhetoric" as commonly practised is not a matter of rational principles at all, but a mere empirical trick of adapting one's tone to the prejudices of an audience. The *Phaedrus* aims at showing how a really scientific "rhetoric" might be built on the double foundation of logical method and scientific study of human passions. Plato contrives, however, by making a real or supposed "erotic" composition of Lysias the starting-point of his criticisms, to unite with this topic a discussion of the psychology of "love," and this, as in the *Symposium*, leads him to speak of the Forms as the objects of transcendental emotion. The soul is immortal, because it has within itself a native source of spontaneous movement.[2] In its disembodied state it shared the life of the gods and could enjoy the direct contemplation of "unbodied" reality, that is, of the Forms. It has suffered an antenatal fall into an embodied condition in which it is blind to everything which does not come in at the avenues of sense.

Now our senses only suggest few and faint images of such Forms as Justice and Temperance, but they can suggest Beauty in a much more impressive and startling way. To "fall in love" is to come under the influence of such sudden and arresting suggestions of Beauty; the "unreason" and "madness" of the lover mean that he is being awakened to realities which other men ignore. The "wings" of his soul are beginning to grow again, and his experience, rightly used, will be the first step in the soul's return to its high estate. This section of the *Phaedrus* is the *locus classicus* in Plato for the Forms as objects of mystical contemplation.

Republic.—The philosophy pre-supposed in all these dialogues receives its fullest exposition in the *Republic*. Here the immediate problem is strictly ethical. What is Justice (τὸ δίκαιον, δικαιοσύνη)? Can it be shown that Justice is always a boon, injustice a curse, to its possessor, apart from all consideration of consequences in this life or another? That is, is there a rational principle at the root of moral distinctions, and does the principle carry with itself its own intrinsic and indefeasible authority?

Plato's answer is that there is such a principle; each of us, in virtue of his special endowments and aptitudes, has a specific "work" or "vocation"; there is some special contribution which he, and no other, can make most effectively to the life of a rational society. Morality, "Justice," is to discharge that vocation to the height and with a single mind (τὰ αὑτοῦ πράττειν καὶ μὴ πολυπραγμονεῖν). To live thus is to be in spiritual health; to live otherwise is to be spiritually diseased. The obligation is thus intrinsic and absolute. This position has to be made good against the incoherencies of a morality of uncriticized traditional maxims, as well as against the "immoralism" of advanced thought (represented by Thrasymachus in Bk. I., expounded more intelligently by Glaucon in Bk. II.).

This leads us to consider what would be the general type of life in a society where the principle of Justice had power as well as manifest authority, and how it might acquire that power. Hence the need for a sketch (II., III.) of the institutions of the reformed society, and particularly of its moral and religious education. We have next to satisfy ourselves that the principles which regulate the public life of the morally healthy society are also recognizably the principles of the great virtues of private life. For this purpose, we need a psychology of voluntary action which is provided (Bk. IV.) by the doctrine of the "tripartite soul." This is not, indeed, a scientific psychology, but proves adequate to describe the moral life of the ordinary good citizen of such a society as we have conceived. The foundation of all this moral excellence

[1]It is important to remember that Socrates professes to be repeating a lesson he had learned at about the age of *30*. This explains at once the words of *Symposium 210a*, where Diotima expresses uncertainty about Socrates' achievement of the complete "vision." He has his life yet to live; what it will be is not revealed. That the words have gravely been interpreted as a claim on Plato's part to have transcended his Master's limitations is only one example of the perversity with which he has been misunderstood.

[2]This is the argument for immortality to which Plato trusts in the *Laws*. It is not specially mentioned in the *Phaedo*, but this can hardly mean that Plato had not yet discovered it, since it is, in fact, taken from Alcmaeon of Crotona, a medical man of the beginning of the fifth century.

is thus laid in absolute loyalty to a sound moral tradition enforced by education. To ensure that the tradition shall be thoroughly sound, we must stipulate that the authorities who create it do not themselves depend on tradition for their convictions about good and evil; they must not "opine," but know, by personal insight. The statesmen at the head of the community must be "philosophers" as well as kings (Bk. VI.).

But the vision of "the Good" will only dawn on them if they have been prepared for it by an intellectual discipline in hard thinking which leads them through the curriculum of the exact sciences to the critical study of the metaphysical principles involved in science (Bk. VII.). The central books of the *Republic* thus present us with an outline of metaphysics and a philosophy of the sciences. We now turn back to consider the various stages of degeneration through which national and personal character pass when the true moral ideal is allowed to fall more and more completely out of view. As we pass them in review, we are increasingly confirmed in our conviction that, in respect of happiness, the life of regard for right is immeasurably superior to that of sating one's cupidities or gratifying one's personal ambitions (VIII.–IX.), and this conclusion is finally clinched (X.) by re-affirmation of the immortality of the soul. Since the soul is immortal, the issue which hangs upon our choice to live well or ill is one of infinite moment (X.).

The ethical scheme of the *Republic*, like that of the *Gorgias* and *Phaedo*, is dominated by the conception of the "three lives," ascribed by credible tradition to Pythagoras. The "lives" are those of the philosopher, the "man of action" (φιλότιμος), the votary of enjoyment (φιλήδονος, φιλοσώματος, φιλοχρήματος). The end of the first is wisdom, of the second, distinction, of the third, the gratifications of "appetite." Distinction is a worthier end in life than mere satisfaction of appetite; the supremely worthy end is wisdom. In a well-lived life, then, the attainment of wisdom will be the paramount end, and ambition and appetite will only be allowed such gratification as is compatible with loyalty to the pursuit of that paramount end. The psychological foundation of this doctrine is the theory of the "tripartite" soul, expounded fully in *Rep*. IV. Analysis of familiar experience reveals three "elements" (μόρια, εἴδη) or "active principles" within us, (1) considered rational judgment of good (τὸ λογιστικόν); (2) a multitude of clamant appetites for particular gratifications, which may be in violent conflict with our own considered judgment of good (76 ἐπιθυμητικόν); (3) a factor of "spirit," higher "ideal emotion," which manifests itself as "resentment" against both the infringement of our just rights by others and the rebellion of our own appetites against our judgment (τὸ θυμοειδές).

The same distinctions reappear in the structure of society. A society naturally falls into three divisions, the statesmen, who direct the public life, the genera1 civilian population, who carry on the business of providing for material needs, and the executive force (army and police), whose function is, in a rightly ordered society, to give effect to the counsels of the statesmen by repressing attacks from without and rebellion from within.

These three "orders" are thus respectively, the judgment, the "appetitive" and "spirited" elements in the national soul. On this basis, we can proceed to work out an ethical and political theory. In ethics we can define the great leading types of "goodness," the quadrilateral, later known as the four "cardinal" virtues. *Wisdom* is the "excellence" of the "thinking part," clear and assured knowledge of the good; *courage,* the fighting man's virtue, is the "excellence" of the "spirited" part, unswerving loyalty, unshaken by pain, by danger, by the seductions of pleasure, to the rule of life laid down by judgment; *temperance,* the special excellence of the "appetitive" part, is the contented acquiescence of the non-rational elements in the soul in the plan of life prescribed by judgment; *justice* is just the state in which each of the elements is vigorously executing its own function and confining itself within the limits of that function. In the rightly ordered society, the national wisdom has the statesmen as its organ, the national courage the executive force; the national temperance is shown in the loyal contentment of each class in the community with its prescribed place and its duties.

Such a society is a true aristocracy, or rule of the best; "timocracy" the military state, in the better sense of that phrase, arises when the mere "man of action," only competent to fill the part of a good soldier, takes the place which rightly belongs to the thinker as directing statesman; "oligarchy" (*i.e.,* the dominance of "merchant princes," plutocracy), is a further deviation from the ideal, which arises when political power is bestowed on property as such. A still worse system is democracy, in which no attempt is made to connect political power with any special qualifications. Worst of all is tyranny, exercise of irresponsible power by the positively disqualified. the man of "criminal" will. The psychological scheme on which this construction is based is not given by Plato as a piece of strict science. We are carefully warned that exact truth is not to be reached by such an analysis of *prima facie* facts of social life (435 d.), and reminded later on that this apparent triplicity of the soul may prove to be only a temporary consequence of its conjunction with the body (611 *b.*).[1] The "tripartite" psychology, it is meant, enables us to give an account of the moral life, as it actually appears in a good citizen, which will fairly describe the facts. It is good popular psychology, useful for the moralist, but it is no more.

Hence it is improbable that the analysis originated with Plato himself. More probably it was, as the Stoic Poseidonius asserted, a piece of earlier Pythagorean doctrine, as is also suggested by the constant recurrence, throughout the section of the *Republic* in which the analysis is offered, of analogies from the specially Pythagorean science of Harmonics, and by the fact that the same doctrine is taught by the Pythagorean speaker in the *Timaeus.* Plato has, however, worked the theory into his ethics so completely that through him it has actually become a part of the psychology of Thomism, where it has to be squared, not quite satisfactorily, with the radically divergent psychological scheme of Aristotle.

In point of fact, the tripartite *schema* proves inadequate in the *Republic* itself when we advance in Bk. VI. to the consideration of the moral life of the "philosopher-king," whose "virtue" is founded on a personal *knowledge* of good. A higher level of moral goodness is demanded of him than of other citizens even of the ideal Utopia; his courage, for example, is declared to be no mere loyalty to right opinions inculcated by early education, but a high serenity arising from the knowledge of the relative insignificance of a brief individual life in the great universe which lies open to his contemplation. This has an important bearing on the teaching of the *Republic* about the unity of virtue.

In the ideal State itself, virtue does not appear as a complete unity. The leading types of moral excellence receive their several definitions. It is recognized that a special demand may be made on a particular section of the society in respect of a particular virtue of which it is, so to say, the public organ, as the fighting force is of the valour of the whole society. This is because, even in the ideal state, the moral convictions of citizens, other than the men of superlative intelligence and character who become "kings," are not supposed to arise from personal insight. They rest on opinions implanted by education, and are thus taken on trust. The good civilian or soldier, after all, is not living by a knowiedge which is his own. But the rulers, by whose knowledge the rest of the community lives, must not, of course, themselves take their convictions on trust. They must know with a personal knowledge. The foundation of their virtue must be *insight* into a system of absolute values embodied in the very structure of the universe. In virtue of this deeper foundation the virtues in them are, so to say, transubstantiated and can no longer be distinguished from one another. They will fuse in knowledge of the good, as, in the Christian saints, they are fused in knowledge and love of God. It is in this form that the Socratic doctrine, "all virtue is one thing, knowledge" reappears in the *Republic* as the foundation of a society in which mankind has at last '(escaped from its wretchedness," because knowledge rules.

In the *Republic,* as in the *Phaedo,* the Forms (ἰδέαι, εἴδη) ap-

[1]Timaeus is expressly made to teach that the θυμοειδές and ἐπιθυμητικό are a "mortal element" (θνητόν εἶδος) added to the immortal soul to fit it for its habitation in the body (*Tim.* 69c.).

pear in the double character of objects of all genuine science and formal causes of the world of events and processes. It is expressly denied that there can be knowledge, in the proper sense of the word, of the temporal and mutable. In the scheme laid down for the intellectual training of the philosophic rulers, ten years, from the age of 20 to that of 30, are assigned for systematic study of the exact sciences in the order: arithmetic, plane geometry, solid geometry, astronomy and harmonics. Special stress is laid on the points that the object of these studies is not practical applications but the familiarizing of the mind with relations between terms. which can only be apprehended by thought, and that diagrams and models are to be treated merely as incidental aids to imagination. Five years are then further to be given to the still severer study which Plato calls "dialectic," a study which avails itself of no sensible aids to imagination. It proceeds "by means of Forms, through Forms, to Forms" *(511 b.)*. It is, in fact, what we should call a critical metaphysic of the sciences. It examines the ὑποθέσεις or unproved postulates, of the various sciences, and its object is to "destroy" their character as unproved ultimate postulates (τὰς ὑποθέσεις ἀναιροῦσα 533 *c)* by discovering some still more ultimate really self-evident principle (an ἀνυπόθετον, 511 *b)* from which they follow as consequences.

There can be no doubt that this most ultimate principle which is more than a "postulate" means the Good or Form of Good (ἰδέα τἀγαθοῦ) which is said to be the source at once of the reality and the knowability of all that is real and knowable, though it is itself neither knowledge nor being, but transcendent of both (509 *b.)*. On the methodological side the *Republic* thus completes the teaching of the *Phaedo* by providing the answer to the question then left open, when a "postulate" (ὑπόθεσις) may be regarded as finally established. It may be so regarded when it is seen to follow itself from the Good, which is the principle at once of existence and of value.

Socrates is made to confess *(506 d-e)* that he can give no positive account of this supreme metaphysical principle; he can only indicate its nature by an analogy. It is to the whole system of Forms what the sun is to the system of visible things, the source at once of their existence and of the light by which they are apprehended. The Good is thus thought of, to use scholastic terminology, as a transcendent reality which can be apprehended but never fully comprehended. The comparison with the sun and the free employment of the metaphor of "vision" indicate that the thought of the *Republic* is here the same as that of the *Symposium;* the Good is no other than the supreme Beauty which was there said to dawn suddenly upon the pilgrim of "Love" as he draws near to the goal of the journey. R. L. Nettleship rightly says that it holds the place taken in later philosophies by God, when God is thought of as the "Light of the world." But it would be deforming Plato's thought to call the Good of the *Republic* "God." The *Republic* is permeated by religious faith, but Theism as a principle of metaphysical explanation only makes its appearance in Plato's latest dialogues, and there as the solution of a problem which can hardly be said to have been adequately faced in the dialogues so far considered.

How the Good gives systematic structure to the plurality of Forms, the *Republic* does not tell us.

Development of the Doctrine of Forms.—So far we have been presented with a body of thought which has remained recognizably the same without serious modification throughout its various expositions. When we come to the two works which there is reason to regard as directly preluding to the dialogues of Plato's old age, the *Parmenides* and *Theaetetus,* we are struck by a remarkable difference of tone. With Plato, as with Kant, the "middle years" of life were clearly a period of fruitful critical reconstruction. There is an obvious motive for each reconstruction suggested by the *Phaedo* and *Republic* themselves.

The theory there expounded does not allow enough reality to the sensible world. It is quite false to say that even the *Phaedo* teaches an "absolute dualism" of two disconnected worlds, a realm of genuine being which never "appears" and a realm of sensible appearances which are merely unreal. What is true is that both *Phaedo* and *Republic* leave us with an unsolved problem. They tell us that a sensible thing is a complex or meeting-place of a plurality of Forms. What else, or what more, it is they do not tell us. And yet it is clear that a "thing" is not simply a bundle of "universal predicates."

Or, to put the point rather differently, according to the *Phaedo* a thing becomes for a while beautiful because Beauty "becomes present to it." But why does Beauty become present to this particular thing at just this particular moment? Clearly the relation between a "thing" and a Form which has been called "participation" needs further elucidation. Again the simple epistemological formula that knowledge is confined to Forms and their relations, while we can only have shifting "opinions" about temporal facts does less than justice to our scientific knowledge of the natural world; "truths of fact" have not yet come by their rights. Finally, if the Forms constitute a rationally ordered system, there must be definite principles of inter-relation between Forms themselves as well as between Forms and sensible things and these principles demand investigation. (If the Good is what the *Republic* saps it is, not only will things "participate" in Forms; Forms also will "participate" in it.) Here are internal motives for active re-examination of the whole system.

It is clear that there was also an external motive. *Parmenides, Theaetetus, Sophistes,* all reveal a special interest in the Eleatic philosophy, and the first and third show an anxiety on Plato's part to maintain that, in spite of important divergences, he, and not the professed Eleatics, is the true spiritual heir of the great Parmenides. This is easily explained when we remember that Plato was personally a friend of the chief representative of Eleaticism among the Socratic circle, Eucleides of Megara, while Polyxenus of Megara, an associate of Eucleides, was a hostile critic of the doctrine of "participation."[1] The doctrine of Eucleides, like that of Parmenides was that "sensible appearances" are illusions with no reality at all. Against criticism from this quarter, it would be necessary for Plato to show that the *Phaedo* itself does not allow too much reality to the sensible; the attempt to prove this point would inevitably show that it had conceded too little. Continued reflection on the same problem of the worth of propositions about sensible fact leads straight to the discussion of the meaning of the *copula,* and the significance of denial, which is the subject of the *Sophistes.*

Parmenides.—Formally the dialogue conducts to an *impasse.* In its first half the youthful Socrates expounds the doctrine of the "participation" of things in Forms to the Eleatic philosophers, Parmenides and Zeno, as the solution of the problem of the One and the Many. Parmenides raises what appear to be insoluble objections to the conception of "participation," though he admits that "dialectic" would be impossible if the existence of Forms were denied; he hints that the helplessness of Socrates under his criticism arises from insufficient training in logic.

In the second and longer half, Parmenides gives an example of the logical training he recommends. He takes for examination his own thesis, "the One is," and constructs an elaborate set of antinomies after the fashion of Zeno, apparently proving that whether this thesis be affirmed or denied, in either case we are compelled either to affirm simultaneously or to deny simultaneously a series of contradictory predicates, alike of the "One" and of the "Many." The conclusion is patently ironical, and we are left to divine the author's purpose, if we can.

The objections to "participation," which is formulated precisely as in the *Phaedo,* are directed not against the existence of Forms, but against the possibility that sensible things should "participate" in them. From the point of view of this criticism Socrates' error is that he attributes some sort of secondary reality to the sensible, The main arguments are two: *(1)* the doctrine does not really reconcile unity with plurality, since it leads to a *regressus in indefinitum.* It says that the many things which have a common predicate "participate of" or "imitate" a single Form. But the Form itself also admits of the common predicate, and there must therefore be a second Form, "participated" or "imitated" alike by the sensible things and the first Form, and so on endlessly. We could not escape by the suggestion that the Form exists only "in our

[1]Alexander Aphrodis. on Aristot. *Met.* 990 b. 17.

minds," since that would mean that a Form is a thought, and it would follow that "things" are made of thoughts. But if so, either everything thinks, or there are thoughts which do not think, and both alternatives are absurd; (2) it is a still graver difficulty that if there are two realms, a realm of Forms and a realm of sensible things, the relations between Forms must belong to the realm of Forms, those between sensible things to the realm of things. We ourselves belong to the second, and therefore all our knowledge belongs to it too; we know nothing of the true realities, the Forms: if anyone knows them, it is God, but God's knowledge, being knowledge of realities, will not extend to *our* world, the sensible. The purpose of the objections is thus to suggest that the "manifold of sense" has not even a derivative reality; it is mere illusion.

This is precisely the position of the Eleatics and their Megarian continuators. The inference is that Plato is reproducing Megarian criticisms of the doctrine ascribed by himself to Socrates, an inference confirmed by the notice preserved by Alexander of Aphrodisias (on *Met.* ggo b 15) of the "third man" argument of the Megarian Polyxenus against "participation." Plato does not indicate his own opinion of the cogency of the reasoning, which is, in fact, fallacious, as was properly pointed out by Proclus.[1]

The purpose of the antinomies which follow has been very differently understood. In the present writer's opinion, they are deliberate parody, the object being to show that the methods of the Megarian logicians are even more damaging to their own fundamental metaphysical tenet than they are to the doctrine of "participation." Megarian logic is a double-edged weapon, and Plato, if he chooses, can apply it even more dexterously than its inventors.

Theaetetus.—Except for a magnificent interlude in praise of the contemplative life, the dialogue is a straightforward discussion of the question how knowledge should be defined. It naturally ends negatively. None of the proposed definitions will stand examination (the reason is that we are really trying to define truth and truth is an ultimate). But the incidental results of the discussion are of the first importance. We learn *(a)* that knowledge cannot be identified with sensation nor with any formless "simple apprehension"; (b) that pure relativism is as impossible in epistemology as in metaphysics. We have the beginning of a doctrine of the "categories" which is further developed in the *Sophistes.*

The increasing value which Plato is coming to put upon "natural knowledge" is marked by the use of the word δόξα, which in earlier dialogues had commonly meant mere uncertain "opinion" as contrasted with knowledge, in the new sense of "judgment" which it retains in Plato's subsequent work. The most striking negative feature of the *Theaetetus* is that it discusses knowledge at length without making any reference to the Forms and the mythology of "recollection." It remains to this day the best of introductions to the "problem of knowledge."

The main argument may be very briefly summarized thus: I. It seems plausible at first to say that knowledge (ἐπιστήμη) *is* sensation (αἴσθησις). This sounds very much like the proposition of Protagoras, "what seems to me is so to me; what seems to you is so to you." We might base such a thorough-going doctrine of the relativity of all knowledge on a still more ultimate metaphysical theory, if we said—it is implied that Protagoras himself said nothing of the kind—that, within us and without us, the only reality is motion. "Organ" and "environment" are both motions; when these motions impinge on one another, they give rise to the twin-product, felt sensation–sensible quality.

Both the sensation and the quality "sensed" will therefore be affected by any difference in the pair of slower "motions" which cause them (the "organ" and its "environment"), and each percipient, therefore, is confined to his strictly private world, which exists only "for" him. There is no "common" perceived world, and therefore no standard of truth or reality other than the individual percipient. A teacher does not aim, any more than a physician, at convincing his pupil of the "falsity" of his judgments, but at giving him "useful" or healthy convictions in place of harmful or diseased convictions.

[1]For a detailed discussion of it, *see A. E.* Taylor, *Parmenides, Zeno and Socrates* (Transactions of Aristotelian Society, N. S. xvi. 234 ff.)

The full discussicn of such a theory would demand a thorough study both of the Heracleitean philosophy, which says that there is nothing but motion, and the Eleatic philosophy which says that motion is an illusion. But for our immediate purpose, a more summary argument is sufficient. It is certain that even the relativists, who hold that each man is the one infallible "measure" of his *present* perceptions, do not hold that he is the only and inerrant measure of his *future* sensations. *A* physician can often judge better than his patient whether the patient is going to have, *e.g.*, the sensations of an ague. A man's own opinion whether a certain course will be expedient or good for him is often far from being the soundest. We must distinguish carefully between what the mind perceives "through bodily organs"—the data of sense—and the things she apprehends "by herself" (αὐτὴ 61' αὑτῆς) without "organs." These latter include number, sameness, difference, likeness, unlikeness, being, good, bad, right, wrong, *i.e.*, the great universal "categories" of fact and value. These are apprehended not by sense, but by thinking, and as they are the formal element in all knowledge, knowledge must be found not in our sensations, but in "the judgment (συλλογισμός) of the mind upon" them.

II. Is knowledge, then, "true judgment"? The statement implies that we know what we mean by "false" judgment, error. But is this the case? Error must not be confused with mere false recognition, misinterpretation of present sensation, since there are purely intellectual errors, and we find ourselves unable to explain the nature of this kind of error. And, in fact, it is clear that persuasive rhetoric may produce in the hearer judgments which are true, but have no claim to be called knowledge. III. Finally, is knowledge "true judgment accompanied by discourse (μετὰ λόγου), true judgment for which we can give grounds"? This would distinguish knowledge from "simple apprehension," and would harmonize with the theory of those who hold that knowledge is always of complexes, never of their simple constituents. But this doctrine has difficulties of its own, and, in any case, if we say that knowledge is true judgment + "discourse," the "discourse" meant must be a statement of the logical *differentia* of the object of which I have knowledge. The proposed definition therefore amounts to saying that knowledge is true judgment about an object + *knowledge* of the *differentia* of that object, and so is circular.

LATER DIALOGUES

Sophistes and Politicus.——Formally these two important dialogues are closely connected. They are made to appear as a sequel to the *Theaetetus*, and a further connection is afforded between them by the fact that both are ostensibly concerned with a problem of definition, which is treated by the characteristic Platonic method of repeatedly subdividing a *genus* until we obtain the *definiendum* as a sub-species. The real purpose of the *Sophistes* is logical or metaphysical; it aims at explaining the true nature of negative predication and so disposing of the Eleatic thesis that the temporal and sensible realm, containing, as it does, a negative moment, must be mere unreal illusion. The object of the *Politicus* is to consider the respective merits of two contrasted forms of government, "personal rule" and "constitutionalism," and to recommend the second, particularly in the form of "limited monarchy," as most suitable to the actual condition of mankind. The *Sophistes* lays the foundations of all subsequent logic, the *Politicus* those of all "constitutionalism."

A more temporary purpose in both dialogues is to illustrate the value of careful classification as a basis for scientific definition. In both dialogues Socrates is almost silent; his place as chief speaker is taken by an unnamed and very unorthodox Eleatic, who seems to be a purely fictitious character. Plato is, in fact, claiming that he, and not the formal logicians of Megara, is the continuator of Parmenides, much as Aristotle in his polemic against Xenocrates claims to be the true successor of Plato.

In the *Sophistes* the main discussion is led up to through a definition of the "sophist" as an "illusionist," a person who, by abuse of logic, produces the illusion, or false appearance, that nature and human life are alike riddled by insoluble contradictions. (This shows that the persons aimed at under the name "sophist" are the

Megarian controversialists who make an illegitimate use of the dialectic of Zeno and Socrates.) Now the "sophist" himself would retort that this definition is senseless, for there can be no such thing as a false statement or a false impression. For the false means "what is not," and "what is not" is nothing at all, and can neither be uttered nor thought. To refute him we need to correct the fundamental thesis of so venerable a thinker as Parmenides.

We must either admit that there can be no false statements, or we must be prepared to maintain that "what is not, in some sense also is," and "what is, in some sense is not" (*i.e.,* we must explain what is the meaning of a significant negative proposition). In our theory of "being" we have to meet at once Parmenides and two different types of pluralist opponents of Parmenides, (a) the corporealists who say that the real, "what is," is just visible and tangible body, and (b) certain "friends of Forms" who maintain that the real is a multitude of incorporeal Forms, denying that sense-perception gives us any apprehension of it. The corporealist is sufficiently refuted by the consideration that he himself cannot deny the reality of "force" (δύναμις) and that force is not a body. The incorporealist "friends of Forms" cannot be met in this way. They regard force, or activity itself as belonging to the unreal realm of "becoming." We meet them by urging that knowing is itself an activity and that we cannot deny intelligence and knowledge to the supreme reality. This means that it has a "soul" and is alive. But if life is real, movement and repose from movement must be real too.[1]

This leaves us free to attack the Parmenidean Monism itself. That is refuted by drawing the distinction between absolute and relative "non-being." A significant denial, *A* is not B, does not mean that *A* is nothing, but that *A* is other than B. Every one of the great categorical features of reality is other than every other, and the true business of "dialectic" is to study the various possible combinations of these universal "categories." The dialogue mentions five of them, being, identity, difference, motion and rest. It is not said that this is a complete list of "categories," though it was treated as such by the Neo-Platonists.

The important result is thus that we have learned to think of Forms themselves as an inter-related system, with relations of compatibility and incompatibility among themselves. Negation is a moment in the system of intelligible reality, and therefore its presence in the sensible realm does not stamp that realm as illusion. This is the ontological position which interests Plato; the recognition of the function of the logical copula is a consequence.

The Politicus has as its main result the conclusion that government by the personal direction of a benevolent "dictator" is not suitable to the conditions of human life, where the direction is necessarily that of a fallible man, not of a god. In an actual human society, the surrogate for personal direction by a god is the impersonal supremacy of inviolable law. Where there is such a recognized sovereign law, monarchy is the most satisfactory type of constitution, democracy the least satisfactory, but where there is no "fundamental law," this situation is inverted. A "sovereign" democracy is preferable to an irresponsible autocrat. The dialogue is rich in thoughts which have passed into the substance of Aristotle's ethics and politics. Aristotle took directly from it the conception of "politics" as the "architectonic" practical science to which all others are subordinate; the formula of the "right mean" comes from it together with the Philebus.

Philebus.—The subject of the dialogue is a strictly ethical one, and this, no doubt, explains why it is the only dialogue after the *Theaetetus* in which Socrates is the principal speaker. The issue propounded is the question whether the "good" is pleasurable feeling or whether it is thought, the exercise of intelligence.

Comparison with the notices of Aristotle in the *Nicomachean* Ethics shows that this was the subject of a sharp division in the Academy, the Hedonist party being led by the mathematician and astronomer Eudoxus, the anti-Hedonists by Speusippus. Under the guidance of Socrates the question is narrowed down to a consideration of the good for *man* in particular, and a mediating conclusion is reached. The best life for man contains both elements, but intelligence is the "predominant partner."

All forms of knowledge find a place in it, but only those pleasures which are compatible with wisdom and virtue, *i.e.,* those which are "unmixed," not preceded by a sense of want or craving, and those of the "mixed" pleasures, the satisfactions of appetite, which are innocent and moderate. The Philebus contains Plato's ripest moral psychology; it is the immediate source of the famous "doctrine of the Mean."

Philosophically the most important feature of the dialogue is a classification adopted with a view to determining the formal character of the two claimants to recognition as the good. All components of the actual belong to one of four classes, (1) the infinite or unbounded (ἄπειρον), (2) the limit (πέρας), (3) the mixture or combination of (1) and (2), (4) the cause of the mixture. ([1] and [2] are just the two fundamental "opposites" of Pythagoreanism.) All the good things of life belong to (3), that is, they are produced by the introduction of definite "limit" or "ratio" into an indeterminate "continuum." (This is precisely the doctrine of the "Mean.") The establishment of such a "ratio" is a *γένεσις εἰς οὐσίαν,* a process resulting in a stable "being," and it is indicated that the cause or agent in such a process is always intelligence, human or divine.

There has been much discussion of the question in which of these "classes" the Forms should be placed. The only tenable alternatives would be to put them into the class of "limit" or into that of the "mixture" (a view suggested both by the teaching of the Sophistes and by Aristotle's express statement that Plato distinguished two constituents within the Form and advocated ably by Dr. H. Jackson). The truth seems to be that the particular classification in the *Philebus* is devised for a special purpose, and that it is not intended to apply to anything but the things and processes of the sensible realm. In that case, though there is a close correspondence between what the *Philebus* teaches about "stable being" in the sensible realm and what, as we know from Aristotle, Plato taught about the Forms, it will be a mistake to look for any actual exposition of the metaphysic of the Forms in the *Philebus.*

Timaeus.—The Timaeus is an exposition of cosmology, physics and biology put into the mouth of the astronomer Timaeus of Locri. Though Plato avoids expressly describing the speaker as a Pythagorean, his doctrine is revealed by attentive analysis as an attempt to combine the mathematics and astronomy of the Pythagorean~with the biology of Empedocles, the real founder of Sicilian medicine. The discussion is introduced by the famous narrative of the gallantry of the prehistoric Athenians who defeated the kings of the imaginary Atlantis in their ambitious attempt to become masters of the world. The story was to have been told more in detail in the unfinished Critias.

Timaeus opens his discussion by drawing a sharp distinction between eternal being and temporal becoming, and insisting on the point that it is only of the former that we can have exact and final knowledge. All accounts of the temporal can be only tentative and liable to repeated revision. Cosmology, then, at best, is not exact science. The visible world, being mutable and temporal, is a copy of a model which is eternal, and the copy is the work of God. The reason why there is a copy at all is the unceasingly active and generous goodness of God. (In the sequel Timaeus speaks of the Forms which God had before Him as His model in much the same language as the Phaedo, except that he uses the Pythagorean word "imitation," not "participation," to describe the relation of sensible things to Forms.)

The world, then, had a beginning. (The Academic tradition from the first was that this is not to be understood literally; Aristotle

[1]It is still a much agitated question who are the "logical atomists" described in the Sophistes as the "friends of Forms." The view that they are adherents of the philosophy of the Phaedo and Republic is deservedly dead. They are still often supposed to be Megarians, but this seems inconsistent with the way in which they are carefully distinguished from the followers of Parmenides as belonging to "the other side" at 245 *e.* Proclus (in Parm. 562 St.) says positively, as though it were the only view known to him, that they are Italian Pythagoreans, and this is probably correct, since the Eleatic of the dialogue refers to them as persons with whom he is "familiar." It is important to remark that the identification of "being" with "force" is given merely as a consequence which would follow from, and contradict, the corporealist "hypothesis." The implication of the passage is rather that the identification is false than that it is true.

insists on taking it literally.) Cod first formedits soul out of three constituents, Identity, Difference, Being. Its body was made later from the four Empedoclean "elements." The world-soul was placed in the circles of the sidereal Equator and Ecliptic, the latter being split into seven lesser circles, those of the planets, and the two were animated with movements in opposite senses. Subsequently were formed the various subordinate gods and the souls of human beings, that is the "immortal" and rational element in the human soul, which come straight from the hands of God Himself. The formation of the human body and of the two lower "mortal" components of the human soul was effected through the intermediacy of the "created gods" (*i.e.,* the stars). The most important question of detail arising from this part of the dialogue is that debated between Boeckh and Grote. Does Timaeus ascribe a motion to the earth? The restoration of the correct text at 40*c*[1], proves definitely that he does, but it is not a diurnal revolution, as Grote supposed; it must be rectilinear displacement of unknown period. The contact is made between Pythagorean geometry and the Empedoclean biology which will be needed for the physiology and medicine of the dialogue by a mathematical construction of the "elements."

Starting with two primitive triangles, the isosceles right-angled, and the right-angled scalene in which the hypotenuse is double the shortest side, Timaeus constructs four of the regular solids, cube, tetrahedron, octahedron, icosahedron, and these are assumed to be the shapes of the corpuscles of earth, fire, air, water. These four in their turn are the immediate constituents of all organic and inorganic compounds.

The important features of the dialogue are not the particular tentative scientific hypotheses but its leading methodological principles. We should note the introduction of God as the intelligent efficient cause of all order and structure in the world of "becoming," which preludes to the natural theology of the *Laws,* and the emphatic recognition of the essentially tentative, and therefore progressive, character of natural science. It is also noticeable that though Plato's scientific ideal is a mathematical corpuscular physics—his influence in creating this ideal has been much more important than that of the ancient Atomists—he constructs his physical world without "matter" as a metaphysical "substrate." The place of matter is taken in his analysis, as Aristotle complained, by *χώρα,* space, as in the *Principia* of Descartes, a point of view to which physical speculation seems to be returning. He analyses the "passage of Nature" into three factors: *ὄν* ("being": a Form), *χώρα* (space), *γένεσις* (happening), much as Whitehead analyses it into "objects," "events" and the "ingredience of object into event."

It is a fundamental point that the presence of *χώρα* as a factor makes it necessary to recognise over and above "God" or "mind" a subordinate element of *ἀνάγκη,* "necessity" in events. Since necessity is also called the "errant" cause, *πλανωμένη αἰτία* (with an allusion to the name of the "planets" or "tramp-stars") the word clearly does not mean "conformity to law." It is rather a name for the fact that there is always in the actual an irreducible remainder of "brute" datum, "conjunctions" in Hume's phrase, which we cannot rationalize completely into intelligible "connections." Thus *ἀνάγκη* is not a rebel or evil principle in the constitution of things; its function is everywhere to be instrumental to the intelligent and beneficent purpose of "mind" or God. There are many facts which we have to be content to accept simply as facts without seeing their "reason why." We do not know and may never know, why it is "best" that they should be as they are—*e.g.,* why "it is best" that we should live on a moving earth—but we may be sure that, since it is the fact. it is in some way best that it should be so. This seems to be what is meant by the statement that God or "mind" (*νοῦς*) persuades *ἀνάγκη.* It is the expression of a rational faith in Providence and the supremacy of the moral order. The details of the cosmology, physiology and psycho-physics of the dialogue are of great importance for the history of science, but metaphysically of secondary interest.

Laws and Epinomis.—The Laws, Plato's longest, is also his most intensely practical work, and contains his ripest utterances on ethics, education and jurisprudence, as well as his one entirely non-mythical exposition of theology. The immediate object is to meet a practical need by providing a model of constitution-making and legislation for members of the Academy who may be called on to assist as advisers in the actual founding or re-founding of cities.

Plato's attempt to do work of this kind himself, at Syracuse, had borne no immediate fruit, but had given the Academy a recognized standing as a school of scientific politics and jurisprudence. The work of constitution-making and legislation was going on in many quarters at the end of his life, and his experience might be made fruitful in sage counsels to younger men. The practical character of the subject explains some novelties in the outward form of the work. As the dialogue is assumed to be dealing with the actual present, Socrates has disappeared and his place is taken by an unnamed Athenian who is, to all intents, Plato himself.

The scene is laid in Crete; the imagined situation is that the Cretans are about to found a settlement on the site of a long deserted city. The chief Commissioner for the project is walking out to inspect the proposed site with a Spartan friend, when they fall in with the Athenian, and being favourably impressed by his conversation invite him to join them as an "expert adviser."

The problem thus differs from that of the Republic; the question is not the construction of an ideal Utopia, but the framing of a constitution and code which might be successfully adopted by a society of average Greeks in the middle of the fourth century. Hence the demands made on average human nature, though exacting, are not pitched too high; the communion of the *Republic* is dropped. And for the same reason it is assumed all through that the regulations are carefully adapted to the particular economic and geographical conditions, though it is said that these conditions will not really suit any actual Cretan locality. If so, we must suppose that Plato, under a transparent disguise, is contemplating the actual conditions in quarters from which the Academy was more likely to receive appeals for help.

The special purpose of the work also explains why purely speculative philosophy and science are excluded from its purview. The metaphysical interest is introduced only so far as to provide a basis for a moral theology; the one matter of first-rate scientific importance touched on is the diurnal motion of the earth, and this is only hinted in connection with the practical problem of the construction of the Calendar. In compensation, the Laws is exceptionally rich in political and juristic wisdom, and appears, indirectly, through its influence on the law of the Hellenistic age, to have left its mark on the great system of Roman jurisprudence.

It is impossible to do more than to call attention to a few of the striking features of this great work. The ethical ideal is still that familiar from earlier dialogues. It is interesting that the demand is expressly made that all "unnatural" vices shall be completely suppressed, and that the rule of sexual life is to be monogamous marriage with strict chastity, outside the limits of marriage, for both sexes. In politics, Plato declares himself definitely in favour of a "mixed" constitution; a good government demands a balance between two principles, *ἐλευθερία,* "popular control," and *μοναρχία,* "personal authority." Persia is an illustration of the mischief of unqualified autocracy, Athens of the evils which come from elimination of the "authoritarian" principle, and considerable care is taken in the suggested system of magis-

[1]The words used of the earth *ἰλλομένην τὴν περὶ τὸν διὰ παντὸς πόλον τεταμένον* admit of only one rendering "going up and down on the path about the axis of the universe." Timaeus thinks of the earth as placed about the axis of the whole universe and being displaced to North and South by a sliding movement along this axis. Aristotle was then exactly right in saying that Timaeus teaches that the earth "is at the centre" and moves there *(de Coelo* 293 *b*30) and distinguishing this view carefully from that which he ascribes to the Pythagoreans, "that the earth revolves as a planet about the centre." It is this second view which is implied in the language of *Laws* 822*a* and *Epinomis* 987*b* and expressly attributed to Plato "in his later years" by Theophrastus ap. Plutarch *Quaest. Plat.* 1006*c.* There is no reason to suppose that Plato ever himself held the curious view he has ascribed to his fifth century Pythagorean. He has his own reasons for insisting as strongly as he does on the provisional character of all the science of the dialogue.

tracies to secure both genuine "popular representation" and the proper regard for personal qualifications. The basis of society is to be agriculture, not commerce; the citizens are to be "peasant proprietors'—communism is regretfully abandoned as impracticable in a society of ordinary human beings. But the patrimony of each household is to be strictly inalienable, and differences in "personal" property are to be kept within strict bounds by what amounts to a super-tax of 100% on incomes beyond the statutory limits. Education, as in the *Republic,* is regarded as the most important of all the functions of government; it is placed under the control of a minister who is the "premier." As far as possible, the distinction between the sexes is, as in the Republic, to be treated as irrelevant to the educational programme.

The most striking features of the scheme are the careful attention paid to the problems of the physical training of children in their earliest infancy, and the right utilization of the child's instinct for play, and the demand. made now for the first time, that in adolescence, the young shall be taught in institutions where expert instruction in all the various subjects is co-ordinated. It is from this proposal that the "grammar school," or secondary school, has taken its origin. Though we hear no more of "philosopher-kings" the demand is still made that the members of the "Nocturnal Council." the supreme Council of the State, which is always in permanent session, and exercises a general control over administration, shall be thoroughly trained, not only in the exact sciences, but in the supreme science, which "sees the One in the Many and the Many in the One;" that is, they are to be "dialecticians."

The work is full of suggestions for the practical application of science, such, for example, as that of the necessity of strictly standardizing all weights and measures, or that of basing the Calendar on a solar year (of 365 days). The object of the apparently arbitrary selection of the number of patrimonies and the scheme of sub-division of the whole society into smaller groups appears to be the practical one of making it easy to determine exactly what quotum each subdivision may justly be called on to contribute to the revenue or the defences.

At least two fundamental improvements are made on the Attic jurisprudence which Plato has adopted as the foundation of his own code. One great blot on the Heliastic system is removed by the regulations which ensure that trials for serious offences shall take place before a court which contains highly qualified magistrates, and shall proceed with due deliberation, and that there shall be provision for appeals from the primary tribunal to a "Court of Cassation." It is even more important, perhaps, that Laws IX. by drawing a clear distinction between βλάβη, detriment, and ἀδικία, infringement of rights, lays the foundation for the discrimination between civil and criminal actions at law.

An incidental passage in the Laws (822 a-h) and another in the *Epinomis* (987*b*) definitely show that Theophrastus was right in crediting Plato with belief in the earth's motion. In the Laws it is said that the real orbit of each planet is a single closed curve, in the *Epinomis* the view that the "circle of the stars" communicates its motion to those of the planets is called that of men "who know but little of the subject." The allusion is to the famous theory of the celestial motions put forward by Plato's friend and associate, the great mathematician Eudoxus.

According to this, the first great "geocentric" theory in scientific astronomy, the movements of each planet can be analyzed into a combination of circular revolutions, the unmoved earth being taken as the common centre of all. What Plato asserts is that each planet has only one "proper" revolution, the remaining revolutions are apparent, not real. The implication is that these apparent revolutions of the planet must be real motions of the earth from which we make our observations. The earth is thus a planet, though not a satellite of the sun. The language of the *Epinomis*—which may bc safely regarded as at least true to Plato's thought—definitely makes the sun, itself, one of the planets. We have, therefore, to think of the earth as also a planet revolving with the rest round an unseen centre. We may infer from the words of Theophrastus that Plato, like some of the Pythagoreans, held that there is a luminary, the "central fire," at this centre. The period of the earth's revolution would certainly be taken to be the natural day, so that the motion ascribed to the earth is equivalent to the diurnal rotation, though from Plato's point of view, it is not a rotation on an axis, but a revolution round a centre. It follows that the alternation of day and night is no longer accounted for by a rotation of the "heaven of the fixed stars." This "outermost circle" is still credited in the *Epinomis* with a revolution in the sense E. to W., but its period is not specified. We need not suppose either that Plato could have specified the period or that he used it to explain any special appearances.[1]

What is to Plato's credit is that he has the insight to see that, with all its attractions, the scheme of Eudoxus starts from a wrong pre-supposition, a stationary earth.

In Laws X. Plato, for a practical purpose, creates natural theology. There are three false beliefs which are fatal to moral character, atheism, denial of the moral government of the world, the belief that divine judgment can be bought off by offerings. Plato holds that he can disprove them all. The refutation of atheism turns on the identification of the soul with the "movement which can move itseif," already used in the *Phaedrus.* All motion is either communicated from without or self-initiated, and the ultimate source of all communicated motion must be self-initiated motion. The only thing which can move itself is a soul. It follows that all motion throughout the universe is ultimately initiated by souls. It is then inferred from the regular character of the great cosmic motions and their systematic unity, that the souls which originate them form a hierarchy with a "best soul," God, at their head. Disorderly and irregular motions are equally due to souls, but to bad and disordered souls, and since there are disorderly motions, it is inferred that the "best soul" cannot be the only soul.

There is no suggestion that there is a "worst soul," a "devil" or "evil world-soul"; all that is said is that there *must* be one soul which is not the best, and may be more. This is Plato's way of excluding Pantheism, as incompatible with the reality of evil. The argument thus establishes at once the immortality of the soul and the existence of God. The other two heresies can now be disposed of. It is inconsistent with the goodness of the best soul to be indifferent to our conduct, and still more so to be venal. The moral government of the world is, in fact, assured by the establishment of the single principle that every soul gravitates into the society of its likes, and consequently "does and has done to it what it befits such a soul to do and have done to it." Plato thus becomes definitely the originator of the view, that there are certain theological truths which can be strictly demonstrated by reason.

It is these demonstrable truths which are subsequently named by Varro "natural" or "philosophical" theology in contradistinction to the "poetical theology." the myths related by the poets, and the "civil theology," the ritual cultus instituted by politicians. From Varro the distinction of three theologies passed to St. Augustine, and thus in the end became the foundation of the scholastic distinction between natural theology, those truths about God which can be ascertained independently of any specific revelation, and revealed theology, the further truths which are only made accessible by the Christian revelation. Since Plato's object in demonstrating his three propositions is an ethical one, he goes on to enact that the maintenance of any of them shall be a grave crime to be visited by the State with penalties ranging from a minimum of five years' solitary confinement, and with death on a second conviction. Plato is thus the inventor, so far as European society is concerned, of the proposal to make an official creed for the State and to treat dissent from it as criminal, an innovation foreign to the spirit of the Hellenic cities, in which religion was a matter not of beliefs but of cultures. Plato's last word, then, on the problem how the sensible comes to "partake" of Form is that it does so through the agency of divine goodness and wisdom. God moulds the sensible upon the pattern of the' intelligible. The obvious question, how God, who is a "soul"

[1]It has nothing to do with "precession of the equinoxes," being in the wrong sense for that purpose.

not a Form, is related to "the Good" which is the supreme Form never receives discussion or solution. To answer it was to be the main business of Plotinus.

PLATONISM AFTER PLATO

Aristotle's Account of Platonism. — Since Plato refused to write any formal exposition of his own metaphysic, our knowledge of its final shape has to be derived from the statements of Aristotle, which are confirmed by scanty remains of the earliest Platonists preserved in the Neo-Platonist commentaries on Aristotle. These statements can, unfortunately, only be interpreted conjecturally. According to Aristotle (Metaphysics, *A* 987, *b* 18–25) Plato's doctrine of Forms was, in its general character, not very different from Pythagoreanism, the Forms being actually called Numbers. The two points on which Aristotle regards Plato as disagreeing with the Pythagoreans are, that (1) whereas the Pythagoreans said that numbers have as their constituents, the unlimited (ἄπειρον) and the limit (πέρας), Plato taught that the forms have as constituents "the One" and the "great and small"; (2) the Pythagoreans had said that things are numbers, but Plato intercalated between his Forms (or Numbers) and sensible things an intermediate class of "mathematicals." It is curious, that in connection with the former difference Aristotle dwells mainly on the substitution of the "duality of the great-and-small" for the "unlimited," not on the much more significant point that the "One," which the Pythagoreans regarded as the simplest complex of unlimited and limit, is treated by Plato as itself the element of limit. He further adds that the "great-and-small" is, in his own technical terminology, the "matter," the One, the formal constituent, in a Number.

If we could be sure how much of the polemic against Number-Forms in *Metaphysics* M-N is aimed directly at Plato, we might add considerably to this bald statement of his doctrine, but unluckily it is certain that much of the polemic is concerned with the teaching of Speusippus and Xenocrates. It is not safe, therefore, to ascribe to Plato statements other than those with which Aristotle explicitly credits him. We have then to interpret, if we can, two main statements: (1) the statement that the Forms are Numbers; (2) the statement that the constituents of a Number are the "great-and-small" and "the One."

Light is thrown on the first statement if we recall the corpuscular physics of the Tirnaeus and the "mixture" of the *Philebus.* In the *Timaeus,* in particular, the behaviour of bodies is explained by the geometrical structure of their corpuscles, and the corpuscles themselves, are analysed into complexes built up out of two types of elementary triangle, which are the simplest "elements" of the narrative of Timaeus. Now a triangle, being determined in everything but "absolute magnitude" by the numbers which express the ratio of its sides, may be regarded as a triplet of numbers.[1] If we remember then, that the triangles determine the character of bodies, and are, themselves, determined by numbers, we may see why the ultimate Forms on which the character of Nature depends should be said to be Numbers, and also what is meant by the "mathematicals" intermediate between the Forms and sensible things. According to Aristotle, these "mathematicals" differ from Forms because they are many, whereas the Form is one, from sensible things in being unchanging. This is exactly how the geometer's figure differs at once from the type it embodies and from a visible thing. There is, for example, only one type of triangle whose sides have the ratios 3:4:5, but there may be as many "pure" instances of the type as there are triplets of numbers exhibiting these ratios; and again, the geometrical triangles which are such "pure" instances of the type, unlike sensible three-sided figures, embody the type exactly and unchangingly. A mathematical physicist may thus readily be led to what seems to be Plato's view that the relations of numbers are the key to the whole mystery of nature, as is actually said in the *Epinomis* (ggoe).

We can now, perhaps, see the motive for the further departure from Pythagoreanism. It is clear that the Pythagorean parallelism between geometry and arithmetic rested upon the thought that the "point" is to spatial magnitude what the number 1 is to number. Numbers were thought of as collections of units, and volumes, as, in like fashion, collections of points; that is, the point was conceived as a minimum volume. As the criticisms of Zeno showed, this conception was fatal to the specially Pythagorean science of geometry itself, since it makes it impossible to assert the continuity of spatial magnitude. (This, no doubt, is why Plato, as Aristotle tells us, rejected the notion of a point as a fiction.)

There is also a difficulty about the notion of a number as a "collection of units," which must have been forced on Plato's attention by the interest in "irrationals" which is shown by repeated allusions in the dialogues, as well as by the later anecdotes which represent him as busied with the problem of "doubling the cube" or finding "two mean proportionals" "'Irrational" square and cube roots cannot possibly be reached by any process of forming "collections of units," and yet it is a problem in mathematics to determine them, and their determination is required for physics (*Epin.* 990*c*–991b).

This is sufficient to explain why it is necessary to regard the numbers which are the physicist's determinants as themselves determinations of a continuum (a "great and small"), by a "limit" and why, at the same time "the One" can no longer be regarded as a "blend" of "unlimited" and "limit" but must be, itself, the factor of "limit." (If it were "the first result" of the blending, it would re-appear in all the further "blends"; all numbers would be "collections of one" and there would be no place for the "irrationals.") There is no doubt that Plato's thought proceeded on these general lines. Aristotle tells us that he said that numbers are not really "addible"(οὐ συμβλητοὺς εἶναι robs ἀριθμοὺς πρὸς ἀλλήλους, Met M 1083 a 34), that is that the integer-series is not really made by successive additions of 1[2], and the *Epinomis* (*loc. cit.*) is emphatic on the point that contrary to the accepted opinion, "surds" are just as much numbers as integers. The underlying thought is that numbers are to be thought of as generated in a way which will permit the inclusion of rationals and irrationals in the same series. In point of fact there are logical difficulties which make it impossible to solve the problem precisely on these lines. It is true that mathematics requires a sound logical theory of irrational numbers, and again, that an integer is not a "collection of units"; it is not true that rational integers and "real numbers" form a single series.

The Platonic number-theory was inspired by thoughts which have since borne fruit abundantly, but it was itself premature. We learn partly from Aristotle, partly from notices preserved by his commentators, that in the derivation of the integer-series, even numbers were supposed to be generated by the "dyad" which "doubles" whatever it "lays hold of," odd numbers in some way by "the One" which "limits" (ὁρίζει) or "equalises" (ἰσάζει), but the interpretation of these statements is, at best, conjectural. In the statement about the "dyad" there seems to be some confusion between the number 2 and the "indeterminate dyad," another name for the continuum also called the "great-and-small," and it is not clear whether this confusion was inherent in the theory itself, or has been caused by Aristotle's misapprehension.

Nor, again, is it at all certain exactly what is meant by the operation of "equalising" ascribed to the One." It would be improper here to propound conjectures which our space will not allow us to discuss.

The Academy After **Plato.**—Though Plato's Academy produced only one later philosopher of the first order, it continued to exist as a corporate body down to the year 529 A.D. when the Emperor Justinian, in his zeal for Christian orthodoxy, closed the

[1]Thus the two fundamental triangles of Timaeus may be called the triplets $(1,1,\sqrt{2})$ $(1,\sqrt{3},2)$ respectively.

[2]2, for example, does not "contain" two 1's, 2 is not "1 and another 1"; it is "the integer after 1."

[3]A full collection and examination of all the available evidence is given by L. Robin in his *Théorie platonicienne des Idées et des Nombres d'après Aristote* (1908), and an admirable exposition of the significance of the problem of the irrational for Plato's philosophy by G. Milhaud in *Les philosophes-géomètres de la Grèce, Platon et ses prédécesseurs* (1900). For a recent conjectural interpretation *see* A. E. Taylor's essay, "Forms and Numbers," in Mind, N.S. 140, 141.

schools of Athens and appropriated their emoluments. Plato's greatest scholar, Aristotle, finally went his own way and organised a school of his own in the Lyceum, claiming that he was preserving the essential spirit of Platonism, while rejecting the difficult doctrine of the Forms; the place of official head of the society was filled first by Speusippus, Plato's nephew (347–339 B.C.), then by Xenocrates (339–314 B.C.). Under Arcesilaus (276–241 B.C.) the Academy began its long-continued polemic against the sensationalist dogmatism of the Stoics, which accounts both for the tradition of later antiquity which dates the rise of a "New" (some said "Middle") and purely sceptical "Academy" from Arcesilaus, and for the eighteenth-century associations of the phrase "academic philosophy."

In the first century B.C. the most interesting episode in the history of the school is the quarrel between its President, Philo of Larissa and his scholar Antiochus of Ascalon, of which Cicero's *Academica* is the literary record. Antiochus, who had embraced Stoic tenets, alleged that Plato had really held views indistinguishable from those of Zeno of Cittium, and that Arcesilaus had corrupted the doctrine of the Academy in a sceptical sense. Philo denied this. The gradual *rapprochement* between Stoicism and the Academy is illustrated from the other side by the work of Stoic scholars like Panaetius of Rhodes, and Poseidonius of Apamea, who commented on Platonic dialogues and modified the doctrines of their school in a Platonic sense.

The history of the Academy after Philo is very obscure, but early in our era we meet with a popular literary Platonism of which the writings of Plutarch are the best example. This popular Platonism insists on the value of religion, in opposition to Epicureanism, and on the freedom of the will and the reality of human initiative, in opposition to the Stoic determinism; a further characteristic feature, wholly incompatible with the genuine doctrine of Plato, is the notion that matter is inherently evil and the source of moral evil.

Genuine Platonism was revived in the third century A.D. at Rome, and independently of the Academy, by Plotinus. His Neo-Platonism (*q.v.*) represents a real effort to do justice to the whole thought of Plato, but there are two sides of it which inevitably, in the changed conditions, fell into the background, the mathematical physics and the politics. The third century A.D. had no understanding for the first, and the Roman Empire under a succession of military chiefs no place for the second. The doctrine of Plotinus is Platonism seen through the personal temperament of a saintly mystic, and with the *Symposium* and the teaching of the *Republic* about the "Form of Good" always in the foreground. Plotinus lived in an atmosphere too pure for sectarian polemic, but in the hands of his successors, Neo-Platonism was developed in conscious opposition to Christianity. Porphyry, his disciple and biographer, was the most formidable of the anti-Christian controversialists; in the next century, "Platonists" were among the allies and counsellors of the Emperor Julian in his ill-advised attempts to invent an Hellenic counterpart to Christianity.

Early in the fifth century, Neo-Platonism flourished for a short time in Alexandria (which disgraced itself by the murder of Hypatia in 415) and captured the Athenian Academy itself, where its last great representative was the acute Proclus (A.D. 410–485). The latest members of the School, under Justinian, occupied themselves chiefly with learned commentaries on Aristotle, of which, those of Simplicius are the most valuable. The doctrine of the school itself ends in Damascius with complete agnosticism.

Influence on Christian Thought.— Traces of Plato are probably to be detected in the Alexandrian *Wisdom of Solomon;* the thought of the Alexandrian Jewish philosopher and theologian Philo, at the beginning of our era, is at least as much Platonic as Stoic. There are, perhaps, no certain marks of Platonic influence in the New Testament[1], but the earliest apologists (Justin, Athenagoras) appealed to the witness of Plato against the puerilities and indecencies of mythology. In the third century Clement of Alexandria, and after him, Origen, made Platonism the metaphysical foundation of what was intended to be a definitely Christian philosophy. The Church could not, in the end, conciliate Platonist eschatology with the dogmas of the resurrection of the flesh and the final judgment, but in a less extreme form the Platonizing tendency was continued in the next century by the Cappadocians, notably St. Gregory Nyssen, and passed from them to St. Ambrose of Milan. The main source of the Platonism which dominated the philosophy of western Christian divines through the earlier Middle Ages, were, however, Augustine, the greatest thinker among the Western Fathers, who had been profoundly influenced by Plotinus, read in a Latin version, before his conversion to Christianity, and Boethius, whose wholly Platonist vindication of the ways of Providence in his *Consolatione Philosophiae* was the favourite "serious" book of the Middle Ages.

[1]We may perhaps detect it in John i. 18 if the true text is "the only begotten God (μονογενὴς θεός) which is in the bosom of the Father" This may be an echo of the phrase used in the *Timaeus* (92*d*) about the visible world "A God apprehensible to sense one and only begotten" (μονογενὴς ὤν). But it *is* not safe to assert it.

A further powerful influence was exerted by the writings of the so-called Dionysius the Areopagite, which laid down the main lines of mediaeval mystical theology and angelology. These works are, in fact, an imperfectly Christianized version of the speculations of Proclus, and cannot date before the very end of the fifth century A.D. at the earliest, but they enjoyed an immense authority based on their attribution to an immediate convert of St. Paul.

After their translation into Latin in the ninth century by Johannes Scotus Erigena, their vogue in the West was as great as in the East. Apart from this theological influence, Plato dominated the thought of the earlier Renaissance which dates from the time of Charlemagne in another way. Since the West possessed the philosophical writings of Cicero, with the Neo-Platonic comment of Macrobius on the *Sontnium Scipionis,* as well as the Latin translation of the first two-thirds of the *Timaeus* by Chalcidius, with his commentary on the text, and versions, also, at least of the *Phaedo* and *Meno,* whereas nothing was known of the works of Aristotle except Latin versions of some of the logical treatises, the Middle Age, between Charlemagne and the beginning of the 13th century, when the recovery of Aristotle's physics and metaphysics from Moors, Persians and Jews began, was much better informed about Plato than about Aristotle; in particular in the various "encyclopaedias" of this period, it is the *Timaeus* which forms the regular background.

The thirteenth century saw a change. Aristotle came to displace Plato as "the philosopher," partly in consequence of the immediately perceived value of his strictly scientific works as a storehouse of well-digested natural facts, partly from the brilliant success of the enterprise carried through by St. Thomas Aquinas, the reconstruction of philosophical theology on an Aristotelian basis. Plato is, however, by no means supplanted in the Thomist system; the impress of Augustine on Western thought has been far too deep for that. Augustine's "exemplarism," that is, the doctrine of Forms in the version, ultimately derived from Philo of Alexandria, which makes the Forms "creative thoughts" of God, is an integral part of the Thomist metaphysics, though it is now denied that the exemplars are themselves cognizable by the human intellect, which has to collect *its* "forms," as best it can, from the data of sense.

Directly or through Augustine, the influence of Plato, not only on strictly philosophic thought but on popular ethics and religion, has repeatedly come to the front in ages of general spiritual requickening, and shows no signs of being on the wane.

Two "revivals" in particular are famous. The first is that of the 16th century, marked by the Latin translation of Marsilio Ficino and the foundation of Lorenzo dei Medici's fantastic Florentine Academy. What was revived then was not so much the spirit of Plato as that of the least sober of the Neo-Platonists; the influence of the revival was felt more in literature than in philosophy or morals, but in literature its importance may be measured by the mere mention of such names as Michelangelo, Sidney, Spenser.

In the 17th century, Plato, seen chiefly through the medium of Plotinus, supplied the inspiration of a group of noble thinkers who were vindicating a more inward morality and religion against the unspiritual secularism and erastianism of Hobbes, the so-called "Cambridge Platonists," Whichcote, Henry More, Cudworth, John Smith. At the present moment the writings of A. N. Whitehead contain an attempt to work out a philosophy of the sciences which confessedly connects itself with the ideas of the Timaeus.

BIBLIOGRAPHY.—EDITIONS: *Complete Works.* A. P. Manutius and M. Musurus, *Omnia Platonis opera* (Aldine Press, Venice, 1513); H. Stephanus and J. Serranus (de Serre), *Platonis opera quae extant omnia* (Paris, 1578); G. Stallbaum, *Platonis quae supersunt Opera*, 12 vol. with commentary, *Parmenides* omitted (Leipzig, 1821–25), and *Platonis Opera Omnia* (1850); C. F. Hermann, *Platonis dialogi secundum Thrasylli Tetralogias dispositi* (Leipzig, 1851–53); I. Bekker, *Platonis Dzalogi, Graece et Latine*, 10 vol. (Berlin, 1816–23); J. G. Baiter, J. C. Orelli, and A. G. Wincklemann, *Platonis Opera Omnia*, 21 vol. (Zürich, 1839–41); R. B. Hirschig and C. E. C. Schneider, *Platonis Opera* (1856–73); M. Schanz, *Platonis Opera quae feruntur omnia*, 12 vol. (Leipzig, 1875–79); J. Burnet, *Platonis Opera*, 5 vol. (Oxford Library, 1899–1907); *Platon. Oeuvres Complètes*, Collection des Universités de France (1920, etc.). Only the last two mentioned are adequate to critical requirements. *Separate Works:* L. F. Heindorf, *Platonis, Lysis, Charmides, Hippias, Major, Phaedrus, Gorgias, Theaetetus, Gratylus, Parmenides, Euthydemus, Phaedo, Sophistes, Protagoras* (1802–10); D. Tarrant, *The Hippias Major* (1928); C. Badham, *The Philebus of Plato* (1878); E. Poste, *The Philebus of Plato* (Grk. and Eng., 1860); R. G. Bury, *The Philebus of Plato* (1897); J. Riddell, *The Apology of Plato* (1867); J. Burnet, *Plato's Euthyphro, Apology of Socrates* and *Crito* (1924); J. Adam, *Platonis Protagoras* (1893); L. Campbell, *The Theaetetus of Plato* (1883); J. Burnet, *Plato's Phaedo* (1911); T. H. Martin (Timaeus) *Étude sur le Timée* with text, Fr. trans. and commentary (1841); A. E. Taylor, *Plato*, a commentary on the *Timaeus* (1908); G. Stallbaum, *De primordiis Phaedri Platonis* (Leipzig, 1848); W. Waddell, *Parmenides* (Glasgow, 1894); Seymer Thompson, *The Meno of Plato* (1901); W. H. Thompson, *The Phaedrus of Plato* and *The Gorgias of Plato*, Bibliotheca Classica (1868 and 1894); R. G. Bury, *The Symposium of Plato* (1909, rev. ed. 1925); C. E. C. Schneider, *Platonis Civitas* (1830); B. Jowett and L. Campbell, *Plato's Republic* (1894); J. Adam, *The Republic of Plato* (1902); L. Campbell, *The Sophistes and Politicus of Plato* (1867); F. Ast, *Platonis Leges et Epinomis* (1814); C. Kitter, *Platos Gesetze* (German commentary only, Leipzig, 1896); E. B. England, *The Laws, Publ.* of the Univ. of Manchester (1921); R. G. Bury, Laws (vol. ix. of the Loeb *Plato*, 1926).

TRANSLATIONS.—*Latin:* M. Ficinus (1491), printed in the Basle ed. of the text (1534); I. Bekker, *Platonis Dialog?, Graece et Latine*, 10 vol. (Berlin, 1816–23). *English:* (1) *Complete:* E. Sydenham and T. Taylor, *The Works of Plato*, 5 vol. (1804); B. Jowett, *The Dialogues of Plato* (3rd ed. rev. 1892). (2) *Partzal:* J. L. Davies and D. J. Vaughan, *The Republic of Plato* (3rd ed. 1866); B. Jowett, *The Republic of Plato* (3rd ed. 1908); F. T. Church, *The Trial and Death of Socrates*, containing the *Apology* and *Crito* (1880); B. Jowett, *The Apology of Socrates, Crito and Phaedo of Plato* (1882); F. A. Paley, *The Theaetetus of Plato* (1875); B. H. Kennedy, *The Theaetetus of Plato* (1881); E. Poste, *The Philebus of Plato* (1860); E. M. Cope, *Plato's Gorgias* (1864); J. Wright, *Protagoras, Phaedrus and Lysis* (2nd ed. 1888); P. B. Shelley (Symposium) *The Banquet* (London, 1905; New York, 1908) and *Ion* in Cassell's National Library vol. 80 (1886); R. D. Archer-Hind, *The Timaeus* (1888); A. E. Taylor, *Timaeus and Critias* (1909); L. A. Post, *Epistles* (1925); J. Harward, *Epinomis* (1928). *German:* F. Schleiermacher, *Platons Werke*, in der Realschulbuchhandlung (1817–28); O. Apelt, *Platons Dialoge* (Leipzig, 1919); C. Ritter and others in J. G. H. Feder and C. Meiners, *Philosophische Biblioethek* (1788 etc.). *French:* V. Cousin, *Oeuvres de Platon* (1822–40). *Italian:* R. Bonghi, *Dialoghi di Platone* (Rome and Turin, 1880, etc.).

DISSERTATIONS: E. Zeller, *Plato and the Older Academy*, trans. from the German of Section 2, part 2, vol. 2 of *Philosophie der Griechen* by S. F. Alleyne and A. Goodwin (1876); B. Jowett, *Introduction in The Dialogues of Plato* (3rd ed. rev. 1892); G. Grote, *Plato and Other Companions of Socrates* (2nd ed. 1867); W. Pater, *Plato and Platonism* (1893); R. L. Nettleship, *Lectures on the Republic of Plato* (2nd ed. 1901), and "The Theory of Education in Plato's Republic" in E. Abbott, *Hellenica* etc. (1880); T. Gomperz, *Great Thinkers*, vols. II. and III. (Eng. trans. 1905); W. Lutoslawski, *Origin and Growth of Plato's Logic* (1897); L. Campbell, *Religion in Greek Literature* (1898); J. A. Stewart, *The Religion of Plato* (1905), *Plato's Doctrine of Ideas* (1909); E. Barker, *Great Political Theory: Plato and His Predecessors* (1918); J. Burnet, *Greek Pltilosophv, Part I. Thales to Plato* (1914); A. E. Taylor, *Platonism and its Influence* (1925), *Plato, the Man and His Work* (1926); P. Shorey, *The Unity of Plato's Thought* (1904); P. E. More, *The Religion of Plato* (1921). *German:* E. Zeller, *Grundriss der Geschichte der griechischen Philosophie* (last ed., 1914); O. Apelt, *Beiträge zur Geschichte der griechischen Philosophie* (1891); C. Baeumker, *Das Problem der Materie in der griechischen Philosophie* (1890); H. Bonitz, *Platonische Studien* (1886); T. Gomperz, *Griechische Denker*, vol. II. (1902); P. Natorp, *Platons Ideenlehre* (1903); H. Raeder, *Platons philosophische Entwickelung* (1905); C. Ritter, *Platon* (vol. I. 1910, vol. II. 1923), *Untersuchung uber Platon* (1888), *Neue Untersuchung über Platon* (1910); J. Stenzel, *Zahl und Gestalt bei Platon und Aristoteles* (Leipzig, 1924); U. von Wilamowitz-Moellendorf, *Platon* (1919); E. Meyer, *Geschichte des Altertums* vol. V. (1902); P. Friedlander, *Platon: Eidòs, Paidsia, Dialogos* (1928). *French:* A. Diès, *Autour de Platon* (1927); G. Milhaud, *Les Philosophes-Géomètres de la Grèce* (1900); L. Robin, *La Théorie Platonicienne, des idées et des nombres* (1908); *Études sur la signification et la place de la physique dans la Philosophie de Platon* (1919), *Lo Pensée grecque* (1923); J. Wahl, *Études sur le Parmtnide de Platon* (1926). *Italian:* A. Levi, *Sulle interpretazioni immanentistiche della filosofia di Platone* (1921), *il Concetto del tempo nella filosofia di Platone* (1920); F. Tocco, *Ricerche Platoniche* (1876).

DICTIONARIES.—T. Mitchell, *Index to Plato* (1832); F. Ast, *Lexicon Platonicum* (1833); E. Abbott, *Index to Plato* (1875).

In the mss. *see* specially the collations in I. Bekker's edition of the text (1816–23), and the prefaces and prolegomena to the volumes of the editions of Schanz, Burnet, the *Collection des Universités de France* (1920), also pp. xciv. ff. of the introduction to Waddell's edition of *Parmenides*, Jowett and Campbell's *Republic*, vol. ii. The important *Codex* Clarkianus (B) of the Bodleian Library has been reproduced in facsimile with a preface by T. W. Allen (1898–1899). *See* also ARISTOTLE, NEOPLATONISM, SOCRATES. (A. E. TA.)

PLATO, Athenian comic poet of the Old Comedy, flourished between 428–389 B.C. According to Suïdas, he was the author of 30 comedies. Some of these deal with political matters. Such were the *Cleophon* and *Hyperbolus*, directed against the well-known demagogues. His later plays are satires handled in a burlesque spirit. Such were the *Sophistae*, akin to the *Clouds* of Aristophanes; the *Cinesias*, an attack on a contemporary poet and the *Festivals*.

See T. Kock, *Comicorum atticorunt fragmenta*, i. (1880); A. Meineke, *Poetarum comicorum ggrecorum fragmenta* (1855).

PLATON, LEVSHIN (1737–1812), Russian divine, was born at Chashnikovo near Moscow, and educated in the academy of that city. In 1763 the empress Catherine II. invited him to instruct her son Paul in theology, and he became one of the court chaplains. Three years afterwards Platon was appointed archimandrite of the monastery of the Trinity (Troitskaya Lavra) near Moscow, in 1770 archbishop of Tver, and in 1787 archbishop of Moscow and metropolitan. He died in 1812, one of his last acts having been to write an encouraging letter to the emperor Alexander I. in view of the French invasion. Platon was a brilliant and learned man, and the author of *A Short History of the Russian Church*.

PLATONIC LOVE, a term commonly applied to an affectionate relation between a man and a woman into which the sexual element does not enter. The term in English goes back as far as Sir William Davenant's *Platonic Lovers* (1636). It is derived from the conception, in Plato's *Symposium*, of the love of the idea of good which lies at the root of all virtue and truth.

PLATOON, a sub-division of a company of infantry. In the 17th century it was, in some cases, the infantry tactical unit and was commanded by a captain. At the beginning of the 18th century the term referred to a small body of musketeers of about 40 or 50 men arranged in a square to strengthen the angle of the battalion when formed in hollow square. About the middle of the 18th century a battalion was generally organized into 16 platoons, of about 24 men each, plus two or four platoons of grenadiers. In the 19th century, the term has been applied solely to a squad of recruits under training. "Platoon fire" was the systematic and regulated fire of platoon volleys. Hence a "platoon" sometimes meant a volley. The term was retained for a type of manual exercise. As a sub-division of an infantry company it was re-introduced into the British service in 1913 and is now the name of the sub-division of a company in most modern armies (*see* COMPANY). In the U.S. cavalry a troop is divided into four platoons.

PLATOON SCHOOL, a work-study-play school organization found in the educational system of the United States. It was originated by William Wirt who started the first school of this type in Bluffton, Ind, in 1902. When he became superintendent of schools of Gary, Ind., in 1907, he organized all the schools of that city on the work-study-play plan. By 1917, 25

American cities had schools so organized, and by 1928, there were 153 cities in 38 States which had over 850 platoon schools.

We begin with the theory that modern cities are extremely bad for children since they deprive them of the healthful work and play which are as essential elements in a child's education as study. The platoon school returns to children opportunities for work and play by providing schools containing not only classrooms but well-equipped shops, science rooms, drawing and music studios, cooking rooms, auditoriums, playgrounds and gymnasiums. The traditional public school is operated on a "peak. load" plan of operation, *i.e.,* on the principle of reserving a school sear. for the exclusive use of one child during the entire year. When the children leave these seats to go to shops or playgrounds the seats remain vacant. Under such a plan there are seldom enough seats, playgrounds or shops to accommodate all the children in a city at one time.

Under the platoon plan, on the contrary, all facilities in the school—classrooms, auditoriums, gymnasiums, shops and laboratories—are in use every hour of the day. The school is divided into two parts, each having the same number of classes and each containing aii the eight or nine grades. While one of the schools is in classrooms, the other is in special activities, auditorium, playgrounds and gymnasiums. This means that only half the usual number of classrooms is needed. Since the cost of a classroom (1928) is approximately $12,000, this means that in a go-class school only 15 classrooms are needed, instead of 30, with the result that 15 times $12,000 is released for all other activities in the school. Under this "balanced load," the special facilities add nothing to the cost of the school. According to tests, the children in platoon schools rank as high as the children in non-platoon schools in tests of accuracy; in comprehension and reasoning tests they rank higher.

BIBLIOGRAPHY.—R. S. Bourne, *The Gary Schools* (1916); Charles L. Spain, *The Platoon School* (1924); William Wirt, *Creating a Child World,* The Platoon School, 1: 4–7, January 1927. (A. BAR.)

PLATT, CHARLES ADAMS (1861–1933), American architect, was born in New York city on Oct. 16, 1861 and educated in the National academy of design, and in Paris under Boulanger and Lefebre. At first he intended to become a painter and etcher, but the outcome of a visit to Italy was a book, *Italian Gardens* (1892). This explained his adoption of architecture, and his work showed the marked influence of Italian form. He designed many private houses and gardens in addition to public buildings, among the latter being the Maxwell memorial library, Rockville (Conn.) (1917); the Freer Gallery of Art, Washington (D C.) (1918); the library, Connecticut college for women, New London (1922); the agricultural building, University of Illinois, Urbana (Ill.) (1923); and the Lowell memorial fountain, New York city.

See *Monograph of the Work of Charles A. Platt,* with an introduction by Royal Cortissoz (1913).

PLATTE, a river system of Colorado, Wyoming and Nebraska, tributary to the Missouri river, which it enters immediately north of Plattsmouth, Nebraska, 18 m. below Omaha, in about 41° 3′ N latitude. Including the North Platte it is about 900 m. long from its headwaters, with a drainage basin for the entire system of 90,000 square miles. The tributaries of the main stream all flow in from the north; the most important being the Loup, and the Elkhorn. The main stream west of Kearney, as well as the North and the South Platte, are extensively used for irrigation.

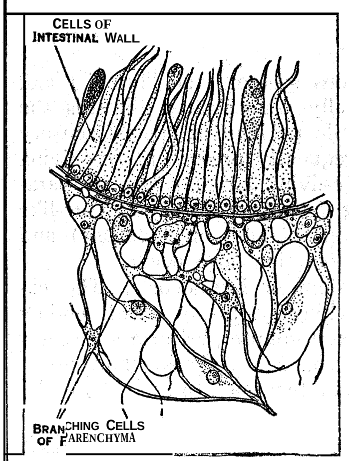
See R P. Teele, "Water Rights in Interstate Streams," U.S. Dept. of Agric. *Bulletin No. 157* (1905) and J. C. Stevens, *Surface Water Supply of Nebraska* (1909).

PLATTEVILLE, a city of Grant county, Wisconsin, U.S.A., 20 mi. from the southwest corner of the state; on federal highway 151 and served by the Chicago and North Western and the Chicago, Milwaukee, St. Paul and Pacific railways. Pop. (1930) 4 047; in 1940, 4,762. It is in a zinc and lead mining region, and is the seat of a state teachers college. The city was settled about 1827 and incornorated in 1880.

PLATTSBURG, a city of northern New York, U.S.A., on the west shore of Lake Champlain, is on federal highway 9 and is served by the Delaware and Hudson railway and lake steamers. Pop. (1930) 13,349 (90% native white); 1940 federal census 16,351. Plattsburg is surrounded by beautiful scenery: the broad, island-studded lake in front, with the Green mountains beyond, and on the southern horizon the distant Adirondacks. South of the city, at Piattsburg barracks (an army post established in 1815), 29,000 reserve officers were trained during the war of 1914–18, and since 1920 it has been one of the citizens' military training camps, with an enrolment of 3,000 to 4,000 every summer. Cliff Haven (2 mi. S.) is the seat of the Catholic Summer School of America, which has an attendance of about 3,000. Plattsburg is a centre for summer touring and winter sports. Its manufactures (chiefly lumber and various kinds of paper) were valued at $7,698,292 in 1937. Plattsburg was founded by Zephaniah Platt (1740–1807), who brought a colony from Long Island. It was incorporated as a village in 1795 and as a city in 1902. The opening naval engagement of the Revolution (a victory for the British) tonk place at Valcour island, j mi. S E. of Plattsburg, on Oct. 11, 1776. In the War of 1812 Plattsburg was the headquarters of the American army on the northern frontier. On Sept. ' ' the village was besieged by land, and or, Sept. 11, the Commodore Thomas Macdonough defeated the invading fleet.

PLATTSMOUTH, a city of eastern Nebraska, U.S.A., on the Missouri river, at the mouth of the Platte, 21 mi. below Omaha; the county seat of Cass county. It is on federal highways 73 and 75, and is served by the Burlington Route and the Missouri Pacific railway. The pop. was 3,793 in 1930; 4,268 in 1940. The city ships grain and cattle, and has large railroad shops. flour mills, broom factories and other manufacturing plants. Plattsmouth is one of the oldest settlements of the state. A trading post licensed by the U.S. government was opened there in 1853; a town was platted in 1854; and the city was incorporated in 1855.

PLATYHELMINTHES or **PLATODARIA,** a phylum of invertebrate animals, containing soft-bodied creatures which are bilaterally symmetrical and usually somewhat flattened in shape, and in which there is no true "coelom" or perivisceral cavity and no true (metameric) segmentation. The animals contained in this group (flatworms) are the simplest and probably the most primitive of those in which the tissues and organs of the body are developed from three, instead of two, original embryonic layers.



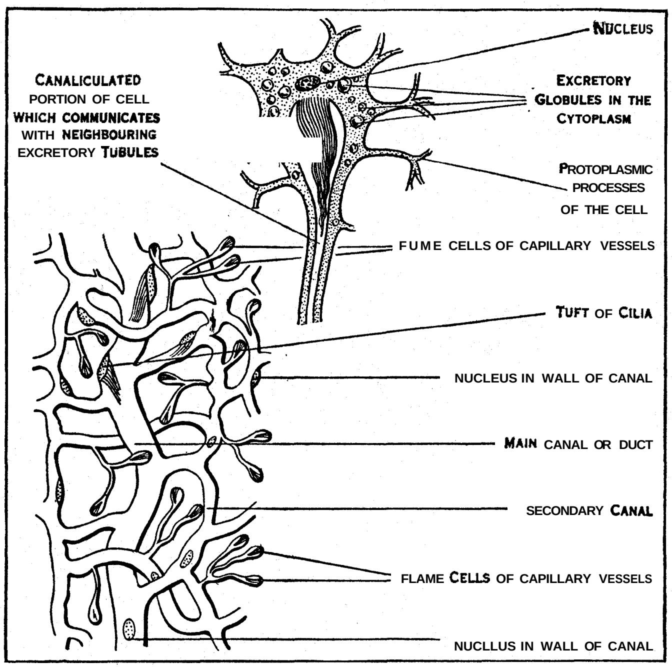
AFTER KERBERT, IN "ARCHIV FUR MIKROSKOPISCHEN ANATOMIE" (FRIEDRICH COHEN)

FIG. 1.—SECTIONAL PORTION THROUGH THE BODY OF A TREMATODE (PARAGONIMUS), SHOWING STRUCTURE OF TISSUES

The external covering of the body is typically an epidermis provided with vibratile cilia These serve partly for locomotion and partly for creating a respiratory current In the adults of certain parasitic groups, the epidermis is replaced by a smooth or spiny cuticle Pigment is commonly present beneath the epidermis in free-living forms, but is usually absent in those which are parasitic. The spaces between the internal organs are for the most part filled up with a kind of loose connective tissue called the parenchyma. The coelom is represented, perhaps, by the cavities of the gonads and of the excretory organs. The musculature of the body is mainly peripheral, consisting of layers of transverse, longitudinal and sometimes also oblique muscle-fibres running through the outer, or "cortical," portion of the parenchyma. These muscles render the body capable of extreme elongation and contraction, and often of surprising variability in shape.

Anterior and posterior ends of the body can usually be distinguished, the animals having a definite direction of locomotion, accompanied by a greater degree of specialization of, the anterior extremity. Dorsal and ventral surfaces are also generally distinguishable, the latter being that on which the animal creeps, and on which the oral and genital apertures are commonly situated. In the parasitic flatworms special clinging organs are generally developed, in the form of muscular suckers, often supplemented by chitinoid hooks or spines.

An alimentary canal may or may not be differentiated. When present, it may either be a simple sac-like organ or may be variously branched. With very few exceptions, its only aper-



PROM LANKESTER, "TREATISE ON ZOOLOGY" (A. 6 C. BLACK)

FIG. 2.— EXCRETORYSYSTEM OF A PLATYHELMINTH
Below, diagram of a portion of the excretory system showing branching ducts ending in flame cells. Above, a single flame cell more highly magnified

ture is the mouth, which may be situated subterminally, near the anterior end, or much further back, sometimes even behind the middle of the body. The mouth may be surrounded by an oral sucker, or developed into a protrusible and highly muscular pharynx.

The main ganglia of the nervous system (the "brain") and the chief sense-organs are generally concentrated towards the anterior end. In addition to tactile papillae or special sensory cilia, "eye-spots" or ocelli are frequently present in free-living forms, and sometimes in the free-living larval stages of parasitic forms. In certain free-living flatworms statocysts (sac-like organs containing minute calcareous nodules or statoliths) and ciliated pits, probably sensory in function, also occur.

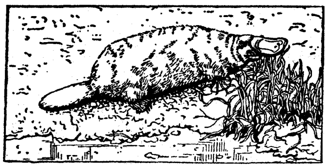
There is no blood-vascular system or haemocoele. The excretory organs consist of a branching system of canals ending internally in "flame-cells." These are minute pyriform structures containing cilia which keep up a constant flickering movement. The main collecting vessels of the system open to the exterior by one, two or many pores.

The Platyhelminthes are, with rare exceptions, hermaphroditic animals, each individual being potentially both male and female. The reproductive system is usually very complex. The male organs consist essentially of one or more (often very numerous) testes, whose ducts are usually connected with a protrusible intromittent organ (penis or cirrus). The essential organs of the female apparatus are an ovary (sometimes multiple ovaries) and a tubular duct communicating with the exterior. The arrangement of the parts of the female system is subject to great variation in different groups. Sometimes the same duct functions in turn as a vagina or fertilization canal, as a uterus or reservoir for fertilized eggs, and as an oviduct by which the eggs reach the exterior. In some cases (most Cestodes) the only communication with the exterior is a vagina, which is connected internally with an oviduct leading from the ovary to a sac-like uterus; but does not serve for the expulsion of eggs. In such forms the eggs are either shed only by the dehiscence of the wall of the uterus and of the body-wall, or by a special (temporary or permanent) birth-pore. In almost all flatworms there is a yolk-gland or vitellarium (often multiple vitellaria), producing yolk-cells which form nutritive material for the developing embryos. The vitellarium, in the most primitive forms, appears to be developed as a sterile portion of the ovary. There is also usually a "shell-gland," possibly concerned in the secretion of the outer covering of the eggs. The ducts of these glands open into the oviduct or into a specialized portion of it called the ootype. The external apertures of the male and female ducts are sometimes separate, but frequently both ducts open into a common "genital atrium," which is often muscular.

The Platyhelminthes are extremely widely distributed, free-living forms occurring in almost every kind of environment—in shallow or deep water, both fresh and marine, and on land—while parasitic forms occur on or in animals of almost every class. The free-living forms usually feed actively on small animals or plants. The parasitic forms show various degrees of modification in habits, some being external parasites and feeding on mucus or other matter derived from the skin of their hosts, while others are internal parasites and feed on partly digested food or on body-fluids. Among the latter class some are without special digestive organs and can only feed by the absorption of liquid nourishment.

The phylum is usually considered to include three main divisions or classes: (1) Turbellaria (including Temnocephalidea), the majority of which are free-living, but some parasitic. This group is probably nearest to the primitive ancestral form. (2) Trematoda (flukes), all of which are wholly or partly parasitic either upon or within other animals. (3) Cestoda (tapeworms), all of which are wholly endoparasitic. See NEMERTINEA, TAPEWORMS, TREMATODES, TURBELLARIA. (H. A. B.)

PLATYPUS, a remarkable Australian aquatic mammal belonging to the primitive sub-class Monotremata (*q.v.*). The duck-billed platypus (*Ornithorhynchus* anatinus), the only species,' is oviparous; two eggs, $\frac{3}{4}$in. long and $\frac{1}{2}$in. wide, each enclosed in a strong, flexible, white shell, are produced at a time. The animal shows many primitive features; there are no true teats in the female, the milk glands being probably modified sweat glands; the body temperature is relatively low. The platypus inhabits the streams and rivers of south-east Australia and Tasmania. About 20in. long, it is clad in short, dense fur of a deep brown above, paler below. There are no teeth in the adult, their purpose being served by horny prominences, two on each side of each jaw, giving the muzzle a very beak-like appearance. In the cheek are capacious pouches. The limbs are short and strong, each with five claw-bearing toes. In the fore-feet, the web extends far beyond the ends of the claws, but it can be folded back on the palm when the animal comes out on to the land. On the heel of the male is a movable horny spur, perforated by a canal which communicates with a poison-gland. The platypus forms deep burrows in the banks, in which it sleeps and brings up its young, the entrance being under water. The food consists of aquatic insects, Crustacea and worms. The animal is nocturnal.



PLATYPUS (ORNITHORHYNCHUS ANATINUS), AN EGG-LAYING MAMMAL

See H. Burrell, *The Platypus* (1927).

PLATYRRHINE APE, the name applied, in contradistinction to Catarrhine [*q.v.*], to the New World monkeys, on account of the broad septum between the nostrils. See PRIMATES.

PLAUEN, a town of Germany, in the Land of Saxony. Pop. (1939) 110,342. Plauen, probably founded by the Slavs, is first mentioned in 1122. It passed under the authority of Bohemia in 1327 and came to Saxony in 1466, remaining united with the electorate after 1569. The manufacture of white goods was introduced by Swabian, or Swiss, immigrants about 1570.

It was formerly the capital of Vogtland, or Voigtland, a territory governed by the imperial vogt, or bailiff, and this name clings to the district, The fine Gothic church of St. John, with twin spires, was restored in 1886. The town hall dates from about 1550; and the old castle, Hradschin, is now a law court. Plauen manufactures embroidered white goods and makes lace. It manufactures much of the machinery used in the town and it has a trade in coal, yarn and cattle.

PLAUTUS, TITUS MACCIUS (originally, perhaps, MACCUS; cf. *Asin,* Prol. 11), the great comic dramatist of ancient Rome, was born at Sarsina in Umbria according to the testimony of Festus, who calls him Umber Sarsinas, and Jerome. The date of his death was 184 B.C. (Cicero, *Brutus,* XV. 60). The date of his birth depends upon an inference based on the statement of Cicero (De *senectute,* xiv. 50) that he was an old man, when he wrote his *Truculentus* and Pseudolus. The latter play was produced in 191 B.C.; hence we get 254–251 B.C. as the approximate date of his birth. The only record that we possess as to his life is that contained in Aulus Gellius iii. 3, 14 (based on Varro), the historical character of which is doubted by Leo (*Plautinische Forschungen*, ch. ii.). The chief fact that emerges is that he left his native Umbrian home and settled as a peregrinus at Rome, where, after earning some money and losing it again, he took to writing plays.

The Plays.—His literary activity may well have begun somewhat late in life; for it must have taken him a long time and much hard study to acquire the mastery of Latin and Greek which his dramas attest. The main body of his extant works belongs, so far as can be ascertained from the scanty evidence which we have, to the last 20 years of his life; 206–204 B.C. is the approximate date of the Miles *Gloriosus;* cj. line 211 seq., quoi *bini custodes* . . . occubant (present tense), which alludes to the imprisonment of Naevius. Of the extant plays the Cistellaria and the Stichus must be associated with the Miles as comparatively early works; for the former was clearly produced before the conclusion of the Second Punic War, see 1. 201 *seq.;* and the Stichus is proved by its didascalia to have been produced in 200 B.C. The Pseudolus and the Truculentus fall within the last seven years of his life; and the *Trinummus* is later than 194 B.C.; cf. 1. 990 *novi* aediles.

The dates of the other extant plays are uncertain. An interesting attempt to place them in chronological order according to the proportion in them of scenes written in lyrical metres and set to music (cantica) has recently been made by W. B. Sedgwick (Classical Review, xxxix., 1925, p. 55 seq.). It is at any rate not improbable that the poet gave greater scope to his musical innovation (see below) as his command over language and metres developed and the success of his experiment became assured. The titles of the other extant plays are (in alphabetical order) Amphitruo, Asinaria, *Aulularia,* Bacchides (later than the Epidicus, see 1. 214), *Captivi, Casina, Curculio, Epidicus, Menaechmi,* Mercator (later than the Rudens according to F. Marx and E. Fränkel, but regarded as one of the earliest plays by P. J. Enk in Mnemosyne, liii., F. A. Wright in Broadway Translations, and W. Beare in Classical Review xlii., 1928, pp. 106 and 214 *seq.*), *Mostellaria,* Persa, Poenulus, Rudens (probably first acted 192 B.C.) *Vidularia* (existing only in a fragmentary condition in the codex Ambrosianus). Some of these may possibly be earlier than 204 B.C.; and it seems a *priori* likely that the 35 other Plautine plays known to us only by their titles and a few fragmentary quotations were not all written within the last 20 years of the poet's life.

Indebtedness and Originality.—The plays of Plautus are based on Greek originals of the New Comedy, of which one complete specimen is extant. But Plautus was not a mere translator. This was shown by K. M. Westaway (The Original Element *in Plautus,* 1917), and has been recently demonstrated in detail by E. Fränkel (*Plautinisches im* Plautus, 1922), who calls attention to certain mannerisms as evidence of unmistakable Plautine additions to the Greek texts, and also points out the originality of the Roman in the introduction of a musical element into his plays (see below). On the other hand, there are passages in which he does not hesitate to take over from his originals, allusions which can hardly have been intelligible to a Roman audience, *e.g.,* the reference to Stratonicus, a musician of the time of Alexander the Great (*Rudens,* 932); and in the delineation of character we have no reason to suppose that he improved on his models (cf. Aul. Gell. ii. 23). Even the bulk of the prologues may be of Greek origin, though certain passages in them must have been added by Plautus, and other passages (e.g., *Casina* 5–20) are post-Plautine. And where Plautus varies his plot on lines of his own by amalgamating the plots of two distinct Greek comedies (*e.g.,* in the Miles and the Poenulus) the result is generally not happy; the romanization of the plays by way of allusions to towns in Italy, to the streets, gates and markets of Rome, to Roman magistrates and their duties, to Roman laws and the business of Roman law courts, banks, comitia and senate, etc., involves the poet in all the difficulties of attempting to blend two different civilizations. The inconsistency of his attitude is shown by his use, side by side, of the contemptuous expressions *barbarus* (applied to the Romans) and pergraecari (applied to the Greeks). In some passages the poet seems to take delight in casting dramatic illusion to the winds (e.g., *Pseudolus,* 720; *Poenulus,* 550).

But as an adapter for the Roman stage Plautus is nothing less than masterly. His command of Latin is such that his plays read like original works, and it may be at least said that some of his characters stand uui su vividly from his canvas that they have ever since served as representatives of certain types of humanity, *e.g.,* Euclio in the *Aulularia,* the model of Molière's miser. Alliteration, assonance, plays upon words and happy coinages of new terms, give his plays a charm of their own. "To read Plautus is to be once for all disabused of the impression that Latin is a dry and uninteresting language" (Skutsch, in Die Cultur der *Gegenwart,* 1905). It is a mistake to regard the Latin of Plautus as "vulgar" Latin. It is essentially a literary idiom, based upon the language of intercourse of the Roman society of the day (cf. Cic. De *oratore,* iii. 12, 45).

The Characters in his plays are the stock characters of the New Comedy, and they remind us also of the standing figures of the Fabulae Atellanae (Maccus, Bucco, Dossennus, etc.). We may miss the finer insight into human nature and the delicate touch in character-drawing which Terence presents to us in his reproductions of Menander, but there is wonderful life and vigour, and considerable variety in the Plautine embodiments of these different types. Their language is often coarse; and there is some deliberate obscenity in it, but not so much as has been discovered by Gurlitt and introduced into his German translation (1920–22). And the careful reader will take note of occasional touches of serious thought (no doubt derived from the Greek originals), as in the enumeration of the ten deadly political sins (Persa, 555 seq.) and allusions to ethical philosophy (Pseud. 972 *seq.; Stich,* 124; Trin. 305 seq., 320 seq., 363 seq., 447; Rud. 767, 1235–1248, etc.). The *Captivi* is the story of the heroic self-sacrifice of a slave. The *Amphitruo* is a mythological burlesque. But most of his plays depend for their main interest in intrigue, such as the Pseudolus, Bacchides, Mostellaria. In the Menaechmi and as a subordinate incident in the Amphitruo we have a comedy of errors.

Metres.—In the metrical structure of his plays Plautus introduced an important innovation. The New Comedy of Greece had confined itself for the most part to the metres of dialogue: Plautus took the bold step of transposing whole scenes into metres suitable for singing to the accompaniment of the flute (cantica); and to other scenes he gave a quasi-operatic character by the use of recitative. But the cantica are not mere inserts or accessories, like the songs introduced in the Shakespearean drama; they form integral parts of the action, which would often be unintelligible without them (see Fränkel [*op. cit.*] whose theory is a development of that of Leo in Die *plautinischen Cantica und* die *hellenistische* Lyrik, 1897). The metres employed were, of course, not invented by Plautus; they are of Greek origin and are common to Roman tragedy and Roman comedy; but Plautus gave them a new development and a wider scope. Further light is thrown upon the immediate source of these Plautine metres by J. H. O. Immisch (*Zur* Frage der *plaut. Cantica,* in Berichte der Heidelb. Akad., 1923). The Plautine metres are wonderfully varied, and the textual critic does well not to attempt to limit the possibilities of original metrical combinations and developments in the Roman comedian.

Reputation.—Plautus was a general favourite in the days of republican Rome. Cicero, though he found fault with the iambics of the Latin comedians generally as abiecti "slovenly" (Orator lv. 184), admired Plautus as elegans, *urbanus, ingeniosus, facetus* (*De. offic.* i.,29,104). To the fastidious critics of the Augustan age, such as Horace, he seemed rude (*cf. Ars Poetica*, 270–274), just as Addison declared Spenser to be no longer fitted to please "a cultivated age." In another passage (Epist. ii. 1 170–176) Horace accuses him of clumsiness in the construction of his plays and the drawing of his characters, and indifference to everything except immediate success; *gestit enim nummum in loculos demittere,* post *hoc securus cadat an* recto stet *fabula talo.* That there are many inconsistencies and signs of carelessness in his work has been proved in detail by Langen. But that he found many admirers, even in the Augustan age, Horace himself bears witness (ibid. 1. 58), where he says that Plautus was regarded as a second Epicharmus: Plautus ad exemplar *Siculi* properare *Epicharmi;* cf. Varro's statement (in Priscian ix. 32), *deinde* ad *Siculos se applicavit.* It is possible that Plautus may have been working on the lines of the old comedy in the tell-tale names which he is so fond of inventing for his characters such as Polymachaeroplagides (*Pseud.* 988), Pyrgopolinices (Mil. 56), Thesaurochrysonicochrysides (*Capt.* 285)—names which stand in remarkable contrast to the more commonplace Greek names employed by Terence.

In the middle ages Plautus was little regarded, and 12 of his plays (*Bacchides—Truculentus*) disappeared from view until they were discovered (in the ms. called D) by Nicholas of Treves in the year 1429. But after the revival of learning Plautus was reinstated, and took rank as one of the great dramatists of antiquity; cf. Shakespeare, Hamlet, II., ii., 420, where Polonius says "The best actors in the world . . . Seneca cannot be too heavy nor Plautus too light."

Influence on Modern Literatures.—A comprehensive view of the widespread influence of Plautus on modern literatures is given by Reinhardstoettner, *Spätere* Bearbeitungen *plautinischer Lustspiele* (1886). Many adaptations for the Italian stage were produced between the years 1486 and 1550, the earliest (the *Menaechmi*) under the direction of Ercole I., duke of Ferrara. From Italy the practice spread to France, Spain, England and other countries.

Of English plays the interlude called Jack Juggler (between 1547 and 1553) was based on the *Amphitruo,* and the lost play called the *Historie* of Error (acted in 1577) was probably based on the *Menaechmi;* Nicholas Udall's Ralph *Royster Doyster,* the first English comedy (acted before 1551, first printed 1566), is founded on Miles *Gloriosus;* Shakespeare's Comedy of Errors (about 1591) is an adaptation of the *Menaechmi;* and his Falstaff may be regarded as an idealized reproduction or development of the braggart soldier of Plautus and Terence—a type of character which reappears in other forms not only in English literature (*e.g.,* in Shakespeare's Parolles and Ben Jonson's Captain Bobadil) but also in most of the literatures of modern Europe. Shakespeare's *Taming* of the Shrew has been influenced in several respects (including the names *Tranio* and Grumio) by the *Mostellaria.* Ben Jonson produced a skilful amalgamation of the *Aulularia* and the *Captivi* in his early play The Case is Altered (written before 1599). Thomas Heywood adapted the *Amphitruo* in his Silver *Age* (1613), the *Rudens* in his *Captives* (licensed 1624), and the Mostellaria in his *English* Traveller (1633). Dryden's *Amphitryon* or the *two Sosias* (1690) is based partly on the *Amphitruo,* partly on Molikre's adaptation thereof; Fielding's Miser (acted 1732) on Molikre's *L'Avare* rather than on the *Aulularia,* and his *Intriguing Chambermaid* (acted 1733) on Regnard's Le *Retour imprévu* rather than on the Mostellaria.

Bibliography.—Standard Texts and Editions with Notes: Texts by Goetz and Schoell (*editio* minor, 1893–1907), by Leo (1895–96), by Lindsay (1904–05). With notes: *Captivi,* by Lindsay (1900), by Brix (6th ed., 1910); *Menaechmi,* by Brix (5th ed., 1912); *Miles* by Lorenz (2nd ed., 1886), by Brix (3rd ed., 1901); *Mostellaria* by Lorenz (2nd ed., 1883), by Sonnenschein (2nd ed., 1907); *Pseudolus* by Lorenz (1876); Rudens by Sonnenschein (1891, ed. min., 1901); *Trinummus* by Brix (5th ed., 1907); other plays in Macmillans Classical Series and the Pitt Press Series. Lexicon: Gonzalez Lodge's *Lexicon Plautinum* (nearing completion and indispensable). Syntax: Lindsay, *Syntax of Plautus* (1907): Metre and Prosody: Lindsay, *Early Latin Verse* (1922); Vollmer, *Römische* Metrik (1923); and Ueber die sogenannte *Iambenkürzung* (1924); Sonnenschein In What *is* Rhythm? (1925, ch. vi.). E. Frankel's *Iktus und Akzent im lateinischen Sprechvers* (1928) is an attempt to show that in the dialogue metres, as distinct from the metres set to music, the verse-stress (ictus *metricus*) nearly always coincides with a genuine speech-accent, or at any rate corresponds to some modification of accentuation or intonation. Translations: English prose by P. Nixon in the Loeb Series (1916–24; 2 vols. still to come); English verse by Wright and Rogers in *Broadway Translations*—select plays (1923).

PLAY: see Drama.

PLAYA (a Spanish word meaning "shore"), the name applied in America to a level plain formed of the deposits of a river which has no outlet to the sea or a lake. If at seasons of high water a river floods any area and temporarily converts it into a lake, which subsequently dries up in hot weather, the tract thus left dry is called a playa. The barren Black Rock desert in north-western Nevada, about 100m. in length by 15 in breadth, is typical.

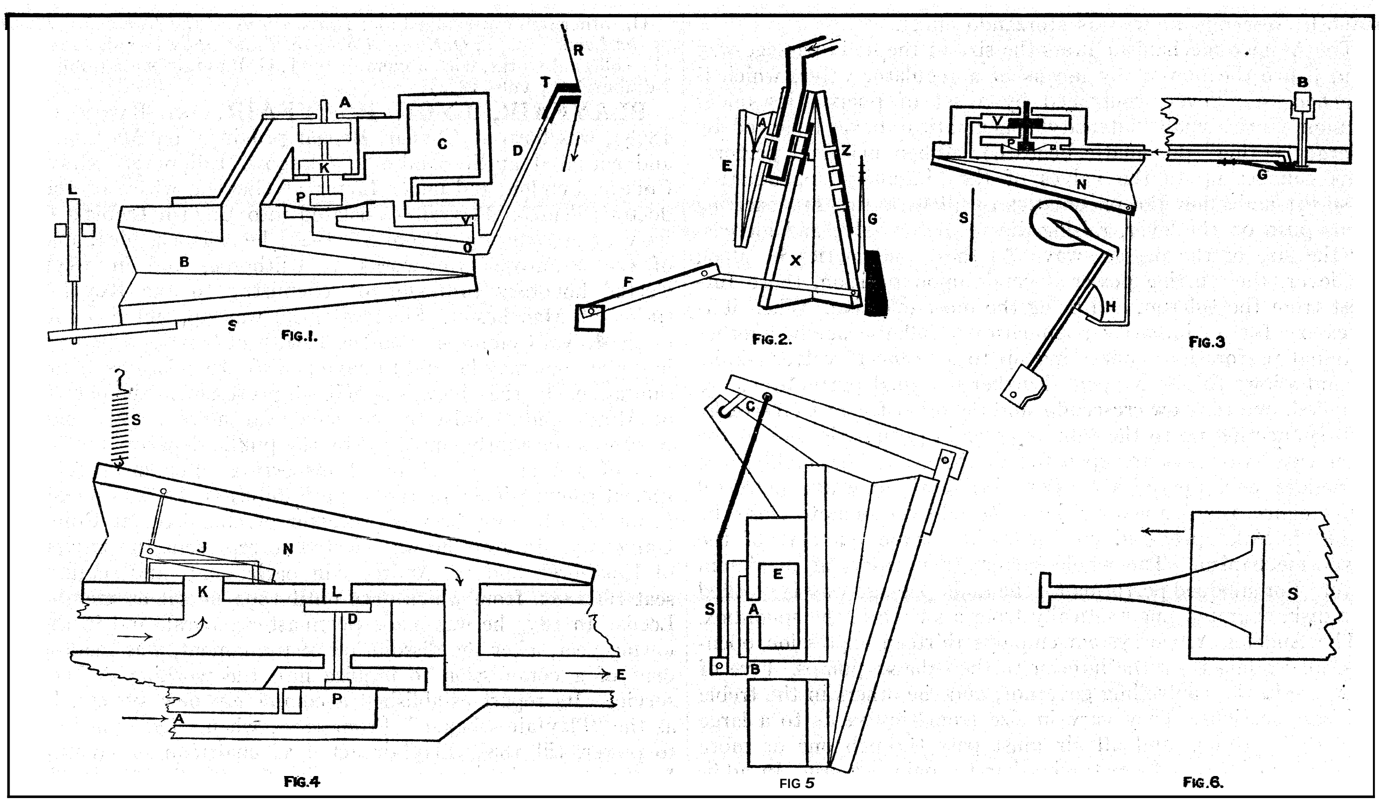
PLAYER-PIANO, a piano equipped with a mechanical device for automatically playing written music or for reproducing the playing of a pianist. All types of player-piano mechanism are operated by utilizing the difference between external and internal air pressures. In fig. 1, the tracker-bar, T, with its 88 holes, is represented as being closed by the paper roll, R, which lies closely against it. Some of the air has been extracted from the duct, D, and from the chamber, C, by means of an air-exhaust to which they are connected. There is a very tiny vent, V, which allows air from the tracker duct to leak into the chamber. A disk, K, closes the chamber from the outer air, being held down because the air in C, is at a lower pressure than normal. The pneumatic, B, is full of air at normal atmospheric pressure and is open to the external air by means of the port, A.

Should a hole in the paper come into line with any hole in the tracker-bar, the external air rushes into the duct and lifts the pouch, P, which is simply a circular piece of soft kid about $\frac{3}{4}$in. in diameter, and bigger than K. Hence it lifts K, connecting the pneumatic with the partial vacuum, C, and disconnecting it from the external air by closing the port A. The air in B spreads to C and, the external pressure on the surface, S, being greater than the reduced pressure inside, the pneumatic collapses suddenly, the movable leaf rising and lifting with it the pilot, L, which operates the piano action.

The pneumatic remains collapsed until paper again blocks the hole in the tracker-bar. The air in D then leaks through into C and can no longer hold up the pouch, which falls back into position and allows K to close the chamber C again, at the same time opening the pneumatic to the external air at A. The external and internal pressure on S now being the same, the pneumatic re-inflates and allows the pilot to drop back into position.

In the days of heavy and clumsy valves it was difficult to provide the necessary power to lift them rapidly without hard pedalling and consequent loud tone. To overcome this defect the more expensive player action was provided with an additional (or primary) valve of light construction, easily lifted by the inrush of air when a hole was opened on the tracker-bar. Its lifting admitted air to the other and heavier valve, through the port O, operating the striking pneumatic as previously described. Both single and double valve systems are still in use.

The interior of the player action is maintained in a steady state of reduced pressure by forcing the pedal, F, to open the exhaust, X (fig. 2). This allows all the interior air to spread itself into X past L, a flat strip of well-tanned leather, lying over holes. A fan spring, G (about 12lb. in strength), then closes the exhaust, expelling the air via another flap valve, Z. A strong spring, A, is always trying to open the equalizer, E, but is prevented from so doing when the external air pressure is much greater than the reduced pressure inside. When, however, there is not much difference between the external and internal pressures the spring can open and in so doing allows air to spread into it from the interior. The effect is to reduce the internal pressure



MECHANISM OF THE PLAYER-PIANO. THE FIGURES AND LETTERS ARE EXPLAINED IN THE TEXT

once more to such an extent that the equalizer begins to collapse. Its constant to-and-fro motion enables a steady amount of reduced pressure to be maintained in the interior channels, despite unsteady working of the pedals.

Controls.—The simplest method of operating the "soft" and "sustaining" pedals is to connect the ordinary mechanism of the piano, by suitable levers, to finger controls in front of the keyboard. Many manufacturers prefer to control the distance from the hammers from the strings as shown in fig. 3. A button, B, opens a gate, G, when pressed down. This admits air to a pouch, P, which lifts the valve lying above it, and puts the pneumatic, N, into communication with a partial vacuum, V, thus collapsing it andwcausing it to lift the hammer rail, H, which softens the tone by giving the hammerhead less distance to travel towards the string, S.

A similar device withdraws all the dampers from the strings. This being a heavier task than shifting the hammers, a larger pneumatic has to be employed, and two valves instead of one. Music rolls are provided with an additional hole at the left-hand edge, which works the lifting of the dampers, if desired.

Change of power, in addition to the means above described, is provided by varying the strength of the blow given to the hammer. Fig. 4 sho s how the normal amount of reduced air is altered by interposing a pneumatic, N, between the main exhaust, E. and the small playing pneumatics. Pressing a button (as in fig. 3), air is allowed to enter at A, the pressure from which lifts the pouch, P, and with it the valve, D. This closes the large hole, L, and leaves only the aperture, K, over which lies a knife-cutter valve, J, so called because it closes like the blade of a pen-knife. The spring, S, is of such strength that it governs the amount of air passing through to the bellows, hard pumping closing N and therefore closing the aperture K and preventing loud playing.

A slight alteration of fig. 4 would give a fair representation of the automatic Accenting Device, which is worked from marginal perforations in the music roll. The valve disk, D, is moved to the other side of the hole, L, keeping it normally closed and softening the tone until a marginal perforation allows air to rush towards P. The pouch lifts the valve, opens L and accents the note.

The pedals also provide sufficient power to work the spool which draws the music roll over the tracker-bar. Five pneumatics of the type shown in fig. 5 are fixed at equal angular distances upon a crank-shaft, C, each one collapsing in turn and so driving the shaft round steadily. Collapse is effected when the hollow slide, S, is covering both of the ports A and B, for the pneumatic is then in direct communication with the main exhaust, through E. As the crank-shaft is thus moved round, the slide is raised, and no longer covers both ports. External air is admitted to the pneumatic, and the collapse of one of its neighbours provides the power to lower its slide and again get into communication with the main exhaust.

All communication between motor and exhaust is by way of a governor pneumatic; powerful pedalling tends to collapse it, but directly this happens a knife-valve partly closes the passage-way (as in fig. 4), and thus prevents the motor from "racing." Variation in tempo is secured by deliberately altering the size of the passage-way within an enclosure known as the Tempo Box. The shape of the slot is usually as shown in fig. 6, over which passes a slide, S. When half the area of the slot is covered, the speed of the motor is half its maximum, and so on, the slide being worked mechanically from the control board.

The holes in the paper roll being so close together, it is essential that they should track correctly, despite the effects of wear and weather. Correct tracking is controlled in ways which vary in detail, but usually depends upon the action of two pneumatics, kept under exhaust. Holes in the tracker-bar are so placed as to be uncovered when (and only when) the roll goes to one side, letting air into one of the pneumatics and causing it to open slightly, taking with it either tracker-bar or spool.

Reproducing Pianos.—The "reproducing" instruments are in a separate class, designed to reproduce faithfully all the shades of tempo and expression made by well-known pianists. All control is rightly withdrawn from the operator when using the specially cut rolls, but the same instrument may be used for ordinary rolls by putting the reproducing mechanism out of action. Additions to the normal player mechanism are mostly for the purpose of controlling more completely the comparative loudness or softness of individual notes. To do this effectively it is necessary to have as many grades of power as possible, to include smooth crescendo as well as sforzando effects.

The Ampico mechanism alters the size of the main passage-way (and hence the power) by means of a regulator valve, which is attached to a lever, controlled by a set of pneumatics under vacuum (three small "intensity" pneumatics above, balanced by a large "spring" pneumatic beneath). When marginal perforations connect up to the valves of the "intensity" pneumatics, these lift and allow the pneumatics to fill with air, thus exerting an up-push on the lever, raising the regulator valve and increasing the size of the passage-way. As these pneumatics lie along the lever, their lifting power depends upon position, those furthest from the fulcrum end being the most effective. When it is necessary for an intensity pneumatic to collapse again, another marginal perforation, connecting up to a "cancel" valve, admits air and allows this to happen. Further marginal perforations are provided, one for slow crescendo, and the other for fast crescendo, each connecting up to the same crescendo pneumatic, but in the latter case two ways are open for the air to escape, making the pneumatic collapse quickly. For "brilliant" or extra powerful performance, the Ampico can be switched over so as to close the slight "in-leak" provided on one of the three pumpers of the power mechanism. The whole system then works at maximum power. For subdued performance the main passage-way is blocked by a disk, operated pneumatically from a switch in the spool-box.

The Angelus Artrio system employs thirteen expression openings, all leading from the interior to the exhaust pumps. Five of these are in the controlling governor, and the others in the treble and bass sections. They vary in size from tiny vents to a large "melody" opening, and all air must pass through one or more openings on its way from tracker-bar to main exhaust. In addition, there is an "in-leak" as on the Ampico, but the Angelus system works it from the tracker-bar. When a perforation appears against the second hole from the left-hand side, the "in-leak" is closed and an increase of power results.

The Duo-Art (Aeolian Company) is essentially a theme and accompaniment expression arrangement, the former being at a higher dynamic power than the other. Each has a knife-valve control of the passage-way, operated by a set of four pneumatics, varying in their amount of possible collapse. In this way sixteen variants of power are obtained There is also an "in-leak," automatically closed by another knife-valve so as to get maximum power when the passage-may is already nearly full open.

The Welte-Mignon is worked by suction fan instead of the usual pumpers. Its expression unit consists of a governor bellows, held open by a coiled spring This controls the position of a conical valve in the passage-way, and is itself automatically responsive to the amount of work being done at any moment within the pneumatic system. The expression pneumatic, which also works the same conical valve, is operated from the tracker-bar, and can act slowly or quickly according to the perforations in operation. (S. A. H.)

Bibliography.—S. Grew, *The Art of the Player-Piano* (1922), *The Book of the Player-Pianist* (1925); D. M. Wilson, *The Player-Piano: its Construction, how to play (1923).*

Value of **the** Player-piano.— The player-piano in its modem perfected form enjoys the whole-hearted support of musicians. In schools it has proved invaluable, while in musical colleges and academies it is utilized as a means of familiarising students with the interpretations of the greatest performers.

PLAYFAIR, JOHN (1748–1819), Scottish mathematician, was born at Benvie, Forfarshire, where his father was parish minister, on March 10, 1748. He was educated at home until the age of 14, when he entered the University of St. Andrews. He was ordained, and succeeded his father in the parish of Benvie, but continued his scientific studies. In 1785 he succeeded Dugald Stewart in the chair of mathematics at Edinburgh, which he exchanged in 1805 for that of natural philosophy. In 1795 he published his *Elements of Geometry,* which later passed through many editions. He enunciated the axiom now known by his name, viz., that two intersecting straight lines cannot both be parallel to the same straight line. He was elected F.R.S. in 1807. He died in Edinburgh on July 20, 1819.

His other publications include: *Illustrations of the Huttonian Theory of the Earth* (1802); *Outlines of Natural Philosophy* (2 vols., 1812–16). His collected works, with a memoir by J. G. Playfair, were published at Edinburgh (4 vols. 1822).

PLAYFAIR, LYON PLAYFAIR, 1st Baron (1818–1898), was born at Chunar, Bengal province, on May 21, 1818, and educated at St. Andrews, Glasgow, Edinburgh, University College, London, and under Liebig at Giessen, where he took his doctor's degree. Playfair translated into English Liebig's *Chemistry of Agriculture.* From 1841–42, he was chemical manager of the Primrose print-works at Clitheroe, and in 1843 was elected honorary professor of chemistry to the Royal Institution of Manchester. Soon after he was appointed a member of the Royal Commission on the Health of Towns, a body whose investigations may be said to have laid the foundations of modern sanitation. In 1845 he was appointed professor in the new School of Mines, and chemist to the geological survey, and thenceforward was constantly employed by the public departments in matters of sanitary and chemical inspection. For his services as special commissioner of the 1851 Exhibition, he was made C.B. From 1856 to 1869 he was professor of chemistry at Edinburgh University. In 1868 he was elected to represent the universities of Edinburgh and St. Andrews in parliament, and retained his seat till 1885, from which date until 1892 he sat as member for Leeds. In 1873 he was made postmaster-general, and in the following year, after the dissolution of parliament, was made president of a commission to inquire into the working of the civil service. Its report established a completely new system, known as the "Playfair scheme." From 1880, when Gladstone returned to power, till 1883, Playfair acted as chairman of committees. In 1892 he received a peerage, and in 1895 the G C.B. He died in London, on May 29, 1898, and was buried at St. Andrews. He published a volume, *Subjects of Social Welfare.*

A memoir by Sir Wemyss Reid was published in 1899.

PLAYFAIR, SIR NIGEL (1874–1934), actor and theatrical manager, was born in London on July 1, 1874. Educated at Harrow and at University college, Oxford, he acted with the Oxford University Dramatic Society. For some time he practised as a barrister. On July 30, 1902, he made his first appearance as a professional actor at the Garrick theatre, London, in "A Pair of Knickerbockers." He was chiefly associated with the Lyric theatre, Hammersmith, London, the management of which he assumed in 1919. Among his most famous productions at this theatre were John Drinkwater's *Abraham Lincoln* (1919) and the revival of Gay's *Beggar's Opera* (1920) which ran for over three years. He published *The Story of the Lyric Theatre, Hammersmith* (1925), and other works. He was knighted in 1928.

PLAYFORD, JOHN (1623–*c.* 1686), English musical publisher, was born at Norwich. From 1653 he was clerk to the Temple church, and from his shop in the Inner Temple issued most of the English music of his day. Of his own compositions the chief are numerous psalm tunes, the popular *Introduction to the Skill of Musick* (1654, 19 ed. 1730) and *The Dancing Master* (1650), a collection of airs for the violin used for country dances which constitute an invaluable treasury of English national tunes.

See F. Kidson, *British Music Publishers.*

PLAY IN ANIMALS. Play is illustrated by kittens with their ball, puppies and their sham-hunt, lambs and their races, monkeys and their "follow-my-leader." There are often sham-fights among birds which seem to be entirely playful, besides exhibitions of flying powers that have no direct usefulness. For it is one of the criteria of play that it is not directly useful. Play is not work, though it may be as strenuous and may lead to exhaustion; it is not mere exercise, though, perhaps, it exercises best; it has no deliberate (or, in animals, perceived) end, for the sake of which it is played, yet it may be almost indispensable if the animal is to attain to the full use of its powers. Play is not necessarily social, for many a kitten plays alone; and it is not necessarily competitive, though rivalry may give it zest. Its key-note is its anticipation of modes of activity characteristic of adult life.

Play is well illustrated by many young carnivores, such as cats, dogs, foxes, otters and bears; by many young ungulates, such as

Lambs, kids, caives and foais; by most monkeys, and by less familiar cases like young squirrels and water-shrews. Yet it cannot be said to be a general feature in the youthful life of mammals. It is not common among birds; it is only hinted at in reptiles, amphibians and fishes; and it is at most incipient among backboneless animals. This raises the question why a playing period should be interpolated in the life-history of only a small minority. There must be some particular biological advantage in play, yet one which only certain types have been able to secure.

Uses **of** Play.—The poet Schiller suggested that animal play is an expression of overflowing energy. But while this theory has its grain of truth, it is far too simple. Thus there are many young animals with abundant vigour that never play; and it is well known that a thoroughly tired animal, such as a dog, may turn in a moment from fatigue to play, as children often do. Moreover, half the problem is that different types of mammals play in characteristic or specific ways.

Schiller's theory of play was re-expressed by Herbert Spencer with the important additional suggestion that imitation accounts for the particular form that the playing takes. The physiological condition of play is superfluous energy, but imitation defines the channel of expression. Young creatures mimic in play what they see their seniors doing in earnest. Here again there is some truth, and corroboration may be found in the imitativeness of certain forms of playing in children. But Spencer's theory will not cover the facts. Thus an isolated young animal, such as a kitten, will play, and will play true to type, provided that an appropriate liberating stimulus, apart from imitation, is supplied at an appropriate time. But if a kitten reaches a certain age—usually about two or three months—without having had any experience of mice, it will not afterwards show any "mousing instinct," nor any capacity for playing with a mouse.

A third idea has some relevance, namely the close correlation between pleasant emotions and bodily movements. It is a familiar fact of experience, elaborately studied by the physiologists and psychologists, that pleasant feelings reverberate in various parts of the body, such as the heart, lungs, larynx, food-canal and bladder. The correlation of emotional excitement and activity of the suprarenal bodies is well known. But to the internal movements there may be added movements of the body as a whole, and these will be naturally specific for different types. The child dances with joy; the otter cub gambols exuberantly. This simple movement-play may be a useful safety-valve, but it is also a natural expression of overflowing *joie-de-vivre.*

To Karl Groos we owe the illuminating suggestion that play is important as an irresponsible apprenticeship to the subsequent business of life. It is the young form of work, and this accounts for its specificity. The young carnivore has its sham hunt, the young ungulate its amateurish race, neither involving serious responsibilities. Under the shelter of parental or communal care the playing animal educates powers essential in after-life, and is afforded opportunities without the serious consequences involved whenever the struggle for existence sets in keenly. As Groos puts it, animals do not play because they are young; they continue young in order that they may play. No doubt non-playing young animals also educate their capacities, but the point is that the interpolation of the play-period is an additional advantage which some plastic and well-endowed creatures have been able to secure for themselves. It is interesting that most of the mammals man has succeeded in domesticating are playing mammals.

Another aspect of the play-period is that it affords opportunity for testing new variations before the struggle for existence sieve becomes too fine in the mesh. Play affords elbow-room for new departures. and its value is particularly clear when the adult life is very varied, like an otter's, demanding plasticity and resourcefulness. Here there is a marked contrast between games, which are restricted to mankind, and play, which children share with young animals. For the game has its rules and demands self-subordination, whereas play is spontaneous and allows of idiosyncrasies and experimentation. From the biological point of view it is clear that human games cannot fulfil all the functions of play.

According to Groos there is no general "instinct to play"; it is enough to suppose that each type of playing animal has its inborn or instinctive system or pattern of predispositions towards particular types of adult activity, and that the young are peculiarly sensitive to liberating stimuli. Play implies not only susceptibility, but precocity and plasticity. It secures a certain freedom for initiative before habituation sets in. And this, as has been said, is of especial value when the adult life demands considerable versatility. In such cases, the animals that play best are also likely to work best.

Types **of** Play.—If play is anticipatory of future work, the different kinds of play will correspond to the chief activities of adult life. (a) Many forms of play are of the nature of experiments in locomotion, as in aimless racing, rival jumping, riotous gambolling and feats of climbing or of flying. Here one pictures the behaviour of lambs, kids, calves, young antelopes, young chamois, foals, young squirrels and young monkeys. (b) On another line is sham-hunting, in which the young animal chases some moving object irrespective of all utility. A leaf blown by the wind or a ball of grass will pull the trigger as effectively as a small animal, The mother sometimes aids and abets, and here play may coalesce with education *(see* ANIMALS, EXPERIMENTS *OK).* The kitten's play with the mouse, often absurdly misinterpreted as "delight in torture," is paralleled in many other young carnivores. It is justified in the present by the repetition of pleasurable excitement, and in the future by the increased dexterity it develops. When the mouse-play is exhibited by cats of mature years, and apart from their education of their kittens, it is probably a relapse into youthful play, illustrated less poignantly in some other adults. (c) **A** third form of play is the sham-fight, familiar in puppies. It has been described among lions, tigers, hyenas, wolves, foxes, bears and other carnivores; among lambs, kids, calves, foals, antelopes and other ungulates. It is also common among birds. Care must be taken to keep the sham-fight distinct from the combats of rival males, the first hints of which may begin early, as in bull-calves. And even apart from sex, it is not always easy to distinguish the sham-fight from serious combativeness. In his description of the behaviour of two young gluttons, Brehm says that nothing could be more playful, they were hardly at a rest for a minute, but every now and then the note of earnest was struck. Very curious, considering the level at which they occur, are the so-called sham-fights which several good observers have described among ants. There is energetic wrestling and the like, but no discharge of poison or actual wounding. *(d)* Perhaps one may recognize another type which may be called playful experiment, when animals test things, often pulling them to pieces; or test themselves, often performing interesting but useless feats; or test their neighbours, discovering how they will respond to sundry provocations. The difficulty is to distinguish these playful experiments from the ways in which many well-endowed young animals feel their way about in their environment. But Hamerton describes how his young goats would spend hours in jumping in and out of a basket, or would try to upset the artist by getting under his seat, or would tease the big dog to the limit of his endurance.

Along this line the subtlest forms of play are found in apes, where experimenting may go far, and sometimes become sheer mischief. Chimpanzees often show what looks like delight in being a cause, and an entirely useless activity may be repeated over and over again. Thus a chimpanzee will entice a hen with bread, and pull the reward away at the last minute, repeating the trick many times with evident gusto. Or it will attract a hen close to the cage and then give her a sudden poke with a stick when she is preoccupied with her food. This seems almost like a joke.

Of interest are those cases where playing or something like playing is continued long after youth is past. This is familiar in domestic dogs, but is also exhibited in natural conditions, for instance by the otter. This extension of play may be sometimes associated with the mother's habit of playing with successive litters of young ones year after year. But this interpretation does not apply to all cases, for instance to the communal playing of full-grown penguins on the sea-ice. Thus Murray Levick has described the diving play in which the succession of birds may be so rapid "as to have the appearance of a lot of shot poured out of a bottle into the water." A favourite activity was to board an ice-floe till it would hold no more, and get carried by the tide to the lower end of the rookery, where every bird would suddenly jump off and swim back against the stream to catch a fresh floe and get another ride down. An adult snake-bird (*Anhinga*) has been seen playing catch with twigs, an activity obviously correlated with its dexterity of head and neck in catching fish. Many birds have flight games; the "shooting" and tumbling of rooks and herons, and the turning upside-down of ravens may be specially mentioned. It seems impossible to restrict the idea of play to youth.

But in general play is a mode of behaviour characterizing the youthful period of certain well-endowed animals, a precocious exhibition of activities more or less anticipatory of those characterizing adult life, but not in themselves of direct utility. Its biological significance is partly as a safety-valve for overflowing energy, partly as an early expression of imitativeness, partly as a correlate of pleasant feelings, but mainly as an irresponsible apprenticeship to adult activities and an opportunity for testing new departures, especially in habit.

***Restrictions of* Play.**—Since these characteristics of typical play are tolerably well-defined, it is undesirable that the concept should be blurred by a vague and loose application of the term. The following restrictions may be suggested: (1) The term play should not be used for the idle movements of animals, such as insects and fishes, unless there is evidence that these are serving as an apprenticeship. Gregarious swimming on the part of cuttle-fishes and fishes, gregarious flying on the part of insects and birds, may have no utility, and yet hardly deserve the name of play.

(2) It is undoubtedly difficult to draw the line, but it seems useful to try to exclude from typical play all activities bound up with sex-display or courtship. For while these resemble play in being artistic and spontaneous expressions of individuality, they have an immediate outcome: they serve to arouse sex interest and sex desire, whereas typical play never has any immediate reward. If it seem impossible to draw a line between play and display, it might conduce to clearness if the word, sex, were used as a prefix. Thus' one might use some phrase such as courting dance for many of the extraordinary displays that birds make at the breeding season (see BIRD, *Reproductive* Habits; COURTSHIP OF ANIMALS). W. H. Hudson portrays the dance of the cock-of-the-rock (*Rupicola*) of tropical South America: "A mossy level spot of earth surrounded by bushes is selected for a dancing-place, and kept well-cleared of sticks and stones; round this area the birds assemble, when a cock-bird, with vivid orange-scarlet crest and plumage, steps into it and, with spreading wings and tail, begins a series of movements as if dancing a minuet; finally, carried away with excitement, he leaps and gyrates in the most astonishing manner, until, becoming exhausted, he retires and another bird takes his place." This strikes a note quite different from that sounded in the races of lambs and kids, wild foals and asses, or "tag" and "follow my leader" among monkeys.

(3) It is part of the essence of play that it is not directly useful, but has a prospective value in educating efficiency. But not a few animals with abundant spare energy and initiative are known to indulge in occasional adventures which, though they can hardly be called other than playful, have no prospective meaning. Some of the experiments of apes, to which we have already referred, may illustrate this kind of behaviour, and should perhaps be called tricks rather than play. True play is characteristic of a species and is neither occasional nor individual. A naturalist relates that on one occasion, when botanizing on the Alps, his dog ceased to follow him on the graduated path, and was seen to choose a more direct slope of hard snow. There he lay down on his back, folded his legs and slid down like a toboggan. At the foot he looked up at his astonished master and wagged his tail! No conclusion can be based on single instances, however well documented, but we cite this case as an instance of probable misinterpretation. The observer supposed that the dog had thought out a short cut—an unnecessarily generous view; others have called it a piece of play. But the probability is that it was a casual adventure, such as may be reasonably put to the credit of many a well-endowed animal. Similar instances are known at much lower levels of intelligence. The ecological concept of animal play is most useful when employed in the strictest sense, as already defined. (See ANIMAL BEHAVIOUR; PSYCHOLOGY, COMPARATIVE; SEXUAL SELECTION.)

BIBLIOGRAPHY.—Karl Groos, *Play of Animals* (1898); J. Arthur Thomson, *Biology of the Seasons* (1911); *The Minds of Animals* (1927); P. Chalmers Mitchell, *The Childhood of Animals* (1912); W. P. Pycraft, *The Infancy of Animals* (1912); Murray Levick, *Natural History of the Adélie Penguin* (1915); W. Kohler, *The Mentality of Apes* (1925); Frances Pitt, *Animal Mind* (1927).

(J. A. TH.)

PLEADING: see PRACTICE AND PROCEDURE.

PLEASANTVILLE, a city of Atlantic county, New Jersey, U.S.A., 5 mi. W.N.W. of Atlantic City; served by the Pennsylvania and the Reading railways. Pop. (1930) 11,580; (1940) 11,050.

PLEASURE: see FEELING, PSYCHOLOGY OF; HEDONISM; ETHICS.

PLEBISCITE, a term borrowed from the French for a vote of all the electors in a country or given area taken on some specific question. The most familiar example of the use of the plebiscite in French history was in 1852, when the coup *d'état* of 1851 was confirmed and the title of emperor was given to Napolean III. Its essential characteristic, as distinguished from the referendum (*q.v.*), is this:—A plebiscitary vote decides a specific question, ad *hoc* and pro *hac* vice. It is not, as in the case of the referendum, a normal method or procedure of voting applied on a general system to certain classes of legislation. It is sometimes used in England to decide questions of municipal rates or other local questions, and extensively in the Dominions and the United States on certain local or State questions. In Europe its use has been almost wholly political and national.

In that sense it is a method of ascertaining the general desire of the inhabitants of a given territory or area. As a means of settling the destination of populations and territories, this method was first used in the French Revolution to defend the wholesale annexations of territory made by the conquering French Republic, and subsequently by Napoleon I. It was revived by Napoleon III. and applied (successfully for him) in the case of Nice and Savoy, and (successfully for Victor Emmanuel) in the duchies of north Italy during the years 1859–60.

The Peace Conference of 1919 proposed the taking of 17 plebiscites to settle difficult national questions of which eight were actually held. Of these the Turkish plebiscite in Transcaucasia was a farce. Others, which decided the fate of Allenstein Marienwerder, of the Burgenland, of Klagenfurt, the economic destiny of Luxembourg, the attribution of the northern and southern zones of Slesvig, and the partition of Upper Silesia had substantial and important results, which are noted elsewhere under the individual articles, The Versailles Treaty provided for a plebiscite of the Saar district in 1935 to decide the future of the region.

BIBLIOGRAPHY.—H. W. V. Temperley, ed., *A History of the Peace Conference of Paris* (1920); references in Subject Index to vol. vi., 703; *Plebiscites* in Historical Section of Foreign Office Peace Handbooks; Sarah Wambaugh, *A Monograph on Plebiscites*, Carnegie Endowment for International Peace (1920); Sarah Wambaugh, *La Pratique des Plébiscites*, Recueil des Cours de l'Academie de Droit International; F. Llewellyn Jones, *Plebiscites*, Grotius Society Transactions (1927).

PLEBS, the "multitude," or unprivileged class in the early Roman state (from the root *pleo*, seen in Latin *plenus*, fill; cf. Gr. πλῆθος). For the origin and history of this order see PATRICIANS. Its disqualifications were originally based on descent, but after the political equalization of the two orders these ceased.

PLECOPTERA (Gr. πλέκος plaited, and πτερόν, a wing) is that order of insects which comprises the stone-flies: by some authorities they are termed Perlaria from *Perla*, the principal genus. Stone-flies are dull coloured insects, either black, brown or grey, or in some species green. They are poor fliers and do not wander far from water where their early stages are passed. Their habitation is the margins of streams and lakes, especially in hilly or rocky districts and they are usually found resting on stones, palings or tree-trunks, or crawling about over stones or plants: the green forms frequent bushes or other herbage and are difficult to detect. Fewer than 500 species are known and these are classified into seven families: about 30 species inhabit the British Isles and a considerably larger number is found in the United States. The richest fauna is found in the southern hemisphere and the earliest forms are confined to the Australian region and Chile.

Stone-flies are soft-bodied insects with long thread-like antennae: the wings are membranous, folded flat over the back in repose and the hind pair is usually the largest with a plicated posterior lobe. The mouth-parts are weak and of the biting type, the tarsi are three-jointed and the body is generally terminated by long, many-jointed tail-feelers. These insects derive their name from the fact that their nymphs are often common beneath stones in the beds of streams. The females discharge their eggs in masses into the water: metamorphosis is incomplete and the nymphs only occur in clear, unfouled streams or lakes, not in stagnant water. Some are carnivorous, while others feed upon organic particles of various kinds. In form they resemble the perfect insects very closely except for the absence of wings: they are provided with lateral tufts of abdominal tracheal gills or with a terminal group of these organs around the anus. When fully grown the nymph crawls out of the water and the imago emerges. A few Plecoptera in the fossil condition are met with in the Upper Jurassic rocks of Europe, and in the Lower Permian of Kansas.

The nymphs serve as food for certain fishes, such as trout, and are in that respect valuable. The species Taeniopteryx *pacifica,* has been recorded as damaging the buds of fruit trees in Washington State.

Further information on these insects will be found in works on aquatic insects (see INSECTS), while for the British species see papers by K. J. Morton in Trans. *Entomological Soc.* London (1894, 1896). The North American species are dealt with by J. G. Needham and C. P. Claassen, The Plecoptera or Stone-Flies of North America (1925), and for the general classification of the order see R. J. Tillyard, Canadian *Entom.* (vol. liii., 1921). (A. D. I.)

PLECTRUM, a small contrivance, made of metal, wood or some other suitable material, and used as a substitute for the finger in plucking the strings of musical instruments. In ancient times the strings of the lyre were sometimes so plucked, while later the lute was similarly played, as are the mandolin and zither to-day; the same term being applied also to the quills and bristles of the harpsichord and spinet.

PLEDGE or **PAWN,** in law, a "bailment of goods by a debtor to his creditor to be kept till the debt is discharged" (Jones on Bailments). The term is also used to denote the property which constitutes the security. Pledge is the *pignus* of Roman law from which most of the modern law on the subject is derived. It differs from hypothecation and from the more usual kind of mortgage in being confined to personal property, and also in that the pledge is in the possession of the pledgee. A mortgage of personal property, in the majority of instances, takes the name and form of a bill of sale (*q.v.*). In the case of a pledge, it is held that a special property passes to the pledgee, sufficient to enable him to maintain an action against a wrongdoer, but the general property, *i.e.,* the property subject to the pledge, remains in the pledgor. As the pledge is for the benefit of both parties, the pledgee is bound to exercise only ordinary care over the pledge. He must, however, insure against loss by fire (35/36 Vict. ch. 93, s.36). The pledgee has the right of selling the pledge if the pledgor makes default in payment at the stipulated time.

The law of Scotland as to pledge generally agrees with that of England, as does also that of the United States. The main difference is that in Scotland and in Louisiana a pledge cannot be sold unless with judicial authority. Chattel mortgages, which differ from pledges in that the owner retains possession of the article, are uniformly required to be recorded in order to be valid against third parties, but except for a few States and aside from the Factors acts, a pledge, for the validity of which possession must be transferred to the pledgee, will be enforcible against third parties without being recorded. (See also FACTORS and PAWNBROKING.)

PLEHVE, VIATSCHESLAF KONSTANTINOVICH (1846–1904), Russian statesman, was born of Lithuanian stock in 1846. He was educated at Warsaw and at the university of St. Petersburg (Leningrad) before he entered the department of justice, in which he rose rapidly to be assistant solicitor-general in Warsaw, then solicitor-general in St. Petersburg, and in 1881 director of the state police. As assistant to the minister of the interior he attracted the attention of Alexander III. by the skill he showed in investigating the circumstances of the assassination of Alexander II. He received the title of secretary of state in 1894, became a member of the council of the empire, and in 1902 succeeded Sipiaguine as minister of the interior. Plehve carried out the "russification" of the alien provinces within the Russian Empire, and earned bitter hatred in Poland, in Lithuania and especially in Finland. He despoiled the Armenian Church, and oppressed the Armenians of the Caucasus. He certainly did nothing to discourage pogroms against the Jews, and he was credited with being accessory to the Kishinev massacres. His logical mind and determined support of the autocratic principle gained the tsar's entire confidence. He opposed commercial development on ordinary European lines on the ground that it involved the existence both of a dangerous proletariat and of a prosperous middle class equally inimical to autocracy. He was a determined and successful opponent of Witte's policy. An attempt was made on his life early in 1904, and he was assassinated on July 28 of the same year by a bomb thrown under his carriage as he was on his way to Peterhof to make his report to the tsar; the assassin, Sasonov, was a member of the socialist revolutionary party.

PLEIAD, in Greek literature, the name given (by analogy from PLEIADES) by the Alexandrian critics to seven tragic poets who flourished during the reign of Ptolemy Philadelphus (285–247 B.C.). In French literature, in addition to the Pleiad of Charlemagne, there were two famous groups of the kind. The first, during the reign of Henri III. (1574–89), the chief member of which was Pierre de Ronsard, sought to improve the French language and literature by enthusiastic imitation of the classics; the second, under Louis XIII. (1610–43), consisted of authors who excelled in the composition of Latin verse.

PLEIADES, the constellation so called is in mythology the seven daughters of Atlas and Pleïone, and sisters of the Hyades. Owing to their grief at the death of their sisters or at the sufferings of their father, they were changed into stars. In another account, the Pleiades and their mother met the amorous hunter Orion (*q.v.*) in Boeotia; for five years he pursued them through the woods, until Zeus translated them all—Pleïone and her daughters, Orion and his dog—to the sky. This is one of the few myths really astronomical in origin, for it is based on the relative positions of the constellations in the sky. The names of the sisters are Alcyone, Asterope, Electra, Kelaine, Maia, Merope, and Taygete (Hesiod fr. 275 Rzach); one is always dim or invisible, because she is Electra mourning for Troy, or Merope, who is ashamed of having wedded a mortal, Sisyphus. All the Pleiades became the ancestresses of divine or heroic families. The spring rising and early winter setting of the Pleiades (Lat. *Vergiliae*) are important dates to the farmer.

See H. J. Rose, Handbook of Greek Mythology (1928).

The stars are situated in the constellation Taurus. They are supposed to be referred to in the Old Testament (Job ix. 9, xxxviii. 31). The brightest star is Alcyone (3rd magnitude); Pleïone and Atlas are also of the 3rd magnitude. This group is physically connected, being distinguished from the background stars by community of proper motion. Photographs show a faint nebulosity filling the whole region; there is little doubt that this is rarefied matter made luminous by stimulation of the radiation of the hot stars comprised in it. The distance of the Pleiades is estimated at 100 parsecs (300 light-years), but is not very certainly known. Alcyone and the other bright stars are of the hottest type of spectrum (Type B), and give out several hundred times as much light as the sun.

PLEISTOCENE (Gr. *πλεῖστον*, most, and *καινός*, recent), in geology the epoch which succeeded the Pliocene. The Pliocene is now usually considered the last of the Tertiary period and hence the Pleistocene forms the lower subdivision of the Quaternary era. The period saw the arrival of the great Ice age (see GLACIAL

PERIOD) and the Pleistocene and Glacial period are sometimes used as if synonymous. The general geology of the period is considered under QUATERNARY.

PLEKHANOV, GEORGY VALENTINOVITCH (N. BELTMAN) (1857–1918), the founder and for many years the chief exponent of Russian philosophic Marxism, was born on Nov. 26, 1857, in the province of Tambov, of an old noble family. His father wished him to enter the army, but while a student he joined the Narodnist (populist) revolutionary movement. In 1876 he led the first great popular demonstration at St. Petersburg (Leningrad) in the Kazansky square. When the majority section of the Narodnists adopted terrorist methods in 1879, Plekhanov seceded, and with Deutsch, Axelrod, Vera Sassulitch and Ignatov, formed the Marxist "Liberation of Labour" group in Geneva (1883). He spent 40 years in exile, chiefly at Geneva, from which town he became the intellectual leader of the Russian Social-Democratic movement, in particular playing a large part in Lenin's early mental development. In the '90s and the early years of the 20th century the two men were closely associated. In Dec. 1900 was founded the S.D. journal Iskra (The Spark) of which Plekhanov was joint editor with Lenin, Martov, and others. In the first split of the Russian S.D. Party in 1903 Plekhanov was largely on the side of the Bolsheviks, holding views closely akin to those of Lenin.

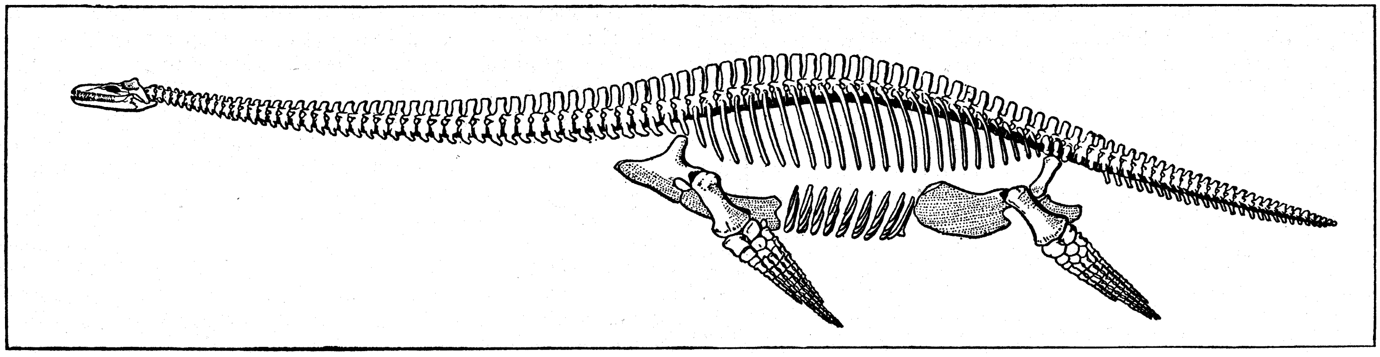
After the resignation of the Mensheviks from editorship of the Zskra Plekhanov and Lenin were joint editors, but some months later differences arose between them on the question of collaboration with the Mensheviks, and Lenin resigned. Thenceforth for several years Plekhanov worked with the Menshevik section of the party, but after 1907, while remaining a Menshevik, he took up an attitude on many issues, particularly on the question of participation in the State Duma and also on illegal activities, in agreement with that of the Bolsheviks. At the end of 1910 he again co-operated with the latter in contributing to the Bolshevik *Zviezda* (The Star) but the alliance did not last long, and when the war broke out in 1914 Plekhanov was foremost in advocacy of the principle of "revolutionary defence" of the country against the Bolshevik policy of working for the defeat of the Government. After the March revolution he returned to Russia and was invited to join the Provisional Government. He refused, but actively supported the Government against the Bolsheviks, and remained an opponent of the Bolshevik revolution until his death in Finland on May 30, 1918.

Plekhanov had an enormous influence on the development of the Socialist movement in Russia. The Moscow Marx-Engels Institute has published a complete edition of his works in 26 volumes. His biggest work is available in German: *Beiträge zur* Geschichfe des *Materialismus*.

PLENER, ERNST, FREIHERR VON (1841–1923), Austrian politician, was born on Oct. 18, 1841, at Cheb in Bohemia, the son of the Austrian statesman Ignaz von Plener (1810–1908). From 1888 onwards he was the acknowledged head of the German Liberals in their struggles against the Slav-Conservative majority in the Chamber. Consequently he represented Germanism on the nationalities question, but was not averse to concessions compatible with the maintenance throughout the whole monarchy of the position due to the German Austrians. He sought to compromise the quarrel between Germans and Czechs, and the so-called "points" of 1890, a summary of the bases for a German-Czech understanding, were essentially his work. In the Windischgratz Coalition Ministry (1893–5), Plener took over the portfolio of Finance. Soon after his retirement from the Finance Ministry, Plener was appointed president of the Supreme Audit Department (Oberster *Rechnungshof*). He entered the Upper House in 1900, and died on May 1, 1923.

Plener wrote a series of economic and political works, among others *Die englische Fabriksgesetzgebung* (1871); *Englische Baugenossenschaften* (1873). He published *Erinnerungen,* 3 vol. (1911–21).

PLESIOSAURUS, technically the name of a genus of extinct reptiles of the group Sauropterygia; it is commonly used to apply to all the later members of that group. The typical plesiosaurs are completely adapted for a marine existence in the open sea.



FROM THE "CATALOGUE OF MARINE REPTILES OF THE OXFORD CLAY"

SKELETON OF MURAENOSAURUS, A LONG NECKED PLESIOSAUR. FROM THE OXFORD CLAY OF PETERBOROUGH, ENGLAND

They first appear in the Rhaetic and are last seen in the Upper Cretaceous. A typical plesiosaur has a small head with a large mouth and slender pointed teeth adapted to the catching of fish. The neck is long, often four times as long as the head. The body is relatively short, as is the tail. All four limbs are converted into paddles, no external trace of the fingers being visible.

From these forms two main evolutionary lines appeared. In one, the animals adopted the habit of living on large prey which they captured by their superior speed; in this line the head grew bigger and the neck shorter until it became no longer than the head. The body is comparatively long, the tail little more than the pointed hinder extremity of the body. The paddles become very large indeed, the hinder pair being bigger than the front ones. The largest members of this group are the plesiosaurs from the European Jurassic. In them the skull may be'nearly 6 ft. in length and an individual tooth a foot long. In an animal whose head was just under 5 ft. in length the whole creature had a length of some 16 ft., and the hind paddles were about 5 ft. long.

The other line consists of animals which fed on small quick-moving prey which they seem to have captured by sudden lateral movements of the head and neck. Its most recent member, *Elasmosaurus,* is found in the Upper Cretaceous of Kansas, England, Queensland and New Zealand. In it the head is about 18 in. in length, the neck with as many as 76 vertebrae may reach a length of 19 ft., and the total length of the animal about 30 ft. The paddles of such an animal were about 3 ft. in length. Some plesiosaurs had the interesting habit of eating pebbles which were kept in the stomach to assist in grinding up food. Although the majority of plesiosaurs were marine, some few are always found in estuaries or freshwater deposits. See REPTILES.

(D. M. S. W.)

PLEURISY or **PLEURITIS.** A medical term for inflammation and the effects of inflammation affecting the pleura (see COELOM AND SEROUS MEMBRANES). Pleurisy may be induced mechanically, *e.g.,* by a blow, but more commonly is the result of microbial infection whether conveyed directly by the blood (as in scarlatina) or extending to the serous membranes from an inflammatory focus in the lung or adjacent part.

The condition may be acute or chronic. In acute pleurisy the normal glistening appearance of the serous membrane is lost, it becomes injected with blood, roughened from the deposition of fibrin from the serum that exudes from the dilated and inflamed blood vessels and so long as the two surfaces are in contact occasions much pain from friction during respiration. The amount of serum poured out into the pleural cavity and the amount of fibrin formed vary within wide limits. The fluid may accumulate to such an extent that there is bulging outwards of the intercostal spaces and the lung is rendered airless and compressed at the back of the pleural cavity close to the vertebral column. The fibrin may form a thick white felty layer over the entire lung.

The subsequent history of a pleurisy varies. If the effusion of fluid causes respiratory or cardiac distress surgical removal (thoracentesis) of a portion of the fluid is necessary; lymphatic and venous drainage are effective in removing the remainder. There may then be complete recovery, the compressed lung resuming its function if it has not been left compressed too long. In other cases fibrous adhesions, formed by the same process as that which leads to scar tissue (see PATHOLOGY) bind the two layers of the pleura together over a greater or less extent of their surface. The condition is then one of chronic pleurisy and recrudescences of inflammation with local pain and effusion of fluid may occur. If the pleurisy arise by extension from a pulmonary, diaphragmatic, costal or pericardial focus of disease its character is determined by that of the primary focus. If tuberculous, tuberculous nodules are found in the thickened material covering and replacing the normal serous membrane; if malignant disease the nodules are cancerous and the fluid often contains many red blood cells; while if the primary focus be that form of pneumonia which is caused by the pneumococcus and is characterized by the local output of numerous leucocytes, the pleurisy will be similar and frequently purulent (see EMPYEMA).

The symptoms and signs of pleurisy present difficulty. Where the patient complains of a sharp pain in the side especially on drawing a deep breath, the normal resonant note on percussion of the chest is replaced by a dead, dull note, the breath sounds are barely audible and the ear applied to the chest detects a rubbing sound, a diagnosis of pleurisy is easy. But the relative infrequency of these phenomena and the very great frequency with which pleural adhesions, often of wide extent, are found in the post-mortem room without the slightest indication that the patient during life complained of symptoms such as the appearances would seem to suggest, indicate that pleurisy is often symptomless. The inference is that pleurisy is very common, but comparatively rarely calls for medical or surgical treatment.

Treatment. — In many cases strapping of the affected side to limit movement is sufficient; where effusion becomes purulent and thoracentesis will be insufficient, a wide opening into the pleural cavity with removal of portions of one or more ribs to provide drainage becomes necessary. (W. S. L.-B.)

PLEURONECTIDAE, the family of fishes to which the name "flat-fish" is popularly applied. It includes the sole, flounder, turbot and plaice (*qq.v.*). (See FISHES.)

PLEURO-PNEUMONIA or **LUNG-PLAGUE,** a contagious disease peculiar to the bovine species generally affecting the lungs and pleura, producing a particular form of lobar or lobular pleuro-pneumonia, and, in the majority of cases, transmitted by the living diseased animal, or, exceptionally, by mediate contagion. Cattle and closely allied species are susceptible; other animals and man are immune. Inoculation of healthy cattle with the fluid from the diseased lungs produces, after a certain interval, characteristic changes at the seat of inoculation, and though the inoculated animal does not develop the lung lesions always observed in natural infection, yet there is a local anatomical similarity or identity. In 1888 Arloing, of Lyons, described various bacilli obtained from the lesions of lung-plague. The cause is now held to be a polymorphic micro-organism capable of passing through ordinary bacterial filters. With a high magnification, coccal-like bodies, vibrios, short spirilla, branching and asteroid bodies, also mycelioid moulds may be seen. Fine mucin coverings are always present and for the latter reason the name Asterococcus mycoides was formulated by Borrel.

The earliest notices of this disease testify that it first prevailed in Central Europe, and in the 18th century it was present in certain parts of Southern Germany, Switzerland and France, and had also appeared in upper Italy. In 1769 it was definitely described as prevailing in Franche-Comté by the name of "murie." From that date down to 1789 it appears to have remained more or less limited to the Swiss mountains, the Jura, Dauphiné and Vosges, Piedmont and upper Silesia; it showed itself in Champagne and Bourbonnais about the time of the Revolution, when its spread was greatly accelerated by the wars that followed. In the 19th century its diffusion was accurately determined. It invaded Prussia in 1802, and soon spread over north Germany. It was first described as existing in Russia in 1824; it reached Belgium in 1827, Holland in 1833, the United Kingdom in 1841, Sweden in 1847, Denmark in 1848, Finland in 1850, South Africa in 1854, the United States — Brooklyn in 1843, New Jersey in 1847, Brooklyn again in 1850, and Boston in 1850; it was also carried to Melbourne in 1858, and to New South Wales in 1860; New Zealand and Tasmania in 1864; and also into Asia Minor. During the 20th century it has occurred in Asia, Africa, Australia, South America, Russia, Germany, France and Spain.

It has now been eradicated, or the incidence very much reduced, in most countries by compulsory slaughter and veterinary police measures. Great Britain has been free since 1898.

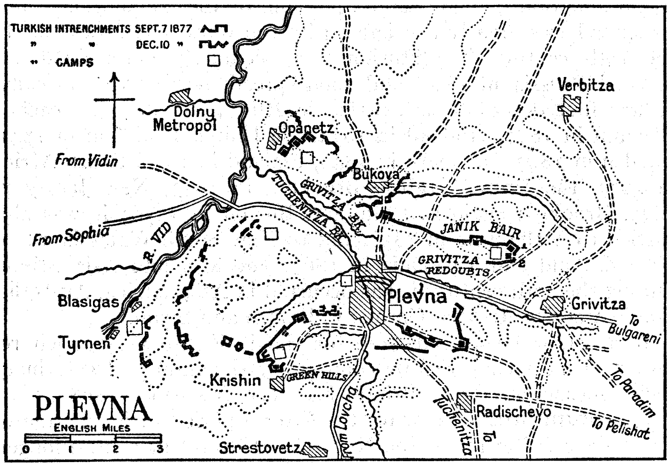
Symptoms and Treatment. — After a period of incubation of 12–16 days (after inhalation Nocard and Roux) or a little longer, loss of appetite and fever are apparent, accompanied by a dry, painful cough, which later becomes more frequent and moister. Pulse and respiration are accelerated with the customary signs of acute pulmonary disease. Generally the disease persists for some weeks before death supervenes, or apparent recovery ensues, with a later recrudescence of symptoms. High temperature with death in a few days is less common. Recovered cases should be regarded with suspicion.

Willems of Hasselt (Belgium) 1852 introduced protective inoculation, employing lymph obtained from a diseased lung; since that date the protective value has been proved in the field. Not entirely free of danger, the method appears to confer a temporary immunity. The inoculation is made in the extremity of the tail. In France, Nocard and Roux have used as a vaccine, an eight days' old culture of the virus in Martin's broth. Injected in the same manner, the method has given good results. An anti-serum, capable of conferring a passive immunity, has also been prepared. The disease is scheduled in Great Britain under the Diseases of Animals Act. (A. R. S.)

PLEVNA (Bulgarian Pleven), a city in Bulgaria; on the Tutchinitza, and Sofia-Varna railway (opened in 1899). Pop. (1934) 31,520. A branch line, 25 m. long, connects Plevna with Samovit on the Danube, where a port has been formed. After the events of 1877, it was almost entirely forsaken by the Turks, and most of the mosques have gone to ruin; but, peopled now mainly by Bulgarians, it has quite recovered its prosperity, and has a large commerce in cattle and wine (see Russo-TURKISH WARS).

Plevna, a small and unknown town without fortifications, became celebrated as the scene of Osman Pasha's exploits. He left Widin on July 13 with a column consisting of some 12,000 men and 54 guns. Hearing that he was too late to relieve Nikopol, he pushed on to Plevna, where there was a small garrison and on July 19 he took up a position on the bare hills to the north and east. He was none too soon. General Schilder-Schuldner, commanding the 5th division of the IX. corps, which had just captured Nikopol, had been ordered to occupy Plevna, and his guns were already in action. On July 20, having made no preliminary reconnaissance, the Russian commander advanced his infantry in four separate columns. On the north flank they pressed into Bukova, and also succeeded in driving back the Turkish right wing; but in both cases Turkish counter-attacks pressed back the Russians, with the result that by noon they were in full retreat, having lost 2,800 men out of a total of 8,000. The Turks lost 2,000. Osman at once drew up plans for the fortification of the position and the troops were employed night and day constructing redoubts and entrenchments. In order to secure his line of communications, he occupied Lovcha (Lovatz). The Plevna garrison had now been reinforced to 20,000. Trenches were 4 ft. deep and the redoubts had a command of 10 to 16 ft., with parapets about 14 ft. thick. There were in some cases two lines of trench to the front, thus giving three tiers of fire.

Second Battle **of Plevna.**—In accordance with orders from the Russian headquarters at Tirnova, a fresh attack was made by



MAP OF PLEVNA SHOWING TURKISH ENTRENCHMENTS DURING THE FIVE-MONTHS DEFENCE OF THE TOWN BY OSMAN PASHA AGAINST THE RUSSIANS IN 1877

Kriidener on July 30. He had been reinforced and his force numbered nearly 40,000 with 176 guns. After a preliminary cannonade the infantry advanced at 3 P.M., as before in widely spread columns. The columns attacking from the north and north-east were repulsed with heavy loss. Shakovskoi temporarily occupied two redoubts, but a counter-stroke by the Turkish reserves forced him back. The Russians retreated, their losses amounting to 7,300, while the Turkish losses exceeded 2,000. The victory was decisive, but Osman again failed to pursue. His troops were elated by success, the moral of the enemy severely shaken, the undefended Russian bridge over the Danube was within 40 m. of him, but he lost his opportunity, and contented himself with strengthening his defensive works. It is said that he was tied down to Plevna by orders from Constantinople.

The Russians now concentrated all their available forces against Plevna and called in the aid of the Rumanians. By the end of August they had assembled a force of 74,000 infantry, 10,000 cavalry and 440 guns. On August 30 Osman moved out of Plevna, and on the 31st attacked the Russians about Pelishat. He returned to Plevna the same evening. The Turks lost 1,300 and the Russians 1,000 men. The Russians determined to occupy Lovcha, and so cut Osman's communications before again attacking Plevna. After three days' fighting this was accomplished by Skobelev, acting under Imeretinski, with a force of 20,000 men, on September 3. Osman moved out to the relief of the garrison that day with a strong column, but, finding he was too late, returned to Plevna on the 6th. The survivors from Lovcha were re-formed into 3 battalions, including which Osman had been reinforced to a strength of over 30,000, with 72 guns.

Third Battle of **Plevna.**—The Russians moved to their preliminary positions on the night of September 6–7. Their plan was to attack the north-east, south-east and south fronts simultaneously. An artillery bombardment began at 6 A.M. on September 7, and was carried on till 3 P.M. on the 11th, when the infantry advanced. The Rumanians took one Grivitza redoubt; Skobelev occupied two redoubts on the south front, but the centre attack on the Radischevo front failed. On the 12th the Turks recaptured the southern redoubts, the Rumanians remained in possession of the Grivitza redoubt, but the Russian losses already amounted to 18,000 and they withdrew, and entrenched themselves on a line Verbitza-Radischevo. with cavalry on either flank to the Vid. The Turkish losses totalled 5,000, of which only a few hundred were caused by the artillery fire of the first few days. There was no question of pursuit. The Russians were greatly superior in numbers and the Turks were completely exhausted.

Investment and Fall of **Plevna.**—This was the last open-force attack on Osman's lines. General Todleben, the defender of Sevastopol, was now entrusted with the conduct of the siege, and he determined to complete the investment, which was accomplished by October 24, Osman's request to retire from Plevna having been refused by Constantinople. Supplies eventually gave out and a sortie on the night of Dec. 9–10 failed, with the result that he and his army capitulated.

Plevna is a striking example of the futility of the purely passive defence, which is doomed to failure however tenaciously carried out. Osman Pasha repelled three Russian attacks and practically held the whole Russian army. It remained for the other Turkish forces in the field to take the offensive and by a vigorous counter-stroke to reap the fruits of his successes. Victories which are not followed up are useless. (J. H. V. C.)

See W. V. Herbert, *The Defence of Plevna, 1877* (London, 1895); F. V. Greene, *The Russian Army and its Campaign in Turkey* (London, 1880); General Kuropatkin (Ger. trans. by Krahiner), *Kritische Rückblicke auf den russisch-türkischen Krieg;* Mouzaffer Pacha and Talaat Bey, *Dtfense de Plevna;* Krahmer's German translation of the Russian Official History; General H. Langlois, *Lessons of Two Recent Wars* (Eng. trans., War Office, 1910); Th. von Trotha, *Kampf um Plewnu* (Berlin, 1878); Vacaresco (Ger. trans.), *Rumaniens Antheil am Kriege, 1877–1878* (Leipzig, 1888).

PLEYEL, IGNAZ JOSEPH (1757–1831), Austrian musician, was born at Ruppersthal, near Vienna, on June 1, 1757, the 24th son of a poor village schoolmaster. He studied the pianoforte under Van Hal (known in England as Vanhall), and in 1772 learned composition from Haydn, who became his dearest friend. He was appointed temporary *maître* de *chapelle* at Strasbourg in 1783, receiving a permanent appointment to the office in 1789. In 1791 he paid a successful visit to London. He narrowly escaped the guillotine on returning to Strasbourg, and was only saved by the existence of a cantata which he had written, and in which the inspiration could fairly be claimed to be on the side of liberty; so that he was permitted to remain until 1795, when he migrated to Paris. Here he opened a large music shop, published the first complete edition of Haydn's quartets, and founded, in 1807, the pianoforte manufactory which still bears his name. The latter years of his life were spent in agricultural pursuits. He died on Nov. 14, 1831, in Paris.

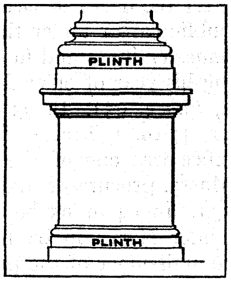
PLIEKSANS, JAN (1865–1929), Latvian poet and dramatist, was born on Sept. 12, 1865, at Tadenava in the district of Illulrst, Courland. He adopted the pen name of József Rainis. He was educated at the Riga gymnasium, and from 1884 to 1888 studied law at St. Petersburg (Leningrad). He then practised as a barrister at Mitau, Courland. From 1891 to 1895 he edited in Riga a democratic Latvian paper, Dienas *Lapa* (Daily Paper). He was arrested by the Russian Government on political grounds and remained in exile, first at Pskov and then at Viatka, until 1903. He may be considered the chief exponent of democracy in Latvian poetry. He translated plays from Shakespeare, Goethe and Schiller. His principal historical tragedies are Uguns *un* nakts (Fire and night), *Put vejini* (Blow *breeze*) and Daugava (The Dvina). The *Sons* of *Jacob* has been translated into English, and was produced on May 22, 1925, at the New Scala theatre, London, by the International Theatre Society. For several years he was director of the Latvian National Theatre, and in 1920 became member of the Latvian Saeima (parliament).

PLIMER, ANDREW (c. 1763–1837), English miniature painter, was the son of a clock-maker at Wellington. With his brother Nathaniel (1757–*c.* 1822) he joined a party of gipsies and wandered about with them, eventually reaching London, where in 1781 he was engaged by Mrs. Cosway as studio boy. Cosway sent him to a friend to learn drawing, and then received him into his own studio. In 1785 he set up lor himself in Great Maddox Street. He exhibited many times in the Royal Academy, resided ior a while in Exeter and travelled a good deal through England. He died at Brighton in 1837 and was buried at Hove His miniatures are of great brilliance and are in considerable demand among collectors. They are to he distinguished by the peculiar wiry-treatment of the hair and by the large full expressive eyes which Plimer invariably gave to his female sitters, eyes resembling those of his own wife and daughters. *See* G. C. Williamson, *Andrew and Nathaniel Plimer* (1903). (G. C. W.)

PLIMSOLL, SAMUEL (1824–1898), British politician and social reformer, was born at Bristol on Feb. 10, 1824. His efforts for reform were directed more especially against "coffinships" — unseaworthy and overloaded vessels, often heavily insured, in which unscrupulous owners risked the lives of their crews. Plimsoll entered parliament as Liberal member for Derby in 1868, and failing to pass a bill dealing with the subject, he published a work entitled *Our Seamen* (1872), which made a great impression throughout the country. On Plimsoll's motion in 1873, a royal commission was appointed, and in 1875 a government bill was introduced, which Plimsoll, though regarding it as inadequate, resolved to accept. On July 22, when Disraeli, announced that the bill would be dropped, Plimsoll lost his self-control, applied the term "villains" to members of the house, and shook his fist in the Speaker's face.

Eventually Piimsoli apologised, but the country shared his view that the bill had been stifled by the pressure of the shipowners, and the popular agitation forced the government to pass a bill, which in the following year was amended into the Merchant Shipping Act. This gave stringent powers of inspection to the Board of Trade. The mark that indicates the limit to which a ship may be loaded is generally known as Plimsoll's mark. Plimsoll was re-elected for Derby at the general election of 1880, but gave up his seat to Sir W. Harcourt, in the belief that the latter, as home secretary, could advance the sailors' interests more effectively than any private member. Later on Plimsoll was estranged from the Liberal leaders by what he regarded as their breach of faith in neglecting the question of shipping reform. He became president of the Sailors' and Firemen's Union, and raised a further agitation about the horrors of the cattle-ships. Later he visited the United States with the object, in which he did good service, of securing the adoption of a less bitter tone towards England in the historical textbooks used in American schools. He died at Folkestone on June 3, 1898.

PLINTH, in architecture, the lowest member of a classic base, also any rectangular block on which a statue or vase is placed. In a pedestal or podium the plinth is the lowest member, and usually consists of a projecting, continuous block above which are the base mouldings. *(See* ORDER.)



PLINY THE ELDER (GAIUS PLINIUS SECUNDUS) (*c.* A.D. 23–79), Roman polymath, was born at Novum Comum (Como), in Transpadane Gaul, on which ground he claims Catullus, a native of Verona in the same region, as a fellow countryman *(N.H. praef.* I., *Catullum conterraneum meum*). The date of his birth is fixed as A D. 23 or 24 (Plin. *Epp. III.* 5,7). He must have come to Rome at an early age (N.H. *XXXVII.* 81). He practised for some time as an advocate (Plin. *Epp. 111.* 5, 7, *aliquamdiu causas actitasse).* He saw military service in various parts of the world, Germany, Spain, Gaul. Under Vespasian, with whom he was on the most intimate terms (Plin. *Epp. III.,* 5, 9), he served as *procurator* in Gallia Narbonensis (A.D. 70) and Hispania Tarraconensis (A.D. 73). At some time — the date is not known—he was in Africa (N.H. *VII.* 36. *"I* myself saw in Africa," etc., *cf. XVII.,* 41, *XXV.* 123). Frnally Vespasian appointed him praefect of the Roman fleet at Misenum, in Campania, which Augustus had made one of the principal Roman naval stations (Sueton. *Aug.* 49). He was stationed at Misenum when on Aug. 24, A.D. 79 there occurred the great eruption of Vesuvius which overwhelmed Herculaneum and Pompeii and incidentally cost Pliny his life. The circumstances are vividly told in a letter of the younger Pliny to the historian Tacitus (Plin. *Epp.* VZ. 16). Surveying the eruption from a ship, Pliny took refuge with his friend Pompeianus at Stabiae (Castellamare) on the southern shore of the Bay of Naples. There, in order to allay the fears of his friends, he dined, as his nephew says "cheerfully, or what was equally splendid, with a pretence of cheerfulness," and then retired to rest. In the middle of the night, when stones and ashes were already falling about the house and the house itself was rocking alarmingly, he was roused by his friends and the party determined to seek safety in the open, binding pillows about their heads as a protection against falling debris. "Now it was day elsewhere," to use his nephew's words, "but there night darker and denser than any night, alleviated a little by numerous torches and lights of various sorts. It was decided to go out upon the shore and see at close quarters whether the sea now offered any prospect of safety; it still continued wild and adverse. There Pliny lay down upon a cast-off linen cloth, and once and again he asked for cold water, which he drank. Then flames and a smell of sulphur announcing the approach of flames, caused the others to take to flight and roused him. Supported by two slaves he got upon his feet, but immediately collapsed, his breathing, I gather, being obstructed by'the thickening vapour which closed up his throat — naturally weak and narrow and frequently inflamed. When day returned — the third (in English reckoning the second, *i.e.,* Aug. 26) after the last day (Aug. 24) that he had seen—his body was found intact and uninjured, covered as he had been dressed. The appearance of the body suggested one sleeping rather than dead."

A list of Pliny's writings is given in a letter by his nephew, (Plin. *Epp. 111.* 5) as follows: 1. *De iaculatione equestri* (On throwing the javelin from horse-back), "written while he was serving as commander of a cavalry regiment with equal ability and care." 2. *De vita Pomponi Secundi duo* (Life of Pomponius Secundus, in 2 books), "the discharge, as it were, of a debt due to the memory of a friend who had entertained a singular affection for him." This Pomponius, who is described by Tacitus *(Ann.* V. 8) as a man "of refined character and conspicuous ability" was a tragic poet who had also a military career of some distinction, cf. Plin. *N.H. XIV,* 56. 3. *Bellorum Germaniae viginti* (German Wars, in 20 books), "in which he brought together all the wars waged between us and Germany. He began the work while he was serving in Germany, being admonished by a dream. The ghost of Drusus Nero (stepson of Augustus who died in Germany in 9 B.C.) who, having carried his conquest of Germany to the widest extent, died there, stood by him as he slept and commended to him his memory and entreated him to vindicate him from the injustice of oblivion." This work is cited by Tacitus, *Ann. 1.* 69; Sueton. *Calig.* 8 and *Vita Plinii,* and was probably used by Tacitus in his *Germania.* 4. *Studiosi tres* (The Student, in 3 books) "in which he instructs and perfects the orator from the cradle up" *(cf.* Aul. Gell. *IX.* 16. *Plinius Secundus . . . libros reliquit quos studiosorum inscripsit,* Quintil *III.* 1.21). 5. *Dubii sermonis octo* (Dubious Language, in 8 books) "written in the last years of the reign of Nero when slavery had rendered dangerous every study of a free and elevated character," *cf.* Plin. *N.H.* praef. 22. Fragments of the treatise were edited by Beck, Leipzig 1894. 6. *A fine Aufidi Bassi triginta unus* (Continuation of the History of Aufidius Bassus, in 31 books). The History of Bassus seems to have ended with the reign of Claudius (cf. Quintil *X.* 1. 103, Tac. *Dial* 23, Seneca Epp. 30), and Pliny continued the story down to his own times. *Cf. N.H.* praef. 20. 7. *Historiae Naturalis* 37 (Natural History in 37 books). This work alone is extant (for fragments of Pliny's lost works cf. *Historicorum Romanorum Reliquiae,* coll. *H.* Peter, 2,109 ff.).

Pliny, the Younger, has given a description of the uncle's studious habits. He would call upon the Emperor Vespasian before daybreak and then after performing his official duties, return home and devote what time remained to study. After a light luncheon, if it were summer and he had leisure, he would lie in the sun while a book was read, annotated and extracts made: he never read a book without making extracts, holding that no book was so bad as not to contain something good. Next he had a cold bath, a snack, and a short siesta, after which, "as if it were another day," he studied till dinner-time. During dinner a book was read and notes made. He rose from the dinner table in summer before night-fall, in winter within the first hour of night. Thus at Rome; but in vacations no time was exempt from study, save bath-time, nay, even then, he had something read to him or he dictated something, while he dressed. When traveliing he was accompanied by a shorthand writer armed with book and notebook and in winter provided with gloves. To procure time for study he generally drove even in Rome and his nephew tells how he was once reproved by him for wasting valuable time in walking. When he died he bequeathed to his nephew 160 volumes of annotated selections (electorurn *commentarios*) "written on both sides and in the minutest hand," for which, when he was procurator in Spain (A.D. 73) and when the number of volumes was rather less, he had declined an offer from Largius Licinus of 400,000 sesterces.

The Natural History, which was dedicated to Titus, son of Vespasian and his successor as emperor, and of which the first ten books were probably published in A.D. 77, is, as we have seen, in 37 books. Bk. I. has a general preface and contains a table of contents of the other books, to each being appended a list of the authors consulted, the order of enumeration corresponding to the order in which they are utilised. These lists contain the names of 146 Latin and 327 foreign authors. Bk. II. is devoted to a mathematico-physical description of the world and deals with the heavenly bodies—sun, moon, planets, fixed stars; various meteorological phenomena; the succession of the seasons, the earth's shape and surface phenomena; seas, rivers, springs, and the like. The subject matter of this book affords Pliny an opportunity, of which he readily avails himself, to expound his own philosophic creed, which is a modified Stoicism. His view of nature is pantheistic (N.H. II. 1). Bks. III.–VI. are devoted to geography and ethnography. This is unscientific and uncritical but extremely valuable from the incidental facts which it presents. There is an interesting mention of a map of Armenia (N.H. VI. 40).

Books VII.–XI. are occupied with zoology and are the most generally interesting section. The seventh book deals with man and is occupied less with the normal than with the marvellous and portentous, which the scientific creed of the author and his belief in the infinite power of *ingeniosa* natura enabled him to accept or at least not forthwith to reject. Thus we have tales such as would have charmed the ear of Desdemona—of men whose feet were turned the wrong way, of the Mouthless Men (*Astomi*) who subsisted upon the mere fragrance of flower and fruit, of the Umbrella-foots (*Sciapodae*) who used their extensive feet by way of parasol to protect them from the sun; monstrous births; precocity or exceptional development of physical strength or speed, of sight or hearing, of mental powers; of men who were unconscionably long of dying. Incidently (c. 55) he declares his disbelief in immortality. The eighth book treats of terrestrial animals other than man. Here again, amid much that is interesting in detail, there is an unfortunate absence of scientific arrangement and an excessive proneness to accept the marvellous of which he was so unconscious that he expresses surprise at the credulity of the Greeks (N.H. VIII. c. 22 *mirum* est quo procedat Graeca credulitas). Hence side by side with sound science, mostly taken from Aristotle and, so far as concerns Africa, from Iuba, we have a host of imaginary animals—winged horses, unicorns, and the like monstrosities. Book IX. deals with aquatic animals and scientifically is the soundest of all the zoological books, which is no doubt due to the fact that his information is mainly derived from the History of *Animals* of Aristotle, who treats of aquatic animals with unusual fullness. The marvellous in this book is chiefly represented by his belief in Nereids and Tritons and the usual stories of the human sympathies of the dolphin. The tenth book treats of birds, commencing, according to Pliny's practice of beginning with the largest, with the ostrich. Such classifications as he makes of birds is of an empirical kind and based on very superficial observations. The first part of the eleventh book is occupied with insects—the bee being treated with some fullness—and the latter part with what may be called comparative anatomy. Books XII.–XIX. deal, generally speaking, with botany, including forestry and agriculture, the subject of Book XVIII., which is one of the most interesting in this section. Books XX.–XXVII. treat of medical botany or the medicines derived from plants. Books XXVIII.–XXXII. deal with other than botanical *materia medica, i.e.,* of medicines derived from the bodies of man and other land animals (XXXII.). The remaining books are occupied with what may be described roughly as mineralogy, *i.e.,* with metals and metallic products, the precious metals, gold and silver, being discussed in bk. XXXIII., bronze and bronze statuary in bk. XXXIV., painting in bk. XXXV., stone as used in building and sculpture in bk. XXXVI., gems and precious stones in bk. XXXVII.

The style of the *Natural* History gives an impression at once of affectation and of slovenliness which may in some degree be attributable to the condition of the text. On the Natural History was based the Collectanea *rerum memorabilium* of Julius Colinus (3rd cent. A.D.) and on Bks. XX.–XXXII. the *Medicina Plinii,* a compilation of the 4th century.

BIBLIOGRAPHY.—*Editio princeps,* Venice 1469. Editions (Paris, 1685); Franz (Leipzig, 1778–1791); Sillig with Index by O. Schneider (Gotha, 1853–55); von Jan (Leipzig, 1854–1865); Detlefson (Berlin, 1866–73); Mayhoff (Leipzig, 1906–08). Eng. trans. Philemon Holland (London, 1601); French, Littre (1855), German, Grosse (1781–88). *The Elder Pliny's Chapters on the History of Art,* trans. by Jex Blake, comment. by Sellers (London, 1896). On Pliny's authorities Munzer, *Beitrage zur Quellenkritik* (Berlin, 1897); on his *Cosmology,* Friese (Breslau, 1862); his *Botany,* Sprengel (Marburg, 1890); his *Mineralogy,* Nies (Mainz, 1884); his *History of Art, Brunn* (Munich, 1875); Munzer *Hermes* 30 (1895); Kalkmann (Berlin, 1898). (A. W. MA.)

PLINY THE YOUNGER (GAIUS PLINIUS CAECILIUS SECUNDUS) (A.D. 61 or 62–*c.* 113), Latin prose author, was born at Novum Comum (Como) in Cisalpine Gaul. The second son of L. Caecilius Cilo and Plinia, sister of the elder Pliny, he bore the name P. Caecilius Secundus until the death of his uncle (A.D. 79), who by his will made him his adopted son, when he assumed the name C. Plinius Caecilius Secundus. He was then in his 18th year (*Epp.* VI. 20. 5). Educated in rhetoric under Quintilian (*Epp.* II. 14. 9, VI. 6. 3), he made his debut as an advocate at the age of 18 (*Epp.* V. 8. 8).

Pliny was fortunate in having as guardian—doubtless under his father's will (*Epp.* II. 1. 8)—L. Verginius Rufus (A.D. 14–97), who had three times declined to become emperor (in Nero's lifetime, Dio 63. 25, after Nero's death, Plut. Galb. 10. Dio 64. 4, after the death of Otho, Plut. *Oth.* 18). He thus commenced his public career under the most favourable auspices. He became a quaestor in 89 and in 91 a tribune of the plebs, withdrawing during his year of office from practice at the bar (*Epp.* i. 23, vii. 16. 2, Paneg. 95). In 93 he became praetor (*Epp.* 111. 11. 2; VII. 11. 4; 16. 2, Tac. Agric. 6, 45; Juv. x. 36) and during his year of office was one of the counsel for the impeachment of Baebius Massa, procurator of Hispania Baetica (*Epp.* III. 4, VI. 29, VII. 33). In 94 or 95 he was appointed *praefectus* aerarii militaris. Under Nerva in 98 he became praefectus aerarii *Saturni* (*i.e.,* commissioner of the public treasury in the temple of Saturn). In September 100 he became consul, holding office for two months. His oration of thanks to Trajan for his nomination (*Epp.* III. 13. 1; 18. 1) is what is called in the mss. *Panegyricus* Traiano dictus. After acting as counsel for the defence of two ex-governors of Bithynia—Iulius Bassus and Varenus Rufus—he was himself appointed by Trajan, circ. 111 A.D., governor of that province. Whether he died in that office is not known, but the probable date of his death is 113, since in the Comum inscription Trajan is mentioned without the titles, conferred in 114, of *Optimus* and *Parthicus.* The inscription referred to was inscribed on a marble slab in the wall of the baths (thermae) presented by Pliny to Comum and commemorated that and other benefactions, including a library. The stone was removed to Milan and broken into six pieces. Four of these were built into a tomb in the church of St. Ambrose, and from the only one of these now known Mommsen, with the aid of other records, restored the inscription.

The extant works of Pliny are the Panegyric on *Trajan* already referred to (cf. *Epp.* III. 18), which is of some historical importance, the Letters in nine books, and a tenth book comprising his Correspondence *with Trajan.* Mommsen (*Zur Lebensgeschichte des jüngeren* Plinius, in Hermes 3, 1868), suggests as dates: Bk. I., A.D. 97; II., early in 100; III., 101 or 102; IV., early in 105; V., 106; VI., 106 or 107; VII., 107; VIII., 109; IX., perhaps at same time as VIII.; and *Correspondence with Trajan,* 111–113. Merrill has modified Mommsen's theory by the suggestion that the *Letters* were published in groups: I.–II. in 97 or 98, III.–VI. in 106, VII.–IX. in 108 or 109.

The interest attaching to letters selected and edited for publication, like those of Pliny, is wholly different from that of such a frank and unguarded correspondence as the letters of Cicero. There is in Pliny always a suggestion of pose, of self-consciousness and self-complacency. But the *Letters* are admirable examples of polished and pointed Latinity, while the range of subject and the quality of the persons to whom some of them are addressed render them of singular interest and attraction. As an example of his manner may be taken the letter (I. 21) which he writes on hearing of the death of the poet Martial, who had some time before retired from Rome to his native Bilbilis: "I hear that Valerius Martialis has gone, and I am sorry. He was a man able, acute, and keen: one in whose writing there was wit and pungency, yet not less candour. When he was leaving Rome I provided hi; travelling expenses, a tribute to friendship, a tribute also to the lines which he wrote about me. It was an old custom to reward with honours or money those who had written the praises of individuals or of cities: in our times, like other fair and excellent things, this also among the first has become obsolete: for since we ceased to do things worthy of praise, praise itself we account foolishness. You ask what are the lines for which I showed my gratitude? I would have referred you to the book itself [Martial, X., 19], were it not that I remember certain of them. He addresses the Muse, bids her seek my house on the Esquiline, approach it reverently:

> But beware nor in season unpropitious,
> Tipsy reveller, knock upon the door of
> Him who dedicates all his days to Pallas,
> While he cons for the hearing of the Hundred
> What posterity and the after ages
> May compare to the writings of Arpinum:
> Safer go when the lamps of eve are lighted:
> Thine the hour when the ruddy wine is flowing,
> On locks perfume-bedewed the roses glowing—
> Then stern Catos themselves might read my verses.

Did not he who wrote thus of me deserve that I should both speed him then, as I did, in friendliest fashion, and mourn him now, which I do, as a dear friend departed? For he gave me the best that he had to give and would have given me more had be been able. Yet what greater gift can be given to any man than glory and praise and immortality? But his writings will not be immortal? Perhaps not: but he wrote them as if they would be." Other letters of special interest are VI. 16, one of several addressed to the historian Tacitus which gives a vivid account of the death of the elder Pliny (*q.v.* for citations from the letter) through the eruption of Vesuvius; VI. zo, also to Tacitus, narrating the experiences of Pliny and his mother; those (I. 18, III. 8, V. 10, IX. 34) written to Suetonius, the biographer of the twelve Caesars; II. 17 which gives a description of Pliny's Laurentine villa; VII. 27 which recounts a couple of ghost stories.

The *Correspondence with Trajan* which consists, apart from the first 15 letters, wholly of letters written during Pliny's governorship of Bithynia, contains much that is of value regarding provincial administration under the empire. But the interest of the modern reader centres chiefly in the two letters (96 and 97) relating to the Christians. In the first Pliny writes to the emperor:

> Sire, It is my custom to refer to you all matters about which I am doubtful: for who is better able to direct my hesitation or instruct my ignorance? At trials of Christians I have never been present and I am therefore ignorant of the usual and the limits of punishment or in regard to the matter I have had also no little difficulty as to whether some distinction of age should be made, or if persons of the most tender age stand on the same footing as the more adult; whether the penitent is to be pardoned or if a person who has once been a Christian shall have no benefit of ceasing to be one. Whether the mere name of Christian, apart from crime, is punishable, or only crime coupled with the name. Meanwhile in the case of those reported to me as Christians I have followed this procedure. I asked themselves whether they were Christians. If they admitted it, I put the question a second time and a third, with threats of punishment. If they persisted in their confession, I ordered them to be led to execution; for I had no doubt that whatever the nature of that which they confessed, in any case their pertinacity and inflexible obstinacy deserved to be punished. There were others of a similar delusion whom, as they were Roman citizens, I noted for remission to Rome.
>
> Presently the mere handling of the matter produced the usual result of spreading the crime, and more varieties occurred. There was published an anonymous pamphlet containing many names. Those who denied that they were Christians or ever had been, when, after me, they invoked the gods and worshipped with incense and wine your statue which I had ordered to be brought for that purpose along with the images of the gods, and, further, reviled Christ—things which it is said that no real Christian will do under any compulsion—I considered should be dismissed. Others who were named by the informer admitted that they were Christians and presently denied it, admitting indeed that they had been, but saying that they had ceased to be, some several years before, some even twenty. All these likewise did homage to your statue and to the images of the gods and reviled Christ. They affirmed moreover that the sum of their crime or error was that they had been wont to meet together on a fixed day before daybreak and to repeat among themselves in turn a hymn to Christ as to a god and to bind themselves by an oath (*sacramentum*), not for some wickedness but not to commit theft, not to commit robbery, not to commit adultcry, not to break their word, not to deny a deposit when demanded; these things duly done, it had been their custom to disperse and to meet again to take food—of an ordinary and harmless kind. Even this they had ceased to do after my edict by which, in accordance with your instructions, I had forbidden the existence of societies *(hetaeriae)*. For these reasons I deemed it all the more necessary to find out the truth by the examination—even with torture--of two maids who were called deaconesses (ministrae=διακόνοι). I found nothing but a perverse and extravagant superstition.
>
> I have therefore adjourned the inquiry and have had recourse to consulting you. For the matter seemed to me one deserving a consultation, especially in view of the number of those imperilled. For many persons of every age, of every rank, of both sexes even, are daily involved and will be, since not in the cities only, but in villages and country districts as well, has spread the contagion of that superstition—which it seems possible to check and correct. At any rate it is certain that temples which were already almost deserted have begun to be frequented; the customary religious rites, long intermitted, are being restored; and fodder for sacrificial victims—for which hitherto it was rare to find a purchaser—now finds a market. Whence it is easy to infer what a mass of men might be reformed, if penitence were recognized.

The reply of the emperor briefly approves of the procedure adopted by Pliny:

> No formula capable of universal application can be laid down. The Christians are not to be sought out; if reported and convicted, they are to be punished, with this reservation that any person who denies that he is a Christian and confirms his testimony by overt act, that is, by worshipping our gods, however suspect he may have been in the past, shall obtain pardon by penitence. Anonymous publications ought to have no place in a criminal charge. It is a thing of the worst example and unworthy of our age *(et pessimi exempli nec nostri saeculi est)*.

The full discussion of the questions raised by the correspondence on the matter of the Christians belongs to the province of Church history, but no one can fail to be interested in the account which Pliny gives of the practice of the early Christians: the meeting on a fixed day before day-break (if the "fixed day" means Sunday, the early hour points to a desire for secrecy perhaps rather than to the rest of the day being occupied with other avocations); the singing or reciting of a hymn or psalm of an antiphonal character (*rf.* O.T. Psalm lxxxvii. 7); the recital of the ten commandments; the love feast (ἀγάπη) with its innocuous elements; the existence of women office-bearers or deaconesses.

When a person selects for publication from his private letters, or when he writes a private letter with an eye to its eventual publication, he is necessarily confronted by a dilemma. The self-revelation, the candour of motive, the frankness of prejudice or predilection, which are not merely appropriate to the private letters but are its chief charm, are incompatible with the reserve which is proper to a public document, and while suppression and excision inevitably produce an air of unreality, unreserved publication is almost certain to expose the writer to a charge of priggishness or self-conceit. Those who care to attack Pliny on this ground will find a store of arrows ready-winged for their satire in his letters, even without mistranslating or misunderstanding his words (e.g., "*Maxime* imitabilis" used quite innocently of Tacitus in VII. 20). It is a kinder and more pleasing occupation to recognize the amiability and culture of the character which the Letters everywhere reveal, and, what at least no competent judge will seek to controvert, the many admirable qualities — conciseness combined with lucidity, precision united with the picturesque — of the style in which they are written.

It need only be added that though Pliny on occasion courted the Muses (*Epp.* IV. 27, Ego interdurn versibus *ludo,* cf. Mart. X. 19, Non *Musis* vacat aut suis vacaret) and wrote a Greek tragedy at the age of fourteen (Epp. VII. 4), the specimens of his verses which he quotes (Epp. VII. 4 and 9) do not suggest that his talent lay in that direction.

Bibliography.—*Editio princeps* of Letters i.–vii.; ix. (Venice, 1471), Schurener (Rome, 1474), Letters i.–ix. Panegyricus, (Venice, 1485). The Correspondence of *Trajan, Epp.* 41–121, first published by Avantius (Verona, 1502), Epp. 1–40 by Aldus (Venice, 1508). Critical ed. of text, Keil (Leipzig, 1870). Ed. with comment. Gesner and Schaefer (1805), Gierig (1796–1806). Correspondence with *Trajan,* E. S. Hardy (1889). Selected letters, Westcott (1899), Merrill (1903). For Pliny and the Christians, cf. Ramsay, *The* Church in *the* Roman Empire (1893), Hardy, *Studies* in Roman History (1906); E. T. Merrill, *C. Plini Caecili Sec. Epist. Libri* X (1922). (A. W. Ma.)

PLIOCENE (Gr. πλεῖον, more, and καινός, recent), in geology, the name given by Sir Charles Lyell to the system of strata lying between the Miocene and the Pleistocene. The name refers to the increasing number of living species amongst the fossils of this, the highest division of the Tertiary. The Pliocene is now considered the upper of the two subdivisions of the Neogene or Newer Tertiary period.

Conditions During the Pliocene. — During this period the great land masses were approaching the configuration which they exhibit at the present day and the marine Pliocene deposits are limited to comparatively few areas. In Europe the marine regression which closed the Oligocene was succeeded by a new, but feeble, marine transgression in the Pliocene, which was closed by a final regression before the opening of the Quaternary. Reference should be made to the article on Miocene for the extent of the seas at the opening of the period. The North sea of the Pliocene period covered parts of East Anglia, northern Belgium and Holland, and in the earliest part of the period is believed to have occupied the Thames valley. Bays from the Atlantic covered parts of south-western England and north-western France, and the valley of the Guadalquivir. From the western Mediterranean a bay extended up the Rhone valley as far as the present position of Lyons. Early in the period the sea covered considerable areas of Italy and Sicily, but these lands had assumed approximately their present form by the close of the period. The eastern Mediterranean remained cut off from the west, and the Black sea and Aralo-Caspian sea began to assume their present form. Generally, however, all over the world the majority of Pliocene formations are non-marine, and hence local in their distribution. In many areas the Alpine earth movements did not cease until the close of the period, and not only are the Pliocene deposits represented by vast accumulations of coarse sediment — such as the Siwalik series (Mio-Pliocene) of northern India and the Irrawaddian sands (Mio-Pliocene) of Burma — but these sediments have themselves been severely folded. The formation of some of the great rifts, such as those of East Africa, is attributed to the Pliocene period; volcanic outbursts of the central plateau of France, Etna and the Italian volcanoes, and the East Indian volcanoes probably commenced in this period. In North America marine Pliocene is found fringing the coasts of California and continental deposits are widespread. The oncoming of a glacial era is evidenced by the lowering of temperature during the period. In Britain the earlier Pliocene seems to have been warmer than at present, but the percentage of arctic or northern species amongst marine fossils increases as the period advanced.

Life of the Period. — Sir Charles Lyell defined the Pliocene strata as those which contained from 36 to 95% of living marine mollusca. Although this rule is no longer strictly applicable, the Pliocene marine organisms are very like their living representatives, and there is often practically no specific difference. Thus most of the existing genera of mollusca have Pliocene representatives. It is notable, too, that there is often a closer resemblance between Pliocene faunas and the faunas existing in the neighbouring seas or rivers than there is between Pliocene faunas in widely separated regions.

The mammals of the British Pliocene include *Machaerodus* (the sabre-toothed tiger), hyenas, dogs, fox, wolf, glutton, marten, bears (*Ursus* arvernensis, the grizzly bear and the cave bear), seals, whales, dolphins, bisons, musk ox, gazelle, the red deer and many others now extinct, the roebuck, pigs and wild boar, hippopotamus, hipparion and horse (Equus *caballus* and E. stenonis), several species of rhinoceros, tapir, hyrax, elephants (Elephas meridionalis, and E. *antiquus*), several mastodons, squirrel, beaver, hare, mice, voles, etc. The mastodon disappeared from Europe before the close of the period, but lived longer in America. Although no generally accepted direct ancestor of man sufficiently advanced to be called human has yet been found in the Pliocene, there are several manlike forms which represent offshoots from the main human tree. Amongst these the most famous are Pithecanthropus *erectus,* found by E. Dubois in Java, and *Eoanthropus dawsoni,* found by C. Dawson at Piltdown in Sussex. Monkeys such as Macacus and Semnopithecus occur in the Pliocene of Europe as well as in the Upper Siwalik of India. During the Pliocene the mammals of North America were able to migrate into South America, and a few of the southern forms travelled northwards.

Pliocene Stratigraphy. — The following stages have been distinguished in the Mediterranean Pliocene: —

	Marine Facies	Continental Facies
2	Upper — Calabrian	Villafranchian
1	Lower {Astian facies Plaisancian facies	Lower Pliocene

The Pontian, sometimes included as Lower Pliocene, has been considered under Miocene.

The Lower Pliocene of the Mediterranean basin differs from the Miocene in the disappearance of numerous species and the appearance of many new ones. One finds most of the molluscs now living in the Mediterranean as well as others now only found in the marine waters of the west African coasts.

The Upper Pliocene of the Mediterranean basin has a fauna almost identical with that of the Mediterranean of to-day, but includes a few northern forms such as *Cyprina* islandica, now living in the cold seas of the north of Europe, and hence it is believed that the temperature of the Mediterranean sea in late Pliocene times was much lower than it is to-day. This marine type of Upper Pliocene, well developed in Italy, is known as Calabrian or Sicilian. More often the Upper Pliocene is represented by continental formations known as the Villafranchian (from Villafranca d'Asti in Piedmont). The clearest classification of the continental types of Pliocene is by means of the mammalian remains:—

Upper Pliocene or Villafranchian — marked by appearance of true elephants (E. meridionalis), and true horses (E. *stenonis*), and true oxen (*Bovus* etruscus), and by the last mastodons (M. arvernensis). Another mammal is Rhinoceros etruscus. The mastodons are absent from the higher Villafranchian, which is sometimes, therefore, known as Saint-Prestian. Famous localities include Villafranca d'Asti, Val d'Arno and St. Prest near Chartres.

Lower Pliocene — with Mastodon *arvernensis,* M. *borsoni,* Rhinoceros leptorhinus and large antelopes. Famous localities include Montpellier and Bresse.

The Pliocene rocks of Britain now occupy principally a small area in Norfolk, Suffolk, and part of Essex. Small outlying patches in Cornwall (St. Erth and St. Agnes) and elsewhere in the west of England supply evidence that the Pliocene sea was responsible for the planation of much of the present surface of the peninsula of Devon and Cornwall. Small patches of ferruginous sands and gravels on the North downs of Kent and Surrey, on the chalk hills north of London and on the South downs of Sussex have also been shown to be of Pliocene age. In early Pliocene times a large bay of the North sea occupied what is now the

London basin; the shore lines of this bay have been traced. as well as the plane of marine denudation for which it is responsible. Later in the period the sea retreated and covered only parts of East Anglia whilst a great spread of fluvio-marine gravels was deposited in the London basin at an elevation of, roughly, 400 ft. above present sea-level. Still later in the period the sea left even East Anglia, and the highest Pliocene there were probably laid down in a distributary of the Rhine-Thames system. The Pliocene of East Anglia has been classified as follows:—

9 Cromerian	Cromer forest bed series (freshwater and estuarine)
8 Weybournian	Weybourne crag (marine)
7 Chillesfordian	Chillesford clay and sand (estuarine)
6 Icenian	Norwich crag (marine and estuarine)
5 Butleyan 4 Newbournian 3 Waltonian	Red crag (marine)
2 Gedgravian	Coralline crag (marine)
1 Lenhamian or Diestian	Lenham beds (marine)

The Pliocene deposits of Belgium and Holland are closely related to those of Britain but are much thicker and more extensive. The sea retreated northwards as it did in England. In Germany the retreat of the Oligocene sea left vast lakes in which swamp forests gave rise to lignites.

In Brittany and Normandy there are patches of marine sands comparable with those of Cornwall; in Central France no marine beds are found, but many interesting and in some cases highly fossiliferous deposits occur in volcanic rocks.

In North America the marine Pliocene—marls, clays and limestones—are well developed in Florida and can be traced into the Carolinas and Virginia; they have been classed as the Lafayette group (with lignites), the Florida group, and the Calooshatchis stage. On the Pacific coast the marine beds have attained great thicknesses, notably in the Merced series of San Francisco. In the San Luis Obispo region the non-marine Paso Robles beds, said to be 1,000 ft. thick, belong to this period. Other local formations of marine origin in California are those of San Diego and Wild Cat. In the Rocky mountains are large lacustrine formations of considerable thickness, and certain conglomerates in Wyoming and Bishop mountain are assigned to this age.

BIBLIOGRAPHY.—For general references see under EOCENE; also C. Reid, "The Pliocene Deposits of Britain" (Mem. Geol. Surv., 1890); E. T. Newton, "The Vertebrates of the Pliocene Deposits of Britain" (Mem. Geol. Surv., 1891); C. Reid, *Origin* of the British Flora (1899); F. W. Harmer, "The Later Tertiary History of East Anglia" (Proc. Geol. Assoc., vol. xvii., 1902, p. 416); S. W. Wooldridge, "The Pliocene History of the London Basin" (*Proc.* Geol. Assoc., vol. xlii., 1927).
(L. D. S.)

PLOCK or **PLOTSK,** a town of Poland in the province of Warsaw, on the Vistula, 67 mi. by the Vistula W.N.W. of Warsaw. Pop. (1931), 32,777 It has a cathedral, dating from the 12th century, but restored in 1903, which contains tombs of Polish dukes and of Kings Wladyslaw and Boleslaw (of the 11th and 12th centuries). There is considerable navigation at this point on the Vistula. German troops took Plock soon after the start of World War II in 1939.

PLOËRMEL, a town of western France in the department of Morbihan, 36 mi. N.N.E. of Vannes by rail. Pop. (1936) 3,384. Ploermel (*Plo Armel,* people of Armel) owes its name to Armel, a hermit who lived in the district in the 6th century. The Renaissance church of St. Armel (16th century) is remarkable for the delicate carving of the north façade and for fine stained glass. It also possesses effigies of John II. and John III., dukes of Brittany, brought from their tomb in an ancient Carmelite monastery founded in 1273 and destroyed by the Protestants in 1592 and again at the Revolution. The lower ecclesiastical seminary has a room in nhich the Estates of Brittany held several meetings.

PLOEȘTI, the capital of the department of Prahova. Rumania; at the southern entrance of a valley among the Carpathian foothills, through which flows the river Prahova; and at the junction of railways to Buzau, Bucharest and the Transylvanian system. Pop. (1939) 77,376. As the name Ploești (*pluviena,* rainy) implies, the climate is moist. The surrounding hills are rich in petroleum, salt and lignite. Ploești is the greatest centre of the Rumanian oil industry, and as such was severely bombed by British, Americans and Russians in World War II. There are cardboard factories, roperies, tanneries and oil mills. Ploești possesses schools of commerce and of arts and crafts, several banks, and many churches, including the Orthodox church of St. Mary, built in 1640 by Matthew Bassarab.

PLOMBIÈRES-LES-BAINS, a town of eastern France, in the department of Vosges, on a branch line of the Eastern railway, 17 mi. S. of Epinal by road. Pop. (1936) 1,581. The town stands at a height of 1,410 ft. in the picturesque valley of the Augrogne and is a tourist centre, famous for its mineral springs, containing sodium sulphate and silicic acid, varying from 66° to 166° F. The waters have been used since Roman times.

PLOTINUS (A.D. 204 or 205–270) was a native of Egypt, but it is not known from what race he sprang. As a young man he studied philosophy at Alexandria, and at last found a congenial teacher in Ammonius Saccas, under whom he worked till he was 39. Then he accompanied the expedition of the emperor Gordian against Persia, hoping to have an opportunity of studying the wisdom of the East. Gordian was assassinated in Mesopotamia and Plotinus escaped to Antioch with difficulty. In 244 he went to Rome, where he lived for the rest of his life. There he opened a school and gathered round him an enthusiastic band of disciples. For many years the instruction was purely oral, and Plotinus took but little pains to perpetuate his teachings. We owe the preservation of it mainly to his pupil Porphyry, who edited his scattered lectures and tried to reduce them to order. The philosopher died after a long illness at the age of 66. His biographer Porphyry described him as a man of saintly character and very attractive personality. In him philosophy and personal religion were closely connected; the apex of the dialectical pyramid was also the beatific vision in which the mystical life culminates. He made no enemies and was loved and reverenced by all who knew him. The later members of the school spoke of him as "the most divine Plotinus."

The importance of Plotinus in the history of thought can hardly be exaggerated. Among the philosophers of mysticism he holds an undisputed pre-eminence, since no other writer unites in the same measure metaphysical genius with intimate personal experience. On the theoretical side he draws mainly from Plato, but on Plato as interpreted by a long series of scholars, and buttressed by Aristotle and (to a less extent) by the Stoa. The rival schools of Greek philosophy were in fact beginning to coalesce into a theocentric system, at once universal and individual, of religious discipline. Plotinus gave an impetus to this fusion; for the victory of his philosophy was so rapid and overwhelming that it absorbed the other schools, and when Neoplatonism captured the Platonic Academy at Athens, the seat of the official Diadochus, it reigned almost without a rival until Justinian closed the Athenian schools in 529.

Neoplatonism remained attached to the classical tradition, and Porphyry wrote against Christianity. But even Augustine recognized that the differences between Platonists and Christians were slight, and the Church gradually absorbed Neoplatonism almost entire. The Christian Platonists of Alexandria led the way; then came Augustine himself, the Cappadocian fathers, and the Pseudo-Dionysius, a disciple of Proclus, whose writings, popularly ascribed to St. Paul's Athenian convert, introduced the whole scheme of Plntinian mysticism into the Church. It is no paradox to say with Eucken that the pagan Plotinus has left a deeper mark upon Christian thought than any other single man. In reading the Enneads we can realize the truth of Troeltsch's famous dictum, that the Catholic Church does not belong to the middle ages, but is rather the last creative effort of classical antiquity, which may be said to have died in giving birth to it. Troeltsch adds that in a new synthesis of Neoplatonism and Christianity lies "the only possible solution of the religious problem at the present day," and "does not doubt that this synthesis will once more be dominant in modern thought." Such a judgment, from the foremost thinker of his day in Germany, is enough to show that the philosophy of Plotinus, so far from being extinct, is still a factor in modern civilization. As Eunapius said, "the altars of Plotinus are still warm."

His Philosophy. — Whatever English equivalents we choose for the Plotinian technical terms must be misleading. The "Matter" of Plotinus is immaterial, being the all-but nothing which remains when we have deprived an object of contemplation of the form and meaning which make it a possible object of contemplation. "Soul" is often nearer "life," the word usually translated "intelligence" is much nearer to "Spirit"; "God" is not the deity of personal theism, and the Absolute is "beyond existence." It is mainly mistranslation of technical terms that has caused many to ascribe metaphysical dualism to Plotinus, for which there is no ground whatever. There are no hard and fast dividing lines in this philosophy, but a graduated hierarchy of existence and value, in every grade of which the soul finds affinities.

The soul is a stranger among the things of sense, into which it has "come down." From the desire of Soul to create after the pattern of Spirit, "the whole world which we know arose and took its shapes." The universal soul is the creator and providence of the visible world, which is in it, rather than the soul being in the world. "There is nothing between soul and spirit except that spirit imparts and soul receives. But even the Matter of Spirit is beautiful and of spiritual form." "There is nothing Yonder that is not also Here." Plotinus therefore blames the half-Christian Gnostics, who despise the visible world and are blind to its beauties. Souls cannot be divided quantitatively; "all souls are one." In the spiritual world there is distinction without separation; individuality is preserved, but all spirits are transparent to each other. Even on earth there is a "faint sympathy" which connects all beings together, a pale reflection of the complete unity in plurality which prevails Yonder. The character of the soul depends on the sphere in which it voluntarily moves. If it chooses to live among the shadows of the true, it forfeits its birthright, and is "lost," so far as a divine being can be lost. There is a higher soul which never consents to sin, and remains in the eternal world. (Here the school was to differ. Later Neoplatonists asked, "If the will sins, how can the soul be impeccable?")

The soul neither comes into existence nor perishes; "nothing that possesses real being can ever perish." But souls that have lived unrighteously will be punished by being reincarnated in the bodies of lower animals; the soul will also be chastened by its daemcn or guardian angel. It is not quite clear whether every soul must at last find deliverance from its chains. The world Yonder is the heaven of Neoplatonism. It is the realm of spiritual existence, in which the ultimate and eternal values — Truth, Goodness and Beauty — are fully realized and fully operative. It consists in the unity of *Nous, Noësis* and *Noëta*, in which the whole nature of the Absolute is manifested. It is essentially a kingdom of values, but of values which are fully realized. It is eternal, not as existing through an infinite series of moments, but as belonging to the divine life, of which indestructibility is an attribute. The world reflects in its everlastingness the eternity of its archetype. There is no change or progress Yonder, since the perfect cannot receive augmentation; but there is unceasing life and movement, which on the lower side is manifested in perpetual creativeness. The lower orders of being proceed from the higher in a constant stream, though the higher loses nothing in the process of creation. The lower is immanent in the higher, not the higher in the lower. Nothing that takes place in time can affect the essential nature of eternity.

The duality in unity of the spiritual world points to an absolute unity behind it. This unity, though the necessary culmination of the dialectic, is beyond knowledge and existence, and is revealed to experience only in the mystical trance. The "soul become spirit" cannot rest even in this state of blessedness; it is impelled by its inner nature to aspire still further, "always attaining and always striving upward." Plotinus is convinced that in the mystical state we have actually an experience of formless intuition. This is, it is needless to say, the testimony of all the mystics, of every age, country and creed. The mystical ascent seems to those who pass through it to be a progressive stripping off of everything that is alien to the purest nature of the soul, which cannot enter into the Holy of Holies while any trace of earthliness still clings to it. Hence the constant reiteration of such symbols as nakedness, nothingness and darkness. Plotinus in the well-known sentence with which the *Enneads* as arranged by Porphyry end, defines it as "a flight of the alone to the Alone." He gives us several eloquent descriptions of the mystical trance, drawn evidently from intimate personal experience; but like other mystics he knows that it is impossible to utter the ineffable, and repeats cautions like "The vision is for him who will see it"; "he who has seen it knows what I say."

It is part of the fundamental sanity of Plotinus that he always speaks of the vision of the One as an exceedingly rare experience. It is the consummation of a life-long quest of the highest, to be earned only by intense contemplation and unceasing self-discipline. He says nothing of supernatural favours granted for their encouragement to young aspirants. Nor are there any traces of those attempts to force the pace which in many mystics produce the terrible reactions which are described as the dark night of the soul. This sense of dereliction, which fills so large a place in the records of the mysticism of the cloister, may have some connection with a deeper sense of guilt and sinfulness than the Neoplatonists ever felt; but it is partly the effect of nervous overstrain and of severe mortification of the body, which Platonism has never encouraged. Plotinus, as we have seen, lived the active and sociable life of a professor among his pupils; his habits were austerely simple, but neither he nor his disciples tortured themselves like Heinrich Suso and many other Catholic saints. The combination of healthy asceticism with humanism is the hall-mark of Platonists in all times.

The ethical scheme of Plotinus falls, like everything else in his philosophy, under three heads — purification, enlightenment and unification. The "political virtues," which include all the conduct expected of a good citizen. are the preliminary but indispensable prelude to the course. It was not to be expected that any writer in the 3rd century of our era should show much interest in what we call social questions, which occupied the attention of Plato and Aristotle. The special task of philosophy in that distracted age was to isolate religion in its purity, detaching it from all that was local and temporal, and bringing to light its innermost essence. To have done this is an achievement of permanent value, and we must not blame Plotinus for his apparent indifference to the misfortunes which were threatening his country. But, like all the ancients, he does not sufficiently emphasize our need of our fellow-men to develop the best in human nature. The bravest of the Greeks could never renounce the hope of making himself invulnerable.

Neoplatonism culminates in Plotinus. Of his successors, Proclus alone was a thinker of the first rank, and in Proclus the system is intellectualized and scholasticized. The later history of this type of religious thought and practice is mainly within Christianity. As a philosophy, it was restated with acumen by Scotus, Erigena and Meister Eckhart; but many of the post-Kantians are deeply indebted to Plotinus, and Troeltsch is probably right in thinking that even in the future Christian philosophy must continue to be largely Plotinian. The Church carried off this Hymettian honey to its hive just at the time when the intellectual formulation of the victorious creed was taking its permanent shape.

(W. R. I.)

Bibliography.—The *Enneads* of Plotinus were first made known in the Latin translation of Marsilio Ficino (Florence, 1492) which was reprinted at Basle in 1580, with the Greek text of Petrus Perna. Later editions by Creuzer and Moser ("Didot" series, 1855), A. Kirchhoff (1856), H. F. Müller (1878–80), R. Volkmann (1883–84). There is an English translation of selected portions by Thomas Taylor, re-edited in Bohn's *Philosophical Library* (1895, with introduction and bibliography by G. R. S. Mead). Translation of the whole (except *Ennead* vi., not yet published (in 1928) by S. Maclienna.

On Plotinus generally *see* article in Suidas; Eunapius, *Vitae sophistarum;* and above all the *Vita Plotini* by his pupil Porphyry. Among modern works, *see* the treatises on the school of Alexandria by J. F. Simon. I. (1845), and R. Vacherot (1846); A. Richter, *Ueber Leben und Geistesentwicklung des Plotin* (Halle, 1864–67); T. Whittaker, *The Neoplatonists* (1901); A. Drews, *Plotin und der Untergang der antiken Weltanschauung* (1907); E. Caird, *Evolution of Theology in*

the Greek Philosophers (1904), ii. 210–157; W. R. Inge, The *Philosophy of Plotinus* (2 vols., 1918; 3rd ed. revised, 1928); F. Heinemann, *Plotin* (1921). A detailed account of Plotinus's philosophical system and an estimate of its importance will be found in the article NEO-PLATONISM, the works above referred to, and the histories of philosophy. For his list of categories, see CATEGORIES; also LOGOS; MYSTICISM; MAGIC.

PLOUGH, PLOW: see CULTIVATING MACHINERY.

PLOVER, the name given to an indefinite group of birds which, with the snipes and sandpipers, form the group *Limicolae* or "waders," although the plovers themselves rarely enter water. Perhaps the best entitled to the name are the golden plover (*Charadrius pluvialis*) and the grey plover (*Squatarola helvetica*). The latter is the larger and lacks the hind toe; otherwise the two forms are very similar. The grey plover breeds in the far north of America, Asia, and Europe, migrating south in the winter, when it reaches the Cape, Australia, and Ceylon. The golden plover is more local but ranges from Iceland to Siberia, including the British Isles, as a breeding species. It also migrates south in winter. Both forms are exceedingly wary. In America occur two further golden plovers, breeding in the far north, where, in Alaska, their ranges are scarcely 100 miles apart. But whereas the eastern form winters in Patagonia, which it reaches via Labrador, Newfoundland, and the Antilles, returning by way of Panama, the Pacific bird winters in the Low Archipelago (*see* Coward's *Migration of* Birds). Plovers are gregarious but monogamous birds, partial to mud-flats and marshes and eating worms and small arthropods and molluscs. The legs are long, the bill shorter than in most waders.

The ringed plovers include the shore-haunting British bird of that name; killdeer (*q.v.*); zick-zack (*Hoplopterus spinosus*), celebrated for its connection with the crocodile, from the mouth of which it picks leeches and other parasites, besides, from its wariness, acting as a sentinel to the reptile. The coursers, *Cursorius* and allied genera, to which the last belongs, are mainly desert forms from Africa and India. Other allies of the plovers are the stone curlews (*see* CURLEW), lapwings (*q.v.*), oyster-catchers (*q.v.*), turnstones (*q.v.*), and avocets (*q.v.*). (For "plovers' eggs" see LAPWING.)

PLUCKER, JULIUS (1801–1868), German mathematician and physicist, was born at Elberfeld on June 16, 1801. After studying at the universities of Bonn, Heidelberg and Berlin he went in 1823 to Paris, where he came under the influence of the great school of French geometers, whose founder, Gaspard Monge, had only recently died. In 1825 he was received as *Privatdozent* at Bonn, and after three years he was made professor extraordinary. He then held the following posts: professor of mathematics at Friedrich Wilhelm's Gymnasium, Berlin (1833–34), professor of mathematics at Halle (1834–36), professor of mathematics (1836–47) and finally professor of physics at Bonn. He died on May 22, 1868.

From his lectures at Bonn sprang his first great work, *Analytisch-geometrische Entwickelungen* (vol. i., 1828; vol. ii., 1831), in which he introduced the abridged notation which has since characterized modern analytical geometry. (*See* ANALYTIC GEOMETRY.) He applied this notation to the straight line, circle and conic sections, and he used it in his theory of cubic curves. Also he established the great principle of duality. Plucker discovered the six equations known as "Pliicker's equations" connecting the numbers of singularities in algebraical curves. (*See* CURVE.) Plucker communicated his formula? in the first place to *Crelle's Journal* (1834), vol. xii.. and gave a further extension and complete account of his theory in his Theorie der algebraischen *Curven* (1839). In his *System* der *analytischen* Geometrie (1835) he introduced the use of linear functions in place of the ordinary co-ordinates; he also made the fullest use of the principles of collineation and reciprocity. He discussed curves of the third order and gave a complete enumeration of them, including two hundred and nineteen species. In 1846 Pliicker published his *System* der *Geometrie* des *Raumes* in *neuer* analytischer *Behandlungsweise,* but this contains merely a more systematic and polished rendering of his earlier results.

After his appointment as professor of physics at Bonn, Plucker began a series of researches in physics. His first physical memoir, published in *Poggendorffs Annalen* (1847), deals with the behaviour of crystals in a magnetic field. Then followed a long series of researches, mostly published in the same journal, on the properties of magnetic and diamagnetic bodies, establishing results which are now part and parcel of our magnetic knowledge. This was followed by researches on the discharge tube; he investigated the deflection of the discharge by a magnet and the behaviour of the negative glow in a magnetic field. Plucker, first by himself and afterwards in conjunction with Hittorf, made many important discoveries in the spectroscopy of gases. He anticipated Bunsen and Kirchhoff in announcing that the lines of the spectrum were characteristic of the chemical substance which emitted them, and in indicating the value of this discovery in chemical analysis. According to Hittorf he was the first who saw the three lines of the hydrogen spectrum, which a few months after his death were recognized in the spectrum of the solar protuberances, and thus solved one of the mysteries of modern astronomy. Induced by his mathematical friends in England, Plucker in 1865 returned to "line geometry." His first memoir on the subject was published in the *Philosophical* Transactions of the Royal Society of London in 1865. Plücker himself worked out the theory of complexes of the first and second order, introducing in his investigation of the latter the famous complex surfaces of which he caused those models to be constructed which are now so well known to the student of the higher mathematics. He left an uncompleted work on the subject which was so far advanced that his pupil and assistant Felix Klein was able to complete and publish it. (*See* LINE GEOMETRY)

See R. F. A. Clebsch's obituary notice (*Abh.* d. kon. *Ges.* d. *Wiss. z. Göttingen,* 1871, vol. xvi.), to which is appended an appreciation of Plucker's physical researches by Hittorf, and a list of Plucker's works by F. Klein. See also C. I. Gerhardt, *Geschichte* der *Mathematik in Deutschland,* p. 282, and Pliicker's life by A. Dronke (Bonn, 1871).

PLUM, the English name both for certain kinds of tree and also generally for their fruit. The plum tree belongs to the genus *Prunus,* family Rosaceae. Cultivated plums are supposed to have originated from one or other of the species P. *domestica* (wild plum) or P. *insititia* (bullace). The young shoots of P. *domestica* are glabrous, and the fruit oblong; in P. insititia the young shoots are pubescent, and the fruit more or less globose. A third species, the common sloe or blackthorn, P. *spinosa,* has stout spines; its flowers expand before the leaves; and its fruit is very rough to the taste, in which particulars it differs from the two preceding. These distinctions, however, are not maintained with much constancy. P. domestica is a native of Anatolia and the Caucasus, and is considered to be the only species naturalized in Europe. P. insititia is wild in southern Europe, in Armenia, and along the shores of the Caspian. In the Swiss lake-dwellings stones of the *P.* insititia as well as of P. spinosa have been found, but not those of P. *domestica.* Nevertheless, the Romans cultivated large numbers of plums. The cultivated forms are extremely numerous. some of the groups, such as the greengages, the damsons and the egg plums being very distinct, and sometimes reproducing themselves from seed. The colour of the fruit varies from green to deep purple, the size from that of a small cherry to that of a hen's egg; the form is oblong acute or obtuse at both ends, or globular; the stones or kernels vary in like manner; and the flavour. season of ripening and duration are all subject to variation. From its hardihood the plum is one of the most valuable fruit trees, as it is not particular as to soil, and the crop is not readily destroyed by spring frosts. Prunes and French plums are merely plums dried in the sun. Their preparation is carried on on a large scale in Yugoslavia, as well as in Spain, Portugal and southern France.

Plums are propagated chiefly by budding on stocks of the mussel, Brussels, St. Julien and pear plums. The damson, winesour and other varieties, planted as standards, are generally increased by suckers. For planting against walls, trees which have been trained for two years in the nursery are preferred, but maiden trees can be very successfully introduced, and by liberal treatment may be speedily got to a fruiting state. Any good well-drained loamy soil is suitable for plums, that of medium quality as to lightness being decidedly preferable. Walls with an east or west aspect are generally allowed to them. The horizontal mode of training and the fan or half-fan forms are commonly followed; where there is sufficient height probably the fan system is the best. The shoots should be laid in nearly or quite at full length. The fruit is produced on small spurs on branches at least two years old, and the same spurs continue fruitful for several years. Stacdard plum trees should be planted 25 ft. apart each way, and dwarfs 15 or 20 feet. The latter are now largely grown for market purposes, being more easily supported when carrying heavy crops, fruiting earlier, and the fruit being gathered more easily from the dwarf bush than from standard trees.

PLUM (PRUNUS DOMESTICA), SHOWING (A) LONGITUDINAL SECTION THROUGH FLOWER, (B) TWIG WITH BLOSSOM, (C) FRUITS (DRUPES)

Diseases.—The plum is subject to several diseases of fungal origin. A widespread disease known as pocket-plums or bladder-plums is due to an ascomycetous fungus, *Exoascus pruni,* the mycelium of which lives parasitically in the tissues of the host plant, passes into the ovary of the flower and causes the characteristic malformation of the fruit which becomes a deformed, sometimes curved or flattened, wrinkled dry structure, with a hollow occupying the place of the stone. Plum-leaf blister is caused by *Polystigma rubrum,* a pyrenomycetous fungus which forms thick fleshy reddish patches on the leaves. The reproductive spores are formed in embedded flesh-shaped receptacles (perithecia) and scattered after the leaves have fallen. The spots are not often so numerous as to do much harm to the leaves, but where the disease is serious diseased leaves should be' collected and burned. Sloes and bird-cherries should be removed from the neighbourhood of plum-trees, as the various disease-producing insects and fungi live also on these species.

Of recent years the most troublesome disease has been that of Silver leaf due to *Stereum purpureum.* The fungus, one of the Basidiomycetes (*see* FUNGI), enters through a wound and through the mycelium remains in the stem. The leaves become affected and turn a curious ashen colour, something of the appearance of lead. The valuable Victoria plum is particularly attacked. The disease is a notifiable one in Great Britain. (X.)

Cultivation in the United States.—In European countries, varieties of three, or at most four, species of plums are under cultivation, but in North America representatives of at least 12 quite distinct species are commonly cultivated, 2,000 forms of which have been named and described. It is hardly too much to say that of all drupe fruits plums furnish the greatest diversity. Species and varieties give a great range of colours, forms, kinds, sizes, flavours, aromas and textures. The plants are quite as diverse in America as the fruits; some plums are true trees with stout trunks and sturdy branches, while others are slender shrubs; some species have thin, delicate leaves; others, coarse, heavy foliage; in some the plums are large and attractive, in others, small and unattractive with a disagreeable odour.

In geographical distribution in North America, wild and cultivated plums cover almost the whole temperate zone, the several species and varieties being adapted to a great diversity of soils and climates. In Europe nearly all of the varieties of plums belong to the species *Prunus domestica.* This species does not hold the same relative position in America that it does in Europe for the reason that it does not possess in a high degree the power of adaptation to trans-Atlantic environment. The feature of environment most uncongenial to European plums in America is the climate. The plums thrive best in an equable climate like that of Eastern Europe and Western America, and do not endure such extremes of heat and cold, wet and dry, as are found in America east of the Rocky Mountains.

The temperate zone in North America, however, is a natural orchard of wild species of plums, scarcely any part of the United States lacking in one or more species of this fruit growing in the wild. At least ten of these wild species have been more or less domesticated with orchard representatives of several species commonly grown.

The plum is comparatively easy to suit in the matter of soils, and orchard exposure. The chief requisite for the genus in general seems to be a good drainage. Given this condition, some sort of plum can be grown in almost any soil in the United States not wholly prohibitive to plant growth. In western America several plums are commonly grown for the making of prunes. Any plum that can be cured, without removing the pit, into a firm, long-keeping product is a prune. The growth of the prune industry on the Pacific coast is one of the most remarkable industrial developments of American agriculture. The first commercial orchard of prunes was planted in California about 1870. In 1930, the output per annum was valued by the producers at over $1,500,000.

About 1,500 varieties of plums have been described in horticultural literature in America. Of these perhaps 1,000 are of the common European domestic type; perhaps 100 are damson plums; and 400 sorts may be distributed among the 10 or 12 species of wild native plums now under domestication. In addition to the European and native species, an Asiatic plum, *Prunus salicina,* has been introduced from Japan, of which there are probably zoo sorts, if hybrids with native species be included.

The leading varieties of plums cultivated at the present time are in order of ripening:—

Beauty, a splendid large, very early Japanese plum, yellow. juicy flesh; Abundance, a large, juicy, sweet, Japanese plum; Burbank, a productive, red, early Japanese plum, home or local markets: Formosa. Japanese plum recommended for productiveness and large fruits; Santa Rosa, new Japanese plum, tree and fruit characters surpass Abundance and Burbank; American Mirabelle. larger than the European Mirabelle, splendid for dessert and culinary purposes; Grand Duke, very large, dark purple, long oval in shape, low quality; Hall, good, dark purple, large, well flavoured, desirable for roadside stands or city markets; Stanley, prune shape, large, dark blue, freestone. excellent quality; Imperial Epineuse, purplish red, prune shape, excellent in quality; Reine Claude, yellow, roundish oval, good in quality, late, desirable for canning; Italian Prune, purplish black, freestone, excellent quality for dessert or canning; French damson, the largest and best of the damsons, excellent for preserves; Albion, purplish black, large, flesh golden yellow, clingstone, good, very late.

BIBLIOGRAPHY.—L. H Bailey, *Standard Cyclopedia of Horticulture* (1914–27); U. P. Hedrick. Plums *of New York* (1911). (U. P. H.)

PLUMBAGO, a name frequently applied to graphite (*q.v.*).

PLUMBING, properly working in lead (Lat. *plumbum),* now a term embracing all work not only in lead, but also in tin, zinc, copper and other metals, connected with the installation, fitting, repairing, soldering, etc., of pipes for water, gas, drainage, on cisterns, roofs and the like in any building.

Water Supply.—Where there is no public water supply, an important part of plumbing is to bring water for domestic and other purposes from streams and wells, to buildings for distribution to various fittings and sanitary appliances.

In the case of streams giving an abundant supply, the general appliance to use is the hydraulic ram. This works automatically by raising a portion of the water flowing through it to a high level cistern, from which fittings are supplied by gravitation. The ram is fitted in a frost proof house and provided with a supply or drive pipe, delivery and waste pipes. Excess water which forms the motive power may usually be conveyed through the waste pipe to the stream at a lower level. Particular features in this work are strength and permanent soundness, because of the shock and strain due to pulsation of the ram, while entry of air would have detrimental effect. Pipes used in this work are lead, iron or copper.

Water is extracted from wells by pumps of different types. Suction pumps deliver water at their own height, while lift pumps deliver to greater heights than that at which they are placed. As pumps arc dependent for their working upon atmospheric pressure, it is not wise to fix them more than 28 ft. above the water level in the well, consequently, in deep wells, they must be fixed actually in the weil. Lead, iron or copper pipes are used for this work. Suction and delivery pipes should be at least half the diameter of the pump barrel; airtightness is essential, and in the case of long pipes or high lifts adequate air vessels must be inserted to overcome the inertia of water and keep it in motion between the strokes of the pump. Again lead, iron or copper pipes may be used, due regard being paid to the character of the water and its action on metals.

Where there is a public supply, a separate communication pipe is laid to each building, the size being dependent upon the size of the building and whether fire hydrants, etc., are fitted. This pipe should be, at least, 2 ft. 6 in. below ground as a protection from frost, and a stop cock, with draw-off, should be placed in an accessible position, immediately within the premises. Branches are often taken from the communication pipe for drinking water, but its main purpose is to supply the house storage cisterns. Here the supply is controlled by a ball valve which automatically cuts off the supply when the cistern is filled.

House cisterns should be placed in clean, accessible positions, be fitted with a cover and overflow pipe and stand over a metal tray, also provided with an overflow pipe, to protect the structure in case of fracture and leakage.

Distribution pipes of lead, iron or copper are led from the cistern to supply various fittings throughout the building; these should be protected from damage and frost and well fixed to prevent sagging with consequent trouble from air-locks.

The character of the water has an important bearing upon the selection of metals for use in connection with water supply. Soft waters, especially from moorland sources, often dissolve lead, which should therefore not be used for the storage or conveyance in these cases. These waters also cause excessive rusting with iron, with offence to the aesthetic senses, owing to discolouration, and damage to linen when used for laundry purposes. Here copper has manifest advantages.

With hard waters, mineral salts are deposited, causing obstruction in vessels and pipes. Hardness may be removed by the introduction of water softening apparatus in the main supply pipe or by the physical action of "etherium" activators in cisterns.

Rain water is conducted from roofs by gutters and pipes. In towns it is usually run to waste, while in country houses it is collected in underground tanks, filtered, pumped and used for laundry or carriage washing purposes.

Fire hydrants are connected to cast or wrought iron pipes, in which the water is under constant pressure, their disposition being such that operators may have easy escape. Pipe sizes for this work should be carefully calculated to ensure an adequate supply at all points.

Drinking fountains are usually connected to the main water supply, while unfiltered water may be used for ornamental fountains.

Drains.—With ever increasing heavy traffic, drains are best constructed of heavy cast iron. jointed with metallic lead. The use of this material is facilitated by the number of fittings of varying angles now obtainable. In large buildings drains are often fixed on walls or suspended from ceilings in basements, especially where basement floors are below sewer levels. Such drains must be properly sealed at all openings and traps. This procedure necessitates extra provision of ventilating pipes to protect the water seals of traps and to remove gases. Access covers are made air-tight with greased felt washers.

Soil pipes may be in lead or iron. Lead is preferable because of its internal smoothness, adaptability, freedom from corrosion, and permanent soundness when jointed with wiped soldered joints, especially when in concealed positions inside buildings. Lead should not be used for the waste of slop sinks where hot water is used. Cast iron pipes are used where strength is required.

Waste pipes may be in lead, iron or copper. When lead is used for main waste pipes through which heated discharges pass it must have expansion joints to obviate fracture, it must be well supported to prevent sagging. Wrought iron and copper pipes are largely supplanting lead for waste pipes because of their greater strength, whereby they maintain their alignment between fixings Special maiieabie iron fittings are used with wrought iron wastes to maintain internal bore without recesses for lodgement.

Both soil and waste pipes require adequate ventilation to preserve the water seals of traps.

Sanitary Fittings.—All fittings such as baths, bidets, lavatories, slop sinks and water closets should be fixed on impervious floors. The craze for open haths is disappearing. When covered, these fitments should be entirely enclosed so that there is no possibility of undesirable articles being placed underneath. The essential points of sanitary fittings are absence of corners where filth may collect, adequate water supply, quick discharge arrangements, proper trapping and ventilation to preserve the water seals of traps.

In large houses different types of sinks are used for various purposes, such as the reception of slops, preparation of vegetables and food, washing up, etc.

Bath rooms *en* suite with bedrooms are becoming common, and wash basins with running water are frequently fixed in bedrooms. These often necessitate concealed piping systems, which work should only be entrusted to skilled plumbers who have proved their ability as craftsmen and their knowledge of sanitary principles.

Roof Work.—An outstanding feature of plumbing is lead work on roofs. Although lead is not so largely used for covering large flat roof surfaces as formerly, it is in evidence upon practically all roofs in the form of gutters, flashings, etc., for making watertight joints between slated or tiled roofs and brick walls, chimneys, etc., in addition to covering dormer windows, stone cornices, domes, turrets and other ornamental features. The great malleability of lead and comparative ease with which skilled plumbers can boss it into intricate shapes renders it invaluable for this purpose.

For some years there has been a revival in the use of cast lead rain-water pipes, heads, cornices, etc., because of its undoubted superiority and lasting qualities.

Milled sheet lead is more generally used for roof work, although for the very best work, as on cathedrals, and the like, cast sheet lead is still largely used.

An entirely new feature of plumbing is the covering of steel columns and constructional work with ornamental cast lead, both for preservation of the metal structure and to give artistic appearance.

Hot Water.—The increasing number of baths and wash-basins has added much work under the category of plumbing in the arrangement and fixing of domestic hot water apparatus. This consists of the fixing of boilers and storage vessels with circulating pipes between the same, and adequate draw off pipes. Especial points to be considered are the sizing of pipes and vessels to ensure adequate heating of the water, while at the same time providing sufficient supplies; effective insulation to conserve heat; and general arrangement of pipes to ensure the withdrawal of all heated water, upon the opening of taps, before cold water can find exit. One of the greatest faults in this direction is the possibility of drawing cold water from taps while heated water is bottled up in the apparatus. While gravity circulations are more general, accelerating pumps are often installed to ensure adequate circulation and supplies.

Insulation consists of covering pipes and vessels with some porous material to provide a layer of stagnant air around them and so obviate the withdrawal of heat by conduction.

Other Points.—Pipes for conveyance of gas to lighting points, cooking and warming stoves and water heating apparatus are usually of wrought iron or steel with fittings of similar material or malleable iron. Screwed joints being used, the threads are smeared with a lead and oil compound. These pipes must be well fixed to prevent damage. They are usually concealed.

For beer engines, pumps and spirit pipes, block tin pipes are used, joints being of the cupped variety known as blown joints. The solder used contains bismuth to lower its melting point so that a surface alloy is formed at a temperature below the melting point of the pipes. Pewter, an alloy of lead and tin, is used for washing bowls, trays, etc.

Plumbing work in connection with cold storage, etc., consists of bending and fixing wrought iron tubes and connections.

Chemical Plumbing consists of the erection and jointing of large chambers of heavy sheet or plate lead; the manufacture and fixing of large pipes for conveyance of acids and gases; covering of earthenware cocks; iron fans and lining vessels constructed of other metals with lead. In this work lead is used because of its great immunity from destruction by the action of acids; consequently all joints are made by lead burning or the fusing together of edges with the addition of extra lead to strengthen the seams and joints from a filling rod.

Plumbing work on ships is similar in many respects to that ashore. Fresh water is carried on liners in tanks in the ship's bottom, from which it is pumped to the upper decks for filtration, aeration, and storage for delivery by gravitation to various points about the ship. Waste water, soil, etc., from fittings above the water-line is carried in pipes to openings in the ship's side immediately above the water-line, and there discharged into the sea through storm valves. Waste matter from decks and fittings below the water-line is carried to bilge tanks in the ship's bottom, from which such is pumped for delivery overboard. Wrought iron pipes are largely used on ships and the process of welding branches to them, as well as flanges for connections by the oxy-acetylene flame, is largely followed. Plumbing work on ships is of a heavy character. Special fittings such as water closets arranged so that they may be securely bolted to the decks, are used.

Materials. — The following is a short description of materials used in plumbing with methods of jointing.

Sheet lead may be either cast or milled. Cast sheet lead is lead poured over a prepared sand-bed and struck off to a required thickness. With milled sheet lead, sheet copper, zinc and iron, the metals are passed backwards and forwards between huge rollers until they assume a required thickness, consequently these latter are more dense.

All sheet metals used for roof coverings are joined by rolls, laps, welts, etc., which, while providing fixings allow for movements of the metals under the influence of varying temperatures. Soldering, brazing and rigid fixings are not resorted to unless unavoidable.

For internal work, lead is jointed by soldering with wiped joints. Copper is brazed and iron is welded.

Lead pipes are squirted from a machine under great pressure while the metal is in a plastic condition. These are joined by wiped soldered joints, which process consists of pouring or splashing heated solder on to prepared ends, manipulating them until the pipe is sufficiently heated to permit a surface alloy to form, and then the solder is wiped with a cloth.

Lead burning consists of applying an intense flame, produced by mixing coal-gas and oxygen, oxygen and acetylene or other combinations of gases to prepared edges and fusing them together with local heat; extra lead is added from a filling rod.

Cast iron pipes are made by pouring molten metal into a vertical mould with the socket end downwards, or into a horizontal water-cooled mould, which revolves rapidly, thereby spinning the metal to shape with increased density. These pipes are jointed by filling the sockets with yarn and metallic lead tightly staved home with special tools.

Wrought iron and steel pipes are made from strip metal bent to form a tube and welded by either butting or lapping the edges. Lap-welded tubes are the best. These pipes are usually made in three strengths, designated gas, water and steam, and are jointed by threading the ends and screwing together with prepared fittings.

Fittings used with wrought iron and steel tubes are either made from strip metal bent to shape and welded, or of malleable iron, which is cast iron rendered less brittle by extended annealing.

Iron pipes are protected from corrosion by galvanizing, which consists of coating the metal with zinc; painting; subjecting them to the action of superheated steam which forms a protective coating of magnetic oxide on the surface or by dipping them while hot into a bath containing a mixture of coal tar, pitch, resin and linseed oil, the latter process being known as Dr. Angus Smith's method.

Copper tubes are made by drawing extrusions from cast billets over mandrils, with huge machinery. When of stout substance, these tubes are joined by screwed and socketed joints. Owing to the great strength and excellent physical properties of this metal, it has been found that tubes of thin substance or light gauges are extraordinarily strong, although not of sufficient thickness to cut a thread into their walls. The comparatively recent introduction of compression joints, whereby soundness is assured by simply compressing the ends of tubes in gun-metal joints, has rapidly brought these tubes into prominence for use in connection with hot and cold water supplies and other features of plumbing, thus facilitating installations *de luxe* at comparative costs.

Welding operations in plumbing are usually carried out by use of the oxy-acetylene flame (*q.v.*). (W. Sco.)

PLUM CURCULIO, a North American curculionid beetle, or weevil (*Conotrachelus nenuphar*). This insect is confined to North America east of the Rocky mountains. It ranges as far north as Manitoba and Quebec, and as far south as Victoria, Texas, and northern Florida. In this territory it is a serious enemy to stonefruits and also attacks the apple and other pomaceous fruits. It is especially injurious to all varieties of plums, and to peaches and cherries. Its original food was probably the fruit of native *Crataegus*.

The adult 'curculio is small (about ¼ in. long), dark brown in colour, with whitish markings on the thorax and the hinder part of the wing-covers. It lays its eggs in holes next to a crescent-shaped cut made in the skin by the beetle's beak. The function of the crescent-shaped cut is to kill the spot in the fruit containing the egg, so that the latter will not be crushed by the rapidly growing fruit. The larvae penetrate the flesh of the fruit, and a number of them may occur in the same plum or peach. On reaching full growth, the larva leaves the fruit and enters the soil, forming a cell in which it transforms successively to the pupa and adult. It rests in the pupal stage for two or three weeks. The resulting beetles feed upon the fruit and foliage until the approach of cold weather, when they enter hibernating quarters in protected places such as under trash in the orchards or in near-by woods. In its more northern range the insect has but one generation annually. In the far south some individuals develop a second generation.

The plum curculio is a great enemy to orchards. It was estimated in 1938 that the annual loss through its work in the United States was about $10,000,000. It has several natural enemies among the hymenopterous and dipterous parasites, and it is destroyed by a few species of predatory insects. The fruit attacked by it often falls to the ground, and under such conditions poultry destroy many of the pests.

Fruit growers rely chiefly on spraying with lead arsenate for the control of the plum curculio. The foliage of the peach is particularly susceptible to injury by arsenicals, although most of this can be overcome by the addition of lime or of zinc sulphate and lime.

The sprays on peach are usually combined with a self-boiled lime sulphur or one of the so-called wettable sulphurs to control various diseases, especially brown rot, which often gains entrance into the fruit at points injured by the curculio.

In areas in which a second brood of the curculio develops and where the insect becomes especially abundant, spraying is supplemented by a number of other practices, including the jarring of the trees and the capturing of the beetles on sheets placed underneath, the picking up and destruction of infested wormy drop peaches, and cultivation during the period when the insect is transforming in the ground and when it is readily injured by any disturbance of the soil.

Detailed information on the control of the insect may be obtained from State Agricultural Experiment Stations or from the U.S. Department of Agriculture. (L. O. H.)

PLUMER, HERBERT CHARLES ONSLOW PLUMER, 1ST VISCOUNT, of Messines, cr. 1929 (1857–1932), British field-marshal, was born on March 13, 1857, and entered the army in 1876. He served on the Red Sea littoral in 1884, and in 1896 commanded a mounted regiment in the Matabele Campaign. Before the outbreak of the South African War (1899) he raised the Rhodesian field force, which he commanded during the early months of the contest. He was promoted major-general on the conclusion of hostilities.

In May 1915 Sir Herbert Plumer was selected to lead the II. Army on the Western Front. His army was not very actively engaged during the remainder of 1915, nor yet in 1916, but on June 7, 1917, Plumer gained a signal victory at Messines, *(See* YPRES, BATTLES OF.) In November he took charge of the British troops sent to the basin of the Po after the Italian defeat at Caporetto, and in the following March was recalled to Flanders to resume the leadership of the II. Army just before the great German offensive started. In the general advance in August, his army took part in the operations for the recovery of Belgian Flanders. At the peace he received a peerage, promotion to field-marshal and a grant of £30,000. He subsequently commanded the British forces on the Rhine for a short time. From 1919 to 1925 he was governor of Malta, and from 1925 to 1928 high commissioner for Palestine. He died July 16, 1932.

PLUMPTRE, EDWARD HAYES (1821–1891), English divine and scholar, was born in London on Aug. 6, 1821. A scholar of University college, Oxford, and a fellow of Brasenose, he was ordained in 1847, and became professor of pastoral theology at King's college, London. in 1863 he was given a prebendal stall at St. Paul's, and from 1869 to 1874 he was a member of the committee appointed by Convocation to revise the authorized version of the Old Testament. He was Boyle lecturer in 1866–67 ("Christ and Christendom"), and Grinfield lecturer on the Septuagint at Oxford 1872–74. After successively holding the livings of Pluckley and Brickley in Kent, he was installed in 1881 as dean of Wells. He died on Feb. 1, 1891.

Plumptre translated the plays of Sophocles (1865) and Aeschylus (1868), and the *Divina commedia* of Dante (1886). In verse his main achievements were *Lazarus* (1864), and *Master and Scholar (1866).* Among his many theological works may be mentioned *An Exposition of the Epistles to the Seven Churches of Asia* (1877), *The Spirits in Prison* (1884), "The Book of Proverbs" (which he annotated in the Speaker's *Commentary),* the "Synoptic Gospels, Acts, and II. Corinthians," in Bishop Ellicott's *New Testament Commentary,* and *Life of Bishop* ***Ken*** *(1888).*

PLUNKET, OLIVER (1629–1681), Irish Roman Catholic divine, was born at Loughcrew, Co. Meath. He was appointed archbishop of Armagh and primate of Ireland in July 1669 and in November he was consecrated at Ghent, reaching Ireland in March 1670. The measures following on the Test Act bore hardly upon him, and in Dec. 1678 he was imprisoned in Dublin Castle for six weeks. Accused of a share in the Irish branch of the "Popish Plot," he was brought to London, and in June 1681 arraigned in the King's Bench, charged with conspiring to bring a French army to Carlingford. He made a good defence, but on the most absurd of evidence the jury convicted him of treason, and on July 1, he was hanged, drawn and quartered at Tyburn.

PLUNKET, WILLIAM CONYNGHAM PLUNKET, 1ST BARON (1764–1854), Irish lawyer, orator and statesman, was born in the county of Fermanagh in July 1764, the son of a Presbyterian minister, and studied at Trinity college, Dublin. Having entered Lincoln's Inn in 1784, Plunket was called to the Irish bar in 1787. He gradually obtained a considerable practice in equity and was made a king's counsel in 1797.

In 1798 he entered the Irish parliament as member for Charlemont. He was an anti-Jacobin Whig of the school of Burke, and a fervent Irish patriot. But he was a sincere admirer of the constitutional government of England as established in 1688; he even justified the ascendancy it had given to the Established Church, although he thought that the time had arrived for extending toleration to Roman Catholics and dissenters. To transfer it to Ireland as thus modified, and under an independent legislature, was the only reform he sought for his country; he opposed the union because he thought in incompatible with this object.

When Plunket entered the Irish parliament, the Irish Whig party was almost extinct, and Pitt was feeling his way to accomplish the union. In this he was seconded ably by Lord Castlereagh, by the panic caused by a wild insurrection, and by the secession of Grattan from politics. When, however, the measure was brought forward, among the ablest and fiercest of its adversaries was Plunket, whose powers as a great orator were now universally recognized. His speeches raised him immediately to the front rank of his party; and when Grattan re-entered the moribund senate he took his seat next to Plunket, thus significantly recognizing the place the latter had attained.

After the union Plunket returned to the practice of his profession, and became at once a leader of the equity bar. In 1803 he was selected as one of the Crown lawyers to prosecute Emmet. For his speech on this occasion he was exposed to much obloquy, and more especially to the abuse of Cobbett, against whom he brought a successful action for damages. In 1803, in Pitt's second administration, he became solicitor-general, and in 1805 attorney-general for Ireland; and he continued in office when Lord Grenville came into power in 1806. Plunket held a seat in the Imperial parliament during this period, and there made several able speeches in favour of Catholic emancipation, and of continuing the war with France; but when the Grenville cabinet was dissolved he returned once more to professional life.

In 1812 he re-entered parliament as member for Trinity college, and identified himself with the Grenville or anti-Gallican Whigs. He was soon acknowledged as one of the first orators, if not the first, of the House of Commons. In 1822 Plunket was once more attorney-general for Ireland, with Lord Wellesley as lord-lieutenant. One of his first official acts was to prosecute for the "bottle riot," an attempt on his part to put down the Orange faction in Ireland. He strenuously opposed the Catholic Association, which about this time, under the guidance of O'Connell, began its agitation. In 1825 he made a powerful speech against it; thus the curious spectacle was seen of the ablest champion of an oppressed church doing all in his power to check its efforts to emancipate itself. In 1827 Plunket was made master of the rolls in England; but, owing to the professional jealousy of the bar, who regarded an Irishman as an intruder, he resigned in a few days. Soon afterwards he became chief justice of the common pleas in Ireland, and was then created a peer of the United Kingdom. In 1830 he was appointed lord chancellor of Ireland, and held the office, with an interval of a few months only, until 1841, when he finally retired from public life. He died on Jan. 4, 1854, and was succeeded by his eldest son, Thomas Spen Plunket (1792–1866), bishop of Tuam, as and baron. *See* the *Life of the First Lord Plunket* (1869), by his grandson, David Robert Plunket.

PLUNKETT, SIR HORACE (CURZON) (1854-1932), K.C.V.O. (1903), son of the 13th Baron Dunsany, was born on Oct. 24, 1854, and educated at Eton and Oxford. After engaging in cattle ranching for ten years, his interest in agriculture led him to devote himself to the promotion of agricultural co-operation, and in 1894 he founded the Irish Agricultural Organization Society. As a member of parliament from 1892 to 1900, he strongly advocated the cause of agriculture, and in 1899 he was appointed vice-president of the department of agriculture and technical instruction for Ireland. Two years later he became commissioner of the Congested Districts Board in Ireland. He was elected F.R.S. in 1902, and in 1919 endowed a trust, known by his name, for the development of agriculture. He presided over the Irish Convention of 1917–18, and was a Senator (1922–23) of the Irish Free State. He died March 26, 1932.

His works include, *Ireland in the New Century* (1904); *The Rural Life Problem of U.S.* (1910); *Some Tendencies of Modern Medicine* (1913); and *A Better Way* (1914).

PLURALISM. The term describes certain schools of philosophical thought. It is, indeed, distinctive of one of the two groups into which metaphysical theories may be divided by what is perhaps the profoundest of the many differences apparent between the various directions taken by the speculations of eminent philosophers. In short, every philosophical system is either singularistic or pluralistic; that is, it takes for its starting point, and for the guiding principle which directs its development, the idea of the essential unity of reality; or, on the other hand, it regards as fundamental the characters of diversity and plurality which are everywhere in evidence in the realms open to observation.

Nevertheless, the term "pluralism" is by no means definite in meaning. On the contrary it is ambiguous and capable philosophically of a number or different meanings, each of which, however, refers to some peculiarly radical distinction in philosophic thought. But, as so frequently happens in such cases, the word has tended more and more to become restricted in meaning to one particular type of theory. This is perhaps an example of the survival of the fittest, for it is probable that what is nowadays generally meant by "pluralism" is capable of giving a better account of itself and of putting up a stronger defence than any of the other kinds of theory which may be included within the scope of the term as literally interpreted

QUALITATIVE PLURALISM

In the first place the term "pluralism" may have a *qualitative* meaning. One of the oldest problems of philosophy is that which concerns itself with the question whether the ultimate fundamental stuff, which is the ground of reality, is a single substance or includes a number of substances with differing attributes. Theories founded on the supposition that there are many ultimate substances, or at any rate more than one, are "pluralistic" in the qualitative sense of the term.

As a matter of fact only one theory of this type has ever been seriously propounded and effectively defended. This is the theory of "dualism," which holds that there are two kinds of fundamental substance. The two substances of dualism are commonly termed "mind" and "matter." and the distinctive attributes assigned to them are not merely different but are strictly incomparable with one another. The essential property of "mind" is thought; that of "matter" is extension. Dualism, which probably approximates more nearly than any other metaphysic to the practical, if unformulated, belief of the ordinary man who does not concern himself with philosophical analysis, recurs at intervals, in one form or another, throughout the history of speculative thought. But the clearest statement and the most able defence of it are to be found in the writings of Descartes (1596–1650), with whom modern philosophy is generally regarded as beginning. Descartes starts from the existence of the self. The fact of consciousness is, he holds, quite undeniable. He then proceeds to deduce the existence of God from the presence in our minds of an idea of God which embraces attributes so exalted as to make it inconceivable that the idea could have originated in anything so limited as the human mind. Accordingly its presence can only, he thinks, be explained by an external cause, namely, God himself. From this it is an easy step to the existence of matter. For God, being perfect, would not falsify our clearest perceptions; and among these is the perception of matter. Moreover, the attribute of matter which is most distinctly apparent to us is its extension, or occupancy of space, and this must accordingly be regarded as the essentially distinctive property of material substance.

We need not stop to consider in detail the defects of this argument which Descartes elaborated with remarkable thoroughness and ingenuity. It is sufficient to point out that the essential feature of his analysis, namely, the division of reality into mind and matter, was at fault. Matter as he conceived it, so far from being a substance and therefore concrete in the most complete sense, was altogether abstract. The same is true, though to a lesser extent, of his conception of mind. In fact the dualistic division of the universe into mind and matter, though it starts, as all philosophical theories must start, from the elements given in immediate experience, proceeds by abstracting some of these elements and elevating them to the position of concrete entities in their own right. This process, useful and indeed necessary for the purposes of such bodies of knowledge as the special sciences, is too artificial to yield anything of metaphysical value. Metaphysics, to achieve its end, must keep in constant touch with the concrete, that is, with experience. But a process of reasoning like that adopted by Descartes inevitably tends further and further away from the concrete to the abstract. The practical consequences of this for dualism are seen in its inability to attack with any success such problems as those concerned with the relation of body and mind, the nature of the external world, and the question as to how knowledge is possible at all.

Dualism is the only form of qualitative pluralism which has ever been seriously developed. (But it should perhaps be pointed out that the cosmology of Empedocles [490–430 B.C.], with its four elements, earth, air, fire, water, together with the qualitative atomism of his follower Anaxagoras, who regarded the universe as made up of a countless number of qualitatively simple elements, are really forms of qualitative pluralism.) It is true that some of the doctrines of theosophy and allied systems appear to tend to a pluralism of more than two kinds of substance, but these doctrines are essentially speculative and have never been developed in a form sufficiently definite, nor defended by arguments sufficiently logical, to affect at all seriously the development of philosophical thought. We may therefore conclude this brief survey of qualitative pluralism and pass on to consider quantitative pluralism.

QUANTITATIVE PLURALISM

. Quantitative pluralism includes all those theories which hold reality to be made up of a number of relatively independent substantial entities, each of which exists, at any rate to some extent, in its own right. Quantitative pluralism is thus sharply contrasted with those forms of singularism or absolutism which regard reality as ultimately consisting of a single individual being, of which the many and diverse elements which seem to exist in the world are no more than mere appearances, qualities, or modes, having no real existence in themselves. This contrast has sometimes been expressed by saying that whereas, according to pluralism, the multitude of entities which appear to find a place in the universe have a "substantival" existence, according to singularism their existence is merely "adjectival" as attributes or aspects of the one real being.

We may classify types of quantitative pluralism according to their doctrine regarding the substance composing the real entities which they postulate. This substance may be material, spiritual (or mental), or it may be neutral in the sense that its essential character is unknown, or, if known in part, cannot be placed definitely in any particular category.

Neutral Pluralism.—The first kind of neutral pluralism, where the nature of the ultimate substance of which individual entities are composed is taken as unknown, though not altogether untenable, is philosophically barren and need not detain us. Its best known exponent is Herbart, who contended that reality is ultimately made up of a number of independent entities, of the inner nature of which we could know nothing, although they were the ground of all the facts of which knowledge was possible. Herbart's theory did not seriously affect the course of metaphysical speculation. It was largely a reaction against the philosophy of Hegel (1770–1831).

The second kind of neutral pluralism, in which the nature of the ultimate reals is regarded as known, at least in part, but as not definitely classifiable, has been developed only in comparative!~recent years. William James (1842–1910), foremost and most original of American philosophers, seems to have been the first to have given it clear expression, though he was probably influenced to some extent by the speculations of the German physicist Ernst Mach. James based his belief on what he himself described as a "radical empiricism." He held essentially that the world of which we have knowledge is made up of a number of fundamental elements which may be taken as arranged in different types of patterns or sequences. If the elements are set out in one way we get the kind of structures or series which make up the contents of what we call "minds." Another method of selecting the elements will give the type of arrangements which constitute those entities which we know as material objects or physical events. Yet the elements of a pluralistic universe of this kind are not to be regarded as themselves essentially mental or material—they are of "neutral" stuff. Incidentally James was the first thinker to give the term "pluralism" currency among English-speaking philosophers, though in Germany we find it even as early as Wolff, the disciple of the great Leibniz (1646), to whom we shall refer later.

More recently still, a neutral pluralism which in some respects exhibits a strong family likeness to that of William James has been developed in England by Bertrand Russell, who describes his own theory by the name "logical atomism." Russell's procedure consists essentially of an exceptionally detailed analysis of the material open to immediate observation, especially the particulars given in sensation and in imagery, followed by an attempt to build up from this material alone constructions corresponding to the fundamental concepts characteristic of physics and of philosophy, or to such among these concepts as analysis may show to be valid within their limits. Russell has applied his method to the analysis both of "mind" and of "matter." Current developments in the theories of some of the American neo-realists seem also to be moving along rather similar lines.

There can be no doubt that a neutral pluralism of the type we have outlined is in many respects an extremely powerful theory. Not only does it establish a metaphysical position which calls for serious consideration, but it introduces into the philosophical world an analytic technique the value of which it would be difficult to overestimate. It is not possible to undertake a detailed criticism here; but it is probable that the chief objections to current expositions of the theory are to be found in the fact that they dispose of some of the traditionally pressing questions of metaphysics with arguments which may be regarded as unduly facile, to say the least; while many will feel that most of the really ultimate problems are left untouched. No doubt the supporters would retort that these problems are insoluble, and no more time should be wasted on them.

Material Pluralism.— There remain for consideration material pluralism and spiritual pluralism. For the material pluralist the world consists, in the last analysis, entirely of particles or bodies, the properties of which are among those commonly associated with the concept of matter, in particular mass (or, perhaps, electric charge); position and (perhaps) extension in space; and position and (perhaps) extension in time.

The earliest philosophers to give coherent expression to a theory of this kind were the Greeks, Leucippus and Democritus (about 460–350 B.C.). We owe to Leucippus the first clear statement of philosophic materialism, namely, the reduction of all reality to the primary qualities of matter. The denial of qualitative differences between the elements was combined with an atomic theory of matter which was conceived as split up into an infinite number of minute reproductions of itself, these "atoms" being invisible to the eye, eternal and unchangeable, and differing from one another only in shape and size. The scientific development of this point of view by Democritus was an outstanding philosophical achievement which marked a definite stage in the progress of the speculative thought of antiquity.

Although material pluralism, or atomistic materialism, suffered long periods of eclipse during the middle ages and the Renaissance, it has been revived at intervals and was finally given complete and powerful expression as a result of the great advances made during the last century in physical and biological science. Twentieth century materialism is chiefly associated with the name of Herbert Spencer (1820–1903), who developed an extremely comprehensive system based on three current doctrines which were just then achieving remarkable triumphs in the respective realms of chemistry, physics and biology. These doctrines were the atomic theory, the principles governing the distribution and conservation of energy, and the Darwinian theory of evolution by natural selection. In a swift and temporarily overwhelming advance, philosophic materialism reached its zenith. But its success was a transient one. Before the end of the century it was already beginning to stagger under the powerful blows of its opponents, and during the years that have since elapsed it has ceased to be regarded as a tenable metaphysical theory. It can probably be safely stated that it will never again be revived unless it be in so changed a form as to be unrecognizable. Briefly, its downfall may be said to be due to three inherent defects. In the first place the concepts and principles on which it is based are merely descriptive in character, that is, they do no more than give an account of what actually occurs, or is presumed to occur, in the world, and do not even begin to provide any kind of genuine explanation of reality. Not only this, but secondly, modern analysis has shown that most of the conceptions of conventional materialism, so far from corresponding to anything really concrete, are most probably no more than abstractions from, or constructions made up of, the content perceived by minds in sense-experience or perception. Thirdly, materialism has never yet been able to give an account of the origin of mind which could possibly be accepted as a satisfying one, while its consequent attempts to dismiss mind as unreal or at most real but ineffective, have been extremely facile and altogether unconvincing.

Spiritual Pluralism.— There remains spiritual pluralism, and it is to this type of theory that the name "pluralism" is most commonly understood to apply at the present time. It is the belief that the world consists ultimately of an indefinite number of beings, essentially spiritual in character. Its origin can be traced back, albeit in a vague form, even to the obscure hylozoism of the ancients, who regarded all nature as alive and informed with a countless number of animate beings, to whose activities all her manifestations were due. But at this epoch the distinction between the physical and ihe mental had not begun to emerge clearly, and only when this occurred was it possible for the development of spiritual pluralism to take place.

But it was not till the coming of Leibniz (1646) that spiritual pluralism at last received definite and coherent statement, together with logical development. Leibniz started from a conception of mind directly opposed to that which had been given currency by Locke and the English empiricists. The latter regarded the mind as a passive receiver of impressions from objects external to it. But Leibniz realized that it is the essence of mind to be active. In his famous work, the *Monadology,* he elaborated the theory that reality consists of an infinite number of individual forces or agents, psychic in nature, which he termed "monads." These individual minds or spirits exhibited every degree of mental development and complexity, from that of beings even higher than man (the "angels") right down to that of psychic entities of so low an order that Leibniz described their being as a *mens momentanea* or mere flash of conscious awareness. In this hierarchy of mind a complete continuity from one level of development to another was postulated.

Leibniz conceived each monad as reflecting within itself the rest of the universe from its own particular "standpoint." The perceptions of each monad were partly conditioned by its particular level of development, and constituted the appearance to it of all the other monads. But Leibniz met with great difficulty at this point. He had conceived the monads as absolutely independent reals with no ground of connection between them. But how could the appearance of beings other than itself arise in such an isolated entity as a monad, which, being "windowless" (as Leibniz put it), was impervious to external influence? Leibniz tried to solve this difficulty by his doctrine of "Pre-established Harmony," which involved the introduction of the idea of God into his system. According to this doctrine the development of the universe is the working out of a plan conceived by God when he created the monads. Each monad contains the principle of its own development, but the course of that development is so arranged that, at any instant, the unfolding order of phenomena within each monad is an accurate representation of the rest of the universe at that instant. This may be illustrated by the analogy of a number of clocks set going by the watchmaker so as always to keep time with one another, though actually there is no connection between them.

The spiritual pluralism of Leibniz, though it continued to exert a dominant influence in Germany until the time of Kant (1724–1804), did not find much vogue among English-speaking philosophers until comparatively recent times. During the last years of the 19th and the early years of the present century, however, it was adopted and developed, in the reaction against crude materialism, by one or two influential thinkers, including Howison in America and the late James Ward in England. Though his system is founded on that of Leibniz, Ward introduced very considerable modifications, exposing the weaknesses of the original theory and endeavouring to eliminate them. He pointed out that pluralism has to explain away three difficulties. Two of these are concerned with what he calls respectively "the upper limit" and "the lower limit" of pluralism. If we are to make reality at all intelligible we must, with Leibniz, postulate continuous development of the monads. But from what did this development originate and how was it set going? We can trace it downwards to ever lower levels, but we cannot find within it the principle and the explanation of its own origin. On the other hand, whither is it tending? A mere plurality of independently developing beings cannot contain any indication of a satisfying explanation which shall harmonize, and give point to, the manifold separate developments. Thirdly, there is the old difficulty, encountered by Leibniz, as to the impossibility of interaction between the monads if these are really independent individuals.

Ward comes to the conclusion that a thoroughgoing pluralism is untenable. It must be supplemented by a principle of unity which, while it does not destroy the conception of the monads as real individuals having a "substantival" and not a merely "adjectival" existence, at the same time enables us to get rid of the difficulties raised by a pure pluralism. Ward finds his unifying principle in a theistic theory, conceiving God as a supreme being transcending the world of the many and yet immanent in it. On the one hand God, as creator, originates monadic development; on the other, He stands as the supreme unity to a harmonious co-existence with whom that development is for ever more nearly approaching. Moreover, as immanent in the world, He mediates the interaction between the monads.

It is impossible to enlarge here upon the metaphysical theory thus outlined. It must suffice to point out that it has many important possibilities and merits serious consideration. Moreover, it is a healthy corrective to the cruder forms of materialism, for while the latter are ultimately based on conceptions which can be shown to represent pure abstractions, spiritual pluralism starts from a fact of which each of us is certain from his own immediate experience, namely, the concrete existence of such a thing as an individual "mind," or better, perhaps, "spirit."

A form of spiritual pluralism is being developed in America by the Personal Idealists; while in England Wildon Carr has propounded an interesting monadism with especial reference to the philosophical importance of Einstein's principle of relativity and its apparent implication of the reality and profound significance of the existence of individual observing minds.

BIBLIOGRAPHY.—Descartes, *Meditations* (1640); Leibniz, *Monadology* (1714); Spencer, *Synthetic Philosophy: First Principles* (1862, 1890); Latta, *Leibniz: The Monadology,* etc. (1898); Howison, *The Limits of Evolution* (1901); James, *A Pluralistic Universe* (1908); Ward, *The Realm of Ends* (1912); C. A. Richardson, *Spiritual Pluralism and Recent Philosophy* (1919); Bertrand Russell, *The Analysis of Mind* (1921) and *The Analysis of Matter* (1927); Wildon Carr, *A Theory of Monads* (1922).
(C. A. R.)

PLURALITY, a term applied particularly to the holding of two or more offices by the same person (called then a *pluralist).* In ecclesiastical law, plurality, or the holding of more than one benefice or preferment, was always discountenanced, and is now prohibited in England by the Pluralities Act, 1838, as amended by the Pluralities Act, 1850, and the Pluralities Acts Amendment Act 1885. By the latter act a provision was made that two benefices might be held together, by dispensation of the archbishop on the recommendation of the bishop, if the churches be within four miles of each other, and if the annual value of one does not exceed £200. *(See* BENEFICE.)

In the United States, the term is used in election law to denote the number of votes which a candidate has received for a public office in excess of the number received by any one of two or more other candidates.

PLURALITY OF CAUSES, in logic, is the view that one and the same kind of effect can be produced in different cases by different causes. This is quite distinct from the question whether the cause of an effectis as a rule a complex or multiplicity of several or many constituent or contributory factors or conditions. Assuming the complexity of each cause, there still remains the further question whether any one of several separate causes can produce the same kind of effect as another. In other words can one cause ever act vicariously for another? (Hence the alternative, and less ambiguous name, "vicarious causes.") J. S. Mill is the best known advocate of the doctrine of plurality of causes. Examples taken from daily experience seem to support the view. Many different causes can produce death for example. For most practical purposes the doctrine holds good. The whole system of substitutes, in peace and in war, is based on it. But for practical purposes many effects are sufficiently similar, although they are really very different when closely scrutinised. The *total* state called death is very different according as one cause or another led to it. The holding of coroner's inquests is based on the assumption that a close examination of the state of a dead body can help to determine the precise cause of death in each case. Similarly with all cases in which details matter. The total effect produced by one kind of cause is never precisely the same as that produced by any other. So that strictly speaking the doctrine of plurality of causes is not true. But where the interest is centred in broad kinds of effect, and differences of detail do not matter much, there the doctrine holds good for all practical purposes.

See J. S. Mill, *System of Logic* (1875 etc.); J. Venn, *Empirical Logic* (1889); J. Welton, *Manual of Logic* (1896).

PLUSH. Plush fabrics are characterized by a fur-like or velvet pile surface somewhat typical of the short hairy pelts of certain animals as, for example, the seal and otter. A plush pile surface is developed in woven fabrics by causing a series of tufts of pile to project more or less vertically from a foundation texture. The tufts of pile virtually consist of short lengths of warp threads usually of silk, artificial silk or mohair yarn interwoven with the foundation fabric in such a manner that the tufts of pile are looped under the picks of weft by which they are securely retained in the fabric.

PLUTARCH (Gr. Πλούταρχος) (*c.* A.D. 46–120), Greek biographer and miscellaneous writer, was born at Chaeronea in Boeotia. After having been trained in philosophy at Athens he travelled and stayed some time at Rome, where he lectured on philosophy and undertook the education of Hadrian. (There seems no authority for this statement earlier than the middle ages.) Trajan bestowed consular rank upon him, and Hadrian appointed him procurator of Greece. He died in his native town, where he was archon and priest of the Pythian Apollo. In the *Consolation to his Wife* on the loss of his young daughter, he tells us (§ 2) that they had brought up four sons besides, one of whom was called by the name of Plutarch's brother, Lamprias. We learn incidentally from this treatise (§ 10) that the writer had been initiated in the secret mysteries of Dionysus, which held that the soul was imperishable. He seems to have been an independent thinker rather than an adherent of any particular school of philosophy. His vast acquaintance with the literature of his time is everywhere apparent.

The celebrity of Plutarch, or at least his popularity, is mainly founded on his 46 *Parallel Lives.* He is thought to have written this work in his later years after his return to Chaeronea. His knowledge of Latin and of Roman history he must have partly derived from some years' residence in Rome and other parts of Italy *(Demosth.* § 2), though he says he was too much engaged in lecturing (doubtless in Greek, on philosophy) to turn his attention much to Roman literature during that period.

Plutarch's design in writing the *Parallel Lives—for* this is the title which he gives them in dedicating *Theseus* and *Romulus* to Sosius Senecio—appears to have been the publication, in successive books, of authentic biographies in pairs, taking together a Greek and a Roman. In the introduction to the *Theseus* he speaks of having already issued his *Lycurgus* and *Numa,* viewing them, no doubt, as bearing a resemblance to each other in their legislative character. Theseus and Romulus are compared as the legendary founders of States. In the opening sentence of the life of Alexander he says that "*in this book* he has written the lives of Alexander and Caesar" (Julius), and in his *Demosthenes,* where he again (§ 1) mentions his friend Sosius, he calls the life of this orator and Cicero the fifth book. (It is quite evident that the original order of the books has been altered in the series of *Lives* as we now have them.) It may, therefore, fairly be inferred that Plutarch's original idea was simply to set a Greek warrior, statesman, orator or legislator side by side with some noted Roman celebrated for the same qualities, or working under similar conditions. Nearly all the lives are in pairs; but the series concluded with single biographies of Artaxerxes, Aratus (of Sicyon), Galba and Otho. In the life of Aratus, not Sosius Senecio, but one Polycrates, is addressed.

The *Lives* are works of great learning and research, long lists of authorities are given, and they must for this very reason, as well as from their considerable length, have taken many years in compilation. It is true that many of the lives, especially of Romans, do not show such an extent of research. But Plutarch must have had access to a great store of books, and his diligence as an historian cannot be questioned, if his accuracy is in some points impeached. From the historian's point of view the weakness of the biographies is that their interest is primarily ethical. The author's sympathy with Doric characters and institutions is very evident; he delights to record the exploits, the maxims and virtues of Spartan kings and generals. This feeling is the key to his apparently unfair and virulent attack on Herodotus, who, as an Ionian, seemed to him to have exaggerated the prowess and the foresight of the Athenian leaders.

The voluminous and varied writings of Plutarch exclusive of the *Lives* are known under the common term *Opera moralia.* These consist of above 60 essays, some of them long and many of them rather difficult, some too of very doubtful genuineness. Their literary value is greatly enhanced by the large number of citations from lost Greek poems, especially verses of the dramatists, among whom Euripides holds by far the first place. The principal treatises in the *Opera moralia* are the following: —

On the Education of Children; How a Young Man Ought to Hear Poetry, on the moral aspect of Homer and the tragedians, with quotations *On the Right Way of Hearing* (Περὶ τοῦ ἀκόυειν) is another educational essay. Among the moral essays may be included: *How a Flatterer may be Distinguished front a Friend, How One May be Conscious of Progress in Goodness,* addressed to Sosius Senecio, consul under Nerva and Trajan; three short essays, *On Having many Friends, On Chance* and *On Virtue and Vice,* mainly valuable for quotations from poets otherwise lost; *Advice to the Married, On the Late Vengeance of the Deity, On the Genius of Socrates, On Superstition, On Exile,* a fine essay plentifully illustrated with quotations; *The Amorous Man,* and the *Gryllus,* an entertaining dialogue proving the moral superiority of many animals over man. The speakers are Circe, Odysseus, and a pig; the pig wins.

Another group includes some physical treatises such as *Precepts about Health,* which do not often coincide with modern ideas; *On the Face of the Moon's Disk,* which throws light on ancient astronomical theory; *Whether Land or Water Animals are the Cleverer; Whether Water or Fire is the More Useful; On Primary Cold; Questiones Naturales* and *On Flesh Eating.* The historical treatises include: *On the Fortune of the Romans,* two essays on the career of Alexander, *Whether the Athenians were More Renowned for War or for Wisdom,* and the famous *De Malignitate Herodoti,* charging Herodotus with unfair treatment of the non-Ionic States. There are also a purely metaphysical work, the *Platonic Questions,* and two political treatises, *Should a Man Engage in Politics when No Longer Young?* and *Political Precepts.* There are also two *Consolations,* one to Apollonius for his son, and one to his own wife for their daughter. There remains a group of his most valuable and interesting works, on archaeological questions generally, and especially religious history. These include *On Isis and Osiris, On the Cessation of Oracles, On the Pythian Responses* (an appendix to the last), and *On the* E *at Delphi,* of the exclusively ritual discussions; and t o miscellaneous works, which contain a vast collection of information and discussions on points of almost every kind, the *Symposiaca* (9 books), and the *Quaestiones Romanae* and *Graecae,* which is of considerable importance to classical archaeology. There is also the collection of *Short Sayings,* divided into (1) of kings and commanders, (2) of Spartans, and (3) of Spartan women. Doubt is thrown on the validity of The *Banquet of the Seven Wise Men, On Fate; Parallels; On Accepted Opinions and the Lives of the Ten Orators.*

BIBLIOGRAPHY.—Editio princeps, by H. Stephanus (1572); other complete editions by J. J. Reiske (1774–82), J. G. Hutten (1791–1804), T. Dohner and F. Dubner (1846–55). Of the *Lives,* there are editions by A. Coray (1809–14), C. Sintenis (1839–46; ed. min., 1874–81), and of many separate lives by Siefert-Blass, Sintenis-Fuhr, Holden, Hardy and others; Loeb ed., with trans. (11 vols. 1914–26). There are many English translations, of which the most popular is that by John and William Langhorne; also the old French version by Jacques Amyot (1559) from which Sir Thomas North's (1579) was made, newly edited by G. Wyndham (1895); many of the Roman lives have been translated, with notes, by George Long. The *Moralia* has been edited by D. Wyttenbach (1795–1830), and G. N. Bernardakes (1888–96) Loeb ed, with trans. (1927–). The old English translation by Philemon Holland (1603) has been revised by C. W. King and A. R. Shilleto in Bohn's *Classical Library* (1882–88), and a later translation by various hands (London, 1684–94), edited by W. W. Goodwin with introduction by R. W. Emerson, has been republished at Cambridge, Massachusetts (1874–78). Mention may also be made of P. Holland's *Roman Questions,* edited with introductory dissertations by F. B. Jevons (1892); *Roman Problems,* with essay on "Roman Worship and Belief," by G. C. Allen (1904); H. J. Rose, *The Roman Questions of Plutarch* (Text and Commentary, 1924); *De la Musique,* edit. H. Weil and Th. Reinach (1900); J. Oakesmith, *The Religion of Plutarch as expounded in his Ethics* (1902); Archbishop Trench, *A Popular Introduction to Plutarch* (1873); O. Gréard, *De la Morale de Plutarque* (1866); R. Volkmann, *Leben, Schrif n und Philosophie des Plutarch* (1869); R. Hirzel, *Plutarch* (1912). The earlier literature of Plutarch is very extensive, for which W. Engelmann, *Scriptores graeci* (1881), may be consulted.

PLUTARCH, of Athens (350?–430), Greek philosopher, head of the Neoplatonist school at Athens, was the son of Nestorius. His main principle was that the study of Aristotle must precede that of Plato, and that the student should be shown the fundamental points of agreement between them. With this object he wrote a commentary on the *De anima* which was the most important contribution to Aristotelian literature since the time of Alexander of Aphrodisias. This critical spirit reached its greatest height in Proclus, the ablest exponent of this latter-day syncretism. Plutarch was versed in all the theurgic traditions of the school, and believed in the possibility of attaining to communion with the Deity by the medium of the theurgic rites. Unlike the Alexandrists and the early Renaissance writers, he maintained that the soul which is bound up in the body by the ties of imagination and sensation does not perish with the corporeal media of sensation. He interposed between sensation and thought the faculty of Imagination, which is the activity of the soul under the stimulus of unceasing sensation, and provides the raw material for Reason. Reason is present in children as an inoperative potentiality; in its pure activity, it is the transcendental or pure intelligence of God.

See Marinus, *Vita Procli,* 6, 12; Zeller's *History of Greek Philosophy.*

PLUTO, a euphemistic name for the Greek god of the lower world (Gr. Πλούτων), properly Hades, Aïdes or Aïdoneus, "the Unseen." He was the son of Cronus and Rhea, and brother of Zeus and Poseidon. Having deposed Cronus, the brothers cast lots for the kingdoms of the heaven, the sea, and the infernal regions. The last, "the house of Hades," sometimes loosely called Hades, fell to Pluto. Here he ruled with his wife, Persephone, over the other powers below and over the dead. He is stern and pitiless, deaf to prayer or flattery, and sacrifice to him is of no avail; only the music of Orpheus prevailed upon him to restore his wife Eurydice. His helmet, given him by the Cyclopes after their release from Tartarus, rendered him invisible (like the Tarn —or Nebelkappe of German mythology). Being feared, he is usually alluded to by euphemistic epithets: Polydectes (the receiver of many), Clymenus (the Illustrious), Eubulus (the giver of good counsel). But, perhaps by contamination with a god of the fertility of the earth, he is also Pluto, the "giver of wealth" (a name that first occurs in the Attic poets of the fifth century), and at most of the centres of his cult he was so worshipped; At Elis alone he was Hades, the god of the dead. The plants sacred to him were the cypress and narcissus; black victims were sacrificed to him, as to all underworld powers. In art he was represented like Zeus and Poseidon, but sterner; his attributes are a sceptre and Cerberus; he carries the key of the world below and is frequently in company with Persephone.

PLUTO is the outennost known member of the planetary system, ninth in order of distance from the sun. It was discovered by C. W. Tombaugh of the Lowell Observatory on January 23, 1930 by examination of photographic plates of the region of the sky near the star δ Geminorum. The discovery was the result of a systematic search, both theoretical and observational, instituted by the late Percival Lowell because of his belief that the motion of Uranus gave evidence of the existence of a trans-Neptunian planet. It is believed among those most conversant with this field of astronomy, however, that the finding of Pluto was a happy accident of the search and that the discordance between theoretical and observed motion of Uranus is evidence of inaccuracy of the older observations and incompleteness of theory for that planet rather than of gravitational attraction by the newly-discovered one.

Pluto moves around the sun in an ellipse with major axis 79 astronomical units in length and minor axis three per cent shorter, passing within less than 30 units of the sun at perihelion (as in 1989 for instance) and receding to an aphelion distance of almost 50 units during the century and a quarter following. The orbital plane is inclined about 17 degrees to the plane of the ecliptic and is so oriented in space that the apparent path of the planet on the celestial sphere intersects the ecliptic near δ Geminorum and near π Sagittarii. The planet was near its northward crossing (or ascending node) when discovered and requires 248 years to make one complete circuit of its path. It should be noticed that it is only this inclination of the orbit of the outer planet which prevents the orbits of Neptune and Pluto intersecting in space.

Pluto appears of the fifteenth magnitude on the astronomical scale, that is of the brilliance of an ordinary candle four hundred miles from the observer; it is half as bright photographically and must therefore have a surface of slightly yellowish cast. The evidence so far adduced suggests a diameter about one-half and a mass about one-tenth that of the earth. Solar radiation provides illumination on Pluto about equal to that produced by a 75-watt mazda lamp at a distance of one yard, but furnishes so little heat that the surface temperature is probably below $-200°$ Centigrade.

PLUTO MONKEY, a guenon, *Cercopithecus leucampyx,* nearly allied to the mona monkey, which takes its name from the black fur of the under-parts, passing into blackish gray on the head and back. The violet-coloured face is fringed by large bushy whiskers and surmounted by a white band above the brows. The species extends from the Congo to Nyasaland.

PLUTUS, properly, the abundant increase of the earth; child of Demeter (*q.v.*) and Iasion; in art, usually shown as a child. alone or in company with Tyche, Eirene, Athena, or some other goddess. In popular thought, allegories and comedy, he was represented as Wealth. He was said to be blind.

PLYMOUTH, a city and county borough and seaport of Devonshire, England, 231 mi. W.S.W. of London. Pop. (est. 1938) 211,800. Area 14.9 sq.mi.

Plymouth, the Suton of Domesday, was afterward divided into the town of Sutton Prior, the hamlet of Sutton Valletort and the tithing of Sutton Ralph. The market, established about 1253, became in 1311 town property. In 1292 the town first returned members to parliament. In the 14th century it was often used for armies to and from France and it suffered from French attacks. In 1412 the inhabitants petitioned for a charter, which was granted Nov. 12, 1439, the town being the first in England to be incorporated by act of parliament. In the discovery of the new world it played an important part. Sir John Hawkins was port admiral and (in 1571) M.P. From Plymouth in 1577 Drake set out on his voyage round the world; in 1581 he became mayor and represented the borough in parliament during 1592–1593. Sir Humphrey Gilbert (M.P. 1571) sailed on his second colonizing expedition to America in 1583 from the port. Plymouth supplied seven ships against the Armada, and it was in the sound that the English fleet awaited the Spaniards. A stone on a quay at the Barbican records the fact that this was the last port touched by the Pilgrim Fathers on their voyage to America. During the Civil War the tonn withstood all efforts by the Royalists to take it, and it early declared for William of Orange. Plymouth was created a city in 1928 and the title of lord mayor was granted in 1935. Four years later its area was extended by almost 4,000 ac.

It lies at the head of Plymouth sound. stretching westward from the river Plym toward the mouth of the Tamar, from which it is separated by the township of East Stonehouse and the borough of Devonport, both of which were included in Plymouth in 1914. The water frontage of the "Three Towns" consists of Plymouth sound, with its inlets. The Cattewater and Hamoaze are flanked on the east and west respectively by high ground, on which are built forts. On the western side of the entrance to Cattewater is the Citadel, founded in the reign of Henry VIII and rebuilt by Charles II. It is a specimen of 17th century military architecture, an irregular bastioned pentagon in trace and during World War II was used as army headquarters and barracks. The adjacent Hoe extends along the northern edge of the sound. To the north is seen the town of Plymouth. In the sound is Drake's (formerly St. Nicholas's) island. The city suffered air raids during World War II, and much of it was destroyed. More than 50,000 houses had been damaged before the close of 1941 and among noteworthy buildings the Guildhall (which contained a contemporary portrait of Sir Francis Drake), the law courts, the municipal buildings, the G.P.O., the old Guildhall, the library and the city hospital were wiped out, along with the main shopping centres of both Plymouth and Devonport. Among churches, St. Andrews, a Perpendicular building of 1480–1520 restored in 1874, was destroyed, only the walls and clock tower remaining.

Plymouth is the seat of a Roman Catholic bishopric founded in 1851, the cathedral, in Wyndham street, being completed in 1858. The building is in the Early English style, and adjoining are the bishop's house and the convent of Notre Dame.

The "Port of Plymouth" in 1311 embraced Plympton, Modbury and Newton Ferrers, and received a customs grant from Richard II. In 143j sixty-five cargoes mere imported, and in the reign of Elizabeth it rose to be the foremost port in England. The 18th century saw a great development of trade with Virginia and the West Indies, and this resulted in the establishment of a sugar-refining industry that was maintained into the 20th century.

In 1749 the "town's water" was carried to the Barbican to supply shipping. The port of Plymouth as at present constituted embraces the waters of the Plymouth sound and the Hamoaze. The chief water area within the limits of the port is the sound with its inlets, the Cattewater, Sutton Pool, Mill Bay, Stonehouse Pool and the Hamoaze. The sound itself covers an area of 4,500 ac. and is sheltered from the southwest gales by a breakwater a mile long with a lighthouse at its eastern end. It was constructed in 1841. Cattewater, Sutton Pool and Mill Bay constitute the three mercantile harbours of Cattewater harbour, Sutton harbour and the Great Western docks, while Hamoaze was set aside for H.M navy. Cattewater harbour has an area of 260 ac. and 8,000 ft. of quayage space. Sutton harbour entered from Cattewater has a quayage space of 4,500 ft. Great Western docks at Mill Bay has an outer basin of 35 ac., an inner one of 13.

Steamers sail regularly from Plymouth for Australia, New Zealand, the Cape and North America. The port has productive fisheries. It has also a considerable export and import trade. As a naval station it is second only to Portsmouth. The city is served by the G.W. and S. railways.

The industries of Plymouth include soapmaking, manufacture of chemicals, artificial manure and paper staining. There is some electrical engineering, and a clothing factory. Plymouth has returned three members to parliament, from the Drake, Devonport and Sutton divisions, since 1918. Lady Astor, the first woman elected to the House of Commons, was returned in 1919.

PLYMOUTH, a town of Massachusetts, U.S.A., 37 mi. S.E. of Boston, on Plymouth bay; a port of entry and the county seat of Plymouth county. It is served by the New York, New Haven and Hartford railroad and in summer by buses from Boston. Pop. (1930) 13,042 and in 1940 it was 13,100. Visitors to the number of many thousands are brought annually by the historic interest of the town and its attractions as a summer resort. The modern town has important manufacturing industries (notably the largest cordage works in the world, with its own steamers bringing cargoes of sisal fibre from Yucatan). Plymouth has two large woollen mills. Other important industries are cranberry culture, herring fisheries and the propagation of clams. Lobster fishing is also an important industry.

Plymouth was the landing-place of the Pilgrims and the first permanent settlement by Europeans in New England. Plymouth Rock, the granite boulder on which the Pilgrims stepped from the shallop of the "Mayflower" on Dec. 21, 1620, was placed in 1920 on the spot it originally occupied, under a protecting portico of granite, presented by the Society of Colonial Dames, and this part of the water front has been made a part of the State park system. Rising behind the Rock is Cole's Hill, where during their terrible first winter in America the Pilgrims buried half their number, levelling the graves and sowing them with grain in the spring to conceal their losses from the Indians. Burial Hill (the site of the first fort and of a watch-tower) contains the graves of William Bradford and others of the original Pilgrims, though the oldest stone is dated 1681. In the Registry building are the original records of Plymouth Colony, the will of Myies Standish, the original patent of Jan. 23, 1630, and many other interesting historical docunients. Pilgrim hall, a large stone building erected in 1824, houses a rich collection of relics of the Pilgrims and of early colonial times. The oldest house still standing (the Crowe house) was built in 1664, and many others antedate the Revolution. In the northern part of the town is the National Monument to the Forefathers (of Maine granite), designed by Hammatt Billings, which was dedicated on Aug. 1, 1889, 30 years after the cornerstone was laid. Plymouth dates its founding from the landing of the Pilgrims. It was never incorporated as a town, but in 1633 the general court of the Colony recognized it as such by ordering that "the chiefe government be tyed to the towne of Plymouth." It remained the seat of government until 1692, when Plymouth Colony was united to Massachusetts Bay.

PLYMOUTH, a borough of Luzerne county, Pennsylvania, U S.A., on the west bank of the Susquehanna river, opposite Wilkes-Barre. It is on federal highway 11 and is served by the Lackawanna railway. Pop. (1920) 16,500 (24% foreign-born white, over half from Poland and Lithuania); 1940 federal census 15,507. Plymouth is in the midst of the anthracite fields, and is surrounded by the beautiful scenery of the Wyoming valley. The mining, preparation and handling of anthracite provide the principal occupations, but there are silk mills and various other factories, with an output in 1937 amounting to $618.625. Plymouth was settled in 1769 under the auspices of the Susquehanna Company of Connecticut, by colonists from Plymouth, Litchfield county, Conn., and other places in New England, and became a centre of the conflict known as the Pennamite-Yankee War. *(See* WYOMING VALLEY.) The first coal shipped from the anthracite region was sent from Plymouth in 1808 by Abijah and John Smith. The borough was incorporated in 1866.

PLYMOUTH BRETHREN, a community of Christians who received the name in 1830 when the Rev. J. N. Darby (1800–1882) induced many of the inhabitants of Plymouth, England, to associate themselves with him for the promulgation of his opinions. Although small Christian communities existed in Ireland and elsewhere calling themselves *Brethren,* and holding similar views, the accession to their ranks of Darby so increased their numbers and influence that he is usually called the founder of Plymouthism. Darby had been a curate in Wicklow 1825–1827, when he felt himself constrained to leave the Anglican communion; going to Dublin, he became associated with several devout people who met statedly for public worship, and called themselves "Brethren." Among these were A. N. Groves and J. G. Bellett, who deserve to rank among the founders of the movement. In 1830 Darby at Plymouth won over many people to his way of thinking, among them the well-known Biblical scholar Samuel Prideaux Tregelles. During the next eight years progress was rapid, and communities were founded in many of the principal towns in England.

In 1838 Darby went to reside in French Switzerland, and made many disciples. French Switzerland has always remained the stronghold of Plymouthism on the Continent, and far his followers there Darby wrote two of his most important tracts, Le *Ministère considéré dans sa nature* and *De la Présence et de l'action du S. Esprit dans l'église.* The revolution in the canton Vaud, brought about by Jesuit intrigue in 1845, brought persecution to the Brethren in the canton and in other parts of French Switzerland and Darby's life was in great jeopardy.

He returned to England, and his reappearance was followed by divisions among the Brethren at home. These divisions began at Plymouth. Benjamin Wills Newton, head of the community there, who had been a fellow of Exeter College, Oxford, was accused of departing from the testimony of the Brethren by reintroducing the spirit of clericalism. Unable to detach the congregation from the teacher, Darby began a rival assembly. The majority of the Brethren out of Plymouth supported Darby, but a minority remained with Newton. The separation became wider in 1847 on the discovery of supposed heretical teaching by Newton. In 1848 another division took place. The Bethesda congregation at Bristol, where George Muller was the most influential member, received into communion several of Newton's followers and justified their action. Out of this came the separation into Neutral Brethren, led by Muller, and Exclusive Brethren or Darbyites, who refused to hold communion with the followers of Newton or Muller. The Exclusives, who were the more numerous, suffered further divisions. An Irish clergyman named Samuel O'Malley Cluff had adopted views similar to those of Pearsall Smith, who preached a doctrine of sanctification called "Death to Nature" as an antidote to the supposed prevalent Laodiceanism, and when these were repudiated seceded with his followers. The most important division among the Exclusives came to a crisis in 1881, when William Kelly and Darby became the recognized leaders of two sections who separated on a point of discipline. This was followed (1885) by the disruption of the strict Darbyite section, two communions being formed out of it upon points of doctrine.

The theological views of the Brethren differ considerably from those held by evangelical Protestants (for a list of divergences, see Teulon *History and Doctrines of the Plymouth Brethren).* They make the baptism of infants an open question and celebrate the Lord's Supper weekly. Their distinctive doctrines are ecclesiastical. They hold that all official ministry, whether on Episcopalian, Presbyterian or Congregationalist theories, is a denial of the spiritual priesthood of all believers, and sets aside the Holy Spirit's guidance. The movement, if it has had small results in the formation of a sect, has at least set churches to consider how they might make their machinery more elastic. The movement spread to the United States where, in 1915, there were 10,566 communicants.

BIBLIOGRAPHY.—Darby, *Collected Works* (32 vols., edited by Kelly, with supplementary volume, 1867–83); *A.* Miller, *The Brethren, their Rise, Progress and Testimony* (1879); Rogers, *Church Systems of the Nineteenth Century;* Teulon, *History and Doctrines of the Plymouth Brethren* (1883); article "John Nelson Darby," in *Contemp. Rev.* (Oct. 1885); *W.* B. Neatby, *A History of the Plymouth Brethren* (London, 1902, 2nd ed.).

PLYMPTON ST. MARY and **PLYMPTON ST. MAURICE** or **ERLE,** two small adjacent towns in Devon, England, 5 mi. E.N.E. of Plymouth, on the Great Western railway. Pop. (1931), Plympton St. Mary, 5,077, Plympton St. Maurice, 1.075. The earthworks on which in the 12th century Richard de Redvers reared his Norman castle at Plympton St. Maurice were probably of British origin; traces of the castle remain. A Saxon document dated 904 records a grant by Edward the Elder to Asser, bishop of Sherborne, of twelve manors in exchange for the monastery of "Plymentun." Plympton St. Mary has a Decorated and Perpendicular church, with a lofty tower of the later period. Near it are remains of the former Augustinian priory of Plympton, founded by William Warelwast, bishop of Exeter (1107–36). They include an Early English refectory with Norman undercroft, the kitchen and other fragments; but there are no remains of the great priory church. There are several old houses in the town, together with a guildhall dated 1696, and a grammar school founded in 1658, of which Sir Joshua Reynolds's father was master.

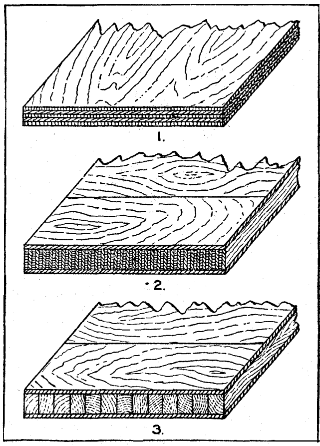
PLYNLYMON (*Plynlimmon, Pumplumon, Pumlumon, Penlumon:* pump means fire: *lumon*, chimney flag or beacon; *pen*, head), a mountain of Wales 2,463 ft. high, about 10 m. from Machynlleth and Llanidloes. It is composed of Bala (Ordovician) grits and stands out above the high plateau of Central Wales. There are three summits with a carnedd (stone-pile, probably a military or other landmark, rather than the legendary barrow or tomb) on each. Plynlymon is the source of the Rheidol, the Llyfnant and the Clywedog, the Wye and the Severn.

The morasses of Plynlymon saw many a struggle, notably the war between Owen Cyfeiliog (*fl. c.* goo), prince of Powys, and Hywel ab Cadogan. Here also Owen Glendower unfurled the banner of Welsh independence; from here, in 1401, he harassed the country, sacking Montgomery, burning Welshpool, and destroying Abbey Cwm Hir. Aberystwyth obtains its water from a reservoir on the mountain slopes. There are slate quarries, also old lead and copper mines in the district. The district west, north and east of Plynlymon is a very wild and lonely moorland, with very few roads. Around the sharp northern and western edges of the moorland are deep-cut ravines with waterfalls.

PLYWOOD. Board made of several plies or veneers (*q.v.*) of wood, glued together with the object of obtaining comparatively large sheets free from some of the natural defects and limitations of timber. Rotary cut (peeled) or sliced veneers are used, if necessary joined edgewise, to form each ply, and thus large sheets with an unbroken surface are obtained; the plies are sorted as to their appearance, and the inferior (knotty, shaky or sappy) material is generally utilized for the interior of the board (core), leaving the best plies for the outer surfaces (face and back).

The natural tendency of wood to shrink, swell and warp is effectively neutralized, and the comparatively low tensile strength of wood along its grain is greatly improved upon, by carefully cross-graining the plies. In the result, a large flat board of wood is produced, practically unaffected by climatic influences, and possessing considerably higher shearing, braking and bending properties than ordinary wood of similar thickness.

The plies are glued (cemented) together under considerable pressure, different adhesives being used, dependent upon whether or not the gluing process is aided by heat, and also varying according to the kind of timber used. The veneers are wet when produced from the log and may be glued together either in their wet state or after a pre-drying process. Plywood is, therefore, grouped into two classes, wet and dry produce. The drying of veneers before being cemented and pressed into a board prevents their shrinkage during the pressing process and, therefore, helps to make a better plywood board. If the veneers be glued wet the drying process is combined with the glueing operation in the press, and this often produces face checks (cracks) on the surfaces of the finished board.



PLYWOOD CONSTRUCTION
(1) Ordinary plywood, (2) laminated plywood, (3) batten board

In the construction of plywood the following different types are known:

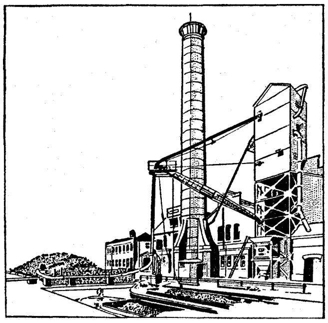
The outside plies of the laminated type and of battenboards may be occasionally superimposed on so-called crossbandings (veneers lying crosswise to the outer plies) to ensure still greater rigidity of the boards.

Utilization.— Plywood is used wherever a material is required to cover large unbroken spaces with a light but strong and rigid sheeting, *e.g.*, in cabinet-making (for panels, bed-ends, sides of wardrobes, tabletops, etc.); *building* (for doors, wall panelling, ceilings, flooring, etc.); coach-building (for coach panels, motor bodies, railway carriage roofs and walls, vans, baby carriages, etc.); *shipbuilding* (for bulkheads, etc.); boxmaking (for tea chests, rubber chests, cases, etc.); engineering (for aeroplane fuselages, hydroplane hulls, bed plates, etc.); etc.

Although there is evidence that the principle of "plying" thin strips of wood into panels to ensure permanent flatness was known and practised in very early days of civilization and was continued by the cabinet-maker and builder all over the world, mechanical production of plywood originated comparatively recently, *i.e.*, in the eighteen-eighties, when the first factories specializing in the production of plywood were erected in Russia. The industry has since spread to all parts of the world wherever large timber resources are available and where widespread employment of the material makes local manufacture profitable.

BIBLIOGRAPHY.—E. Vernon Knight and Meinrad Vulpi, Veneers and Plywood (N.Y. 1927); Shirley P. Wainwright, Modern Plywood (1927); Bulletins of the Forest Products Laboratory, U.S. Department of Commerce; B. C. Boulton, The Manufacture and Use of Plywood and *Glue* (1920); The Timber Trades Journal (London; wkly.).
(A MOR.)

PNEUMATIC CONVEYING is the utilization of the conveying power of air in motion. It will be realized that conveyance of material through a pipe-line, either by suction or blast, is ideal; since there are no mechanical parts in the path of the material there cannot be any contamination by lubrication. Another advantage is the greater flexibility of pneumatic plant; every part of the hold of a vessel, for instance, can be reached by flexible tubes for the purpose of unloading a grain cargo, whereas a more complex mechanical plant is rigidly fettered to straight lines.


BY COURTESY OF MESSRS. HENRY SIMON, MANCHESTER
PNEUMATIC COAL-HANDLING PLANT AT BRIMSDOWN POWER STATION

The *modus operandi* of a pneumatic plant is extremely simple and is as follows:—Into a grain cargo in a vessel, for instance, a hosepipe is lowered, the nozzle at the end of which admits a mixture of air and grain. The other end of the pipeline enters tangentially into the upper part of a cylindrical receiver from which the air is exhausted, while the grain is withdrawn from the cone-shaped lower end by an air-trap, without, however, admitting air into the receiver. When comparing pneumatic with mechanical handling devices the former have but one drawback, viz.: the greater consumption of driving power for handling a given quantity. This, however, is more than compensated for by the greater flexibility and the hygienic value of the system. The first grain handling installation on the Duckham system was known as "Mark Lane No. 1," and was built, under the personal supervision of the inventor, by the East Ferry Road Engineering Co., during the closing years of the 19th century. This was one of the most epoch-making revelations of all systems of handling. The plant is mounted on a pontoon and sucks the grain through a nozzle and pipeline from the ship's hold to an elevated receiver, whence it runs by gravity to a given point, via an air trap; an exhauster furnishes a partial vacuum by pipes connected with the said receiver.

As has been shown, the material in a pneumatic plant floats, so to speak, in a current of air, from which it is separated by its specific gravity when the air expands in the receiver. The heavier the material to be handled the greater must be the speed of travel of the air in the conveying pipes in order to ensure the floating of the material in and with the air. If the air speed is too slow the tendency will be for the material to separate from the air and thus block the pipes, especially such portions as are horizontally disposed, or nearly so. Obviously, therefore, installations for such heavy materials as coal and ash require more powerful pumps. Similar installations in which, however, draught is induced by "steam jets" are successfully employed for handling ash from boilers.

Owing to the advantages accruing from the use of pneumatic handling plants new avenues for their employment are being constantly opened. Such varied materials as grain, small coal, chemicals, ashes, potatoes, and even red-hot rivets and artillery shells are now successfully handled by pneumatic means. An offshoot of this system is the pneumatic tube, which is largely employed in postal and telegraph offices, as well as in great variety in business offices and stores. (*G.* F. Z.)

PNEUMATIC DISPATCH, a system of transporting written dispatches through long tubes of small diameter by means of compressed or rarefied air. It was introduced in 1853 by J. Latimer Clark between the Central and Stock Exchange stations of the Electric and International Telegraph company in London, the stations being connected by a tube 1½in. in diameter and 220yd. long, the messages, enclosed in a tight fitting carrier, being drawn through it by the production of a partial vacuum at one end. The system was improved in 1858 by C. F. Varley, who used compressed air to return the carriers in the other direction. By this means it was possible to develop two-way working on single tubes between a central station, equipped with air-compressing plant, and outlying offices

Pneumatic dispatch tubes are in extensive use in many countries for both telegraphic and postal matter.

Radial System: This system of pneumatic dispatch was developed by R. S. Culley and R. Sabine in connection with the British post office for the transmission of telegrams between local collection and delivery offices and the central telegraph office; it became generally more economical, under normal conditions of traffic and distance, to transmit these messages by tube rather than wire so dispensing with the employment of skilled telegraphists.

Since that time the system has been greatly extended both in London and the large provincial towns until in London alone the street tubes laid measure over 57m., varying in length from 100yd. to nearly 4,000yd. These tubes are either single tubes working in both directions or, where the traffic warrants it, separate "up" and "down" tubes are installed. In a few cases intermediate offices are connected to the tubes, but this practice is not desirable as delay in transmission is caused and direct tubes are installed wherever possible.

A further development is the laying of pressure worked trunk tubes from the central telegraph office to an outlying centre, messages being transmitted between this centre, where a pumping plant is also installed, by radial tubes to offices in the vicinity.

House Tubes and Street Tubes.—Short tubes known as house tubes are in use in a large number of offices and telephone exchanges for carrying messages from the public counter or one room to another. These tubes, which are generally 1½in. in diameter, are made of brass and are operated by hand-worked pumps where the distance is short and the traffic inconsiderable, or by means of small electrically driven centrifugal fans or other form of blower. The pressure or vacuum required is only a few inches as shown by water gauge and the blowers are either run continuously or switched on as required.

Street tubes used by the post office are generally 2¼in. in diameter, but 3in. and 1½in. tubes are also used. These tubes when laid in the street are in all cases made of lead and are protected by cast-iron pipes. Where they are run in buildings or subways brass tubing is used. They are operated by electrically driven compressors.

Carriers.—The carriers, in which the messages are inserted for dispatch, are made of gutta-percha covered with felt, the front of the carrier being provided with a buffer or head formed by several layers of felt fitting the tube closely, the messages being held in place by means of an elastic band. The 3in. carriers hold 50, the 2¼in. carriers 20 and the 1½in. carriers five ordinary forms. The carrier used on house tube systems are generally made of fibre the messages being retained by a clip.

Working.—The air for working the street tubes is supplied by electrically driven compressors, the standard pressure and vacuum used being 10lb. and 6½lb. per sq.in. respectively, which values give approximately the same speed.

The time of transit of a carrier through a tube at the ordinary pressures in use is given approximately by the empirical formula:—

$t=\cdot 00872\sqrt{\frac{l^3}{Pd}}$ where l=length of tube in yards,

d=diam. in inches, P=effective air pressure in pounds per sq. inch,

t=transit time in seconds.

For vacuum working the formula is:—

$t=\frac{\cdot 00825}{1\cdot \quad \cdot \quad -P_1}\sqrt{\frac{l^3}{d}}$ where P_1=effective vacuum in lb. per sq. inch.

The horse-power required to propel the carrier is approximately

for pressure $\text{H.P.}=(\cdot 574+\cdot 0011P)\sqrt{\frac{P^3d^5}{l}}$

for vacuum $\text{H.P.}=(5\cdot 187-1\cdot 214\sqrt{15\cdot 5-P_1})\,P_1\sqrt{\frac{d^5}{l}}$

For a given transit time the horse-power required is less in the case of vacuum than in the case of pressure working, owing to the lesser density of the air column moved: thus, for example, the transit time under 10lb. pressure is the same as with a vacuum of 6½lb., but the horse-power required is as 1·83 to 1. A 2¼in. tube 1m. long worked at 10lb. per sq.in. pressure will have a transit time of 2¼min. and will theoretically require 3·35 h.p. to work it. Actually owing to various losses 25% more power must be allowed for the compressor. When working at the same pressure the transit time for a 2¼in. tube is 16% more than that for a corresponding length of 3in. tube, but the power required is 50% less and it is therefore advisable to use the smallest tube compatible with the traffic.

Dispatching and Receiving Apparatus.—On house tube systems, where only low pressures and vacuum are required, simple forms of terminals consisting of cast-iron bodies with flap-doors are used, the doors being opened to insert a carrier, and through which carriers are automatically ejected, the door closing behind them. Dispatching funnels are also used at the open end of tubes.

On the street tubes, however, a more complicated type of apparatus, called a double slide switch, is used at the central office. This consists of two vertical sections of tube secured into top and bottom plates and provided with a handle by which it is rocked between two fixed horizontal plates forming a frame, three holes being provided in each plate, the air supply pipe and dispatch tube being connected to the centre holes and funnels for inserting or removing the carriers to the other holes. The carrier on arriving is received in one of the vertical sections and on the rocker being moved to its second position the carrier drops out through the funnel provided. The second tubular section is now ready to receive a carrier, which is discharged when the rocker is returned to its first position. The process is reversed for dispatching purposes, and where the tube is used for two-way working one position is reserved for sending and one for receiving. The supply of air, and whether under pressure or vacuum for sending or receiving purposes, is controlled by a three-way valve mounted under the switch.

A form of flap terminal, the door being restrained by a spring in view of the higher pressures used, is installed at the outlying offices in place of the receiver originally used and the carrier is automatically ejected.

On tubes where the carrier reaches a high velocity, a by-pass is provided near the terminal by means of which the air pressure behind the carrier is released after it has passed this point so as to reduce the velocity of egress. This terminal is also used for the dispatch of carriers to the central office, the supply of air to the tube being changed from vacuum to pressure at the latter point in response to a bell signal. When used for dispatching the by-pass is cut off by a remote control valve. Carriers may be diverted from one tube to another by means of a moving section of tube directly or remotely controlled.

A further development is the provision of an automatic rotat-

ing pneumatic tube switch by which carriers can be transferred between street and house tubes for both sending and receiving purposes, the terminals used being of the flap type.

Circuit *System.—Another system of working is the circuit system, in which stations are arranged in circular or loop lines round which the carriers travel in one direction only, both pressure and vacuum being used. This system is in use in Paris and other Continental cities. In Messrs. Siemens' system a continuous flow of air is maintained in the tube, the carriers being dispatched or removed through a form of rocking switch so designed that the movement of carriers in other parts of the system is not interfered with. More usually carriers, or trains of carriers, are dispatched at intervals, the air supply being cut off when not required. Long tubes may be sectionalized, means being provided at the various stations by which air is only supplied to the working section.*

In America, under the Batcheller system, tubes 8in. *in diameter are used for postal purposes in New York, Brooklyn, Chicago, Philadelphia, Boston and St. Louis; tubes* 6in. *and* 10in. *in diameter are also used. These tubes are essentially cast-iron pipes, carefully bored and equipped with suitable apparatus for introducing and receiving the carriers. The carriers for the* 8in. *tubes consist of cylindrical steel shells about 7in. in diameter and* 21in. *long (inside dimensions) with suitable end covers. They are fitted with lubricated soft bearing or packing rings. The working capacity of these tubes may be taken as* 8lb. *per container and six containers per minute, or* 2,880lb. *of postal matter per hour in each direction, the average speed being about* 25 *to* 30m. *per hour.*

The dispatching apparatus is similar to that in the Siemens' system, consisting of two sections of tube supported in a rocking frame so arranged that either section may be brought into line with the main tube, in which a current of air is constantly flowing. One of these sections maintains the continuity of the tube while the other section is loaded. The switch is then swung over by means of a pneumatically operated piston to insert the carrier in the tube. A by-pass is provided to maintain the flow of air in the tube during the operation. As soon as the carrier leaves the switch it trips a lever and the switch automatically returns to the loading position. A time lock is used to prevent carriers being dispatched too frequently. The carrier is received by an air cushion formed by closing the end of the tube with a sluice gate, a by-pass being provided before this point to allow the air to flow away.

In addition to their use for postal and telegraphic purposes pneumatic dispatch tubes are used for internal communication in offices, hotels, etc., also in shops for the transport of money and bills between the counters and the cashiers' desk. Pneumatic tubes are also used for the unloading and transport of grain and other commodities in bulk between warehouses and ships, trains, etc.

BIBLIOGRAPHY.—*The system as developed for use in the British post office by Messrs. Culley and Sabine is described in a* paper *in Min. Proc. Inst. Civil Eng., vol. xliii. The same volume contains a description of the Paris system and of experiments thereon by M. Bontemps, and also a discussion of the theory of pneumatic transmission by Prof. W.* C. *Unwin. Reference should also be made to a paper by C. Siemens (Min. Proc.* Inst. *Civ. Eng. vol. xxxiii.),* describing *the Siemens' circuit system; to Les Télégraphes, by M. A. L.* Ternant *(1881); to* the *report to Congress of the American joint commission on pneumatic tube mail service, March* 1919; *General Post Office engineering department's Technical Instruction* No. *X (Pneumatic Tubes); a short paper by J.* McGregor *on the automatic system in the post office (P.O. Elec. Eng. Journal, vol. xix., part 1), and to Kempe's Engineer's Year Book.* (J. McG.)

PNEUMATIC GUN. *Air as a propellant commended itself to some early designers of guns on account of its comparatively gentle action which proved advantageous with the primitive high explosive shells of the time. In 1883 Mefford of Ohio utilized an air pressure of* 500lb. *per* sq.in. *in a 2-in. gun, and succeeded in propelling a projectile* 2,100yds. *The arrangement was of the simplest form—a hose with an ordinary cock by which the air was admitted into the gun behind the projectile. The question was then taken up by Capt. E. L. Zalinski* (1849–1909) of *the United States Artillery, who in 1888 reduced the so-called "dynamite gun" to a more practical shape and obtained excellent firing results.*

The only record of the practical employment of a dynamite gun afloat was the case of the U.S. gunboat "Vesuvius," which carried three of the weapons in the bows. The guns were fixed at a constant angle of elevation, and the range regulated by an air valve, training being given by the helm. The "Vesuvius" was employed during the Spanish-American War of 1898, when on several nights in succession she approached the defences of Santiago under cover of darkness and discharged three projectiles. Fire delivered under such conditions could not be sufficiently accurate to injure coast defences; but the shells burst well, and made large craters. A small dynamite gun on a field-carriage was used in the land operations above Santiago in the same war.

PNEUMATIC POWER TRANSMISSION. *Every wind that blows is an instance of the pneumatic transmission of power, and every windmill or sail that catches the breeze is a demonstration of it. The modern or technical use of the term, however, is confined to the compression of air at one point and its* transmis*sion to another point where it is used in motors to do work. The first recorded instance of this being done was by* Denis Papin *(b.* 1647*), who compressed air with power derived from a water-wheel and transmitted it through tubes to a distance. About* 1800 *George Medhurst* (1759–1827) *took out patents in England for compressing air. He compressed and transmitted air which worked motors, and he built a pneumatic automobile. William Mann in 1829 took out a patent in England for a compound air compressor. In his application he states: "The condensing pumps used in compressing I make of different capacities, according to the densities of the fluid to be compressed, those used to compress the higher densities being proportionately smaller than those previously used to compress it to the first or lower densities," etc. This is a very exact description of the best methods of compressing air to-day, omitting the very important inter-cooling. Baron Van* Rathen *in 1849 proposed to compress air in stages and to use inter-coolers between each stage to get 7jo lb. pressure for use in locomotives. For the next 40 years inventors tried without success all manner of devices for cooling air during compression by water, either injected into the cylinder or circulated around it, and finally, with few exceptions, settled down to direct compression with no cooling worthy of mention. Only in the last ten years of the* 19th *century were the fundamental principles of economical air compression put into general practice, though all of them are contained in the patent of William Mann and the suggestion of Van* Rathen.

The first successful application of compressed air to the transmission of power, as we know it, was at the Mont Cenis tunnel in 1861. The form of compressor used was a system of water rams—*several of them in succession—in which water was the piston, compressing the air upwards in the cylinder and forcing it out. Although the air came in contact with the water, it was not cooled, except slightly at the surface of the water and around the walls of the cylinders. The compressors were situated near the tunnel, and the compressed air was transmitted through pipes to drilling machines working at the faces in the tunnel. Rotary drills were tried first, but were soon replaced by percussion drills adapted from drawings in the U.S. Patent Office, copied by a French and Italian commission from the patent of J. W. Fowle of Philadelphia. H. S. Drinker (Tunneling, Explosive Compounds and Rock Drills, New York, 1893) states positively that the first percussion drill ever made to work successfully was patented by J. J Couch of Philadelphia in 1849. Shortly afterwards Fowle patented his drills, in which the direct stroke and self-rotating principle was used as we use it now. The first successful drill in the Hoosac tunnel was patented in 1866 by W. Brooks, S. F. Gates and C. Burleigh, but after a few months was replaced by one made by Burleigh, who had bought* Fowle's *patent and improved it. Burleigh made a compressor, cooling the air during compression by an injected spray of water in the cylinders. The successful work in the Mont Cenis and Hoosac tunnels with the percussion drilling machines caused the use of compressed air to spread rapidly, and it was soon found there were many other purposes for which it could be employed with advantage.*

Application of Pneumatic Power.—The larger tunnels and metal mines were naturally the earliest to adopt pneumatic transmission, often using it for pumping and hoisting as well as drilling. In Paris and Nantes, in Berne and in Birmingham (England), street tramways have been operated by pneumatic power, the transmission in these, however, being in tanks rather than pipes. Tanks on the cars are filled at the central loading stations with air at very high pressure, which is used in driving the motors, enough being taken to enable the car to make a trip and return to the loading station. Several attempts in pneumatic street traction were made in America, but failed owing to financial troubles and the successful introduction of electric traction. It is used very successfully, however, both in Europe and in America, in underground mine haulage, being especially adapted to coal mines, where electricity would be dangerous from its sparks. The copper smelting works at Anaconda, Mont., uses 12 large pneumatic locomotives for charging the furnaces, removing slag, etc. Many stone quarries have a central plant for compressing air, which is transmitted through pipes extending to all working points. and operates derricks, hoists, drills, stone cutters, etc., by means of motors. Every considerable ironworks, railroad shop or foundry has its pneumatic transmission plant. Also in the erection of the larger steel bridges or buildings a pneumatic transmission system is part of the contractor's outfit, and many railways have a portable compressing plant on a car ready to be moved to any point as needed.

Dr. Julius G. Pohle, of Arizona, patented in 1886, and introduced extensively, the use of compressed air for lifting water directly, by admitting it into the water column. His plan is largely adopted in artesian wells that do not flow, or do not flow as much as desired, and is so arranged that the air supply has a back pressure of water equal to at least half the lift. If it is desired to lift the water 30 ft. the air is admitted to the water column at least 30 ft. below the standing water surface. The air admitted being so much lighter than the water it displaces, the column 60 ft. high becomes lighter than the column 30 ft. high and is constantly released and flows out at the top. The efficiency of this method is only 20 to 40%, depending on the lift, but its adaptation to artesian wells renders it valuable in many localities.

A remarkable pneumatic transmission system was installed in 1890 by Priestly in Snake River desert, Idaho. On the north side of the river is a cliff, nearly perpendicular, about 300 ft. high. One hundred and ninety feet above the river, for a considerable distance along the cliff, streams of water gush out from between the bottom of the great lava bed and the hardened clay of the old lake bottom. Priestly, without knowledge of Pohle's system, built a pipe line down the bluff and trained the water into it in such a way that it carried a very considerable quantity of air in the form of bubbles along with it down the pipe, compressing it on the way. The air was collected at the bottom in a covered reservoir, and taken up the cliff again to the lower part of an inverted siphon pipe, one side of which reached down from the water-supply about 60 ft. and the other side reached up and over the bluff. Allowing the water to fill both sides of the pipe to the level of the water-supply, he admitted his compressed air at about 7j lb. pressure into the long side of the pipe near the bottom, and soon had water flowing upwards over the cliff and irrigating a large tract of rich lava land. He had made a power, a transmission and a motor plant without a moving part. A similar compressor was installed near Montreal, Canada, in 1896; another at Ainsworth, British Columbia, in 1898; and another at Norwich, Conn., in 1902. These are called hydraulic air compressors and show an efficiency of about 70%. They are particularly adapted to positions with a large flow of water with a slight fall or head.

Theory **of** Pneumatic Power Transmission.—The actual transmission of power by air from the compressor to the motor is simple and effective. The air admits of a velocity of 1j to 20 ft. per second through pipes, with very slight loss by friction, and consequently there is no necessity for an expensive pipe system in proportion to the power transmitted. It is found in practice that, allowing a velocity as given above, there is no noticeable difference in pressure between the compressor and the motor several miles away. Light butt-welded tubing is largely used for piping, and if properly put in there is very slight loss from leakage, which, moreover, can be easily detected and stopped. In practice, a sponge with soap-suds passed around a joint furnishes a detective agency, the escaping air blowing soap bubbles. In good practice there need not be more than 1% loss through leakage and 1% possibly through friction.

Air develops heat on compression and is cooled by expansion, and it expands with heat and contracts with cold. For the purpose of illustration suppose a cylinder 10 ft. long containing 10 cu.ft. of air at 60° F, with a frictionless piston at one end. If this piston be moved $7\frac{1}{2}$ ft. into the cylinder, so that the air is compressed to one-quarter of its volume, and none of the heat developed by compression be allowed to escape, the air will be under a pressure of 90 lb. per square inch and at a temperature of 460° F. If this air be cooled down to 60° F the pressure will be reduced to 45 lb. per square inch, showing that the heat produced in the air itself during compression. gives it an additional expansive force of 45 lb. per square inch. The average force or pressure in compressing this air without loss of heat is 21 lb. per square inch, whereas if all the heat developed during compression had been removed as rapidly as developed the average pressure on the piston would have been only 11 lb. per square inch, showing that the heat developed in the air during compression, when not removed as fast as developed, caused in this case an extra force of 10 lb. per square inch to be used on the piston. If this heated air could be transmitted and used without any loss of heat the extra force used in compressing it could be utilized; but in practice this is impossible, as the heat is lost in transmission. If the piston holding the $2\frac{1}{2}$ cu.ft. of air at 45 lb. per square inch and at 60° F were released, the air expanding without receiving any heat would move it back within 35 ft. of the end only, and the temperature of the air would be lowered 170° F, or to 110° F below zero. If the air were then warmed to 60° F again it would move the piston the remaining 35 ft. to its starting point.

It is seen that the ideal air-compressing machine is one which will take all the heat from the air as rapidly as it is developed during compression. Such "isothermal compression" is never reached in practice, the best work yet done lacking 10% of it. It follows that the most inefficient compressing machine is one which takes away no heat during compression—that is, works by "adiabatic compression," which in practice has been much more nearly approached than the ideal. It also follows that the ideal motor for using compressed air is one which will supply heat to the air as required when it is expanding. Such "isothermal" expansion is often attained, and sometimes exceeded in practice by supplying heat artificially. Finally, the most inefficient motor for using compressed air is one which supplies no heat to the air during its expansion, or works by adiabatic expansion, which was long very closely approached by most air motors. In practice isothermal compression is approached by compressing the air slightly, then cooling it, compressing it slightly again and again cooling it until the desired compression is completed. This is called compression in stages or compound compression. Isothermal expansion is approximately accomplished by allowing the air to do part of its work (as expanding slightly in a cylinder) and then warming it, then allowing it to do a little more and then warming it again, and so continuing until expansion is complete. It will be seen that the air is carefully cooled during compression to prevent the heat it develops from working against compression, and even more carefully heated during expansion to prevent loss from cold developed during expansion. More stages of compression of course give a higher efficiency, but the cost of machinery and friction losses have to be considered. The reheating of air is often a disadvantage, especially in mining, where there are great objections to having any kind of combustion underground; but where reheating is possible, as W. C. Unwin says, "for the amount of heat supplied the economy realized in the weight of air used is surprising. The reason for this is, the heat supplied to the air is used nearly five times as efficiently as an equal amount of heat employed in generating steam." Practically there is a hot-air engine, using a medium much more effective than common air, in addition to a compressed-air engine, making the efficiency of the whole system extremely high. (*See* also PNEUMATIC TOOLS.)

(A. DE W. F.)

PNEUMATICS, the branch of physical science concerned with the properties of gases and vapours (Gr. πνεῦμα, wind, air).

PNEUMATIC SUCTION CLEANING AND CONVEYING: *see* VACUUM CLEANER.

PNEUMATIC TOOLS comprise various classes of hand tools which are operated by compressed air power. They are divided in two general classes according to the principle of operation (1) percussion, (2) reciprocating motor-driven. Under percussion tools are grouped rivetting, chipping and sand rammers, pneumatic diggers, rock drills, paving breakers, etc.; each using a piston or plunger for striking a blow. Reciprocating motor-driven tools employ a reciprocating piston air motor to drive a spindle from which power can be used for drilling, grinding, etc. The tools under this classification include pneumatic drills, grinders, motors, hoists, etc. Pneumatic tools usually operate best when supplied with compressed air at 90 lb. gauge pressure.

The principal uses of pneumatic tools occur on those classes of work where it is not possible or not advisable to take the work to a machine. A pneumatic tool, being a self-contained power unit, can be taken to the work and various operations performed rapidly, with a minimum of manual labour. Pneumatically operated tools are suited for a wide variety of uses because of their availability, the adaptability of compressed air power, the absence of danger and because they embody within small confines a great range of power and action. Other advantages are rugged construction, simplicity, and easy operation.

Pneumatic Hammers are made in a variety of sizes and types, and the name for each is governed largely by the work to be performed. This group covers chipping, rivetting, scaling and caulking hammers, diggers, paving breakers, rock drills and the like implements. (*See* BLASTING.) Each class of work requires a hammer of a particular size, weight, speed and strength of blow. In the operation of most rivetting hammers air enters the hammer at the air inlet in the handle, the amount of air being controlled by the throttle valve which is actuated by a trigger. After passing the throttle valve the air is conducted through the passage in the handle to the valve chamber containing the operating valve and valve box. The valve is moved back and forth in the valve box by the action of the air pressure on its differential areas. As the valve moves forward it admits air back of the piston, throwing it forward against the rivet set, which forms the rivet head. The piston, after striking a blow, is returned for another stroke by air admitted to the front of the cylinder, which is covered by the piston in this position. Hammers for chipping, caulking and scaling are very similar in construction to the rivetting hammer. The chipping hammer is used to clean foundry castings, for caulking the seams of boilers and tanks, pipe joints, etc., saving two-thirds the time required by hand work.

Sand Rammers have a long barrel containing a piston having a projecting rod at one end, to which the tamping butt is attached. In action the piston moves rapidly up and down in the barrel lifting the tamping butt from the sand and returning it with considerable impact against the material to be rammed. The ramming of certain classes of moulds in foundry work, a long and arduous task when done by hand, is rapidly accomplished by means of the pneumatic sand rammer. Machine-rammed moulds are harder and more uniform than those rammed by hand, resulting in better castings. Floor rammers are used for working on large moulds on the floor, and the bench rammer on small bench moulds. These tools strike up to 800 blows per minute. The force and number of blows are regulated by the operator with a throttle. The sand rammer is also used to tamp the back-fill in trenches in city streets, where it is desired to pack the sand solidly and by this means avoid the subsequent settling.

Pneumatic Drills. — Portable pneumatic drills are divided into four general types: the reversible drill, the non-reversible drill, the woodborer and the close-quarter drill. The several types are also given certain other minor divisions according to the use to which they are put, such as boring, reaming, tapping, flue rolling and stud-setting. The larger sizes of pneumatic drills use a four-cylinder V-type air motor, with one crank throw provided for each pair of cylinders in the same cross plane. The power from the crank-shaft is transmitted to the drilling spindle by gears arranged to give the spindle speed desired. A feed screw with a feed handle is used to feed the drill up to the work. A main valve, of rotary type, controls the supply of air to each of the four cylinders, the air supply reaching this main valve through a throttle handle. At the upper end of the main valve is located a centrifugal speed governor which limits the speed of the drill motor after it has passed the point of maximum horsepower.

Another small class of pneumatic drills employ a three-cylinder radial air motor, the three cylinders being in one plane with one crank provided for all three cylinders. The power from the crank is transmitted through a spindle and gears to the point where the drill chuck is attached. The main spindle also serves as a valve controlling the air to the three cylinders, greatly simplifying the construction of the tool. These tools are used for light drilling in metal, in the automobile assembly plants for running up nuts, and for running in screws. They are equipped with either feed screw, spade handle or breast plate. The close-quarter type of pneumatic drill uses a two-cylinder, double-acting motor to give a flat and compact construction. The power is transmitted from the crank-shaft to the spindle by a train of gears. A feed screw is located at the end of the spindle and can be turned by means of the ratchet handle. This type of drill is used for drilling, reaming and tapping in cramped spaces where the usual drill cannot be employed.

Pneumatic Grinders. — The pneumatic grinder is similar in general construction to the air drill except that a higher speed motor, operating at 3,000 to 6,000 r.p.m. is used. The motor is directly connected to a spindle upon which is mounted the grinding wheel. These tools are used in all kinds of service where a portable grinding tool, buffer or polisher is needed and are widely used in foundries and machine shops, monumental stone shops and automobile body plants.

Pneumatic Diggers. — Pneumatic diggers, of the same operating principle as a rivetter, are made in two styles. A short-handle type is used in tunnel work or in close quarters and an extension-handle type for trench or shaft. Pneumatic diggers are a recent development for work where it is desired to replace the hand pick. The tools are used for loosening up clay, hard ground, etc. The pneumatic digger consists of a hammer having a piston which strikes against a blade or scoop. The blows of the piston drive the blade into the ground, prying it loose. One man with such a tool is the equal of six men using ordinary hand picks.

Rock Drills.- he removal of solid rock in excavation for foundations, trenches, highways, in mining and many other projects calls for the use of a vast number of compressed-air rock drills. These tools are made in a wide variety of sizes for all classes of work, depending on the size and depth of the hole to be drilled, the hardness of the rock and other factors. In the "Jackhammer" type of rock drill, compressed air enters to a throttle valve in the handle and then passes to a flapper type of plate valve, which controls the movement of the piston. On the forward or downward movement of the piston it strikes against the shank of the drill steel, and imparts a cutting action to the points of the steel. On the back stroke of the piston it slides over a fluted rifle-bar which turns the piston and causes it to turn the drill steel. Rotation of the drill steel is desired in order that the cutting edges on the end of the drill steel may be put in a new position with regard to the rock being drilled. A ratchet mechanism ensures rotation in one direction. To blow out the cuttings and dust from the hole in the rock, air is passed down through the rifle-bar and piston and through the drill steel to the cutting face.

These tools make it possible to drill holes in rock for inserting the explosives which blast out rock. One rock drill bores 100 to 150 ft. of hole in rock in an eight-hour day, while the best a man can do using a hand hammer and steel is not more than 8 to 10 ft. a day. Rock drilling requires the use of pointed drill steels which must be resharpencd as the cutting edges become worn and dulled by the rock. This is done by compressed-air-operated drill steel sharpening machines in which after the drill steel is heated and inserted quickly shapes and sharpens the steel by means of dies many times faster than is possible by hand methods.

Paving **Breakers.**—The paving breaker is a tool somewhat similar in construction to the rock drill and is used in demolition work such as breaking up pavement, tearing out concrete walls, foundstions, etc. This tool uses a pointed chisel or steel, but it is not rotated. The absence of the rotation mechanism simplifies the general construction of the paving breaker. Paving breakers are extensively used by public utilities for making openings in the pavement prior to installing or repairing sewer pipes and connections. They are usually operated from a portable air compressor, mounted on a motor truck, which can be quickly taken to the place where the work is to be done. One man operating one tool is able to break out more pavement in a given time than 12 to 15 men using hand sledges and steels.

Air Motor Hoists.—These are made in a range of sizes to handle loads from 500 lb. up to 20,000 pounds. This style of hoist is equipped with a high-powered air motor of the four-cylinder type which is geared to a hoisting drum. A feature of these hoists is the automatic brake which acts to hold the load at any point after the air pressure is shut off. When the motor is operating, air passes to the brake through a connecting tube releasing it. When the air is shut off at the throttle, the brake is automatically applied. These air hoists are widely used in industrial plants for handling material too heavy to be easily lifted by one man. In machine shops they lift and place heavy parts on lathes, milling machines and planers. (See MECHANICAL HANDLING.)

Air hoists are particularly suited for foundry work because the operation is not affected by dust, dirt or fumes, and they are not damaged by overloading. Another type is the portable hoist, which can be mounted wherever convenient; *i.e.*, to a post or timber. It is used for pulling cars, skidding timbers, pulling a scraper on back-fill work, and dozens of other applications.

Tools for Railroad Track Work.—Special pneumatic tools have been developed for a number of applications in railroad track construction and maintenance. There are pneumatic tie tampers for tamping ballast under ties, pneumatic spike pullers, spike drivers, rail drills, pneumatic wrenches, rail bonding drills and others. Tamping ballast with pneumatic tampers is much easier than swinging a pick or tamping with a hand bar. The air tampers strike a uniform blow all day long and produce a uniform track. In removing old rail, the old spikes must be pulled. A compressed-air-operated spike puller draws 10 to 15 spikes per minute. One such machine does as much work as eight to ten men using hand claw bars. The pneumatic wrench removes the nuts or runs up nuts on the joint bolts much faster than is possible with a hand wrench. The air-operated spike driver puts down the spikes in a fraction of the time required by a hand hammer. A pneumatic rail drill bores a $\frac{7}{8}$ in. hole through the web of a rail in from 25 to 30 seconds. Small holes for signal wires are drilled with pneumatic rail bonding drills at the rate of 60 per hour. (R. A. Lu.)

PNEUMATOLYSIS (nū-măt-ŏl'ĭ-sĭs), in petrology, discharge of vapours from igneous magmas and effects produced by them on rock masses (so called from Gr. πνεῦμα, vapour, and λύειν, to set free). In volcanic eruptions the gases given off by molten lavas are powerful agencies. The slaggy clots of lava thrown out from the crater are so full of gas that when they cool they resemble spongy pieces of bread. The lava-streams as they flow down the slopes of the volcano are covered with white steam clouds, while over the orifice of the crater hangs a canopy of vapour which is often darkened by fine particles of ash.

Cause of Volcanic Explosions.—Most authors ascribe volcanic explosions to the liberation of steam from the magma which held it in solution, and the enormous expansive powers which free water vapour possesses at very high temperatures. Of these gases the principal are water and carbonic acid; but by analysis of the discharges from the smaller fumaroles, for the active crater is generally too hot to be approached during an eruption, it has been ascertained that hydrogen, nitrogen, hydrochloric acid, boron, fluorine, sulphuretted hydrogen and sulphurous acid are all emitted by volcanoes. A recent lava flow has been likened to a great fumarole pouring out volatile substances at every crack in its slaggy crust. Many minerals are deposited in these fissures, and among the substances produced in this way are ammonium chloride, ferric chloride and oxide, copper oxide (tenorite and cuprite) and sulphur; by reacting on the minerals of the rock many zeolites and other secondary products are formed. These processes have been described as "juvenile" or "post-eruptive," and it is believed that the amygdales which occupy the cavities of many porous lavas are not due really to weathering by surface waters percolating in from above, but to the action of the steam and other gases set free as the lava crystallizes. The zeolites are the principal group of minerals which originate in this way together with chlorite, chalcedony and calcite. The larger cavities (or geodes) are often lined with beautiful crystal groups of natrolite, scolecite, thomsonite, stilbite, and other minerals of this order.

Solfataric Activity.—The active gases were evidently in solution in the magma as it rose to the surface. Geologists now believe they are of subterranean origin like the lava itself, and an essential or original component of the magma. Long after a lava has cooled down and become rigid the vapours continue to ooze out through its fissures, and around many volcanoes which are believed to be extinct there are orifices discharging gas in great quantities. This state of activity is said to be "solfataric," and a good example of it is the volcano called the Solfatara near Naples. The numerous "soufrières" of the West Indies are further instances. The prevalent gas is steam with sulphuretted hydrogen and carbonic acid. White crusts of alum, various sulphates, and sulphides such as pyrites, also carbonates of soda and other bases, are formed by the action of the acid vapours on the volcanic rocks. The final manifestation of volcanic activity in a solfataric region may be the discharge of heated waters, which have ascended from the deep-seated magma far below the surface, and make their appearance as groups of hot springs; these springs persist long after the volcanoes which give rise to them have become extinct.

Rôle of Hot Waters.—It is now believed by a large number of geologists and mining engineers that these ascending hot waters are of paramount importance in the genesis of some of the most important types of ore deposits. Analyses have proved that the igneous rocks often contain distinct though very small quantities of the heavy metals; it is also established beyond doubt that veins of gold, silver, lead, tin and mercury most commonly occur in the vicinity of intrusive igneous masses. At Steamboat, Nev., hot springs, probably of magmatic origin, are forming deposits of cinnabar; at Cripple Creek, Colo., and in many other places gold-bearing veins occur in and around intrusive plugs of igneous rock. Tin ores in all parts of the world are found in association with tourmaline granites, and in all cases the veins bear evidence of having been filled from below by hot waters set free during the cooling of the igneous intrusions. Volcanic rocks are consequently the parent sources of many valuable mineral deposits, and the agency by which they were brought into their present situations is the volatile products discharged as the magma crystallized. The process was no doubt a long one and it is most probable that both steam and water took part in it. In what condition the metallic ores are dissolved and by what reactions they are precipitated depends on many factors only partly understood. The tin ores are so often associated with minerals containing boron and fluorine that it is quite probable that they were combined with these elements in some way, but they were deposited in nearly all cases as oxides. Other gaseous substances, such as sulphuretted hydrogen, carbonic acid and hydrochloric acid, probably have an important part in dissolving certain metals; and the alkaline carbonates, sulphides and chlorides have been shown by experiment to act also as solvents. In these ore deposits not only the heavy metals are found, but often a much larger quantity of minerals such as calcite, barytes, fluorspar, quartz and tourmaline which serve as a matrix or gangue, and have been deposited by the same agencies, and often at the same time as the valuable minerals.

Alteration of Minerals.—In their passage upwards and outwards through the rocks of the earth's crust, these gases and liquids not only deposit minerals in the fissures along which they ascend, but attack the surrounding rocks and alter them; the granite or other plutonic mass from which the vapours are derived is specially liable to transformation, probably because it is at a high temperature, not having yet completely cooled down. Around the tin-bearing veins in granite there is extensive replacement of felspar and biotite by quartz, tourmaline and white micas (the last-named often rich in lithia). In this way certain types of altered granite are produced, such as greisen (*q.v.*) and schorl rock (see SCHORL). In the slates adjacent to the tin veins tourmalinization also goes on, converting them into schorl-schists. The alteration of felspar into kaolin or china clay is also a pneumatolytic process, and is often found along with tin veins or other types of mineral deposit; probably both fluorine and carbonic acid operated in this instance along with water. Equally common and important is the silicification of rocks near mineral veins which carry gold, copper, lead and other metals. Granites and felsites may be converted into hard cherty masses of silica; limestones undergo this transformation very readily; at the same time they are regarded as rocks very favourable to the deposition of ores—probably the great frequency with which they undergo silicification and other types of metasomatic replacement is one of the main causes of the abundance of valuable deposits in them. The process known as "propylitization," which has extensively affected the andesites of the Hungarian goldfields, is believed to be also a consequence of the action of pneumatolytic gases. The andesites change to dull, soft, greenish masses, and their original minerals are to a large extent replaced by quartz, epidote, chlorite, sericite and kaolin. Around granites intrusive into serpentine and other rocks containing much magnesia, there is often extensive "steatization," or the deposit of talc and steatite in place of the original minerals of the rock. Some of the apatite veins of Canada and Norway accompany basic rocks of the gabbro group; it has been argued that the apatite (which contains phosphorus and chlorine) was laid down by vapours or solutions containing those gases, which may play a similar part in the basic rocks to that taken by fluorine and boron in the pneumatolytic veins around granites. In the country rock around the veins scapolite (*q.v.*), a lime alumina silicate, containing chlorine, often is substituted for lime-felspar.

These extensive changes attending the formation of mineral veins are by no means common phenomena, but in many plutonic masses pneumatolytic action has contributed to the formation of pegmatites (*q.v.*). (J. S. F.)

PNEUMONIA, a term used for inflammation of the lung substance. The disease has long been divided into three varieties: (1) Acute Croupous or Lobar pneumonia; (2) Catarrhal or Broncho-pneumonia; (3) Interstitial or Chronic pneumonia.

1. Acute Lobar Pneumonia (Pneumonic Fever) is now classed as an acute infective disease of the lung, characterized by fever and toxaemia, running a definite course and being the direct result of a specific micro-organism or micro-organisms. The micrococcus lanceolatus (pneumococcus, or diplococcus pneumoniae) of Fränkel and Weichselbaum is present in a large number of cases in the bronchial secretions, the affected lung and the blood. This organism is also present in many other infective processes which may complicate or terminate lobar pneumonia, such as pericarditis, endocarditis, peritonitis and empyema. The bacillus pneumoniae of Friedlander is also present in a proportion of cases, but is probably not the cause of true lobar pneumonia. Lobar pneumonia is an acute endemic disease of temperate climates, though epidemic forms have been described. It has a distinct seasonal incidence, being most frequent in the winter and spring. Osler strongly supported the view that it is an infectious disease, quoting the outbreaks reported by W. L. Rodman of Frankfort, Kentucky, where in a prison of 735 inhabitants there were 118 cases in one year; but direct contagion does not seem to be well proved, and it is undoubted that the pneumococcus is present in the fauces of numbers of healthy persons and seems to require a lowered power of resistante or other favouring condition for the production of an attack.

Lobar Pneumonia begins with an acute inflammatory process in the alveoli. The changes which take place in the lung are chiefly three: (1) Congestion, or engorgement, the air cells still contain air. (2) Red *Hepatization,* so called from its resemblance to liver tissue. In this stage the congested blood-vessels pour into the air spaces of the affected part an exudation which speedily coagulates, causing the lung to become airless and solid. In this condition the lung substance sinks in water. (3) Grey *Hepatization.* In this stage the lung still retains its liver-like consistence, but its colour is now grey, not unlike the appearance of grey granite. This is due partly to anaemia from pressure of the solidified exudation on the pulmonary capillaries, partly to local accumulation of enormous numbers of white blood corpuscles. The fibrin of the solid exudation is now liquefied by a process of autolysis or peptonization by unorganized ferments and the entangled cells undergo fatty degeneration ("resolution"). Absorption of this liquefied material is carried out by the lymphatics and veins and in most cases the lung soon recovers its normal function apparently uninjured. The absorbed exudate is mainly excreted by the kidneys, excess of nitrogen being found in the urine during this period. When resolution does not take place, death may occur from extension of the disease and subsequent toxaemia, heart failure, the formation of abscess or, more rarely, gangrene of the lung or from some complication. Usually pneumonia affects one lower lobe but it may extend to the whole lung or even to parts of both lungs (double pneumonia). In some cases, and particularly in children, the apex of the lung alone is affected. The prognosis of lobar pneumonia depends to a great extent on the previous history of the patient, especially in respect of alcohol; a chronic alcoholic patient with apical or double pneumonia rarely recovers. The death rate of acute lobar pneumonia in the chief London hospitals is 20%.

Symptoms.—The attack is usually ushered in by a rigor (or in children a convulsion), and rise of temperature to 102° F or more. Pulse and respiration are quickened but disproportionately so that the normal ratio (3 or 4:1) is replaced by 2:1 or even 1:1. The extraordinary muscles of respiration come into play and rhythmic dilatation of the alae nasi is very characteristic. Pain in the side is felt, especially should any amount of pleurisy be present, as is often the case. Cough is an early symptom. It is at first frequent and hacking, and is accompanied with a little tough colourless expectoration which soon, however, becomes more copious and of a rusty red colour, either tenacious or frothy and liquid. The patient during the greater part of the disease lies on the back or on the affected side. The urine is scanty, sometimes albuminous, and its chlorides are diminished. In favourable cases, however severe, there generally occurs after six or eight days a distinct crisis, marked by a rapid fall of the temperature accompanied with perspiration and a copious discharge of lithates in the urine. Although no material change is as yet noticed in the physical signs, the patient breathes more easily, sleep returns, and convalescence advances rapidly in the majority of instances.

The complications of acute pneumonia are pleurisy, empyema, pericarditis and endocarditis, while meningitis is responsible for a large percentage of the fatal cases. The pneumococcus has been found in the exudate in all these cases. Secondary pneumonias chiefly follow the specific fevers, as diphtheria, enteric fever, measles and influenza. Bacteriologically a number of different organisms have been found, together with the specific microbe of the primary disease; the striking features of primary lobar pneumonia are often masked in these types.

Treatment.—This is partly general, partly by means of vaccines and serums. Many trials have been made with antipneumococcic serum, but it has not been shown to have a very marked effect in cutting short the disease. The polyvalent serum of Romer has given the best results. Much more favourable results have been obtained from the use of a vaccine. The vaccine producing the best results is autogenous, *i.e.*, prepared from the patient's own strain of pneumococcus but in order to save time a "stock" mixture of known pneumococcus strains is employed, at least for a first injection. The value of vaccine treatment seems to depend upon recognition of the particular "type" of pneumococcus causing the disease.

2. **Broncho-Pneumonia** (Catarrhal or Lobular Pneumonia or Capillary Bronchitis). The term "broncho-pneumonia" is here used to denote a widespread catarrhal inflammation of the smaller bronchi which spreads in places to the alveoli and produces consolidation. All forms of broncho-pneumonia depend on the invasion of the lung by micro-organisms. No one organism has however been constantly found which can be said to be specific, as in lobar pneumonia; the influenza bacillus, micrococcus catarrhalis, pneumococcus, Friedlander's bacillus and various staphylococci have been found and often the infection is mixed. Broncho-pneumonia may occur as an acute primary affection in children, but more usually is a secondary extension of the bronchitis found in infectious fevers, measles, diphtheria, whooping cough, scarlet fever and typhoid fever. In these it forms a frequent and often a fatal complication especially in early childhood. In adults it may follow influenza or complicate chronic Bright's disease or various other. disorders. Broncho-pneumonia also may follow operations on the mouth or trachea, or the inhalation of foreign bodies into the traches.

The lung shows numerous prominent dark red patches in contact with depressed areas of collapsed and airless lung. Under the microscope the air vesicles and finer bronchi are blocked with epithelial cells and leucocytes, but there is no fibrinous exudation as in croupous pneumonia. In favourable cases resolution takes place by fatty degeneration, liquefaction, and absorption of the cells, but in weakly children the foci are liable to be infected by B. tuberculosis and the subsequent changes are those of tuberculosis. Broncho-pneumonia is a serious disease; the death-rate in children under five has been estimated at 30 to 50%.

The treatment is mainly symptomatic. In children, should the secretion accumulate in the bronchial tubes an emetic is useful. Inhalations relieve the cough, and circulatory stimulants such as strychnine are valuable, together with belladonna and oxygen.

3. Chronic Interstitial Pneumonia (Cirrhosis of the Lung) is a fibrosis chiefly around the walls of the bronchi and vessels, and in the intervesicular septa, which proceeds to such an extent as to invade and obliterate the air cells. The lung becomes shrunken, dense in texture and solid, any unaffected portions being emphysematous; the bronchi are dilated (see BRONCHIECTASIS), the pleura thickened, and the lung substance often deeply pigmented, especially in miners, who are apt to suffer from this disease. This condition is present to some degree in almost all chronic diseases of the lungs and bronchi, but it is specially apt to arise in persons folloxving dusty occupations such as those of colliers, flax-dressers, stonemasons, millers, etc., to which the term pneumonokoniosis is now applied (including anthracosis, siderosis,chalicosis and "grinder's rot"). (See MINERS' PHTHISIS.)

The malady is usually of long duration, many cases remaining for years in a stationary condition and even undergoing temporary improvement in mild weather, but the tendency is on the whole downward.

BIBLIOGRAPHY.—R. Murray Leslie, *Pneumonia,* London, 1924; H. E. Stewart, *Diathermy with special reference to pneumonia* (2nd ed , New York, 1925); Avery and others, *Acute lobar pneumonia,* Rockefeller Institute for Medical Research, Monograph No. 7 (New York, 1917, bibl.); W. G. MacCallum, Monograph 10 of same series (New York, 1919, bibl); R. L. Cecil, H. S. Baldwin and N. P. Larsen, *Lobar pneumonia;* clinical and bacteriological study of 2,000 typed cases, *Arch. Int. Med.* 1927, xl. 253 (bibl.); F. B. Kelly, "Observations on 6,500 cases of lobar pneumonia, etc.," Jn. *Infect. Dis.* (1926, xxxviii., 24, bibl.).

PNEUMOTHORAX. The lungs are elastic organs kept extended by their indirect attachment to the walls of the bony thorax. This is effected through the intervention of the pleura (see COELOM AND SEROUS MEMBRANES), the surfaces of which are held in contact by atmospheric pressure, and glide over one another during respiration. If gas or air gain entry to the pleural cavity, the lung on account of its elasticity tends to collapse and empty itself of air. This is the condition known as Pneumothorax, and according to the means of its production is spcken of as Spontaneous or Artificial.

Spontaneous **Pneumothorax.**—This is generally due to the rupture of an air-containing lung into the pleural sac, commonly caused by softening of a tuberculous nodule. According to the size and nature of the rupture the pneumothorax is formed gradually, with slow development of symptoms, or suddenly with immediate and urgent distress. A rapid and complete collapse of one lung, accompanied, as commonly happens, by encroachment of the chest contents on the other lung, leads to severe breathlessness. Where, however, the collapsed organ was extensively diseased its loss may be less urgently felt and occasionally its collapse may be actually beneficial. It was largely the benefit arising from certain of these cases that directed attention to the idea of inducing collapse artificially. In most cases of spontaneous pneumothorax the pleura becomes inflamed, and fluid, whether thin or purulent, transforms the condition into a hydro- or pyo-pneumothorax.

Artificial **Pneumothorax.**—Otherwise known as pneumothorax treatment, or as collapse-therapy, artificial pneumothorax was first urged on theoreticai grounds in 1821 by an Irishman, James Carson of Liverpool. His views were supported by clinical observations on Spontaneous Pneumothorax (Houghton, 1832; Stokes, 1837), but not till 50 years later did Potain (1884) put air into a spontaneous pneumothorax, and Cayley (1885) treat a case of haemoptysis by this method. The treatment on its modem lines may be said to originate with Forlanini, who reported his first cases in 1894–5.

The aim of this treatment is the collapse of a diseased lung, where disease does not respond to other measures, and the other lung is sufficiently sound. Its main field has been pulmonary tuberculosis, but it has also been used in lung abscess and bronchiectasis, in the diagnosis of obscure lung conditions, especially turnours, and to assist the surgeon in certain chest operations. The gases used are commonly air, nitrogen or oxygen, according to the requirements of the case.

The gas is delivered from a "gas bottle" connected with a "pressure bottle" containing fluid, and enters the chest through a special needle attached to a water manometer to control the pressure. It is introduced in small quantities at first and collapse brought about slowly. As it collapses the lung squeezes out the diseased secretions it contains, and these are brought up as sputum. In a favourable case the sputum then ceases, the temperature becomes normal and the patient regains his lost health. Gas is introduced every few weeks, and treatment is carried on till disease is judged to be healed. The lung is then allowed to expand and does so to a varying extent. The main impediment to pneumothorax treatment is the occurrence, in a large proportion of cases, of adhesions between the surfaces of the pleura. The main source of failure during its course is the development of fresh disease in the functioning lung. The success of pneumothorax treatment in severe tuberculous disease has been very notable, at least 50% being improved, arrested or cured.

BIBLIOGRAPHY.—Medical Research Council, *Special Report* No. 67, *Report on Artificial Pneumothorax* (*H.M.* Stat. Off., 1922); C. Riviere, *The Pneumothorax and Surgical Treatment of Pulmonary Tuberculosis* (2nd ed. London, 1927); J. B. Amberson, Jr. and A. Peters, *Pulmonary Tuberculosis; its Treatment by Induced Pneumothorax* in *H.* Lilienthal's *Thoracic Surgery,* vol. ii. p. 320 (Philadelphia. 1925, bibl.); J. Gravesen, *Surgical Treatment of Pulmonary and Pleural Tuberculosis* (London, 1925); J. Alexander, *Surgery of Pulmonary Tuberculosis* (London, 192j, bibl.). *See* also *E.* Loewenstein, *Handbuch der Gesamten Tuberculose-Therapie* (Berlin, 1923).

(C. RI.)

PNOM-PENH, a town of French Indo-China, capital, since 1886, of the protectorate of Cambodia and seat of the resident-superior. Pop. (1936) 103,000, consisting of Cambodians, Annamese, Chinese, Malays, Indians and some Europeans. It is situated on the Mekong about 173 m. from its mouth at the point where it divides into two arms and is joined by the Tonlé-Sap river. Its position makes it the market for the products of Cambodia, Laos, Upper Burma and part of Siam (dried fish, rice, cotton, indigo, cardamoms, etc.). The administrative opening of the Mekong to maritime navigation in 1908 has contributed a great deal to its development. The palace of the king of Cambodia occupies a large space in the Cambodian quarter. The town gets its name from the Pnôm, a hill surmounted by an ancient pagoda.

PO (anc. *Padus*, Gr. Πάδος), a river of northern Italy, and the dominating factor in its geography. It is the longest river in Italy (310 m. direct, 417 m. including its many windings), and the area of its basin, which includes portions of Switzerland, is estimated at 26,798 sq.m. For its course and principal tributaries, *see* ITALY.

The lower valley of the Po was at an early period occupied by people of the Palaeolithic and Neolithic stages of civilization, who built houses on piles along the swampy borders of the streams. The river regulation works originated in pre-Roman times. The reclaiming and protecting of the riparian lands went on rapidly under the Romans, and in several places the rectangular divisions of the ground are still remarkably distinct. *(See* ESTE.) During the barbarian invasions much of the protective system decayed but the later middle ages saw the works resumed, so that the present arrangement existed in the main by the close of the 15th century.

The Ligurian name of the Po was Bodincus or Bodencus, *i.e.,* the bottomless. The name Padus was taken from the Celts or the Veneti. Thus we find Bodincomagus as a town name (Industria) on the upper course, and Padua, as a name of one of the mouths of the river. The name Ἠριδανός (Eridanus) of Greek poetry was identified with it at a comparatively late period.

See A. Beltramelei, *Da Comacchio* ad *Argentn* (Bergamo, 1905); *A.* Cappellini, *Il Polesine* (Rovigo, 1925).

POBÊDONOSTSEV, CONSTANTINE PETROVICH (1827–1907), Russian jurist, state official, and writer on philosophical and literary subjects. Born in Moscow in 1827, he studied at the School of Law in St. Petersburg, and entered the public service as an official in one of the Moscow departments of the senate. From 1860 to 1865 he was professor of Russian civil law in Moscow University, and instructed the sons of Alexander II. in the theory of law and administration. In 1868 he became a senator in St. Petersburg, in 1872 a member of the council of the empire, and in 1880 chief procurator of the Holy Synod. He was an uncompromising reactionary.

In the early years of the reign of Alexander II. (1855–1881), Pobêdonostsev maintained, though keeping aloof from the Slavophils, that Occidental institutions were radically bad in themselves and totally inapplicable to Russia. Parliamentary methods of administration, modern judicial organization and procedure, trial by jury, freedom of the press, secular education—these were among the principal objects of his aversion. He subjected all of them to a severe analysis in his *Reflections of a Russian Statesman* (English by R. C. Long, London, 1898). To these dangerous products of Occidental rationalism he opposed the autocratic power, and the traditional veneration for the ritual of the national Church. He therefore persecuted the dissenters, Stundists, Doukhobors and others, and insisted on severe measures of repression in education and in the press. In the sphere of practical politics he exercised considerable influence by inspiring and encouraging the Russification policy of Alexander III. (1881–1894). After the death of Alexander III. he lost much of his influence. Pobêdonostsev retired in 1905, and died on March 23, 1907.

For an account of Pobêdonostsev's policy of repression *see* B. Pares, *A History of Russia.*

POCAHONTAS (1595–1617), daughter of the Indian chief, Powhatan, is the heroine of one of the best-known traditions connected with the beginnings of American history. The story is that Capt. John Smith, as head of a band of soldiers in search of food and exploring the Chickahominy river, was waylaid by Indians and taken prisoner by their chief, Powhatan. Smith had been forced to kneel down while his head was laid on a stone preparatory to having his brains crushed out with heavy clubs, when Pocahontas, a young daughter of the chief, sprang forward, seized his head in her arms, and saved his life. She is supposed to have come again to his aid a year later by revealing a plot made against Smith by her father. All this is said to have happened in connection with the expedition under Capt. Bartholoinew Gosnold and others, who landed in Chesapeake Bay in 1607, explored the James river, and formed a settlement. Owing to the fact, however, that no mention of this experience is made in the minute personal narrative covering this period, written by Capt. Smith at the time of the supposed occurrence and published immediately thereafter, nor in the recollections of his comrades who usually gave him full credit for any of his exploits, doubts have arisen as to the authenticity of the tale. The first story concerning Pocahontas appears in the *Generall Historie,* first published in 1624, after she had been made much of in England as the attractive daughter of an emperor and the first convert of her tribe to Christianity, and it is to be feared that the temptation to bring her on the stage as heroine in a new character in connection with Smith, ever the hero of his own chronicles, was more than he or the publishers of the *Generall Historie* could withstand. Among the many prominent Virginia families who trace their ancestry to the son of Pocahontas and her husband, John Rolfe, are the Bollings (Mrs. Edith Bolling Galt married President Woodrow Wilson in 1915), the Guys, the Robertsons, the Elbridges, and the John Randolphs. (See *Lincoln Library of Facts* and *American Antiquarian Society Trans.,* vol. iv., p. 40.)

POCATELLO, a city of southeastern Idaho, U.S.A., on the Portneuf river, at an altitude of 4.460 ft., 170 mi. S. by W. of Yellowstone National park; the county seat of Bannock county and the second city of the state in size. It is on federal highways 30N and 91 and the Union Pacific railway system; and has a municipal airport and station for the air-mail service. Pop. (1940) 18,133—82% native white—16,471 in 1930 by the federal census. Beyond the Snake river (15 mi. distant) to the north and west stretches the Snake river lava plain of 20.000 sq mi. American Falls (1940 pop. 1,439), 23 m i W. of Pocatello, is the centre of a great hydro-electric power and irrigation project. Pocatello has extensive railroad shops, large wholesale houses and a variety of manufacturing establishments (including cheese factories with a norld-wide market) with an output valued in 1940 at $8,000.-000. It is the seat of the southern branch of the state university. which duplicates the first two years of the curriculum offered at Moscow. Seven miles north is the Ft. Hall Indian Reservation. and within its limits is the site of old Ft. Hall. built in 1834 at the intersection of the Missouri-Oregon and the Utah-Canada trails. The early history of this region, when the overland stage made its way through the Portneuf valley, was full of episodes with Indians and highwaymen. At Massacre Rocks, 38 m. S.W. of Pocatello, an emigrant train was annihilated by Indians in Aug. 1862. The city is built on 2,000 ac. sold by the Indians to the United States. It began as a tent colony in 1882, when the railroad was completed to this point, and was incorporated in 1892. Its growth was due at first to the railroad shops, and later to the irrigation projects which turned much of the surrounding desert into productive agricultural lands.

POCHARD, a diving duck, *Nyroca ferina,* the female of which is sometimes called the dunbird. In the male in full plumage the head is coppery-red, the breast black, and the back and flanks a dull white, closely barred with fine undulating black lines. The tail coverts and quill feathers are black and the lower surface dull white. The female is duller. The pochard breeds throughout the northern hemisphere, migrating to the coast in winter and retiring southward. The American subspecies is larger. A second American species is the much bigger canvas-back duck (*q.v.*). Both species are excellent table birds when they frequent fresh water, the canvas-back being pre-eminent.

Allied to the pochards are the scaup duck (N. *marila*), the tufted duck and the eiders.

POCKET-GOPHER, the name of a group of (chiefly North) American rat-like rodents, characterized by large cheek-pouches, the openings of which are external to the mouth; while their inner surface is lined with fur. The second and third front-claws are greatly enlarged, and all the claws are furnished at the base with bristles. The eyes are small, and the external ears rudimentary.

Pocket-gophers, which typify a family, the *Geomyidae,* spend the whole of their time underground, their powerful claws being adapted for digging, while the bristles on the toes prevent the earth from passing between them. The upper incisor teeth are employed to loosen the ground, like a fork; and the little rodents are able to move both backwards and forwards in their runs. The cheek-pouches are employed in carrying food, which consists of roots. The common pocket-gopher, *Geomys bursarius,* of the Mississippi Valley measures about 8 in. in length, with a tail of between 2 and 3 in.; its colour being rufous brown and greyish beneath. A well-known representative of the second genus is the Canadian *Thomomys talpoides,* which is considerably smaller than the former. *(See* RODENTIA.)

POCKET-MOUSE, the name of a number of small jerboa-like, chiefly North American rodents belonging to the family *Heteromyidae,* and including the genera *Dipodomys, Microdipodops, Perognathus,* and *Heteromys.* The typical pocket-mouse P. *fasciatus* is *a* native of Montana, Dakota and Wyoming. The Pocket-Mice (*Perognathus*) and Kangaroo Rats (*Dipodomys*) are fairly closely allied genera, the latter looking very like jerboas, with long hind-feet and plumed tails. *Heteromys* contains a number of Spiny Pocket-Mice, in which the hair is spiny and the colour of the coat usually black; the majority of the species of this genus are from Central America and Mexico.

POCOCKE, EDWARD (1604–1691), English Orientalist and biblical scholar, the son of a Berkshire clergyman, was educated at the free school of Thame in Oxfordshire and at Corpus Christi college, Oxford of which he became a fellow in 1628. He discovered in a Bodleian ms. the missing Syraic versions of the four New Testament epistles (2 Peter, 2 and 3 John, Jude) which were not in the old Syriac canon, and were not contained in European editions of the Peshito. His edition of these was published at Leyden in 1630, when Pococke sailed for Aleppo as chaplain to the English factory. At Aleppo he studied Arabic, and collected many valuable mss. Laud founded an Arabic chair at Oxford, and invited Pococke to fill it. He began to lecture on Aug. 10, 1636; but next summer sailed again for Constantinople, and remained there for about three years. When he returned to England Laud was in the Tower, but had placed the Arabic chair on a permanent footing. Pococke's rare scholarship and personal qualities won him influential friends among the opposite party, and through the good offices of John Selden and John Owen he was advanced in 1648 to the chair of Hebrew, though as he could not take the engagement of 1649 he lost the emoluments of the post soon after, and did not recover them till the Restoration. During the Commonwealth attempts were made to deprive him of his living of Childrey. In 1649 he published the *Specimen historiae arabum,* a short account of the origin and manners of the Arabs, taken from Barhebraeus (Abulfaragius), with notes from a vast number of *MS.* sources which are still valuable. This was followed in 1655 by the *Porta Mosis,* extracts from the Arabic commentary of Maimonides on the Mishna, with translation and learned notes; and in 1656 by the annals of *Eutychius* in Arabic and Latin.

After the Restoration Pococke's political and pecuniary troubles were removed, but the reception of his *magnum opus*—a complete edition of the Arabic history of Barhebraeus *(Greg. Abulfaragii historia compendiosa dynastiarum*), which he dedicated to the king in 1663—showed that the new order of things was not very favourable to profound scholarship. After this his most important works were a *Lexicon heptaglotton* (1669) and English commentaries on Micah (1677), Malachi (1677), Hosea (1685) and Joel (1691), which are still worth reading.

See a curious account of his life and writings by L. Twells prefixed to *Theological Works of Dr. Pococke* (2 vols., 1740).

PODĚBRAD, GEORGE OF (1420–1471), king of Bohemia, was the son of Victoria of Kunstat and Poděbrad, a Bohemian nobleman, who was one of the leaders of the "Orphans" or modern Taborites during the Hussite wars. George became early prominent as leader of the National, or Calixtine party in Bohemia, becoming its chief at the death of Ptacek of Pirkstein. In 1448, during the minority of Ladislas Posthumus, having raised a force of 9,000 men in north-east Bohemia, where the National cause was strongest and where his own ancestral castle was situated, he marched on Prague and took it, afterwards defeating the Romanist or Austrian party led by Ulrich von Rosenberg. In 1451 the emperor Frederick III., Ladislas' guardian, entrusted Poděbrad with the administration of Bohemia. In the same year a diet assembled at Prague also conferred on Podilbrad the regency. The struggle of the Bohemians against Rome continued uninterruptedly. and Poděbrad's position became very difficult when Ladislas, who was crowned in 1453, expressed his sympathies for the Roman Church, though recognizing the compacts and ancient privileges of Bohemia. In 1457 King Ladislas died suddenly. Public opinion from an early period accused Podilbrad of having poisoned him; but the suggestion is undoubtedly a calumny. On Feb. 27, 1458, the estates of Bohemia unanimously chose Poděbrad as king, even the adherents of the Austrian party voting for him. A year later, Pius II. (Aeneas Sylvius) became pope, and his incessant hostility proved a serious obstacle to Poděbrad's rule.

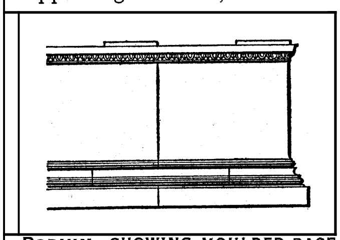
Though refusing to let the compacts be abolished, as Pius demanded, Poděbrad placated him by punishing the most advanced enemies of the papacy, including the newly-founded community of the Bohemian brethren; but his endeavours to establish peace with Rome proved ineffectual, although the death of Pius II. prevented him from carrying out his planned crusade against Bohemia. Despite the prosperity enjoyed by Bohemia under Poděbrad's rule, the malcontent nobles of the Romanist party, meeting on Nov. 28, 1465, at Zelena Hora, formed a confederacy against him which was supported by the Roman see. On Dec. 23, 1466, Paul II., the successor of Pius II., excommunicated Poděbrad and pronounced his deposition as king of Bohemia, forbidding all Romanists to continue in his allegiance. The emperor Frederick III., and King Matthias of Hungary, Poděbrad's former ally, joined the insurgents. Matthias conquered a large part of Moravia, and was crowned king of Bohemia at Briinn on May 3, 1469. On March 22, 1471, Poděbrad's death ended the war. He was the only native king of Bohemia, and the only one not a Roman Catholic.

See H. Markgraf, *Über das Verhältniss des Königs Georg von Poděbrad zu Papst Pius 11.* (1867); Jordan, *Das Königthum Georgs von Poděbrad* (1861); A. Bachmann, *Ein Jahr böhmischer Geschichte* (1876), and *Urkunden . . . zur oesterreichischen Geschichte . . . im Zeitalter George von Poděbrad* (1879); E. W. Kanter. *Die Emordung König Ladislaus* (1906); Novotry, *Über den Tod König Ladislaws Postumus* (1906). *See* also BOHEMIA.

PODGORICA (pronounced *Podgoritsa*), the commercial capital of Montenegro, Yugoslavia, occupied by Italy in 1941. Pop. (1931) 10,651. The town lies in a fertile plain on the Moracha, here spanned by a fine old Turkish bridge, while a tributary separates the Turkish town lying within the ruined ramparts, and inhabited by Albanians, from the new Montenegrin quarter built in 1878. The latter contains a state agricultural college, a gymnasium, a bank, a prison, a large tobacco factory and one of the few sawmills in the country.

PODIATRIST: *see* CHIROPODIST.

PODIUM, in architecture, a continuous pedestal, a low wall supporting columns, or the lowest portion of the wall of a building when given a separate architectural treatment. Sometimes the basement (*q.v.*) story of a classic building may be treated as a podium. The podium is usually designed with a moulded base and plinth (*q.v.*) at the bottom, a central plane surface known as a die or dado, and a projecting cornice or cap. The majority of Etruscan and Roman temples were raised on podiums and the entrance steps ascended between wing walls which were the continuations of the podium at the sides.



PODIUM; SHOWING MOULDED BASE, PLANE SURFACE OR DADO, AND CORNICE

PODMOKLY (Ger. Bodenbach), a town on the Elbe in N.W. Bohemia. Situated on the main Prague-Dresden-Berlin railway, it is an important junction, custom-house and passport control with a transit trade, in part supplied by its varied industries, which include textiles, porcelain, chemicals and foodstuffs. Pop. 22,648. The town was occupied in 1938 by Germany.

PODMORE, FRANK (1856–1910), English psychologist, was born at Elstree, Herts., on Feb. 5, 1856, and educated at Haileybury and at Pembroke college, Oxford. He became interested in psychical research, and was closely associated with Edmund Gurney and F. W. H. Myers in the telepathic and psychical investigations described in their joint publication Phantasms of the Living (1886). He was found drowned near Malvern on Aug. 15, 1910.

His publications include Apparitions and Thought *Transference* (1894); Studies in Psychical Research (1897); *Modern* Spiritualism (1902).

PODOCARPACEAE: see GYMNOSPERMS.

PODOLIA, a former government of European Russia now in the Ukrainian S.S.R. (See UKRAINE.)

PODOLSK, a town of Russia in the province of Moscow, in 5j° 27' N., 37° 28' E., 26 m. S. of Moscow, on the railway and on the Pakhra river, crossed by a suspension and a railway bridge. Pop (1939) 72,422. The town manufactures cement, lime, silicates and silk goods and has a railway repair shop. Until 1781 it was a dependency of the Danilov monastery of Moscow. Near it is an unkept park on the banks of the Pakhra, on the former estate of Count Tolstoi, and a museum, once a house of Prince Golitzin.

PODOPHYLLPN, a drug obtained from the rhizome of the American mandrake or May apple (*q.v.*). As met with in commerce, the rhizome occurs in cylindrical pieces 2 or 3 in. long and about ¼ in. in diameter, of a chocolate or purplish-brown colour, smooth, and slightly enlarged where the juncture of the leafy stem is indicated by a circular scar on the upper and a few broken rootlets on the under side. The odour is heavy and disagreeable, and the taste acrid and bitter.

Podophyllin is a resinous powder obtained by precipitating an alcoholic tincture of the rhizome by means of water acidulated with hydrochloric acid. The powder is soluble in alcohol and strong solutions of alkalis. There are at least two resins in the powder (which is known officially as *Podophylli resina*), one being soluble and the other insoluble in ether. Each contains an active substance, which can be obtained in crystalline form, and is known as podophyllotoxin. It is soluble in alcohol, ether, chloroform and boiling water. The properties of podophyllin resin vary with the reaction of the tissue with which it is in contact; where this is acid the drug is inert, the picro-podophyllin being precipitated. The resin does not affect the unbroken skin, but may be absorbed from a raw surface, and will then cause purging. When taken internally it is both a secretory and an excretory cholagogue. It is largely used in patent medicines, usually as an auxiliary to aloes. The best method of prescribing podophyllin is in pill form. In toxic doses podophyllin causes intense enteritis which may end in death. (See MAY APPLE.)

PODBSTEMONACEAE, a remarkable family of dicotyledonous plants, living only on rocks in rushing streams. The seeds are shed on the rocks during the dry season, germinating when the rocks become submerged in the rainy season. The vegetative parts consist mainly of a flattened green thallus, usually derived from adventitious roots. There are 40 genera and about 175 species, nearly all tropical, a single representative, *Podostemon Ceratophyllum* (river-weed), occurring in North America, found in shallow streams from Maine to Minnesota and southward to Georgia and Alabama. For a treatment of the genera, see A. Engler, "Podostemonaceae." Engler and Prantl, *Natürlichen Pflanzenfamilien,* ed. 2, 18a:3–68, fig. 1–61 (1930).

POE, EDGAR ALLAN (1809–1849), American poet and critic, cultivated the literature of mystery, and is himself, to a great extent, a mystery. His work owes much to the drift of romanticism (of which he is a late heir) towards the occult and the satanic. It owes much also to his own feverish dreams, to which he applied a strange power of logic and a rare faculty of shaping plausible fabrics out of impalpable materials. With an air of objectivity and spontaneity, his productions are closely dependent on his own idiosyncrasy and an elaborate technique.

He was born in Boston, Mass, Jan. 19, 1809, and was three years old when his mother, a young English actress, the widow of an American player, died at Richmond, Va., in 1811. The well-to-do childless Mrs. Allan, who adopted him, gave him motherly care and affection — reluctantly seconded by her husband. Edgar received a good education, first in England, then in a private school at Richmond, whence he went, in 1826, to the University of Virginia. Differences arose between him and his foster-father. Prevented from returning to college after the end of the first year, the youth ran away to Boston, where he enlisted in the Army. For three years he was a soldier (1827–31)—the last three months in the capacity of a cadet at West Point.

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POE'S COTTAGE AT FORDHAM, NEW YORK CITY (RESTORED)

His inclination led him towards writing. In spite of untoward circumstances and uncongenial surroundings, he wrote poetry, which he managed to have published in Boston (Tamerlane, 1827), in Baltimore (*Al* Aaraaf, 1829) and in New York (Poems, 1831). Poe settled as a man of letters at Baltimore in 1832, and struggled with poverty, at times with actual want, upheld by his pride and his set resolution to achieve work that would count in America and in the world. He had neither family nor friends. Disappointments in love and social slights threw a sombre cloud over his disposition. He was afflicted with a strange susceptibility to the effects of liquor, combined with an attraction towards it which he did not always resist successfully.

Jt was this defect (or hereditary flaw) that, in a large measure, made it impossible for him to remain literary editor, in Richmond, Philadelphia or New York, of magazines which he had raised to prosperity; that, later, discouraged J. R. Lowell from taking him as contributor to The Pioneer; that disqualified him for a clerkship in a Government office at Washington. He made worthy efforts to abstain from stimulants after he had married Virginia Clemm (1836), but relapsed when his child-wife fell dangerously ill, in 1841, with scant hope of recovery. After the death of Virginia, in 1847, his morbid condition grew worse and seems to have assumed the form of a lesion of the brain with temporary crises of delirious fever. "I became insane," he wrote, "with intervals of horrible sanity." His last years were marked by fits of platonic erotomania, the objects of which were successively or at the same time women of letters, such as Mrs. Osgood, Mrs. Shew (Maria Louise), Mrs. Whitman (Helen), Mrs. Lewis (Stella), and new or old friends, like Annie and Mrs. Shelton. He died after letting himself be entrapped into drinking too much liquor at Baltimore, in 1849.

For 40 years he had fought, against terrible odds, to keep his genius clear and accomplish the work of a creative artist. While continuing to write verse, he began composing prose tales in 1832, and started a career of literary critic in 1835 which he was to carry on steadily in various magazines till the end. His keen and sound judgment as appraiser of contemporary literature, his idealism and musical gift as a poet, his weirdness and dramatic power as a story teller, though hardly appreciated in his lifetime, have secured him to-day a prominent place among universally known men of letters. The complex and elusive nature of his productions can best be understood when one tries to seize the relations of his personality to the working of his mind.

The outstanding fact in Poe's character is a strange duality. We find this trait in his temper, in his mind, in his art. The wide divergence of contemporary judgments on the man seems to point to the coexistence in him of two persons. With those he loved and who saw him in repose, he was gentle, affectionate, obliging and devoted. Others, who were the butt of his sharp criticism or who happened to meet him in moments of excitement, found him irritable, arrogant, self-centred, sombre, rebellious, and went so far as to accuse him of lack of principle and conscience. Was it, in the latter case, a double of the man rising from harrowing nightmares, or from the haggard inner vision of dark crimes, or from appalling graveyard hallucinations, that ominously loomed through the gentler Poe's unstable being?

If we consider the mind of Poe, the duality is still more striking. On one side he was an idealist and a visionary. His yearning for the ideal was both of the heart and of the imagination. His sensitiveness to the beauty, purity and lovingness of woman, associated with the contemplation of her amid the sweetest objects of nature or in the glory of ethereal radiance, inspired him with his most touching lyrics ("To Helen," "The Sleeper," "Eulalie," "To One in Paradise"), and with the full-toned prose hymns to beauty and love in "Ligeia" and "Eleonora." His imagination carried him away from the earth and the material world into the angels' dwelling-place ("Israfel"), into fairyland or dreamland, or into the empyrean, where souls dwell in immortality, where Monos and Una, Eiros and Charmion, Oinos and Agathos hold discourses on the secrets of life and death, and whither the prophet of "Eureka" takes his flight to meditate on ultimate causes.

This Pythian mood was especially characteristic of the later years of his life. More generally, either in his verse ("Valley of Unrest," "Lenore," "The Raven," "For Annie," "Ulalume") or in his prose-tales, his familiar mode of evasion from the universe of common experience was through converse with death-in-life or life-in-death, and through haunting thoughts, impulses, or fears that seem to belong to an eerie world of horrible dreams, lurking in his abnormal subliminal consciousness. From these materials he drew the startling effects of his "tales of death" ("House of Usher," "Red Death," "Valdemar," "Premature Burial," "Oval Portrait," "Shadow"), of his "tales of wickedness and crime" ("Berenice," "Black Cat," "William Wilson," "Imp of the Perverse," "Cask of Amontillado," "Tell-Tale Heart"), of his "tales of survival after dissolution" ("Ligeia," "Morella," "Metzengerstein"), and of his "tales of fatality" ("Assignation," "Man of the Crowd"). Even when he does not hurl his characters into the clutch of fearful, mysterious or supernal forces or on to the untrodden paths of the beyond, he uses the anguish of imminent death as the means of causing the nerves to quiver and the flesh to creep ("Pit and the Pendulum"), and his very grotesque inventions deal with corpses and decay in an uncanny play with the aftermath of death.

On the other side, Poe is conspicuous for a close observation of minute details, which characterizes the realist or the painter of *trompe-l'oeil* landscapes or familiar scenes. He resorts to this gift of precise, Defoe-like apprehension in the long narratives and in many of the descriptions that introduce the tales or constitute their setting. Closely connected with this accurate scanning of actual or imagined things, is his power of ratiocination. He prided himself on his faultless logic and he carefully handled this real accomplishment so as to impress the public with his possessing still more of it than he had. Hence the would-be feats of thought-reading, problem-unravelling and cryptography which he attributed to his Legrand and his Dupin. This suggested to him the "analytical tales," which introduced into literature the detective story, and his "tales of pseudo-science."

The same duality is evinced in his art. He was capable of writing angelic or weird poetry with a supreme sense of rhythm and word-appeal, or prose of sumptuous beauty and suggestiveness, with the apparent abandon of compelling inspiration; and he would write down a problem of morbid psychology or the outlines of an unrelenting plot in a hard and dry style, with the clear-cut directness of algebraic reasoning. He was capable of throwing massively into a poem or a prose-tale the most impressive unity of effect, as if urged by a flashing vision or an irresistible creative impulse; and he would dissect in cold blood that seemingly unanalysable whole and show by precept and rule that it was the result of the most deliberate and artificial technique. In Poe's masterpieces, the double contents of his temper, of his mind and of his art are fused into a oneness of tone, structure and movement, the more effective, perhaps, as it is compounded of various elements that give depth and intensity to the total sheen or dismal glow.

Poe's genius was first recognized abroad. None did more to persuade the world, and, in the long run, America, of Poe's greatness than Baudelaire and Mallarmé. The one was a romanticist and the other a symbolist; they hailed Poe as the wizard of letters who had had intimation of immortal truths and the divine faculty of calling up an other-worldly thrill. Even if the present and the future generations are less likely to tremble in awe at Poe's would-be revelations of Elysian or Tartarian lore, they will concur with his "discoverers" in admiring his fecund and startling invention, his exact dosage of artifice and spontaneity, and his supreme artistry.

Poe's works have been edited by J. A. Harrison (1903, containing biography and letters), and by E. C. Stedman and G. E. Woodberry (1914, with a memoir, biography and criticism).

See J. H. Ingram, *Edgw Allan Poe* (1880); G. E. Woodberry, *Life of E. A. Poe* (1909); C. Baudelaire, *Edgar Poe* (1856); J. W. Robertsori. *Edgar A. Poe* (1922); S. Cody, *Poe* (1924); C. Mauclair, *Le genie d'Edgar Poe* (1925); H. Allen, *Israfel* (1926); M. E. Phillips, *Edgar Allan Poe* (1926); J. W. Krutch, *Edgar Allan Poe* (1926). (C. C.)

POELZIG, HAMS (1869–), German architect, was born in Berlin, April 30, 1869. He studied architecture at the technical high school in Berlin (1888–93); in 1900 he was appointed a lecturer in the Breslau academy of arts, of which he was subsequently director (1903–16). He was architect to the city of Dresden (1916–20) and also professor at the technical high school there. In 1920 he started an advanced studio for applied arts at the academy of arts in Berlin. He was professor of the architectural section of the Technische *Hochschule* in Berlin 1924–35. Poelzig was also a member of the academies of arts at Dresden and Berlin and president of the Deutscher Werkbund. Among his buildings, which display remarkable versatility, may be mentioned the dam in the Klingenberg valley; the Centenary exhibition in Berlin (gardens and buildings); reconstruction of the Grosses *Schauspielhaus,* Berlin; the water tower at Posen; the "Kapitol" cinema, Berlin; Keksfabrik, Hanover; the remarkable interior of Reinhardt's theatre; a chemical factory at Luban with an effective rhythmical arrangement of windows; an office-building at Breslau, almost completely glass-walled; and flat-roofed dwelling-houses partially in ferro-concrete exhibited at Die Wohnung, Stuttgart, 1927; he was also associated with Prof. Tessenow in a new housing scheme near Berlin.

POERIO, AEESSANDRO (1802–1848), Italian poet and patriot, was descended from an old Calabrian family, his father, Baron Giuseppe Poerio, being a distinguished Neapolitan lawyer. In 1815 he and his brother Carlo accompanied their father, who had been identified with Murat's cause, into exile, and settled at Florence. In 1818 they were allowed to return to Naples. Alessandro fought as a voiunteer, under Guglielmo Pepe (*q.v.*), against the Austrians in 1821, but when the latter reoccupied Naples and the king abolished the constitution, the family was sgain exiled and settled at Gratz. Alessandro studied in Germany, and at Weimar he became the friend of Goethe. In 1835 the Poerios returned to Naples. In 1848 Alessandro accompanied Pepe as a volunteer to fight the Austrians in northern Italy, and on the recall of the Neapolitan contingent he followed Pepe to Venice. He was severely wounded in the fighting round Mestre, and died on Nov. 3, 1848. His poetry "reveals the idealism of a tender and delicate mind"; but he could also sound the clarion note of patriotism, as in his stirring poem *Il Risorgimento.*

His brother Carlo (1803–67), after returning to Naples, practised as an advocate, and from 1837 to 1848 was frequently arrested and imprisoned. Under the short lived constitution of 1848 he was minister of education. He resigned office in April and took his seat in parliament, where he led the constitutional opposition. After the Austrian victory Poerio was arrested (July 19, 1849) tried, and condemned to 19 years in irons. Chained in pairs, he and other political prisoners were confined in one small room in the bagno of Nisida, near the lazaretto. The exposure (1851) of the horrors of the Neapolitan dungeons by Gladstone, who emphasized especially the case of Poerio, awakened the indignation of Europe, but he was not released till 1858. He and other exiles were then placed on board a ship bound for the United States, but the son of Settembrini, another of the exiles, who was on board in disguise, compelled the crew to land them at Cork, whence Poerio made his way to London. In the following year he returned to Italy, and in 1860 he was elected deputy to the parliament of Turin, of which he was chosen vice-president in 1861. He died at Florence on April 28, 1867.

See Baldachini, *Della Vita e de' tempi di Carlo Poerio* (1867); W. E. Gladstone, *Two Letters to the Earl of Aberdeen* (1851); *Carlo Poerio and the Neapolitan Police* (1858); Vannucci, *I Martiri della libertà italiana,* vol. iii. (Milan, 1880); Imbriani, *Alessandro Poerio a Venezia* (Naples, 1884); Del Giudice, *I Fratelli Poerio* (Turin, 1899); Countess Martinengo Cesaresco, *Italian Characters* (1901).

POET LAUREATE. The laurel (Lat. *laurea*) was sacred to Apollo, and as such was used to form a crown or wreath of honour for poets and heroes. The word "laureate" or "laureated" thus came in English to signify eminent, or associated with glory, literary or military. "Laureate letters" in old times meant the despatches announcing a victory; and the epithet was given, even officially (*e.g.,* to John Skelton) by universities, to distinguished poets. The term "poet laureate" was ultimately restricted to the office of the poet attached to the royal household, first held by Ben Jonson, for whom the position was, in its essentials, created by James I. in 1617. (Jonson's appointment does not seem to have been formally made as poet-laureate, but his position was equivalent to that). The office was really a development of the practice of earlier times, when minstrels and versifiers were part of the retinue of the king; it is recorded that Richard Coeur de Lion had a *versificator regis* (Gulielmus Peregrinus), and Henry III. had a versificator (Master Henry); in the 15th century John Kay, also a "versifier," described himself as Edward IV.'s "humble poet laureate." Moreover, the Crown had shown its patronage in various ways; Chaucer had been given a pension and a perquisite of wine by Edward III., and Spenser a pension by Queen Elizabeth. Sir William Davenant succeeded Jonson in 1638, and the title of poet laureate was conferred by letters patent on Dryden in 1670, two years after Davenant's death, coupled with a pension of £300 and a butt of Canary wine. This was the beginning of the official laureateship. The successors of Dryden were T. Shadwell (who originated annual birthday and new year odes), Nahum Tate, Nicholas Rowe, Laurence Eusden, Colley Cibber, William Whitehead, Thomas Warton, H. J. Pye, Southey, Wordsworth. Tennyson, Alfred Austin, Robert Bridges (appointed 1913) and John Masefield (appointed 1930).

The poet lau eate, being a court official, was considered responsible for producing formal and appropriate verses on birthdays and state occasions. Wordsworth stipulated before accepting the honour, that no formal effusions from him should be considered a necessity; but Tennyson was generally happy in his numerous poems of this class. The emoluments of the post have varied. To Pye an allowance of £27 was made instead of the Canary wine. Tennyson drew £72 a year, and £27 in lieu of the "butt of sack."

See Walter Hamilton, *Poets Laureate of England* (1879), and E. K. Broadus, *The Laureateshap* (1921).

POETRY. In modern criticism the word poetry (*i.e.* the art of the poet, Gr. *ποιητής*, maker, from *ποιεῖν*, to make) is used sometimes to denote any expression (artistic or other) of imaginative feeling, sometimes to designate a precise literary art, which ranks as one of the fine arts. As an expression of imaginative feeling, as the movement of an energy, as one of those great primal human forces which go to the development of the race poetry in the wide sense has played as important a part as science. In some literatures (such as that of England) poetic energy, and in others (such as that of Rome) poetic art is the dominant quality. It is the same with individual writers. In classical literature Pindar may perhaps be taken as a type of the poets of energy; Virgil of the poets of art. With all his wealth of poetic art Pindar's mastery over symmetrical methods never taught him to "sow with the hand," as Corinna declared, while his poetic energy always impelled him to "sow with the whole sack."

In some writers, and these the very greatest—in Homer, Aeschylus, Sophocles, Dante, Shakespeare, Milton, and perhaps Goethe—poetic energy and poetic art are seen in something like equipoise. It is of poetry as an art, however, that we have mainly to speak here; and all that we have to say upon poetry as an energy is that the critic who, like Aristotle, takes this wide view of poetry—the critic, who, like him, recognizes the importance of poetry in its relations to man's other expression of spiritual force, claims a place in point of true critical sagacity above that of a critic, who, like Plato, fails to recognize that importance.

With regard to poetry as an art, most of the great poems of the world are dealt with elsewhere in this work, either in connection with the names of the writers or with the various literatures to which they belong; consequently, these remarks must be confined to general principles. Under VERSE the detailed questions of prosody are considered: here we are concerned with the essential principles which underlie the meaning of poetry as such.

All that can be attempted is to inquire:

(1) What is poetry?

(2) What varieties of poetic art are the outcome of the two great kinds of poetic impulse, dramatic imagination, and lyric or egoistic imagination?

Definition of Poetry.—Definitions are for the most part alike unsatisfactory and treacherous; but definitions of poetry are proverbially so. Yet some definition must be here attempted; and, using the phrase "absolute poetry" as the musical critics use the phrase "absolute music," we may, perhaps, without too great presumption submit the following:

Absolute poetry is the concrete and artistic expression of the human mind in emotional and rhythmical language.

This, at least, will be granted, that no literary expression can, properly speaking, be called poetry that is not in a certain deep sense emotional, whatever may be its subject-matter, concrete in its method and its diction, rhythmical in movement, and artistic in form.

That the expression of all real poetry must be concrete in method and diction is obvious, and yet this dictum would exclude from the definition much of what is called didactic poetry. With abstractions the poet has nothing to do, save to take them and turn them into concretions; for, as artist, he is simply the man who by instinct embodies in concrete forms that "universal idea" which Gravina speaks of—that which is essential and elemental in nature and in man; as poetic artist he is simply the man who by instinct chooses for his concrete forms metrical language.

As an example of the absence of concrete form in verse take the following lines from George Eliot's *Spanish Gipsy:*

"Speech is but broken light upon the depth
Of the unspoken; even your loved words
Float in the larger meaning of your voice
As something dimmer."

Without discussing the question of blank verse cadence and the weakness of a line where the main accent falls upon a positive hiatus, "of the unspoken," we would point out that this powerful passage shows the spirit of poetry without its concrete form. The abstract method is substituted for the concrete. Such an abstract phrase as "the unspoken" belongs entirely to prose.

That poetry must be metrical or even rhythmical in movement, however, is what some have denied. Here we touch at once the very root of the subject. Aristotle seems to have assumed that the indispensable basis of poetry is invention; and perhaps the first critic who tacitly revolted against the dictum that substance. and not form, is the indispensable basis of poetry was Dionysius of Halicarnassus, whose treatise upon the arrangement of words is really a very fine piece of literary criticism.

By the poets themselves metre was for long considered to be the one indispensable requisite of a poem, though, as regards criticism, even in the time of the appearance of the *Waverley Novels,* the *Quarterly Review* would sometimes speak of them as "poems"; and perhaps even later the same might be said of romances so concrete in method and diction, and so full of poetic energy, as *Wuthering Heights* and *Jane Eyre,* where we get absolutely all that Aristotle requires for a poem. However, at all events this at least may be said, that the division between poetical critics is not now between Aristotelians and others; it is of a different kind altogether. While one group of critics may still perhaps say with Dryden that "a poet is a maker, as the name signifies" and that "he who cannot make (that is, invent) has his name for nothing," another group contends that it is not the invention but the artistic treatment, the form, which determines whether an imaginative writer is a poet or a writer of prose—contends, in short, that emotion is the basis of all true poetic expression, whatever be the subject-matter, that thoughts must be expressed in an emotional manner before they can be brought into poetry, and that this emotive expression demands even yet something else, viz., style and form.

Although many critics are now agreed that "L'art est une forme," that without metre and without form there can be no poetry, there are few who would contend that poetry can exist by virtue of any one of these alone, or even by virtue of all these combined. Quite independent of verbal melody, though mostly accompanying it, and quite independent of "composition" there is an atmosphere floating around the poet through which he sees everything, an atmosphere which stamps his utterances as poetry. This atmosphere is what we call poetic *imagination.*

In order to produce poetry the soul must for the time being have reached that state of exaltation, that state of freedom from self-consciousness, depicted in ihe lines.—

"I started once, or seemed to start, in pain
Resolved on noble things, and strove to speak
As when a great thought strikes along the brain
And flushes all the cheek."

Whatsoever may be the poet's "knowledge of his art" into this mood he must always pass before he can write a truly poetic line. For, notwithstanding all that may be said upon poetry as a fine art, it is in the deepest sense of the word an '(inspiration." No man can write a line of genuine poetry without having been "born again" (or as the true rendering of the text says, "born from above"); and then the mastery over those highest reaches of form which are beyond the ken of the mere versifier comes to him as a result of the change.

It might almost be said, indeed, that Sincerity and Conscience, the two angels that bring to the poet the wonders of the poetic dream, bring him also the deepest, truest delight of form. It might almost be said that by aid of sincerity and conscience the poet is enabled to see more clearly than other men the eternal limits of his own art—to see with Sophocles that nothing, not even poetry itself, is of any worth to man, invested as he is by the whole army of evil, unless it is in the deepest and highest sense good, unless it comes linking us all together by closer bonds of sympathy and pity, strengthening us to fight the foes with whom Fate and even Nature, the mother who bore us, sometimes seem in league—to see with Milton that the high quality of man's soul which in English is expressed by the word virtue is greater than even the great poem he prized, greater than all the rhythms of all the tongues that have been spoken since Babel—and to see with Shakespeare and with Shelley that the high passion which in English is called love is lovelier than all art, lovelier than all the marble Mercuries that "await the chisel of the sculptor" in all the marble hills.

Varieties **of** Poetic Art.—We have now reached the inquiry: What varieties of poetic art are the outcome of the two kinds of poetic impulse, dramatic imagination and lyric or egoistic imagination? Allowing for all the potency of external influences, we shall not be wrong in saying that of poetic imagination there are two distinct kinds—(I) the kind of poetic imagination seen at its highest in Aeschylus, Sophocles, Shakespeare, and Homer, and (2) the kind of poetic imagination seen at its highest in Pindar, Dante, and Milton, or else in Sappho, Heine, and Shelley. The former, being in its highest dramatic exercise unconditioned by the personal or lyrical impulse of the poet, might perhaps be called absolzrte dramatic vision; the latter, being more or less conditioned by the personal or lyrical impulse of the poet, might be called *relative* dramatic vision. It seems impossible to classify poets, or to classify the different varieties of poetry, without drawing some such distinction as this, whatever words of definition we may choose to adopt.

For the achievement of all pure lyric poetry such as the ode, the song, the elegy, the idyll, the sonnet, the stornello, it is evident that the imaginative force we have called relative vision will suffice. And if we consider the matter thoroughly, in many other forms of poetic art—forms which at first sight might seem to require absolute vision—we shall find nothing but relative vision at work.

Even in Dante, and even in Milton and Virgil, it might be difficult to trace the working of any other than relative vision. And as to the entire body of Asiatic poets, it might perhaps be found (even in view of the Indian drama) that relative vision suffices to do all their work. Indeed the temper which produces true drama is, it might almost be said, a growth of the Western mind. For, unless it be Semitic, as seen in the dramatic narratives of the Bible, or Chinese, as seen in that remarkable prose story The *Two Fair Cousins* translated by Rémusat, absolute vision seems to have but small place in the literatures of Asia. The wonderfulness of the world and the romantic possibilities of fate or circumstance, or chance—not the wonderfulness of the character to whom these possibilities befall—are ever present to the mind of the Asiatic poet. It was left for the poets of Europe to show that, given the interesting character, given the Achilles, the Odysseus, the Helen, the Priam, any adventure happening to such a character becomes interesting.

What then is this absolute vision, this true dramatic imagination which can hardly be found in Asia—which even in Europe cannot be found except in rare cases? Between relative and absolute vision the difference seems to be this, that the former only enables the poet, even in its very highest exercise, to make his own individuality, or else humanity as represented by his own individuality, live in the imagined situation; the latter enables him in its highest exercise to make special individual characters other than the poet's own life in the imagined situation.

"That which exists in nature," says Hegel, "is a something purely individual and particular. Art, on the contrary, is essentially destined to manifest the general." And no doubt this is true as regards the plastic arts, and true also as regards literary art, save in the very highest reaches of pure drama and pure lyric, when it seems to become art no longer—when it seems to become the very voice of Nature herself. The cry of Priam when he puts to his lips the hand that slew his son is not merely the cry of a bereaved and aged parent; it is the cry of the individual king of Troy, and expresses above everything else that most naïve, pathetic, and winsome character. Put the words into the mouth of the irascible and passionate Lear and they would be entirely out of keeping.

Lyric, Epic, *and* Dramatic Singers.—It may be said then that, while the poet of relative vision, even in its very highest exercise, can only, when depicting the external world, deal with the general, the poet of absolute vision can compete with Nature herself and deal with both general and particular. If this is really so, we may perhaps find a basis for a classification of poetry and of poets. That all poets must be singers has already been maintained. But singers seem to be divisible into three classes: first the pure lyrists, each of whom can with his one voice sing only one tune; secondly the epic poets, save Homer, the bulk of the narrative poets, and the quasi-dramatists, each of whom can with his one voice sing several tunes; and thirdly the true dramatists, who, having like the nightingale of Gongra many tongues, can sing all tunes.

It is to the first-named of these classes that most poets belong With regard to the second class there are not of course many poets left for it; the first absorbs so many. But, when we come to consider that among those who, with each his one voice. can sing many tunes are Pindar, Firdausi, Jami, Virgil, Dante, Milton, Spenser, Goethe, Byron, Coleridge, Shelley, Keats, Schiller. Victor Hugo, the second class is so various that no generalization save such a broad one as ours could embrace its members. And now we come to class three, and must pause. The third class is necessarily very small. In it can only be placed such names as Shakespeare, Aeschylus, Sophocles, Homer, and (hardly) Chaucer.

These three kinds of poets represent three totally different kinds of poetic activity.

With regard to the first, the pure lyrists, the impulse is mere egoism. Many of them have less of even relative vision at its highest than the mass of mankind. They are often too much engaged with the emotions within to have any deep sympathy with the life around them. Of every poet of this class it may be said that his mind to him "a kingdom is" and that the smaller the poet the bigger to him is that kingdom. To make use of a homely image—like the chaffinch whose eyes have been pricked by the bird-fancier, the pure lyrist is sometimes a warbler because he is blind. Still, he feels that the Muse loves him exceedingly. She takes away his eyesight, but she gives him sweet song. And his song is very sweet, very sad, and very beautiful; but it is all about the world within his own soul—its sorrows, joys, fears, and aspirations.

With regard to the second class the impulse here is no doubt a kind of egoism too; yet the poets of this class are all of a different temper from the pure lyrists. They have a wide imagination; but it is still relative, still egoistic. They have splendid eyes, but eyes that never get beyond seeing general, universal humanity (typified by themselves) in the imagined situation. Not even to these is it given to break through that law of centrality by which every "me" feels itself to be the central "me"—the only "me" of the universe, round which all other spurious "me's" revolve. This "me" of theirs they can transmute into many shapes, but they cannot create other "me's"—nay, for egoism, some of them scarcely would, perhaps, if they could.

The third class, the true dramatists, whose impulse is the simple yearning to create akin to that which made "the great Vishnu yearn to create a world," are, "of imagination all compact" — much so that when at work "the divinity" which Iamblichus speaks of "seizes for the time the soul and, guides it as he will."

The distinction between the pure lyrists and the other two classes of poets is obvious enough. But the distinction between the quasi-dramatists and the pure dramatists requires a word of explanation before we proceed to touch upon the various kinds of poetry that spring from the exercise of relative and absolute vision. Sometimes, to be sure, the vision of the true dramatists—the greatest dramatists—will suddenly become narrowed and obscured, as in that part of the *Oedipus Tyrannus* where Sophocles makes Oedipus ignorant of what every one in Thebes must have known, the murder of Laius. And again, finely as Sophocles has conceived the character of Electra, he makes her, in her dispute with Chrysothemis, give expression to sentiments that, in another play of his own, come far more appropriately from the lofty character of Antigone in a parallel dispute with Ismene. And, on the other hand, examples of relative vision in its furthest reaches can be found in abundance everywhere, especially in Virgil, Dante, Calderon, and Milton.

In Coleridge's "Ancient Mariner" we find an immense amount of relative vision of so high a kind that at first it seems absolute vision. When the ancient mariner, in his narrative to the wedding guest, reaches the slaying of the albatross, he stops, he can proceed no farther, and the wedding guest exclaims:—

> "God save thee, Ancient Mariner,
> From the fiends that plague thee thus!
> Why look'st thou so?" "With my cross-bow
> I shot the albatross."

But there are instances of relative vision—especially in the great master of absolute vision, Shakespeare—which are higher still—so high indeed that not to relegate them to absolute vision seems at first sight pedantic. Such an example is the famous speech of Lady Macbeth in the second act, where she says:—

> "Had he not resembled
> My father as he slept, I had done't."

Marvellously subtle as is this speech it will be found, if analysed, that it expresses the general human soul rather than any one special human soul. Indeed, Leigh Hunt records the case of a bargeman who, charged with robbing a sleeping traveller in his barge, used in his confession almost identical words—"Had he not looked like my father as he slept, I should have killed as well as robbed him." Again, the thousand-and-one cases (to be found in every literature) where a character, overwhelmed by some sudden surprise or terror, asks whether the action going on is that of a dream or of real life, must all, on severe analysis, be classed under relative rather than under absolute vision—even such a fine speech, for instance, as that where Pericles, on discovering Marina, exclaims:—

> "This is the rarest dream that e'er dull sleep
> Did mock sad fools withal"—

even here, we say, the humanity rendered is general and not particular, the vision at work is relative and not absolute. The poet, as representing the whole human race, throwing himself into the imagined situation gives us what general humanity would have thought, felt, said, or done in that situation, not what one particular individual and he alone would have thought, felt, said, or done.

Now what we have called absolute vision operates in a very different way. So vividly is the poet's mere creative instinct at work that the *ego* sinks into passivity—becomes insensitive to all impressions other than those dictated by the vision—by the "divinity" which has "seized the soul." Shakespeare is full of examples. Take the scene in the first act of *Hamlet*, where Hamlet hears for the first time, from Horatio, that his father's ghost haunts the castle. Having by short sharp questions elicited the salient facts attending the apparition, Hamlet says, "I would I had been there." To this Horatio makes the very commonplace reply, "It would have much amazed you." Note the marvellously dramatic reply of Hamlet—"Very like, very like! Stayed it long?" Suppose that this dialogue had been attempted by any other poet than a true dramatist, or by a true dramatist in any other mood than his very highest, Hamlet, on hearing Horatio's commonplace remarks upon phenomena which to Hamlet were more subversive of the very order of the universe than if a dozen stars had fallen from their courses, would have burst out with: "Amazed me!" and then would have followed an eloquent declamation about the "amazing" nature of the phenomena and their effect upon him. But so entirely has the poet become Hamlet, so completely has "the divinity seized his soul," that ail language seems equally weak for expressing the turbulence within the soul of the character, and Hamlet exclaims in a sort of meditative irony, "Very like, very like!" It is exactly this one man Hamlet, and no other man, who in this situation would have so expressed himself.

While all other forms of poetic art can be vitalized by relative vision, there are two forms (and these the greatest) in which absolute vision is demanded, viz., the drama, and in a lesser degree the Greek epic, especially the *Iliad.* This will be seen more plainly perhaps if we now vary our definitions and call relative vision *egoistic imagination;* absolute vision *dramatic imagination.*

The nature of this absolute vision or true dramatic imagination is easily seen if we compare the dramatic work of writers without absolute vision, such as Calderon, Goethe, Ben Jonson, Fletcher, and others, with the dramatic work of Aeschylus and of Shakespeare. While of the former group it may be said that each poet skilfully works his imagination, of Aeschylus and Shakespeare it must be said that each in his highest dramatic mood does not work, but is worked by his imagination. Note, for instance, how the character of Clytaemnestra grows and glows under the hand of Aeschylus. The poet of the *Odyssey* had distinctly said that Aegisthus, her paramour, had struck the blow, but the dramatist having imagined the greatest tragic female in all poetry, finds it impossible to let a man like Aegisthus assist such a woman in a homicide so daring and so momentous. And when in that terrible speech of hers she justifies her crime (ostensibly to the outer world, but really to her own conscience'), the way in which, by sheer magnetism of irresistible personality, she draws our sympathy to herself and her crime is unrivalled out of Shakespeare and not surpassed even there.

Epic and **Drama Compared.**—Much has been said as to the scope of these. If in epic the poet has the power to take the imagination of his audience away from the dramatic centre arid show what is going on at the other end of the great web of the world, he can do the same thing in drama by the chorus, and also by the introduction into the dramatic circle of messengers and others from the outside world. But as regards epic poetry, is it right that we should hear. as we sometimes do hear, the voice of the poet himself as chorus bidding us contrast the present picture with other pictures afar off, in order to enforce its teaching and illustrate its pathos? This is a favourite method with modern poets and a still more favourite one with prose narrators. Does it not give an air of self-consciousness to poetry? Does it not disturb the intensity of the poetic vision? Yet it has the sanction of Homer; and who shall dare to challenge the methods of the great father of epic? An instance occurs in *Iliad* v. 158, where, in the midst of all the stress of fight, the poet leaves the dramatic action to tell us what became of the inheritance of Phaenops, after his two sons had been slain by Diomedes. Another instance occurs in iii. 243–244, where the poet, after Helen's pathetic mention of her brothers, comments on the cause of their absence, "criticizes life" in the approved modern way, generalizes upon the impotence of human intelligence—the impotence even of human love—to pierce the darkness in which the web of human fate is woven. Thus she spoke (the poet tells us); but the life-giving earth already possessed them, there in Lacedaemon, in their dear native land:—

> ὥς φάτο· robs 6' ἤδη κάτεχεν φυσίζοος αἶα
> ἐν Λακεδαίμονι αὖθι, φίλῃ ἐν πατρίδι γαίῃ.

This, of course, is "beautiful exceedingly," but, inasmuch as the imagination at work is egoistic or lyrical, not dramatic; inasmuch as the vision is relative, not absolute, it does not represent that epic strength which we call specially "Homeric."

The deepest of all the distinctions between dramatic and epic methods has relation, however, to the nature of the dialogue. Aristotle failed to point it out, and this is remarkable until we remember that his work is but a fragment of a great system of criticism. In epic poetry, and in all poetry that narrates, whether the poet be Homer, Chaucer, Thomas the Rhymer, Gottfried von Strassburg, or Turoldus, the action, of course, is moved partly by aid of narrative and partly by aid of dialogue, but in drama the dialogue has a quality of suggestiveness and subtle inference which we do not expect to find in any other poetic form save perhaps that of the purely dramatic ballad. In ancient drama this quality of suggestiveness and subtle inference is seen not only in the dialogue but in the choral odes. The third ode of the *Agamemnon* is an extreme case in point, where by a kind of double *entendre* the relations of Clytaemnestra and Aegisthus are darkly alluded to under the cover of allusions to Paris and Helen. Of this dramatic subtlety Sophocles is perhaps the greatest master; and certain critics have been led to speak as though irony were the heart-thought of Sophoclean drama. But the suggestiveness of Sophocles is pathetic (as Professor Lewis Campbell well pointed out), not ironical. This is one reason why drama more than epic seems to satisfy the mere intellect of the reader, though this may be counterbalanced by the hardness of mechanical structure which sometimes disturbs the reader's imagination in tragedy.

The Lyric *Imagination.*—But we must now give undivided attention to pure egoistic or lyric imagination. This, as has been said, is sufficient to vitalize all forms of poetic art save drama and the Greek epic. It would be impossible to discuss adequately here the Hebrew poets, who have produced a lyric so different in kind from all other lyrics as to stand in a class by itself. As it is equal in importance to the Great Drama of Shakespeare, Aeschylus, and Sophocles, we may perhaps be allowed to call it the "Great Lyric." The Great Lyric must be religious—it must, it would seem, be an outpouring of the soul, not towards man, but towards God, like that of the God-intoxicated prophets and psalmists of Scripture. Even the lyric fire of Pindar owes much to the fact that he had a childlike belief in the myths to which so many of his contemporaries had begun to give a languid assent. But there is nothing in Pindar, or indeed elsewhere in Greek poetry, like the rapturous song, combining unconscious power with unconscious grace, which we have called the Great Lyric. It might perhaps be said indeed that the Great Lyric is purely Hebrew. But, although we could hardly expect to find it among those whose language, complex of syntax and alive with self-conscious inflexions, bespeaks the scientific knowingness of the Western mind, to call the temper of the Great Lyric broadly "Asiatic" would be rash. It seems to belong as a birthright to those descendants of Shem, who, yearning always to look straight into the face of God and live, could (when the Great Lyric was sung) see not much else.

Though two of the artistic elements of the Great Lyric, unconsciousness and power, are no doubt plentiful enough in India, the element of grace is lacking for the most part. The Vedic hymns are both nebulous and unemotional, as compared with Semitic hymns. And as to the Persians, they, it would seem, have the grace always, the power often, but the unconsciousness almost never. This is inevitable if we consider for a moment the chief characteristic of the Persian imagination—an imagination whose wings are not so much "bright with beauty" as heavy with it—heavy as the wings of a golden pheasant—steeped in beauty like the "tiger-moth's deep damasked wings." Now beauty of this kind does not go to the making of the Great Lyric.

Then there comes that poetry which, being ethnologically Semitic, might be supposed to exhibit something at least of the Hebrew temper—the Arabian. But, whatever may be said of the oldest Arabic poetry, with its deep sense of fate and pain, it would seem that nothing can be more unlike than the Hebrew temper and the Arabian temper as seen in later poets. It is not with Hebrew but with Persian poetry that Arabian poetry can be usefully compared. If the wings of the Persian imagination are heavy with beauty, those of the later Arabian imagination are bright with beauty—brilliant as an Eastern butterfly, quick and agile as a dragon-fly or a humming-bird. To the eye of the Persian poet the hues of the earth are (as Firdausi says of the garden of Afrasiab) "like the tapestry of the kings of Ormuz, the air is perfumed with musk, and the waters of the brooks are the essence of roses." And to the later Arabian no less than to the Persian the earth is beautiful; but it is the clear and sparkling beauty of the earth, as she "wakes up to life, greeting the Sabaean morning"; we feel the light more than the colour. But it is neither the Persian's instinct for beauty nor the Arabian's quenchless wit and exhaustless animal spirits that go to the making of the Great Lyric; far from it. In a word, the Great Lyric, as we have said, cannot be assigned to the Asiatic temper generally any more than it can be assigned to the European temper.

The Ode.—In the poetry of Europe, if we cannot say of Pindar, devout as he is, that he produced the Great Lyric, what can we say of any other European poet? The truth is that, like the Great Drama, so straight and so warm does it seem to come from the heart of man in its highest moods that we scarcely feel it to be literature at all. Passing, however, from this supreme expression of lyrical imagination, we come to the artistic code. Whatever may have been said to the contrary, enthusiasm is, in the nature of things, the very basis of the ode; for the ode is a mono-drama, the actor in which is the poet himself; and, as Marmontel has well pointed out, if the actor in the mono-drama is not affected by the sentiments he expresses, the ode must be cold and lifeless. But, although the ode is a natural poetic method of the poet considered as a prophet—although it is the voice of poetry as a fine frenzy—it must not be supposed that there is anything lawless in its structure. "Pindar," says the Italian critic, Gravina, "launches his verses upon the bosom of the sea; he spreads out all his sails; he confronts the tempest and the rocks; the waves arise and are ready to engulf him; already he has disappeared from the spectator's view; when suddenly he springs up in the midst of the waters and reaches happily the shore." Now it is this Pindaric discursiveness, this Pindaric unrestraint as to the matter, which has led poets to attempt to imitate him by adopting an unrestraint as to form. Although no two odes of Pindar exhibit the same metrical structure (the Aeolian and Lydian rhythms being mingled with the Doric in different proportions), yet each ode is in itself obedient, severely obedient, to structural law. This we feel; but what the law is exactly no metricist has perhaps ever yet been able to explain.

It was a strange misconception that led people for centuries to use the word "Pindaric" and irregular as synonymous terms; whereas the very essence of the odes of Pindar (of the few, alas! which survive to us) is their regularity. There is no more difficult form of poetry than this, and for this reason: when in any poetical composition the metres are varied, there must be a reason for such freedom, and that reason is properly subjective—the varying form must embody and express the varying emotions of the singer. But when these metrical variations are governed by no subjective law at all, but by arbitrary rules, supposed to be evolved from the practice of Pindar, then that very variety which should aid the poet in expressing his emotion crystallizes it and makes the ode the most frigid of all compositions. Great as Pindar undoubtedly is, it is deeply to be regretted that no other poet survives to represent the triumphal ode of Greece—the digressions of his subject matter are so wide, and his volubility is so great.

The great difficulty of the English ode is that of preventing the apparent spontaneity of the impulse from being marred by the apparent artifice of the form; for, assuredly, no writer subsequent to Coleridge and to Keats would dream of writing an ode on the cold Horatian principles adopted by Warton, and even by Collins, in his beautiful "Ode to Evening."

Fervour being absolutely essential, we think, to a great English ode, fluidity of metrical movement can never be dispensed with. The more billowy the metrical waves the better suited are they to render the emotions expressed by the ode, as the reader will see by referring to Coleridge's "Ode to France" (the finest ode in the English language according to Shelley), and giving special attention to the first stanza—to the way in which the first metrical wave, after it has gently fallen at the end of the first quatrain, leaps up again on the double rhymes (which are expressly introduced for this effect), and goes bounding on, billow after billow, to the end of the stanza. Not that this fine ode is quite free from the great vice of the English ode, rhetoric. If we except Spenser, and in one instance Collins, it can hardly be said that any English writer before Shelley and Keats produced odes independent of rhetoric and supported by pure poetry alone. But fervid as are Shelley's "Ode to the West Wind" and Keats's odes "To a Nightingale" and "On a Grecian Urn" they are entirely free from rhetorical flavour. Notwithstanding that in the "Ode on a Grecian Urn" the first stanza does not match in rhyme arrangement with the others, while the second stanza of the "Ode to a Nightingale" varies from the rest by running on four rhyme-sounds instead of five, vexing the ear at first by disappointed expectation, these two odes are, after Coleridge's "France," the finest regular odes perhaps in the English language.

The main other varieties of lyrical poetry, such as the idyll, the satire, the ballad, the sonnet, etc., are treated in separate articles.

(T. W.-D.; X.)

MODERN DEVELOPMENTS IN BRITISH POETRY

This note purports only to deal with the principal developments of British verse in the 20th century. The difficulty, however, is to decide when that century began. We cannot, unhappily, for this purpose permit the composers of almanacs to settle the question. Something more subtle than arithmetic is at work. What we have actually to do is to isolate the moment at which Victorianism was definitely spent and something new was born. From that point of view an attempt will be made to show that the new period was precipitated not earlier than 1910 with the Georgians. Till then we are still in the spacious days of great Victoria.

The '90s were, of course, essentially Victorian, in the sense that every blind reaction is an integral part of that from which it reacts. The Rhymers' club was not that new way of saying "yes" which alone is the mark of a new movement. It was merely spirited contradiction, or even what we should now call a rather blatant exhibition of an inferiority-complex. When Arthur Symons, for example, wrote his defence of the prostitute, with cock-robin self-consciousness, he was not so much shocking the suburbs as Lord Tennyson. When Ernest Dowson fainted prettily with Pierrot, or invited Cynara to share his exquisite self-depreciation, he was not in fact languid or corrupt. He was protesting against the heartiness of Dickens and the incorruptibility of King Arthur. In that way a queer self-condemned poetry of artifice arose, which had its roots neither in life nor in the refusal of life, but in the rejection of the poet laureate. That, however amusing or lively, is not a broad enough basis for a new period of literature.

Poetry of the '90s.—Two objections may fairly be raised to this interpretation of the '90s. On the one hand the names of Robert Bridges, Thomas Hardy and Rudyard Kipling will be advanced as proving that at that time there was a volume of virile and important verse being written which was influenced neither by liking nor distaste for Victorianism. On the other hand, it will be pointed out that W. B. Yeats and A. E. Housman—two of the most considerable poets of our time—had both fully established themselves in the '90s. Having regard to the profound influence of *A Shropshire Lad* an objector might go so far as to claim that the 20th century began not in 1906 but ten years earlier in 1896.

Yet these objections, though serious, are not valid. In every period there are distinguished writers who do not influence, and are not influenced by their contemporaries in their sphere of creation. That is essentially true, though for different reasons, of Bridges, Hardy and Kipling. Robert Bridges in such a poem, for example, as "I have loved flowers" permanently enriched the English treasury. But it has that curiously withdrawn quality, that affinity to the grave unswerving mould of the classic, which distinguishes all his work. Both in his simplicity here, and his metrical experiments and complexities elsewhere, Bridges is neither Victorian nor post-Victorian. He contributes, but he neither borrows nor influences. So, too, with Hardy. That reluctant expression, that constant effect of breaking a chisel on obdurate stone, may be admired: it can never be imitated, and it is doubtful whether any one would seek to imitate it. Standards that apply to no other poet, and to no other poetry, have been applied to Hardy, and by those standards he has by some been adjudged triumphantly successful. But he has no disciples as he had no master. To some his poetry may stand out like Stonehenge in a great plain, and in these it will inspire awe and perhaps worship. But it will remain as rugged, as isolated, and to many as unmanageable as those great monoliths. Kipling again, though incomparably the most popular poet of his time, is not, and could not be, a poet's poet. In so far as he was a brilliant and sometimes vicious pamphleteer, he was bound to suffer the fate of all politicians. As the author of *Barrack Room Ballads* he created not so much a new school of verse as a new army, just as in his poems of empire he joined hands with Cecil Rhodes and Joseph Chamberlain, and turned his back on Parnassus. When he consented to be a poet, as in such a perfect lyric as the Valour and Innocence poem in *Rewards and Fairies*, he did not affect his fellow poets because they had been frightened away by the outcries of the imperial buccina. The small body of his real verse will be winnowed out by Time from the great quantity of chaff, but its effect will not be felt till the separation is complete.

W. B. Yeats did start, or was an important part of, a new and fertile period. But it was an Irish and not an English period. It is indeed one of the curiosities of literature (and races) that the Celtic revival so little influenced poetry in the sister-island. Yeats, "A. E." and James Stephens affected the English hardly at all. It is, however, true that for Ireland the 20th century began in the '90s and what a century! Yeats and the Abbey Theatre, rather than all the politicians who spoke and died for Erin, were the fathers of the Revolution. Poets in Ireland always, more than elsewhere, have been recognized as

"the movers and shakers Of the world for ever."

Yeats wrote the first draft of the Constitution of the Free State in "The Lake-isle of Innisfree."

The answer to the objectors, therefore, remains. The typical poets of the '90s did not look forward eagerly, but backward contemptuously. They were not creating; they were for the most part sneering. The more considerable names either like Yeats belonged to Irish literature, or like the other three belonged to themselves only, or with Kipling to himself and certain echoes overseas. But there is still A. E. Housman. In his case it is certain that he did profoundly influence his fellow-writers, but it is more open to question whether it was not rather with the last enchantment of the old than with the first of the new age. Perhaps Housman is no more than Robert Louis Stevenson signalling in vain from his Pacific island to the future. Because, though this has not been generally accepted, if at all, it is Stevenson in verse that was the most potent influence in the early part of the 20th century, and that influence was exerted in part at least through Housman, a disciple so unconscious of his master that he would certainly repudiate him. Yet the two are in essence the same—poets of comment, and not of participation. They have each a small neat explanation of the events they so competently, and sometimes so endearingly, describe. The older man is the more human, the younger the better poet. But Housman carried on the Stevenson note of deliberate interpretation with feeling introduced from without. Housman attracted, and deserved to attract, general attention, but when his *Last Poems* was published three or four years ago, it became clear that he belonged to the world of Stevenson and not to ours. His lads found the brook of the 20th century too broad for leaping. They do not lie on the further side, but they stand there a little wistful and dim against a background of-end-of-the-century self-consciousness. They belong to the horizon whose margin fades behind us "for ever and for ever as we move."

Predecessors of the New Age.—Of the writers who carry over from the '90s to the first decade of the 20th century (for purposes of the almanac) none can be saluted even as the St. John the Baptist of the New World. Three at least deserve mention as writers of importance, though each must be denied the title of the forerunner—John Davidson, "Michael Field" and Stephen Phillips. Of these Davidson in his baffled fury, his fundamental inability to clinch with his hated antagonist because he never recognized him, is nearest to being the prophet. He did not hate Victoria, or the Victorians. He did not hate the gently anaemic Rhymers. But what inspired his fits of temper, that sometimes rose almost into a genuine poetry of hate? Life, of course, but it is doubtful whether he ever knew exactly what in life it was that bit him. Had it ever declared itself then Davidson might have set the trumpet of the herald to his mouth. As it was the instrument was something of a broken reed. "Michael Field," was the name chosen by those two remarkable women, Katherine Bradley and Edith Cooper, aunt and niece, who composed their poems together. For all their lovely cadence the verses never could have been more than a museum-piece in a living world of letters. Though there is in bulk a surprising quantity of their work, and though much of it will endure, yet even while it was, written it had the air of a gracious antique. It was a little as though those delicate fingers had discovered a lost art, and were. like Count Caloveglia in *South Wind,* moulding a Faun with the enigmatic ecstasy of some disciple of Praxiteles. Their best poems had an old and final ring.

Stephen Phillips is a very different case, and much more difficult to assess. In his poetic youth the fixed stars of poetry were crowded by the critics to give place to this new and larger luminary. Within less than a quarter of a century he passed "unwept, unhonoured and unsung." So much so that recently when a posthumous play of his was published the writer who had undertaken the preface used it to indicate his author's remarkable shortcomings. The truth about Stephen Phillips's rise and fall has not been told yet, and certainly the present estimate of his work is unfair to the writer who rediscovered the blank verse line. The rhetoric of *Herod* will disappear. It was inspired rather by Beerbohm Tree than the tetrarch. But "Marpessa" will quietly and in due course climb to its modest place among the quieter candles of the night. For the purpose of this essay, however, Stephen Phillips is important because of the disappointment he provoked. It was believed that the great tradition of English verse that Swinburne had for all his exotic beauty failed to renew, had returned. The blank verse line is the most English and at its best the most decisive of metres. In Stephen Phillips it was hoped that it had resumed its old immortal mastery in a new prevailing way. Stephen Phillips had some of the manner, but none of the substance to restore the accent of the heroes. He had a genuine singing impulse, and hands fit for a flute with two stops. He was asked to play the organ in the Albert Hall. Me should have been strong enough to refuse, but the blame attaches not a little to all the noisy pack of fawning critics who bayed him on to his doom. Whoever's the fault, at least he left no mark on his successors.

They were pressing on. At the very moment when the world was beginning to doubt its new idol, and in their doubt of him renewing their despair in poetry in general, the New Age was beginning in Oxford with a swarthy malcontent called Flecker, at Cambridge with a group which Rupert Brooke led by unquestioned right, and outside Cambridge, but still in the polite world. with a certain Walter Ramal (Walter de la Mare), and a much less certain John Masefield, and outside the world altogether with W. H. Davies, who was not so much a man on the tramp as a bird on the wing. But before all these gathering rivulets converged into the broad flood of Georgianism that forced its way ever widening into the threshhold of the War and, beyond it, strained and parcelled into the swamps of death, there were still the names of Herbert Trench, Sturge Moore, Henry Newbolt and Laurence Binyon, each with his individual claim and contribution. While roaring and laughing by their side, like two huge children in H. G. Wells's *Food of the Gods,* Hilaire Belloc and G. K. Chesterton shouted to each other across the world, and "when all church bells were silent, their caps and bells were heard."

It is perhaps not necessary to attempt to range the first three in this list. Herbert Trench was a far from negligible poet, but he wrote in the grand manner at a time when events were conducting themselves in a manner at once small and obscene. His verse was too much a stranger to the times in which he lived ever to be at home there. He speaks, therefore, always a little like a foreigner. Sturge Moore, also a poet of distinction, perhaps influenced his generation of writers more by his personality than his work, interesting and diverse as it is. He has to his credit not merely a brilliant anthology of "Michael Field," but a solid body of mature and constructive criticism. Henry Newbolt, who is at times unfairly bracketed with Alfred Noyes as a poet of "patriotism," has suffered by succeeding with his worst work. "Drake's Drum" had (and continues to have) almost a music-hall success. The result is that Newbolt has quite unfairly been classified as a minor Kipling—another partisan of the white man's beneficent destiny to take up his dividends. But that is wholly unjust to a poet with a clear perception of realities, and an almost humble readiness to adapt his manner to his subject. He came a little too early to belong to the new movement. If there had been no new movement his name would have stood very high. Nor need we re-classify Hilaire Belloc and G. K. Chesterton. They refused to be treated as grown-up poets. They were Trinculo, Falstaff, or Father Christmas in *The Christmas Carol*, and they deceived the world into believing them to be mere wassaillers. They nlmost deceived themselves, but not quite. Both, when they hated, wrote poetic satire unequalled since Pope, and Chesterton, at least, when he loved had a star hidden up his sleeve. In vain he assured his audience to the contrary. Why, his very words are on fire!

But Belloc and Chesterton stood outside the main stream of development, watching it as though two players in a football match should stand among the spectators applauding heartily. In the circumstances it is difficult to accuse them of desertion: it is better to take them for what they are—and to be thankful. We may turn from them to the players, who are thinking and who thought of nothing but the game.

Georgian Poetry.—The name "Georgian poetry" was coined in the first anthology of contemporary poets published in 1911 under the editorship of Edward Marsh, to whom, and to Harold Monro the publisher of this and the subsequent volumes, modern British poetry owes much. But the name is misleading, and has constantly misled critics. It has been assumed that it represented a single school of writers with the same aim and the same method, much as were exhibited in the case of painting by the Pre-Raphaelites. This is in fact a quite false view. The contributors to the Georgian volume—and to Georgian poetry—represented at least five divergent streams, their only link being a common passion for verse, and a common response to something in the age which was evoking it. Those who believe that the name is more than convenient shorthand may be asked to explain what community of aim and method are represented by de la Mare, Masefield, Hodgson, Drinkwater, Rupert Brooke, Flecker, Harold Monro, D. H. Lawrence and W. H. Davies, to name only nine of the leading figures in the revival. Can the dark Arabian musician mute his strings while Saul Kane is smashing a beer-bottle with a hammer? Would the Song of Honour be audible among the mild country sounds of the Cotswolds? How would the young men "into cleanness leaping" endure the doubtfully delicious neighbourhood of "Yasmin," and what would happen in Harold Monro's week-end cottage if two of D. H. Lawrence's lovers set about breaking up the eloquent crockery in the course of their noisily stark embraces? And would W. H. Davies's nightingales sing through it all like choir boys when the organ's loud? The wealth and the strength of the period consists in its amazing diversity. It was the great achievement of Edward Marsh and Harold Monro to find a common meeting place for all these vigorous tendencies, but they had the wisdom to make no attempt to assimilate them.

It is difficult, if not impossible, to explain why one period rather than another should be rich in poetry. It is, for example, maintained that great verse generally coincides with some great national excitement, either of victory or defeat. Men sing, this view would maintain, best when they are most disturbed, and poetry, like trade, follows the battle-flag. This theory could easily be destroyed by instances both from England and France, and there is another theory which better explains the periods of fertility that supervene, as did the Georgian, on a long period of barrenness. It may perhaps be stated that poetry goes in long cycles for two reasons. First because it is the most intensive form of art: it is a divine shorthand, and can summarize in a page what may require a volume in prose. Poetry therefore is liable quickly to absorb its material. In the second place, though mankind never wants much poetry, it always demands a little. Poetry is in a sense the ultimate luxury of the human mind: it is a luxury that no men want all the time, few men want much of the time, but that all men must have some time. So great a need and so vast a desire do in the long run precipitate their object, and thus after silence song is born.

The Georgian period may have owed something to the stormy days in which it was generated. Imperialism had seen itself in the mirror of the Boer War and found that it looked uncommonly like a skeleton. Industrialism which for a century had been an affair of capital was with urgent creaks and groans becoming a problem of labour. Victorian comfort was changing into the lurid extravagance of Edwardianism. The oil-engine was challenging the printing-press for the control of the soul of man.

Here were conditions which called for examination, explanation, defence and condemnation, and if the prose-writers—Wells, Bennett, Galsworthy and Shaw—were at work, how and why should the poets be still? They weren't. But poetry is a subtler thing than prose. It is less like a photograph than a picture, less like a picture than a face seen by a lightning flash and remembered in a dream. Therefore it is not surprising that this grossly confused age should express itself supremely in a poet of sheer and airy music like Walter de la Mare, or in so consciously exquisite a craftsman as Flecker. These two with Masefield, Davies and Brooke stand out as the leading names of the period.

It is not our business to range as much as to record. The world was in fact brought to the realization of the re-birth of poetry not by Brooke, nor by the first Georgian anthology, nor by the publication of Flecker's *Bridge of Fire*, nor even by the establishment of the Poetry Bookshop in 1912. It was not to the marvel of *The Listeners* that the gates swung open, but to the huge hammer-blows of *The Everlasting Mercy* published in the *English Review*. The effect of that poem was almost comparable to the excitement induced by the appearance of *Don Juan*. Poetry with Masefield had once again ceased to be a matter for poets and coteries: it had become the possession of the people.

By that one blow Masefield flung the door of public interest wide, and the rest of the waiting poets flooded through it with a shout. The period is so rich that in the first place there must be a catalogue of names like the Homeric catalogue of the ships—Lascelles Abercrombie, Gordon Bottomley, Rupert Brooke, W. H. Davies, John Drinkwater. F. S. Flint, John Freeman, Ralph Hodgson, W. W. Gibson, Gerald Gould, D. H. Lawrence, Walter de la Mare, Harold Monro, John Masefield, Thomas Goult, Charlotte Mew, Edward Shanks, Fredegond Shove, J. C. Squire, Anna Wickham, and of the Irish, W. B. Yeats, "A.E.," James Stephens, Padraic Colum, Francis Ledwidge, Seumas O'Sullivan and Dr. Douglas Hyde. And when it is recalled that all belong to the pre-War period, it is reasonable to suggest that Victorianism was dead, that a new and fertile period had begun. It is difficult to classify material so various, or in respect of work so recent to identify the prevailing influence, particularly as these influences are still working themselves out. Certain of these poets, it was clear from the outset, whatever their individual merits, would not be likely to found a school. Lascelles Abercrombie and Gordon Bottomley, for example, both engaged in revising the blank verse line and, if possible, in re-establishing the poetic drama, were necessarily monks of verse. With such preoccupations they would be bound to stand outside the main stream. Both added notably to the intensification of poetic language, and Bottomley in *Gruach* wrote a play in verse which in time will be recognized as a permanent part of British dramatic effort. But they were not likely to impinge on the work of their fellows. D. H. Lawrence, if a poet at all, was one so savagely individual, so arrogantly physical, that he must have abashed even his admirers. He reached the extreme of remorseless resignation to the senses. He might be endured: he could not be copied. Charlotte Mew, Fredegond Shove and Anna Wickham of the women all had their own self-centred emotions. In each case their output was limited to the attar of their spiritual nature. No other poets of their period reached such continuous intensity of expression, but its very merit made it fatiguing. They are all three poets whose poems should be lived with like a great picture rather than caught suddenly like the colour of a flower. Finally, of those not likely to fit into a scheme or to herald a new world those two distinguished poets Gerald Gould and Ralph Hodgson should be mentioned. Both were poets of discontent with their age. Gerald Gould carried into action what Ralph Hodgson immortally expressed in such a poem as "The Gipsy Girl." But each had his own secret. Gould was on a pilgrimage: he was not sure whither, nor could he guide others. But he must seek. Ralph Hodgson of all his age saw loveliness most directly and strongly. He recorded it, and was struck dumb by the very completeness of his utterance.

These were then all poets who belonged to no school. But of the rest it might have been expected that de la Mare, Flecker or Masefield might each have set a fashion, though in fact it was Brooke who with Drinkwater and Harold Monro created that general attitude to which Freeman, Squire, Shanks and later Martin Armstrong, F. W. Harvey and Edmund Blunden attached themselves—the attitude to which the generic term "Georgian" has tended to be specifically applied. Of these in time Squire assumed the leadership, and he will be entitled to special memory if not as the founder at least as the saviour of a school of poetry.

De la Mare founded no school, though his rhythms have effected a profound revolution in the structure of English verse. No poet writing for the next 50 years will or can be unaffected by those fairy declensions, those elfin ascents. De la Mare need not fear mortality. His accent is now a part of English verse. He will continue to have imitators of his manner, but he is too incorrigibly delicate in substance to prevail upon the mind of other poets. Flecker perhaps failed of influence because of his long illness and untimely death. A poet cannot found a correspondence school, and Flecker, except for the earliest years of his output—the Oxford and Cambridge years—was first an exile in the East, and then a dying man in a Swiss sanatorium. It is, even so, surprising that "The Old Ships" should drag no lesser ships in their shining wake, or that no later pilgrims should have set out on "The

Golden Journey to Samarkand."

Effects of the War.—It is a question whether Masefield might not have created a school, if his violence had not been outpointed by the War. Strength and beauty, ranging hand in hand, were an intoxicating sight for all men. but most of all for poets. And it might have been supposed at least that Masefield would restore the narrative poem to its proper place in English poetry. He has not, and it is more than likely that the War, which encouraged pastoral poetry, the verse of retreat from uproar, may have equally turned men's minds from poetry, like Masefield's, of conflict and tumult.

However that may be, it is true that when war had with its usual foul impartiality murdered good and evil alike, it was to Brooke and the poets of release that the world for a moment turned. Brooke burst into fame with his War sonnets consecrated by his death in that Greek island. He became for the moment the expression of the youth of the world, gladly offering itself to wholesale assassination. But behind that momentary magnificence were the more enduring meadows of Grantchester. In these the wracked world might find peace. In these—or by the trees, whose whisper Freeman overheard, in the long wholesome stretches of Drinkwater's Cotswolds, by the harsher northern uplands of Wilfrid Gibson, in Harold Monro's most endearing consolation of the country cottage, or with the birds and the moon of Squire. This was a corporate offer to the world, and it was eagerly accepted.

For the moment. Because it was the habit of the War to make and break its idols almost simultaneously. Hardly had the new recruits flocked to the banner, hardly had Edward Shanks and Martin Armstrong added their conspiracy of release, when the poets of hatred burst upon the world like an angry shell. Robert Graves, Robert Nichols, Wilfred Owen, Siegfried Sassoon one after another blasted the romantic assumption that war was the consecration of youth by fire. In the teeth of a world staggering under its weight of stupid ugliness, these poets flung the single word "Murderers." The other poetry grew for the moment strangely dim and pale. Men were listening to this new and abominable accusation—and even the fields, the birds and the moon could not distract them from it.

The name of Edward Thomas should be mentioned in this connection. Thomas was a much older man than the other poets here mentioned, and had written much before the War. But the War in some way released his response, and his reputation—growing and deserved—is wholly post-War. Because of the circumstances in which he wrote Thomas was entirely a poet for posterity. He could do nothing to arrest the doom of silence which the exhaustion of the War was suddenly to impose. Relentlessly this poison-gas of despair advanced till a period that had seemed to be most fertile since the Elizabethan, ended choking in the fog of the spirit that denies. By the end of the decade which had seen its origin Georgian poetry was spent, and the war poetry with it. Because it seemed that the poets, who had exposed its horrors and cursed its originators, were content to forget, or at least to live back into peace. Wilfred Owen was quiet for ever, Robert Nichols turned to prose and play writing, Siegfried Sassoon at long intervals reminded the world of his genius. Only Robert Graves remained to write new forms of verse in the desperate hope of escaping from the memories he had permanently established in traditional shapes

After the War.—And thereupon the silence smashed in 1910 began slowly to settle again. The Georgian period is over, and the war-period is over. There have been two later revolts, one known as "the Imagist" headed by F. S. Flint, with Transatlantic sanction, another led by Edith, Osbert and Sacheverell Sitwell. The first revolt like the poetry against which it protested has apparently ended. Flint, Richard Aldington and the Americans "H. D." and Ezra Pound, have contributed some ravishing melodies in free verse. They seem now to be replaced by verse not so much of freedom but in dissolution. They cannot compete and they are wisely content to let the beauty they hare made speak for itself. The Sitwell family on the other hand, and in a world of denial, affirm that with a slight shifting of the vision, a little readjustment of values, living beauty can still be restored. At a time when verse was in active danger of dying of suffocation, they breathed new life into it. Their work at least is not dead.

For the rest of the most recent work there should be mentioned Edmund Blunden and Humbert Wolfe. Blunden, though associated with the Georgian school, has lived at first hand with his fields and his farms. To read him is not like paying a visit to the country but like living there. Humbert Wolfe attempted both satire and verse that is accused of a facile romanticism. His *Requiem* was in some quarters regarded as making an advance on his earlier work; but with him, as with the Sitwells, for the moment we must be content with saying that he continued the attack.

Two things have still to be said. Among the greatest of the names in contemporary poetry are the Irish poets, who have only been mentioned, but not discussed. That was for the reason given above, that Yeats created the new Irish poetry and had far less effect on purely English verse than Housman. But the body of English literature is one and indivisible, and though it is possible in the light of the strong impulse given by Yeats to see Irish verse of the century separately, it must at least be mentioned here. All of it, as it was bound to be, is informed by a passionate consciousness of Ireland. But if the matchless rhythms of Yeats turned back to legend for consolation and hope, if "A. E." plunged into a mysticism as profound as Blake's, though, unlike Blake's, regulated by a sweet humanity, James Stephens was already looking forward. He has found truth through laughter, the laughter of a thrush. He has probably more than the other two influenced the latest developments of Irish verse. Padraic Colum and Seumas O'Sullivan are not of the same order as these, though both are poets of distinction. Colum has the quiet dignity of the inspired peasant, while O'Sullivan writes in the immediate shadow of Yeats. There remain Francis Ledwidge, who died young after an early lyric promise of almost torturing loveliness, and Bertram Higgins and Austin Clarke who are going steadily forward in the paths laid down by Yeats and his peers.

(H. Wo.; X.)

United States; Modern Developments.— Modern American poetry, characteristic of the 20th century, attempted a complete fusion of romanticism and realism; Carl Sandburg defined it as a "synthesis of hyacinths and biscuits." It was experimental and, to a large extent, anti-traditional. It sought to find fresh subject matter and unexploited material as opposed to "literary" conventions; it placed its emphasis on the local scene instead of on foreign or mythical regions; it cultivated a native idiom rather than the customary poetic diction. As early as the middle of the 19th century Walt Whitman had invited the Muse to migrate from Greece and Ionia, to "cross out those immensely overpaid accounts, that matter of Troy and Achilles' wrath, and Aeneas', Odysseus' wanderings," and turn from retrospections, recording proofs of the past, to the American continent—

For know a better, fresher, busier sphere, a wide, untried domain awaits, demands you.

Whitman and Emily Dickinson prepared the way for the changes which followed. The pioneer vitalism of the former proclaimed a new force and unity through affirmation of the democratic spirit; the puritan mysticism of the latter achieved another kind of vigour which encouraged the use of daring metaphors and audacious turns of phrase. It took time to establish the new forces. The first edition of Whitman's *Leaves of Grass* was published in 1855 and Whitman prefaced a "deathbed edition" in 1891; Emily Dickinson's first posthumous volume was published in 1890, but no attempt at a biography of Emily Dickinson was written until 1924 and volumes of further unpublished poems kept appearing as late as 1935.

What has been called "the new era in American poetry" manifested itself suddenly in 1913. Edsin Markham's "The Man With the Hoe" had already struck the social conscience, but there was little to rouse the aesthetic consciousness. A number of small magazines devoted themselves exclusively to poetry; controversy was in the air; every month another new name was a signal for dispute which augmented the poetic "renaissance." *General William Booth Enters Into Heaven* (1913) by Vachel Lindsay (1879–

1931) and *The Congo* (1914) brought excitement and a curiously syncopated music into verse; Lindsay's *Collected Poems* (1923) gave America its wide-swinging jazz in terms of literature. A missionary and evangelist at heart, Lindsay combined revivalism and ragtime; he preached the Gospel of Beauty through a saxophone.

Robert Frost's *A Boy's Will* appeared in England in 1913, but it was *North of Boston* (1914) which fully revealed Frost's union of playfulness with profundity and his gift for suggestive understatement. A restrained but distinctive tone of voice rose from all his subsequent work, six volumes of which were assembled in *Collected Poems* (1939), and showed him to be a farmer by circumstance, a philosopher by instinct, and a teacher by experience. Though his backgrounds were those of New England, his half-whimsical, half-sombre lyrics and monologues gave regionalism a universal amplitude and traditionalism a new direction.

The year 1914 marked the rise of free verse and the Imagist movement, a movement which recalled the program of the French Symbolists and which was divided between poetry and propaganda. Amy Lowell (1874–1925) was its militant champion; her own craftsmanship, at its best in *Selected Poems* (1928), preoccupied itself with enamelled images, vivid surfaces, and the swiftly changing contours of the external world.

John Gould Fletcher, another Imagist, intensified motion with emotion; his XXIV *Elegies* (1935) are a far cry from the unrelated "colour symphonies" of *Goblins and Pagodas* (1916). "H. D.," who, with Ezra Pound, was one of the first Imagists, revealed a cumulative tensity beneath the stripped technique of her *Collected Poems* (1925). Edgar Lee Masters' *Spoon River Anthology* (1916) explored the limbo between prose and verse in a set of sociological epitaphs; its disillusioned gossip and documentation of the "small town" gave rise to a school of satire and self-criticism, of which Sinclair Lewis's *Main Street* (1920) was a prose counterpart.

The ranging impulses and far-flung creative energies extended throughout the country and into the mid-twenties. Edwin Arlington Robinson had been writing for years (his concise *Children of the Night* appeared as early as 1897), but *The Man Against the Sky* (1916) was the first of his characteristically astringent works to draw an audience which reached great numbers with *Tristram* (1927); his voluminous *Collected Poems* (1937) appeared two years after his death. Carl Sandburg first blended folk-stuff and fantasy, slang and mysticism in *Chicago Poems* (1916); his *The People, Yes* (1936) added national significance to the peculiar fusion. Edna St. Vincent Millay's remarkable *Renascence* (1917) was succeeded by ten volumes which displayed her virtuosity and which, at the best, engagingly combined the voice of a precocious, eager child and the mind of an experienced, disillusioned woman. Her later work evoked varying degrees of enthusiasm; several critics deprecated the "destructive rôle of unofficial feminine laureate" which Miss Millay seemed called upon to assume in such collections as *Conversation at Midnight* (1937) and *Huntsman, What Quarry?* (1939). Sara Teasdale (1884–1933) became something of a vogue with *Rivers to the Sea* (1915), but the graver music of her *Dark of the Moon* (1926) was almost unnoticed. Elinor Wylie (1885–1928) strengthened the notes sounded by the contemporary singers; her lyrics and sonnets grew from the adroitness of *Nets to Catch the Wind* (1921) to the exaltation of the posthumously published *Angels and Earthly Creatures* (1929).

The strain of lyrical poetry was swelled by Léonie Adams, Louise Bogan, Genevieve Taggard, Jean Starr Untermeyer, and Dorothy Parker, whose wry flippancies were collected in *Not So Deep as a Well* (1936). A still more subtle music was registered in Conrad Aiken's *Selected Poems* (1929); in (or in spite of) the typographical oddities of E. E. Cummings; and in the modern ballads of William Rose Benét and Stephen Vincent Benét, whose *John Brown's Body* (1928) was panoramic in scope and epic in effect. Efforts to sound the "realistic" implications of the American scene were made by Kenneth Fearing, Muriel Rukeyser, and the pioneering William Carlos Williams, whose *Complete Collected Poems 1906–1938* were applauded alike by radicals and conservatives. Robinson Jeffers unleashed a violent. and often uncontrolled, power in a series of volumes from *Roan Stallion* (1926) to *Such Counsels You Gave to Me* (1938). Archibald MacLeish shaped words into surprisingly suspended cadences in *Poems 1924–1933,* fitted them into a new type of poetic drama in *Panic* (1935), put them to work on the radio and on the sound-track in *Land of the Free* and *Air Raid* (1938).

A definite and seemingly determined attempt to join traditional metaphysical poetry with indigenous accents was expressed by a group calling itself "The Fugitives"; its leading exponents were John Crowe Ransom, Allen Tate, Donald Davidson, and Robert Penn Warren. Their verse was alternately teasing and tortuous; the very richness of their allusive material made it difficult. Equally fascinating to the student and equally forbidding to the average reader were the abstract elegances of Wallace Stevens, the verbal legerdemain of Hart Crane, the crowded imagery of Horace Gregory, and the erudite intricacies of tno celebrated cxpatriatcs: Ezra Pound and T. S. Eliot. Eliot's work was the most considerable; it ranged from the baffled frustration of *Prufrock and Other Poems* (1917) through the drought and disintegration of *The Waste Land* (1922) to the desperate faith of Eliot's later religious plays and essays. Finally there were the prodigies, notably Nathalia Crane, whose *The Janitor's Boy* (1924) was published when its author was not quite eleven; George Dillon, who won prizes in his teens and whose *Boy in the Wind* (1927) was published in his twenty-first year; and Merrill Moore, a psychiatrist, uho wrote many of his poems in shorthand, and whose third volume, starkly entitled M (1938), contained 1,000 autobiographical sonnets. (L. UN.)

POEY Y ALOY, FELIPE (1799–1891), Cuban naturalist, was born in Havana on May 26, 1799. He received his degree in law at the University of Madrid (1820) but abandoned practice to devote himself to natural history. He returned to Cuba and formed a collection which he carried back to Paris. Here he remained until 1833, publishing many articles and his *Centurie de Lepidopferes de L'ile de Cuba* (1832). He became professor of zoology and comparative anatomy in the University of Havana in 1842 and in 1863 was appointed to the chair of botany, mineralogy and geology. From 1873 until his death at Havana on Jan. 28, 1891, he was professor of philosophy and belles lettres. His magnum opus is the *Catdlogo rozonado de los peces cubanos,* an atlas of ten volumes with over 1,000 of his own drawings, and describing about 800 tropical fish, about half of which he first made known to science.

POGGENDORFF, JOHANN CHRISTIAN (1796–1877), German physicist, was born in Hamburg on Dec. 29, 1796. He became an apothecary's assistant and later went to Berlin, where he entered the university in 1820. In 1823 he was appointed meteorological observer to the Academy of Sciences. Poggendorff founded in 1824 the *Annalen der Physik und Chemie,* which became the foremost scientific journal in Europe. He was its editor for 50 years. His Biographisch-literarisches *Handworterbuch zur Geschichte der exacten Wissenschaften* (2 vols. 1863) contains notices of the lives and labours of mathematicians, astronomers, physicists and chemists, of all peoples and all ages. This publication was continued by other hands, after his death, in later volumes, which appeared in 1898, 1904, and 1924–25. He devoted his energies to the editorship of the *Annalen,* and to the pursuit of his scientific researches. He died at Berlin on Jan. 24, 1877.

POGGIO (1380–1459). Gian Francesco Poggio Bracciolini, Italian scholar of the Renaissance, was born in 1380 at Terranuova, a village in the territory of Florence. He studied Latin under John of Ravenna, and Greek under Manuel Chrysoloras. His distinguished abilities and his dexterity as a copyist of mss. brought him into early notice with the chief scholars of Florence. Coluccio Salutati and Niccolo de' Niccoli befriended him, and in the year 1402 or 1403 he was received into the service of the Roman curia. His functions were those of a secretary; and, though he profited by benefices conferred on him in lieu of salary, he remained a layman to the end of his life. It is noticeable that, while he held his office in the curia through that momentous period of 50 years which witnessed the Councils of Constance and of Basle, and the final restoration of the papacy under Nicholas V., his sympathies were never attracted to ecclesiastical affairs. Nothing marks the secular attitude of the Italians at an epoch which decided the future course of both Renaissance and Reformation more strongly than the mundane proclivities of this apostolic secretary, heart and soul devoted to the resuscitation of classical studies amid conflicts of popes and antipopes, cardinals and councils, in all of which he bore an official part. Thus, when his duties called him to Constance in 1414, he employed his leisure in exploring the libraries of Swiss and Swabian convents. The treasures he brought to light at Reichenau, Weingarten, and above all St. Gall, restored many lost masterpieces of Latin literature, and supplied students with the texts of authors whose works had hitherto been accessible only in mutilated copies. In one of his epistles he describes how he recovered Quintilian, part of Valerius Flaccus, and the commentaries of Asconius Pedianus at St. Gall.

Manuscripts of Lucretius, Columella, Silius Italicus, Manilius and Vitruvius were unearthed, copied by his hand, and communicated to the learned. Wherever Poggio went he carried on the same industry of research. At Langres he discovered Cicero's *Oration* *for Caecina*, at Monte Cassino a ms. of Frontinus. He also could boast of having recovered Ammianus Marcellinus, Nonius Marcellus, Probus, Flavius Caper and Eutyches. If a codex could not be obtained by fair means, he was ready to use fraud, as when he bribed a monk to abstract a Livy and an Ammianus from the convent library of Hersfield.

Poggio embraced the whole sphere of contemporary studies, and distinguished himself as an orator, a writer of rhetorical treatises, a panegyrist of the dead, a violent impugner of the living, a translator from the Greek, an epistolographer and grave historian and a facetious compiler of *fabliaux* in Latin. Of his moral essays it may suffice to notice the dissertations *On Nobility, On Vicissitudes of Fortune, On the Misery of Human Life, On the Infelicity of Princes* and *On Marriage in Old Age*. These compositions belonged to a species which, since Petrarch set the fashion, were very popular among Italian scholars. They have lost their value, except for the few matters of fact which are embedded in a mass of commonplace meditation, and for occadonal brilliant illustrations.

Poggio's *History of Florence,* written in avowed imitation of Livy's manner, requires scparatc mention, since it exemplifies by its defects the weakness of that merely stylistic treatment which deprived so much of Bruni's, Carlo Aretino's and Bembo's work of historical weight. A somewhat different criticism must be passed on the *Facetiae,* a collection of humorous and indecent tales expressed in such Latinity as Poggio could command. This book is chiefly remarkable for its unsparing satires on the monastic orders and the secular clergy.

Among his contemporaries Poggio passed for one of the most formidable polemical or gladiatorial rhetoricians; and a considerable section of his extant works are invectives. One of these, the *Dialogue against Hypocrites,* was aimed in a spirit of vindictive hatred at the vices of ecclesiastics; another, written at the request of Nicholas V., covered the anti-pope Felix with scurrilous abuse. But his most famous compositions in this kind are the personal invectives which he discharged against Filelfo and Valla. All the resources of a copious and unclean Latin vocabulary were employed to degrade the objects of his satire; and every crime of which humanity is capable was ascribed to them without discrimination. In Filelfo and Valla Poggio found his match; and Italy was amused for years with the spectacle of their indecent combats. About the year 1452 Poggio finally retired to Florence, where he was admitted to the burghership, and on the death of Carlo Aretino in 1453 was appointed chancellor and historiographer to the republic. He had already built himself a villa in Valdarno, which he adorned with a collection of antique sculpture, coins and inscriptions. In 1435 he had married a girl of 18 named Vaggia, of the famous Buondelmonte blood. His declining days were spent in the discharge of his honourable Florentine office and in the composition of his history. He died in 1459, and was buried in the church of Santa Croce. A statue by Donatello and a picture by Antonio del Pollajuolo remained to commemorate a citizen who chiefly for his services lo humanistic literature deserved the notice of posterity.

Poggio's works were printed at Basle in 1538, "ex aedibus Henrici Petri." Dr. Shepherd's *Life of Poggio Bracciolini* (1802) is a good authority on his biography. For his position in the history of the revival, *see* Voigt, *Wiederbelebung des classischen Alterthums* (3rd ed., *1893)* and Symonds, *Renaissance in Italy* (1875–86). (J. A. S.; X.)

POGLIZZA (Serbo-Croatian, Poljica), a tract of mountainous land in Dalmatia, Austria; formerly the seat of an independent republic. The territories of Poglizza lay chiefly within the south-easterly curve made by the river Cetina before it enters the Adriatic at Almissa (Omiš). They also comprised the fastnesses of the Mossor range (4,500 ft.) and the fertile strip of coast from Almissa to Stobrez, 10 m. W.NW. The population of Poglizza numbered 6,566 in 1806. In the following year, however, the republic incurred the enmity of Napoleon by rendering aid to the Russians and Montenegrins in Dalmatia: and it was invaded by French troops, who plundered its villages, massacred its inhabitants, and finally deprived it of independence.

See the *Annuario Dalmatico* for 188; (published at Zara); and A. Fortis, *Travels into Dalmatia* (1778).

POINCARÉ, JULES HENRI (1854–1912), French mathematician, was born at Nancy, on April 29, 1854. He studied at the École Polytechnique, devoting himself to scientific mining, and took his degree in 1879. He was lecturer at Caen and then was transferred to the University of Paris in 1881, lecturing first on physical mechanics, then on mathematical physics, and ultimately on astronomical mechanics.

Poincaré's work falls into three main divisions: his work in pure mathematics, in astronomy and in physics. Most important is his work in pure analytical mathematics; he took the main points of an existing theory, simplified it and then developed it beyond all recognition. In this way he opened up new fields for the mathematician and gave new material to the mathematical physicist. In pure analytical mathematics a good deal of his work is on the theory of functions. He developed automorphic functions and his work on the "Fuchsian" functions he applied to the non-Euclidean geometry of Lobatchevski; he also wrote a number of papers on Abelian functions. Poincaré's work on differential equations is also important; here he extended the work of Cauchy; he dealt with linear differential equations on the lines of Riemann and Fuchs and he wrote a number of papers on the differential equations which occur in physics. In astronomy he dealt chiefly with the theory of orbits; he began with an idea due to Hill and investigated the general problem of three bodies. In addition to his purely mathematical and scientific work he also wrote on philosophy. He died in Paris on July 17, 1912.

His works include *Cours de Physique mathe'matique,* 10 vol. (1889, etc.); *Leçons de la me'canique ce'leste* (1905, etc.); *Théorie de Maxwell et les oscillations hertziennes* (1907); *La théorie du potentiel newtonien* (1899); *Science d'hypothèse* (1903); *La valeur de la science* (1904); *Science et méthode* (1908).

POINCARE, RAYMOND (1860–1934), French statesman, was born at Bar-le-duc on Aug. 20, 1860, the son of Nicolas Poincaré, a distinguished civil servant and meteorologist. Educated at the university of Paris, Raymond was called to the Paris bar, and was for some time law editor of the *T'01taire.* He had served for over a year in the department of agriculture when in 1887 he was elected deputy for the Meuse. He made a great reputation in the chamber as an economist, and sat on the budget commissions of 1890–91 and 1892. He was minister of education, fine arts and religion in the first cabinet (April–Nov. 1893) of Charles Dupuy, and minister of finance in the second and third (May 1894–Jan. 1895). In the succeeding Ribot cabinet Poincaré became minister of public instruction. Although he was excluded from the Radical cabinet which followed, the revised scheme of death duties proposed by the new ministry was based upon his proposals of the previous year. He became vice-president of the Chamber in the autumn of 1895, and in spite of the bitter hostility of the Radicals retained his position in 1896–97.

In March 1906 Poincaré became minister of finance in the Sarrien Government, but he gave up his portfolio to Caillaux in October of the same year, when Sarrien was succeeded by Clemenceau as prime minister. During the next five years, though he still continued to exercise a powerful influence in the senate, Poincaré devoted himself mainly to his legal career. In 1909 he was elected a member of the French Academy. In Jan. 1912, Caillaux, who had been prime minister since the beginning of the previous year, resigned, whereupon Poincaré formed a government in which he himself held the portfolio of foreign affairs.

Poincaré's cabinet constituted an *entente nationale,* and his first aim was to pursue a more definite foreign policy. In home affairs the problem which presented the greatest difficulties was that of electoral reform. Poincaré induced the chamber to pass a proportional representation bill. But above all diplomatic affairs claimed his constant attention; for during the negotiations with Germany which took place in consequence of the dispatch of a gun-boat by that country to Agadir, certain incidents had occurred during the Caillaux administration which had produced a feeling of disquietude in regard to foreign policy. Poincaré therefore sought to re-establish a continuity of policy; and though he maintained courteous relations with Germany his main endeavour was to prove that France would remain faithful to both friends and allies. The ratification by the senate of the Franco-German Treaty of Nov. 4, 1911, was followed by France's definite establishment in Morocco.

Almost immediately after the establishment of the Poincaré Government, an incident had occurred which temporarily obscured the friendly relations between France and Italy. The Italians, who at that moment were at war with the Turks, seized two French mail-steamers, the "Carthage" and the "Manouba," which were on their way to Tunis, on Jan. 16 and 18, 1912. But Poincaré, by his calmness and resolution, succeeded in re-establishing amicable relations between the two countries. By the end of October Italian sovereignty in Libya was recognised, and by a mutual declaration of the two Governments, full liberty of action was granted to France in Morocco and to Italy in Libya. When in the autumn of 1912 the Balkan War broke out, Poincaré made every effort possible to prevent the conflagration from spreading. Nevertheless the succession of European crises, combined with the ever-increasing menace from Germany and Austria-Hungary, rendered it necessary to take precautions; and Poincaré induced parliament to vote a programme of naval construction; through the strengthening of Franco-British relations it became possible to concentrate the whole of the French fleet in the Mediterranean.

On Jan. 17, 1913, Poincaré was elected president of the republic in place of Fallières. In power, he endeavoured to cement the friendships and strengthen the alliances of France. (See FRANCE, HISTORY.) At a later stage, his enemies at home and abroad criticised him severely for this policy; yet it is hardly reasonable because a man is sufficiently far-seeing to apprehend a storm and make preparations for it, to accuse him of wishing to hasten it. He claimed that he did his utmost to avert war, holding that the way to prevent the conflict was for those powers against whom the menace was directed to present a powerful and united front, thus making it imprudent to attempt any act of aggression.

In July 1914 Poincaré went to Russia on a visit which had been planned for some time past. He was on his way home, having arranged to visit the three Scandinavian capitals, when the news of the Austrian ultimatum to Serbia reached him. After a short stay in Stockholm he returned hastily to Paris; and in a letter to King George V. he pleaded for a clear declaration that the entente *cordiale*, if necessary, would prove its strength on the battlefield, pointing out that such a statement would have a restraining effect on the policy of Vienna and Berlin. Throughout the World War he continued to perform his duty with the same energy and discretion as before; though sometimes he visited the front, he never placed any obstacle whatever in the way either of the Government or of the army. In Nov. 1917 he gave proof of his vision and disregard of self by placing in power Clemenceau, who, though undoubtedly the man of the moment, was one with whom he had little sympathy. During the critical months of 1918, Poincaré revealed an inflexible resolution and a supreme confidence in the ultimate victory.

During the peace negotiations divergence of views again became apparent between Poincaré and Clemenceau. On more than one occasion the president found it necessary to write to the prime minister pointing out the errors which, from his paint of view, were being committed. His counsels, however, were not followed, and at the beginning of 1920, after having completed seven years as president, he left the Elysée and was shortly after re-elected senator for the department of the Meuse. In Jan. 1922, the Briand cabinet having resigned, Poincaré once more became prime minister and minister for foreign affairs. He made it his chief aim to insist on the fulfilment by Germany of her obligations in regard to reparations. During the first year of his new government he failed to arrive at any agreement on this subject with the British cabinet, whose views differed so widely from his own. The Inter-Allied Conference in London in Aug. and Dec. 1922 produced no result. A further conference took place in Paris on Jan. 2 and j, 1923. But Poincaré rejected the proposals drawn up by Eonar Law.

At this moment, the Reparations Commission, with Britain dissenting, having declared that Germany had failed to fulfil her obligations in regard to the delivery of coal and coke, Poincaré, in agreement with Belgium, undertook the occupation of the Ruhr (*q.v.*). At first this measure involved merely a method of control, but gradually, owing to the passive resistance of the Germans, it became necessary to exploit the railways and to some extent also the mines by means of Franco-British supervision. But by autumn the passive resistance had ceased, and Poincaré awaited the German proposals which never came. He then accepted the American suggestion that a group of experts should be given the task of finding the solution of the reparation problem; this resulted in the adoption of the Dawes Plan. But Poincaré had made up his mind not to withdraw from the Ruhr until he was satisfied that this plan was being carried out.

During the first three months of 1924 Poincaré had to face a financial crisis due to the state of the exchange. Not without difficulty he induced parliament to vote new taxes and succeeded in saving the situation. But from now onwards he had to withstand strenuous opposition from the parties of the Left consisting of the Radicals and Socialists. The policy of these groups met with a marked success at the general elections of May 11, 1924, and resulted in a majority for the Left which now formed a coalition under the name of the Cartel des Gauches. Immediately the results were announced, Poincaré stated that he would retire on the day when the new Chamber was to assemble, which took place on June 1, 1924.

Thenceforward he took his place in the senate, intervening only rarely in political debates. But he was to come into power once more. When, in the middle of the summer of 1926, the financial crisis, which successive cabinets since 1924 had been unable to check, became more and more serious, public opinion saw in him the only man capable of meeting the situation. After the fall of the Briand-Caillaux cabinet, which only lasted a few weeks, and of the Herriot cabinet, which only existed a few hours, Poincaré, in the last days of July, formed a ministry which included both moderate Republicans and Radical-Socialists, and had as its object the stabilization of French finances by means of a policy of national union. Public opinion was immediately reassured. At the beginning of August the ministry caused the national assembly, meeting at Versailles, to pass, as articles embodied in the constitution, and therefore not at the mercy of political changes, regulations for the establishment of an automatic sinking-fund, to which would be attributed funds which could not be touched (death duties, revenues from the tobacco monopoly, etc.).

In three months he succeeded in raising the value of the franc from 264 francs to the pound sterling, to 124. This rate was achieved in Dec. 1926, and thenceforward the value of the franc did not fluctuate. For a year and a half Poincaré, who had restored a strict financial equilibrium, maintained this stabilization of the currency de *facto*. The general election of April 1928 having returned a majority which approved of his policy, a law was voted in June by the new assembly, and by the senate, establishing the stabilization de *iure*. It was one of the most successful operations of this nature in history. Withdrawal of the Radical-Socialist support from his government, engineered by Caillaux, caused his resignation on Nov. 7, 1928, but he formed a new ministry on Nov. 12. He resigned because of illness, on July 27, 1929. Poincaré undertook the publication of an important work in 10 volumes, entitled *Au* service de la France; *neuf années de souvenirs*, the plan of which is to describe the sequence of events from 1911 to 1920 and the rôle which he himself played in them. Four of these volumes appeared in 1926, 1927 and 1928 under the titles of *Le lendemain d'Agadir*, Les Balkans en feu, *L'Europe sous les armes*, and *L'Union sacrée*. He died Oct. 15, 1934.

See H. Girard, *Raymond Poincaré* (1913); E. Charton, *L'Angleterre et M. Poincaré* (1923); S. Huddleston, *Poincaré* (1924); Sir George Arthur, ed., *Memoirs of Raymond Poincaré* (1929). (P. B.)

POINSETTIA, a popular greenhouse winter-flowering shrub of the family Euphorbiaceae. The *Euphorbia pulcherrima* of gardens, a native of Mexico and Central America, with its scarlet bracts, stands high among decorative plants. The white-bracted sort, var. *alba*, is not so effective, but the double-flowered, var. *plenissima*, in which the inflorescence is branched, is as brilliant as the type, and keeps long in flower.

They are propagated by cuttings in spring. When taken off with a heel. cuttings strike freely in brisk heat. They require good turfy loam, with an addition of one-sixth of leaf-mould and a little sand, and should be kept in a heat of from 65° to 70° at night, with a rise of 10° by day. About August they may be inured to a heat of 50° at night, and should be placed out of doors for a month under a south wall in the full sun. This treatment matures and prepares them for flowering. In autumn they must be removed to a house where the temperature is 50° at night, and by the end of September some of them may be put in the greenhouse, where they will come into flower, the remainder being placed under heat later for succession.

POINSOT, LOUIS (1777–1859), French mathematician, was born at Paris on Jan. 3, 1777. In 1794 he became a scholar at the École Polytechnique, which he left in 1796 to act as a civil engineer. In 1804 he was appointed professor of mathematics at the Lycée, in 1809 professor of analysis and mechanics, and in 1816 examiner at the École Polytechnique. On the death of J. L. Lagrange, in 1813, Poinsot was elected to his place in the Académie des Sciences; he was chosen a member of the senate formed in 1852. He died at Paris on Dec. 5, 1859.

Poinsot's earliest work was his *Élémens de statique* (1803; 9th edition, 1848), in which he introduces the idea of statical couples and investigates their properties. In his *Théorie nouvelle de la rotation des corps* (1834) he treats the motion of a rigid body geometrically.

See J. L. F. Bertrand, *Discours aux funérailles de Poinsot* (1860).

PQINT, in finance, the unit used to estimate or quote the changes in market price of securities, commodities, or exchange. In the security market a point is 1% or $1 per share of stock or $10 per bond. Variations in securities are quoted as low as $\frac{1}{8}$ of a point, $12\frac{1}{2}$ cents on stock and $1.25 on bonds. In commodities such as cotton, coffee, and sugar the point is $\frac{1}{100}$ of a cent per pound, and no fractional points are quoted. Thus in cotton a decline or advance of $\frac{1}{4}$ cent a pound would be 25 points or $1.25 per bale. A point in exchange is $\frac{1}{100}$ of a cent. Thus an advance in sterling from 4.8625 to 4.8635 would be a ten-point rise. In the English market stock is quoted at so much per £100 and the loss of a point would not necessarily mean the loss of 1%. If, for example, £100 worth of stock were quoted at "£87, dropped one point," this would be equivalent to £86. On the other hand, £100 stock quoted at "£237, gained one point," would indicate that the closing price was £238.

POINT PLEASANT, a town and the county seat of Mason county, W. Va., U.S.A., on the Ohio river, at the mouth of the Kanamha river, and about midway between Pittsburg and Cincinnati. Pop. (1940) 3.538. It is on federal highway 35 and is served directly by the Baltimore and Ohio railway, and by the New York Central railway. The Kanawha river is navigable (by the use of locks and dams) for 90 mi. above the town, and Point Pleasant is a reshipping point for Kanawha coal.

The permanent settlement of the town dates from 1785. In 1794 the village of Point Pleasant was planned; it was incorporated as a town in 1833. A granite monument (86 ft. high) commemorating the battle was unveiled on Oct. 10, 1909.

See J. T. McAllister's article, "The Battle of Point Pleasant," in the *Virginia Magazine of History and Biography* (1901–02), vol. x., and Virgil A. Lewis, *History of the Battle of Point Pleasant* (Charleston, W. Va., 1909).

POINT SETS. A point set is a collection of points selected from a given space. The study of the properties of point sets constitutes that branch of mathematics known as point sets, or the theory of sets of points. Generally speaking, the properties of a point set may be classified under two heads, (1) topological and (2) metric. For a description of the former see ANALYSIS SITUS. A brief introduction to the metric properties of point sets is given below.

The Problem of Measure.—In order to approach the subject by as simple an example as possible, let us confine ourselves to the case where the given space is an ordinary straight line, L. If P and Q are distinct points of L, then the point set consisting of P and Q together with all points between them is called an interval and is denoted by $[P,Q]$. Let us imagine that we have a common foot-rule which can be applied to L in order to measure lengths. Then given an interval $[P,Q]$ we can measure its length, and say that it is a certain number of feet. Of a single point we would say, in accordance with the ordinary geometry notion, that its length is zero. If we are given two intervals which have no point in common, it is not natural to speak of the length of the set of points which they represent, the word "length" being usually applied only to connected pieces. In this case we shall use the word "measure," and say that the measure of this point set is the sum of the lengths of the two intervals.

However, when we speak of a point set on L, this does not necessarily imply that we are thinking of an interval, a single point, or a set of intervals; we sometimes mean to indicate a set of points which contains no connected portion, *i.e.,* which contains no interval. One might be tempted to say that since a point has length zero, the "measure" of such a set would be the sum of the lengths of its individual points, *i.e.,* the sum of a set of zeros, and hence zero. Such a hasty decision would not lead to very fruitful results, however, for the following reason. If we determine upon a "measure" for two point sets, A and B, which have no points in common, the sum of their measures should naturally be the measure of the point set which is made up by them taken together. Thus, above, we have stated that the measure of a set consisting of two intervals with no common point is the sum of the lengths of those intervals. Now any interval $[P,Q]$ can easily be shown to be the sum of two sets A and B each of which fails to contain any interval, and if we arbitrarily call the measure of both A and B zero, the sum of their measures would be zero, which is not the length of $[P,Q]$, no matter how small the length of $[P,Q]$. In other words, we want a measure of a set of points which will correspond to the ordinary idea of length.

We have now introduced what is known, in the theory of sets of points, as the problem of measure. There have been several methods devised for finding a measure of an arbitrary set of points. We shall describe, briefly, the theory of Lebesgue measure, which is the foundation of the Lebesgue theory of integration.

Lebesgue Measure.—A set, A, is said to be covered by a collection, G, of intervals, when every point of A is in some interval of G. If the set of intervals G is denumerable, then we shall say that it is a covering of A. (A set is called denumerable if its elements can be "tagged" with positive integers in such a way that no two elements of the set are "tagged" with the same integer.) If the sum of the lengths of the intervals of G exists, let us call this the sum-length of the covering. Now of all possible coverings of A consider the corresponding sum-lengths, and let N be the largest number which is not greater than any of these sum-lengths. Then N is called the exterior measure of A and is denoted by m_eA. Suppose, now, that $[P,Q]$ is some interval, whose length we shall denote by d, such that all points of A are within $[P,Q]$. Let B be the set of all points of $[P,Q]$ that do not belong to A, and let m_eB denote the exterior measure of B, found just as m_eA was found. If it happens that $m_eA+m_eB=d$, then m_eA is accepted as the measure of A, and is what is known as the Lebesgue measure of A. Of course we have at the same time that m_eB is the Lebesgue measure of B, and in accordance with our ideas of length we have required that the sum of the two measures give the length of $[P,Q]$. To be sure, the Lebesgue measure of a set of points may not exist, but it does exist for all ordinary point sets. Indeed it is not at all easy to give an example of a set of points which has no Lebesgue measure, and all of those examples which have been given make use of certain methods which are held to be unacceptable by many mathematicians.

For the measure of a set of points in a plane, areas are employed. Thus, the measure of the set of all points in a square is the area of the square. And to get the measure of a general plane point set M, a covering of M is made by means of squares. In three dimensions cubes are employed, and we deal with sum-volumes.

The introduction of the notion of measure has led to an enriching of the content of general analysis that could hardly have been realized otherwise. And the effect has been felt not only in mathematics itself, but in the closely allied fields of mechanics and dynamics.

BIBLIOGRAPHY.—*Encyklopädie der mathematischen Wissenschaften,* Band II3, Heft 7 (1924). In ss. 18–20c will be found a summary of various kinds of measure. On p. 858 are given references to applications of the notion of measure to problems in physics, astronomy, etc. E. W. Hobson, *The Theory of Functions of a Real Variable* (2nd ed. 1921) vol. i., p. 158 *seq.; A.* N. Whitehead, *An Introduction to Mathematics* (1911), a popular treatise, on pp. 77–79 of which will be found an example of a set which is denumerable, as well as of a set which is not denumerable; W. H. and G. C. Young, *The Theory of Sets of Points* (1906). (*R. L.* WI.)

POISON. There is no official legal definition of the meaning of the word "poison" though from the phraseology of the sections in the various laws relating to poisoning it may readily be inferred what is understood by the term "poison" in its legal aspects.

The legal sections relating to criminal poisoning contain the expressions "poison or other destructive thing," "poison or other destructive or noxious thing," "to inflict upon such person grievous bodily harm," "any chloroform, laudanum or other stupefying or overpowering drug, matter or thing."

These phrases all occur in the sections where the crime for wilful intent in "unlawfully administering" is regarded as felony. In the section dealing with intent to injure, aggrieve or annoy any person the expression "poison or other destructive or noxious thing" is used and the offence is regarded as misdemeanour.

In the section dealing with criminal abortion the term "poison or other noxious thing" is used, and the unlawful administration of such with intent to procure a miscarriage is regarded as felony.

The term "noxious thing" has been held to include all substances causing symptoms which might be dangerous to life, or symptoms giving rise to pain, serious discomfort or incapacity. In the case of abortion it includes all substances which might under the circumstances in which they were administered reasonably give rise to any risk of abortion.

The sale of "poisons" to the public is carefully controlled by law, and the danger to human life from the indiscriminate sale of poisons by unqualified persons is thereby reduced.

With certain exceptions only duly qualified and registered pharmacists and medical practitioners are permitted to sell poisons.

Definition.—A convenient and comprehensive definition of the word "poison" is "A substance which by its direct action on the mucous membrane, tissues, or skin, or affer absorption into the circulatory system can, in the way in which it is administered, injuriously affect health or destroy life." This definition includes such substances as powdered glass, metallic filings, etc., which would act mechanically as irritants if swallowed. It also includes substances which are ordinarily of a harmless nature but by nature of the excessive quantity, or of their physical condition or manner of administration may act injuriously on the body, for example, water at the boiling temperature or milk given intramuscularly or intravenously would be included.

The commonly understood definition of a poison would be a substance which if taken internally in small doses is capable of acting deleteriously on the body or of destroying life.

Poisoning may be accidental, suicidal or homicidal. By far the commonest type of poisoning is that due to accidental causes. In spite of the precautions taken by the State in the sale of poisons much too little care is taken by the public in the safeguarding of poisons in their possession, and these are commonly taken in mistake for other substances of a harmless nature, or often an overdose is taken from pure carelessness.

Thus, oxalic acid crystals when purchased in a paper packet may be transferred to a bottle or jar which is unlabelled and then taken in mistake for Epsom salts which they closely resemble.

Similarly tablets of corrosive sublimate have been taken in mistake for tablets of a harmless nature such as Blaud's pills. It cannot be too strongly insisted upon that it is the duty of every individual possessing a substance of poisonous nature to take the utmost care that this is correctly labelled and kept safely guarded under lock and key; by this means accidental poisoning would be largely prevented.

ACTION OF POISONS

Poisons may have a local action or a general systemic action after absorption into the circulatary system, or they may act in both ways. Almost all poisons have a general systemic action. Some poisons such as "corrosives" destroy the mucous membrane or tissues with which they come in contact and cause serious or dangerous injury thereby. Irritant poisons set up a local inflammatory reaction in the mucous membrane of the alimentary tract.

Apart from these local effects, the common result of the absorption of a poison is the harmful effect produced by the poison on the important organs of the body, for example, the liver, kidneys, heart and nervous system are almost certain to be adversely affected. A poison after absorption attacks all the organs of the body to a more or less extent and it is a mistake to regard poisons as being exclusively selective in their action though some poisons appear to direct the brunt of their attack on a particular system.

Among the conditions affecting the action of a poison may be mentioned the following:

1. The Amount Taken.—Usually the quantity of a poison taken bears a relation to the effects produced; exception to this rule are substances in the case of which owing to the quantity taken vomiting occurs so that most of the poison is expelled; oxalic acid and tartar emetic are examples.

The term "fatal dose" when applied to a poison means the smallest amount which is known to have caused death in an adult. Frequently larger doses may be taken without death resulting, but much depends on other factors than quantity, and also as to whether adequate treatment has been adopted.

2. Mabit.—A tolerance to some poisons occurs after their repeated use, and in some cases doses far greater than a normal "fatal dose" may be tolerated without serious symptoms developing; examples of such drugs are morphine, opium, cocaine and alcohol. In the case of some of these poisons their repeated use leads to the development of the "drug habit" with all its pernicious symptoms and effects.

3. Idiosyncrasy.—Some persons are exceedingly intolerant of certain drugs which in moderate doses may cause in them dangerous or even fatal symptoms; examples are salicylates and aceto-salicylic acid which in some persons have a severe cardio-depressant action.

4. Age.—Usually children are much more susceptible to the effects of a poison than adults. The dosage of drugs in the case of children has been fixed by a pharmacological rule, but exceptions to this are morphine, opium and its preparations which are much more toxic than the rule would indicate; on the other hand children tolerate belladonna preparations better than adults. Aged persons withstand poisons badly.

5. The State of Health.—In disease, usually drugs are much more toxic and this is especially so where the excretory organs are diseased. For example, in nephritis medicinal doses of such drugs as morphine, salvarsan, hyoscine, etc., often cause dangerous symptoms, likewise in cirrhosis of the liver there is a greatly increased susceptibility to such drugs. In conditions of gastritis or enteritis irritant drugs like arsenic are especially toxic.

On the other hand in some conditions associated with delirium or pain large doses of sedative drugs produce little effect provided that the excretory organs are healthy.

6. Condition and Mode of Administration.—If a poison is taken by the mouth in solution it acts much more powerfully than if in an insoluble form, for example, an insoluble preparation of arsenic may produce little poisonous effect even in large doses; similarly strychnine given in hard pills has a much delayed action.

The state of the stomach as regards the presence of food has a marked influence on the effect of a poison; for example, if the stomach is empty the effect will be rapid, particularly so when the poison is in a soluble form; on the other hand if the stomach is full considerable delay may occur in the action of the poison as is well shown in acute arsenical poisoning.

Poisons administered subcutaneously or intravenously act more powerfully than by the mouth.

When a poison is inhaled in the form of spray, vapour or gas its absorption from the respiratory tract is rapid and the effect great. Poisons may be absorbed by the skin or mucous membrane of the vagina or rectum with fatal result.

DIAGNOSIS AND TREATMENT OF POISONING

Evidence of Poisoning.— It must be remembered that the symptoms of poisoning may be closely simulated by the symptoms of natural disease and the greatest care must be taken before a diagnosis of "poisoning" is arrived at. For example, the symptoms of acute arsenical poisoning closely resemble those of cholera or acute bacterial food poisoning. The only certain differentiation is the finding of arsenic in the excreta or of the bacteriological evidence of a cholera or food poisoning infection.

The evidences of poisoning are — (I) The symptoms are usually sudden in onset and they occur after the taking of food or drink or after exposure to poisonous gases or vapours. (2) If several persons are similarly exposed all are affected more or less with similar symptoms. An exception may occur in the case of bacterial food poisoning (so called ptomaine poisoning) where certain persons may be immune, or some be specially susceptible. (3) The analysis which should always be carried out in suspected cases may reveal the presence of the poison in the vomit and urine and faeces and possibly also in some articles of food or medicine.

Post-mortem Evidence.—If death occurs a post-mortem examination should only be made following instructions from the coroner. The post-mortem signs found should be consistent with those occurring from poisoning by the suspected poison. The analysis of the viscera should yield results consistent with that of poisoning by the suspected poison having regard to the circumstances attaching to the date of administration and death.

Treatment.— The mode of treatment to be adopted varies according to the nature of the poison.

The first *measure* to be adopted *without* delay, is the removal of the unabsorbed poison. If the case is seen within six hours of the taking of the poison by mouth the stomach should be emptied and *washed* out as soon as possible. Emetics are a poor substitute for the emptying and washing out of the stomach by means of the funnel and stomach tube, but they may be employed if the more effective treatment is impossible. Safe emetics are mustard and water, salt and water, ammonium carbonate (30 grains) in a tumblerful of water, or apomorphine **gr.** $\frac{1}{10}$ hypodermically.

The only contra-indication to the emptying and washing out of the stomach by means of the stomach tube and funnel are where poisoning occurs from the corrosive mineral acids or alkalies. In such cases there might be danger of perforation. After the stomach has been emptied and washed out suitable antidotes should be given, such as chalk and lime water to neutralize oxalic acid and the mineral acids, lime water for carbolic acid. Atropine may be given hypoderniically in the case of morphine poisoning. Where morphia and cocaine are taken the stomach should be washed out with diluted permanganate of potash solution.

Elimination by the bowel is facilitated by colon washes with warm normal saline solution and by free bowel evacuations. The symptoms of poisoning are subdued by the administration of appropriate remedies, thus, pain may be relieved by hypodermic injection of morphine, and the convulsions from strychnine by chloroform inhalation.

CHARACTERISTICS OF DIFFERENT POISONS

Classification.— Poisons may be classified in many different ways, *e.g.,* according to their chemical composition, to their action on the body. to their physical characters, etc.

The following is a convenient and simple classification.

1. Corrosive Poisons are those which destroy by direct action the tissues with which they come in contact. They are the mineral acids such as sulphuric, hydrochloric, nitric acids, etc; the caustic alkalies such as caustic soda, caustic potash, ammonia, etc.; carbolic acid; metallic poisons such as corrosive sublimate, zinc chloride, silver nitrate. These latter will be considered under irritant poisoning. It should be remembered that corrosive poisons in diluted condition lose their corrosive effect and become irritants.

2. *Irritant* Poisons.—These poisons by their direct action on the mucous membrane set up inflammation. Examples are:— oxalic acid and its soluble salts; arsenic compounds, antimony compounds; most of the metallic poisons in solution; phosphorus, bromine, iodine, boracic acid, etc.

3. Systemic Poisons which act on the nervous system or other important organs such as the heart, liver, lungs or kidneys without having any special irritant or corrosive effect. This group includes the majority of poisonous substances such as the vegetable poisons or their alkaloids, hydrocyanic acid, its salts, chloral, chloroform, alcohol, ether, hypnotic drugs such as veronal, sulphonal, etc. Also liver poisons such as those causing toxic jaundice, tetrachlorethane, trinitrotoluene, picric acid, etc., and renal poisons such as cantharides, turpentine, etc.

4. Gaseous Poisons such as chlorine, carbon-monoxide and coal gas, carbon-dioxide, etc.

5. Poisonous Foods such as mushrooms, shell fish and food contaminated with dangerous pathogenic bacteria.

CORROSIVE POISONS

Symptoms.—These produce severe symptoms immediately they are taken—"a burning pain" in the mouth, throat and oesophagus and pain referred from the stomach and intestines. Vomiting occurs quickly and the vomit contains blood which may be altered in colour by the action of the poison; often also shreds of destroyed mucosa are present, Collapse occurs early, and perforation is common when, should the patient survive, signs of general peritonitis develop.

An examination of the patient will show signs of the corrosive action of the poison on the mouth and throat, and marked tenderness will be present on palpation over the stomach and intestine. Corrosive poisons if swallowed in poisonous quantity are usually fatal within 24 hours unless immediate treatment with a suitable antidote is adopted.

Should the patient survive the immediate effects of the poison, serious after effects result owing to the damage done to the alimentary tract and in the case of volatile corrosives often serious pulmonary complications ensue. Post-mortem examination shows evidence of the destructive action of the poison on the mucous membrane of the mouth, throat, oesophagus and stomach, there being often extensive haemorrhage in the underlying tissues.

Among examples of corrosive poisons may be named:

The Corrosive Mineral Acids.—These include: *Sulphuric* Acid commonly known as oil of vitriol; this is used in various industries and in all chemical laboratories. It is a most powerful corrosive in the concentrated form, whether taken internally, or applied externally as in cases of "vitriol throwing." One drachm has caused death in an adult, and half that quantity in a child.

Hydrochloric Acid is known also as muriatic acid or spirits of salts. It is used largely for industrial and chemical purposes and is a common article of domestic use. It is readily obtainable and is very commonly used for suicidal purposes. It is a most dangerous corrosive and one drachm has caused death in an adult.

Nitric Acid is known as "aqua fortis" and is used for industrial and chemical purposes. It is a most dangerous corrosive and produces characteristic yellow staining of the tissues with which the strong acid comes in contact. The vapour of the acid, if inhaled into the lungs, often produces an acute fatal form of pneumonia which is a common cause of death in nitric acid poisoning. Two drachms of the acid have caused death.

Other mineral acids such as *Hydrofluoric, Phosphoric* and *Sulphurous* acids in concentrated form produce similar effects.

Treatment.--The treatment of poisoning by corrosive mineral acids consists in giving as soon as possible harmless alkaline remedies such as magnesia powder, lime water, sodium bi-carbonate or chalk. These should be given freely, and plenty of egg albumen (white of egg) should also be given since this tends to neutralise the acid by forming a protein combination, and also it has a soothing effect on the damaged mucosa.

The stomach should not be washed out for fear of perforation Pain is relieved by the free use of morphine hypodermically and after the swallowed acid has been neutralised food should be withheld by the mouth and normal saline given as freely as can be retained per rectum.

The Caustic Alkalies.—Among these may be named the following: Caustic potash or potassium hydrate or potash lye is a powerful corrosive, and potassium carbonate known as salt of tartar has a similar but less powerful effect. Both are used industrially. Forty grains of caustic potash have caused death.

Caustic Soda or Sodium Hydrate, or Soda lye is a powerful corrosive and quite as dangerous as caustic potash. It is commonly used industrially.

Ammonia, liquid ammonia or spirits of hartshorn, is used largely for domestic and industrial purposes. It is also used in the form of smelling salts when mixed with carbonate of ammonia. It is a powerful corrosive poison and in addition the vapour has a very injurious effect on the lung giving rise to bronchopneumonia which takes on a septic type. One drachm of the strong solution has caused death.

As regards treatment in respect of the foregoing, harmless acid drinks such as diluted vinegar or lemon juice or citric or tartaric acid should be given freely. Pain should be relieved by the free use of morphine hypodermically and nourishment should not be given by the mouth but rectal feeding adopted.

Carbolic Acid or phenol is commonly used as a disinfectant for domestic and surgical purposes. Allied preparations such as creasote, cresol, etc., have a similar poisonous effect. Lysol is a combination of cresol with soap and is similar in action to phenol.

Carbolic acid and the allied substances have a powerful corrosive action causing necrosis of the tissues with which they come in contact, the superficial part of which has a whitish appearance, the deeper parts being dark red owing to resulting haeinorrhage into them Carbolic acid is one of the poisons most frequently used by suicides, and owing to its common use for domestic purposes accidental poisoning by it often occurs.

The symptoms caused by carbolic acid are those of corrosive poisoning but owing to its local anaesthetic action vomiting may he absent, and pain may be less marked. If death does not result from shock, the profound effect of the poison on the nervous system causes paralysis of the respiratory and cardiac centres, with rapid feeble pulse, and stertorous breathing, coma develops in severe cases and is usually followed by death.

One drachm of carbolic acid taken by the mouth has caused death in 12 hours. Death has resulted from the absorption of phenol by the skin, and from rectal injections of the drug in solution. Usually death occurs in from 3 to 4 hours after the taking of a large dose.

With respect to treatment, the stomach should be washed out by means of a soft stomach tube with diluted saccharated lime water, or fresh lime water; by this means the phenol is converted into calcium phenate which is not poisonous.

IRRITANT POISONS

The more important irritant poisons will be considered under this heading (vide list above) but it must be remembered that many of the general poisons, *e.g.*, savin, cantharides, etc., have an irritant action on the stomach and intestines in addition to their special action on important organs and nerve centres.

Oxalic Acid occurs in colourless crystals resembling Epsom salts; it is very soluble in water. Salts of Sorrel or Salts of *Lemon* is the quadrioxalate of potash; it is a white powder very soluble in water. Both of these substances are commonly used for domestic purposes, *e.g.*, for cleaning straw hats, removing ink stains, cleaning brasses, etc. They are frequently the cause of accidental and of suicidal poisoning.

As regards symptoms, when swallowed in solution the typical symptoms of irritant poisoning are set up, but in addition the poison when absorbed into the system has a profound depressing action on the heart and nervous system. Thus an acrid burning taste is experienced and pain occurs which is referred from the throat, oesophagus, stomach and later possibly the intestines. Vomiting is common, the vomit being very acid, and giving the tests for oxalic acid. It often contains blood. Unless immediate treatment is adopted collapse speedily occurs, the patient being cold, pale and faint with a rapid feeble pulse and at this stage death from syncope may occur. In some cases nervous symptoms such as tinglings and numbness, muscular spasms, convulsions, delirium and coma occur, but these symptoms are uncommon. Owing to the rapid absorption of the poison death is likely to occur rapidly, *e.g.*, within an hour, but it may be delayed.

As respects treatment, fresh lime water, or better the saccharated lime water which is 15 times as strong, should be given in large quantities and it should be mixed with calcium carbonate in the form of chalk or whiting. Since oxalic acid has only slight corrosive action the stomach should be washed out immediately if no antidote is at hand. It is best to give the antidote freely if immediately available and after a few minutes to wash out the stomach thoroughly with a soft stomach tube and funnel, and then finally introduce a pint of lime water made into a thin cream with an ounce of chalk, leaving this mixture in the stomach.

Arsenic.—This is the most important of the irritant poisons and owing to the tasteless property of many of its compounds and preparations it is the commonest poison used for homicidal purposes.

The most important and commonest compound is arsenious anhydride or white arsenic. It occurs in the form of a white powder or in lumps of a white porcelain-like appearance. The powdered form resembles powdered sugar or flour and when mixed with food is almost tasteless. It is sparingly soluble in cold water. When mixed with alkaline substances white arsenic becomes freely soluble.

Commercial preparations containing white arsenic mixed with alkalies such as sodium hydrate or carbonate are weed killers, sheep dip and wood preservatives which may contain from 20% to 40% of white arsenic. Copper arsenite (Scheele's Green), lead arsenate and other arsenical preparations are used as insecticides for the spraying of fruit trees. Kat poisons may contain arsenic as the active ingredient. Wallpapers which formerly often contained green pigment (Scheele's Green) or the yellow sulphides of arsenic are now coloured with arsenic-free pigments, arsenic being prohibited from use. White arsenic, if sold except for medicinal purposes, must be coloured with soot or indigo

Arsenic in Food.—Accidental contamination of food with arsenic has occurred in the past. Thus in 1900 a beer poisoning epidemic occurred as the result of the use of commercial glucose which contained arsenic in the preparation of beer. (See ADULTERATION.)

Acute Arsenical Poisoning.—When arsenic is taken by the mouth in poisonous quantities symptoms of acute gastro-intestinal irritation such as vomiting, diarrhoea and abdominal pain occur within a few hours and death may result within a few days. Two grains of arsenic have caused death though larger quantities have been taken without fatal result. In acute arsenical poisoning the heart, kidneys and other organs are seriously affected so that the poison has a systemic action in addition to its irritant properties to the stomach and intestines.

Chronic *Arsenical* Poisoning occurs when small quantities of arsenic are absorbed over long periods. The gastro-intestinal symptoms may be slight. but other symptoms such as skin rashes and pigmentation, conjunctivitis, become manifest.

In suspected arsenical poisoning the diagnosis can be made certain by analysis of the vomit, urine and faeces in acute cases. In chronic cases additional information may be obtained by analysis of the hair and nails.

Antimony is an irritant poison like arsenic. Tartar emetic or potassium antimony tartrate is one of the most commonly used compounds. It has on several occasions been used for homicidal purposes owing to the possibility of its being administered without detection by taste or smell.

Metallic Poisons if taken by the mouth give rise to irritant poisoning. Examples are:—

Lead.—The common salts of lead will in large doses cause gastro-intestinal irritation. Acute poisoning by lead is rare Chronic lead poisoning is caused by the continued absorption of small quantities of lead and is a dangerous condition owing to the causation of disease of the kidneys, blood vessels, heart and nervous system. Lead-tetra-ethyl is a very poisonous organic compound of lead. It has been recently used commercially as a constituent of ethyl petrol, which is claimed to be superior in some respects to ordinary petrol as a fuel for motor engines. In Great Britain the possible dangers from its use have led to a special Government enquiry.

Copper.—The sulphate of copper (blue vitriol) and other copper compounds are irritant poisons. The use of copper salts as a colouring matter of foodstuffs such as preserved green vegetables is reprehensible, and has often led to legal action.

Zinc Salts are irritant poisons. The sulphate of zinc (white vitriol) occurs in crystals like Epsom salts for which it has been taken in mistake. Zinc chloride has a corrosive as well as an irritant action.

Barium Salts.—Except the quite insoluble sulphate these are irritant poisons and may also act on the nervous system.

Chromates especially potassium bichromate are powerful irritant poisons.

Phosphorus.—The yellow variety is intensely poisonous and used to be used iargeiy in the manufacture of matches. Owing to its dangerous properties its use for this purpose has been abandoned. Yellow phosphorus is used as a constituent of some rat poisons. The substance, in addition to being a gastro-intestinal irritant, is a deadly poison to the liver and kidneys.

Mercury.—Acute mercurial poisoning usually arises from the taking of mercuric chloride (corrosive sublimate) or from the biniodide of mercury, both of which are extensively used as disinfectants for medical purposes. The immediate symptoms are those of acute gastro-intestinal irritation (vomiting, abdominal pain and diarrhoea) but they are generally followed by suppression of urine and symptoms of acute ulcerative colitis which latter symptoms are commonly fatal. Chronic Mercurial Poisoning is characterised by inflammation of the mouth and gums.

SYSTEMIC POISONS

The systemic poisons include the following:—

Prussic or *Hydrocyanic* Acid.—Hydrocyanic acid is one of the best known poisons, and a very deadly one. In the pure state it is said to kill with lightning-like rapidity. It is met with in commerce only in a dilute state. In Great Britain two kinds of acid are commonly sold—the pharmacopoeia1 acid, containing 2% of anhydrous prussic acid, and Scheele's acid, containing 4 to 5%. Less than a teaspoonful of the 2% acid has caused death.

Given in fatal doses, the symptoms of prussic acid poisoning set in with great rapidity; and, in consequence of the readiness with which the poison is absorbed from the stomach and diffused through the circulation, the onset of symptoms is reckoned by seconds rather than by minutes. Occasionally the victim may be able to perform a few voluntary actions before alarming symptoms are developed. There is first a very brief stage of difficult breathing, and slow action of the heart, with a tendency for the organ to stop in the state of dilatation. With widely dilated pupils of the eye the patient is then seized with violent irregular convulsive movements. The rhythm of the respiratory movements is disturbed, and the countenance becomes of a bluish cast. The patient now sinks to the ground with complete loss of muscular power; and the third or asphyxia1 stage is reached, in which there are slow gasping respirations, loss of pulse, and paralysis of motion. Death is frequently preceded by spasms.

The lightning-like character of the illness, and the speedy death of the patient, coupled with the peculiar odour of the acid in the breath and atmosphere around the body, seldom leave any doubt as to the nature of the case.

The treatment consists in inhalation of fumes of strong ammonia, drinks of warm and cold water alternately, friction of the limbs, and artificial respiration. The subcutaneous injection of atropine, which acts as a cardiac stimulant, may prove serviceable.

Other soluble cyanides, more especially cyanide of potassium, a salt largely used in photography and in the arts, are equally poisonous with hydrocyanic acid.

Strychnine and *Strychnine-yielding* Plants.—The alkaloids strychnine and brucine, as well as the plants in which they are found, all act in the same manner, being highly poisonous and causing death after spasms of a severe character. Many vermin-killers contain strychnine as their active ingredient.

Strychnine, and all substances containing that alkaloid, produce their effects within a very few minutes—usually within ten or fifteen minutes. The patient complains of stiffness about the neck, and his aspect exhibits terror. There is an impression of impending calamity or death. Very speedily the head is jerked back, the limbs extended, the back arched (opisthotonos) so that the body may rest on the head and heels only. In a few moments these symptoms pass off, and there is complete relaxation of the spasm. The spasmodic condition speedily returns, and is brought about by the slightest touch or movement of the patient. Accessions and remissions of the tetanic state ensue rapidly till the patient succumbs, usually within half an hour of the administration of the poison.

The best treatment is to put the patient under the influence of chloroform and wash out the stomach, a full dose of chloral and bromide being afterwards introduced into the stomach.

Opium.—In consequence of the extent to which opium, its preparations, and its active alkaloid morphia are used for the relief of pain, poisoning by opium is of frequent occurrence. It is largely used by suicides; and children, being very susceptible to its influence, frequently die from misadventure after administration of an overdose of the drug. The ordinary preparations of opium are the drug itself, which is the inspissated juice of the oriental poppy, and the tincture, commonly known as laudanum. Opium contains a variety of more or less active principles, the chief of which is the alkaloid morphia, which is present in good opium to the extent of about 10% in combination with meconir acid, which is physiologically inactive.

Heroin is an artificial derivative of morphine (diacetyl morphine hydrochloride) and is more toxic than morphine. It has been largely used medicinally. It is a dangerous drug of addiction (see DRUG ADDICTION).

Belladonna.—The belladonna or deadly nightshade, atropa belladonna, contains an alkaloid, atropine, which is largely used by oculists to procure dilatation of the pupils of the eye. The brown or black berries of the plant have been eaten by children, who are attracted by their cherry-like appearance. Belladonna produces dilatation of the pupils, rapid pulse, hot dry flushed skin, with an eruption not unlike that of scarlatina, soreness of the throat, with difficulty of swallowing, intense thirst and delirium.

The treatment consists in evacuation of the poison by means of the stomach-pump, and the hypodermic injection of morphia as a counter-poison. Stramonium, hyoscyamus (henbane), hyoscyamine, hyoscine and scopolamine all produce symptoms similar to atropine poisoning, the narcotic effects being more marked.

Aconite Poisoning.—The ordinary aconite, wolfsbane or monkshood (*Aconitum Napellus*), and an alkaloid extracted from it, aconitine, are perhaps the most deadly of known poisons. One-sixteenth of a grain of aconitine, its active alkaloid, has proved fatal to a man. All the preparations of aconite produce a peculiar burning, tingling and numbness of the parts to which they are applied. When given in large doses they produce violent vomiting, as a rule, more or less paralysis of motion and sensation, and great depression of the heart, usually ending in death from syncope. Intelligence remains unaffected till almost the last.

The treatment consists in the hypodermic injection of digitalin, which is a counter-poison in its action upon the heart. The root of aconite has been eaten in mistake for that of horse-radish.

Cocaine Poisoning.—Cocaine is the active alkaloid of coca leaves. The hydrochloride salt is the commonly used preparation. It is a powerful deliriant narcotic poison. If taken by the mouth or given hypodermically or otherwise absorbed it may cause delirium and coma. Sometimes convulsions and sudden death occur. It acts on the heart and may cause fatal syncope. Cocaine is a dangerous drug of addiction (see DRUG ADDICTION).

Organic *Compounds* Used as Hypnotics.—These if taken in excessive doses act as poisons, and the symptom which attracts attention is the deep coma produced.

Examples are:—chloral, veronal and its derivatives, medinal, proponal, luminal, also sulphonal, trional and tetronal. Any hypnotic drug if taken in excessive quantity will act as a coma-producing poison. (See BARBITURIC ACID and SULPHONAL.)

GASEOUS POISONS

These include the following:

Carbon Monoxide Poisoning.—This occurs from coal gas, water gas or exposure to the suffocating fumes from fires. smoky grates, stoves or lamps; also from the fumes from geysers.

The diagnosis may be made at once by the clinical symptoms of drowsiness, collapse and coma and the cherry-red colour of the face and mucous membranes. The examination of the blood will make the diagnosis certain, since the presence of carbon monoxide haemoglobin may readily be detected by the spectroscope.

The treatment consists in giving oxygen freely and employing artificial respiration if necessary. Strychnine and digitalin should be given hypodermically, also brandy by the mouth, and warm saline either subcutaneously or by the bowel may be given. For heart failure pituitary extract may be given hypodermically.

Carbon Dioxide Poisoning, or *Carbonic* Acid Poisoning.—This occurs in coal mines from choke-damp or after-damp. Cellars of houses, wells, brewers' vats, lime-kilns, etc., frequently contain large quantities of carbonic acid gas.

The treatment consists in fresh air, rest, oxygen, artificial respiration if necessary, and the employment of warmth and stimulants.

Sulphuretted Hydrogen *Poisoning.*—This occurs from contamination of the air with sewer gas, and from the gases evolved when iron slag becomes moistened with water. The gas is frequently produced in various chemical processes.

The treatment consists in giving the patient plenty of fresh air. Oxygen and stimulant treatment must be used.

Chlorine.—This, even in minute proportion in the air, acts as a powerful irritant to the lungs, and causes an acute bronchial catarrh and pulmonary congestion, which may be followed by bronchopneumonia and other serious complications. Intense cyanosis and dyspnoea occur quickly, and severe spasm of the glottis occurs often associated with some oedema.

POISONOUS FOODS

Poisonous fungi, for the characters of which the reader is referred to special works on toxicology, are sometimes eaten in mistake for mushrooms. They cause a severe gastroenteritis and at the same time are powerful general poisons having a profound action on the nervous system and liver.

Food Poisoning (*q.v.*) generally results from the contamination of food with pathogenic bacteria allied to the typhoid and colon group of bacilli. "Food poisoning" is often erroneously called "ptomaine poisoning." The symptoms are those of acute gastroenteritis and may clear up quickly or terminate fatally. In some cases a prolonged illness with pyrexia like that of typhoid results. The symptoms of "food poisoning" usually come on within 3 days and most often within **24** hours of the taking of food. In some cases the symptoms are so acute as to resemble cholera.

The treatment and general management of these cases is on the same lines as that of acute gastroenteritis.

It must be remembered that "food poisoning" is a notifiable disease in some districts, and in all cases where death occurs the coroner should be informed. (W. H. WI.)

BIBLIOGRAPHY.—*General:* A. W. Blyth, Poisons: their *effects* and detection; A Manual for the use of analytical chenzists and experts (1884, 5th ed. enlarged and rev. 1920); L. Lewin, Lehrbuch der *Toxicologie* (Vienna and Leipzig, 1885); T. G. Wormley, *Micro-*Chemistry of Poisons (Philadelphia, 1885); B. Small, "Poisoning" and J. Stewart, "Poisoning from Lead, Arsenic, Zinc, Copper, Mercury, Silver and Phosphorus" in T. L. Stedman's Twentieth Century Practice, vol. 3 (1894–96); T. Oliver, "Metallic and Some Other Forms of Poisoning" in C. Allbutt, A System of Medicine, etc., vol. 2 (1897); J. Ogier, *Traité* de Chimie toxicologique (1899); A. H. Brundage, Manual of Toxicology (1901, 15th ed., 1926); M. E. Pozzi-Escot, The Toxins and Venonzs and their Antibodies (trans. by A. I. Cohn, 1926); K. A. Dieudonné, Bacterial Food Poisoning (ed. C. Boldnan, 1909); R. A. Witthaus, Manual of Toxicology (1911); A. L. Marchadier and A. Goujon, Les Poisons *méconnus* (1921); W. Autenrieth, Laboratory *Manual* for the Detection of *Poisons* and Powerful Drugs (1st trans. ed., Philadelphia, 1921; 2nd trans. ed., 1928). Legal: J. Glaister, Text-book of Medical Jurisprudence and *Toxicology* (1906, 5th ed., 1924); W. G. A. Robertson, *Manual* of Medical Jurisprudence and Toxicology (1908, 5th ed., 1925); J. D. Mann, Forensic Medicine and Toxicology (1914); R. J. Buchanan, *Buchanan's* Text-Book of Forensic Medicine and *Toxicology* (Edinburgh, 9th ed., rev. by J. E. W. MacFall, 1925). Venomous animals: A. Calmette, Venomous Animals and Antivenonzous *Serum* (trans. by E. E. Austin, 1908); M. Phisalix, *Animaux vénimeux* et *vénins*, 2 vol (with full bibl., 1922). Poisonous plants: G. Henslow, Poisonous Plants (1901); A. B. Smith, Poisonous Plants of all Countries (Bristol, 1905; 2nd ed., 1923); H. C. Long, Plants *Poisonous* to Live Stock, Camb. Agric. Monograph (1917). Veterinary toxicology: H. C. Long, as above; G. D. Lander, Veterinary Toxicology (1912). Asiatic and Anzerican poisons: F. W. Windsor, Indian Toxicology (Calcutta. 1906); J. D. Gimlette, Malay Poisons and Charm Cures (191j, 2nd ed., 1923).

POISON GAS: see CHEMICAL WARFARE.

POISON HEMLOCK: see WATER HEMLOCK.

POISON IVY, the name commonly applied to several, mostly white-fruited, trifoliate species of woody vines or shrubs of the genus *Toxicodendron* (family Anacardiaceae), native to North America. The forms with bushy habit and lobed leaflets are often called "poison oak," especially in the western United States. The common poison ivy (*Toxicodendron radicans*), the most widespread species, abundant in eastern North America and less common westward, is a variable species with a bushy or climbing habit, leaves with three leaflets which may be smooth and glossy or hairy, entire, toothed or lobed. Many of these not too constant variations have been designated as separate species or varieties. The more common of these forms with their ranges are: *T. quercifolium*, with deeply lobed leaflets, Maryland to Texas; T. radicans rydbergi, with thicker leaves, Great Plains to Rocky mountains; and T. diversilobum, with leaflets mostly scalloped on the margin, Pacific coast. The poison sumac (*T. vernix*), native in swamps from Quebec to Minnesota and south to Texas and Florida, is a tall bush or small tree with pinnately-compound leaves with 7 to 13 entire leaflets and drooping, axillary clusters of persisting white fruits. All species of Toxicodendron are poisonous to touch, producing in many persons a severe inflammation of the skin or dermatitis. Sumacs with red fruits are nonpoisonous. The toxic principle, urushiol, is produced in the resinous juice of the resin ducts of the leaves, flowers, fruits and bark of stems and roots but not in the pollen grains. Being almost nonvolatile, the urushiol may be carried from the plant on clothing, shoes, tools, soil, by animals, by smoke from burning plants, to persons who never go near the poison ivy plants. Poisoning may occur if clothing is worn a year after contact with poison ivy.

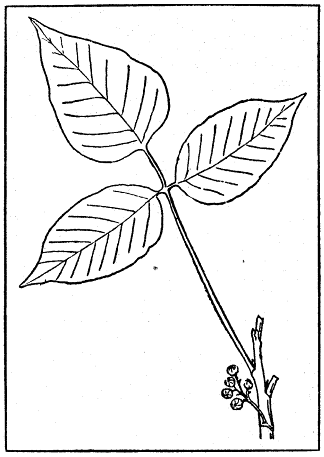

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FIG. 1.—A LEAF OF POISON IVY (TOXICODENDRON RADICANS)

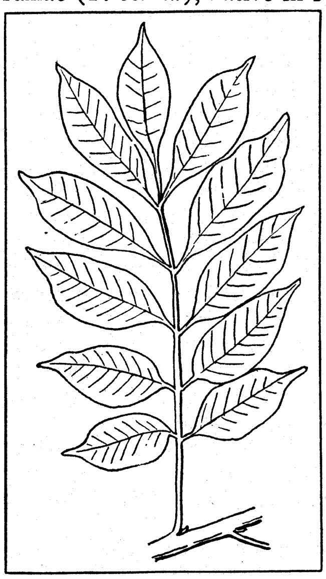

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FIG. 2.—A LEAF OF POISON SUMAC (TOXICODENDRON VERNIX)

The remedies and preventive treatments used against poisoning from contact with species of Toxicodendron are legion. With the exception of the following, none should be used without the advice of a physician. Either before exposure, or immediately after it is discovered that contact has been made with the plant, wash the exposed parts of the body thoroughly with water and an alkaline laundry soap. Lather the parts well and let the lather dry on. Repeat this treatment every 3 or 4 hours, leaving the dry lather on between applications. Avoid oily soaps or washing with alcohol to prevent spreading the toxic material.

(W. C. M.)

POISONOUS PLANTS. It is not practicable to divide the members of the vegetable kingdom into poisonous and nonpoisonous plants. Most of the quarter million known species of plants are harmless; only a relatively few are poisonous under ordinary conditions; others are poisonous only under special conditions. I'oisonous plants under natural conditions contain or produce physiologically active substances in quantities sufficient to cause death or a disease condition when eaten, or sometimes when touched, by man or animals.

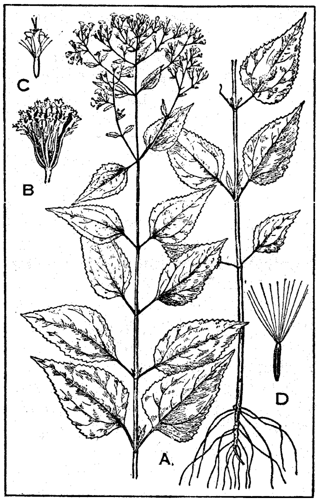

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FIG. 1.—WHITE SNAKEROOT (EUPATORIUM RUGOSUM). A, PLANT SHOWING GENERAL HABIT: B, HEAD OF FLOWERS; C, FLOWER: D. SEED (ACHENE) WITH PAPPUS ATTACHED

In general the toxic properties of poisonous plants are due to the presence, in some or all parts of the plant, of one or more organic compounds such as alkaloids, glucosides, resinoids and organic acids. Alkaloids are responsible for the toxic properties in certain members of the families Liliaceae, Amaryllidaceae, Papaveraceae, Ranunculaceae. Leguminosae and Solanaceae. Among the glucosides that yield toxic substances upon hydrolysis are those produced in wild cherries (*Prunus* sp.), flax (*Linum* sp.), purple cockle (*Agrostemma githago*), foxglove (Digitalis purpurea), and various members of the mustard family, Cruciferae. Resinoids containing toxic substances occur in poisonous members of the heath family, *Ericaceae*, water hemlock (Cicuta maculata), and milkweeds (*Asclepias* sp.).

Not all parts of a poisonous plant are equally toxic. In some the toxic principle is mostly concentrated in the seed, *e.g.,* purple cockle (*Agrostemma* githago); in others the root is the most toxic part, *e.g.,* water hemlock (*Cicuta* maculata). Some plants are toxic only in certain stages of development. The cocklebur (*Xanthium* orientale) is very poisonous in the seedling stage and harmless in later stages of growth. Other plants are poisonous when eaten green but are harmless after they are thoroughly dried and the toxic principle is dissipated. Some plants, *e.g.,* certain locoweeds (Astragalus sp.), vary greatly in their toxicity, depending upon the type of soil on which they grow.

Most cases of poisoning from eating toxic plants occur in animals; comparatively few occur in man. Some plants, such as water hemlock (*Cicuta* maculata), poison hemlock (*Conium maculatum*) and locoweeds (Astragalus sp.), produce characteristic symptoms in animals poisoned by eating them. Many poisonous plants, although belonging to widely unrelated plant families, may produce identical symptoms because their toxic principle is the same; *e.g.,* species of wild cherries (Prunus sp.), sorghum (Holcus sp.) and arrowgrass (Triglockin *maritima*) all produce the same symptoms because the toxic principle in them is prussic acid, which under certain conditions is released by the hydrolysis of glucosides produced in them. Another example of a disease caused by widely different plants is trembles, caused by white snakeroot (*Eupatorium* rugosum) in the eastern United States and by the rayless goldenrod (*Aplopappus heterophyllus*) from western Texas to Arizona and adjacent Mexico. In these plants the toxic principle is tremetol, which, being soluble in the fat of milk, may be transmitted from diseased cows through the milk to humans, causing the disease known as milk sickness. Some plants, *e.g.,* scouring rushes (*Equisetum* spp.) and iocoweeds (Astragalus spp.) may produce different types of diseases, acute or chronic, depending upon whether an animal eats a large quantity of the plants at one time or small quantities repeatedly for a considerable time.

Among cultivated plants the following poisonous species, originating mostly in the old world, are common and widely grown in the temperate regions: castor bean (*Ricinus communis*), daphne (*Daphne* nzezereum), foxglove (Digitalis purpurea), lily-of-the-valley (Convallaria *majalis*), meadow saffron (*Colchicum* autumnale), monkshood (*Aconitum* napellus), larkspur (*Delphinium* spp.), narcissus (Narcissus poeticus), oleander (*Nerium* oleander).

Plants Poisonous by Contact. — Most cases of contact poisoning by plants occur in man; animals are rarely poisoned by contact alone. In man certain plants produce a skin poisoning or dermatitis consisting of minor or temporary irritation or a painful inflammation with vesicles or blisters lasting for days or weeks. depending upon the susceptibility of the individual or the severity of the infection. The toxic principle in these plants is often most concentrated in a resinous or milky juice. Among the species uhich cause many cases of dermatitis may be mentioned the following:

Cashew family.—Poison ivy and poison oak (Toxicodendron radicans) and related forms, common in North America; poison sumac (Toxicodendron *vernix*), eastern North America; poison wood (*Metopium* toxiferum), of southeastern United States and West Indies; Japanese lacquertree (Toxicodendron *verniciflunm*), eastern Asia; cashew (*Anacardium* occidentale), widespread in tropical regions.

Spurge family.—Manchineel tree (*Hippomane mancinella*), common in the West Indies and Central America; sandbox tree (Hura *crepitans*), native to Central American lowlands; spurges (Euphorbia spp.), many species, especially some native to Africa and Asia, very toxic; snow-on-the-mountain (Euphorbia *marginata*), an annual native to western North America, widely introduced as an ornamental. A few species of primrose, notably *Primula* obconica, a favourite house plant, several kinds of lady-slipper (*Cypripedium reginae* and C. *parviflorum*), native to eastern North America, the garden parsnip (Pastinaca sativa), often escaped as a weed, and several species of milkweed (*Asclepias*), are responsible for dermatitis in many susceptible persons.

Photodynamic Plants.—Several plants appear to contain substances that sensitize domestic animals to light. If animals with white fur or unpigmented skin eat these plants and are subsequently exposed to strong sunlight they may develop a disease with characteristic symptoms that may result in death. Animals that are not exposed to sunlight subsequent to eating these plants do not develop any symptoms. Some of the widely distributed photosensitizing plants are buckwheat (*Fagopyrum* esculentum), St. Johnswort (*Hypericum perforatum* and H. *crispum*), bur clover (Medicago denticulata) and puncture vine (*Tribulus terrestris*).

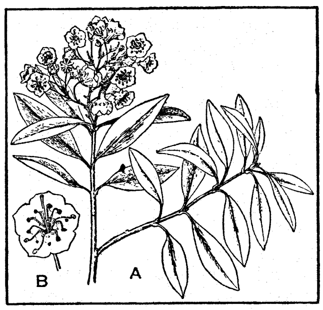

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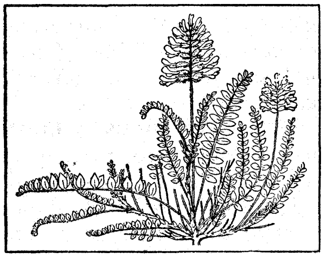
FIG. 2.—MOUNTAIN LAUREL (KALMIA LATIFOLIA). A, FLOWERING BRANCH; B, FLOWER

Seleniferous **Plants.**—Several species of plants when growing on certain soils from Cretaceous or Eocene shales take up enough selenium compounds to make them toxic. In several regions in western North America, cattle and horses have been poisoned by eating such seleniferous plants, resulting in alkali disease and blind staggers. Selenium absorbed from seleniferous shales by these plants upon their decomposition is returned to the soil and becomes available and may be taken up by other native plants or by crop plants that are unable to absorb inorganic selenium. By such action crops like wheat may become poisonous. The locoweeds (*Astragalus bisulcatus,* A. pectinatzis, *A. racemo-*

sus), wild aster (*Aster commutatus* and *A. xylorrhiza*), princes plume (*Stanleya bipinnata* and *S. pinnata*), are examples of seleniferous plants of western North America.

Principal Stock-poisoning Plants.—Several forms of bracken or brake-fern (*Pteridium*) occurring in widely distributed places throughout temperate regions from Eurasia to Australia and North America, when eaten fresh or in hay over a prolonged period, are the cause of poisoning of cattle and horses. Horsetail (*Equisetum arvense*) of Eurasia and North America causes an acute or chronic disease, equisetosis. Arrowgrass (*Triglochin maritima*) of Eurasia, North Africa and North America produces prussic acid which poisons cattle and sheep. Darnel (*Lolium temulentum*), native to Europe and introduced in North America, contains a poison in its grains. Death camas (*Zygadenus venenosus*) and related species, all native to North America, contain toxic alkaloids and cause considerable losses among sheep and cattle grazing on ranges in the spring. False hellebore (*Veratrum viride*), widespread in North America, and the European V. *album* contain toxic alkaloids.



FROM "POISONOUS PLANTS OF U.S." BY W. C. MUENSCHER, THE MACMILLAN CO.

FIG. 3.—WOOLLY LOCOWEED (ASTRAGALUS MOLLISSIMUS)

Fly poison (*Amianthemum muscaetoxicum*) causes losses among cattle and sheep in the eastern United States. Lily-of-the-valley (*Convallaria majalis*), native to Europe and the eastern United States, widely cultivated as an ornamental, contains toxic alkaloids. Star-of-Bethlehem (*Ornithogalum umbellatum*), native to Europe and naturalized in North America, and other species of *Ornithogalum* native to South Africa cause poisoning of cattle and sheep. Meadow saffron (*Colchicum autunrnale*), native to Europe and widely introduced in North America, contains toxic alkaloids. Lechuguilla (*Agave lechegzcilla*), native to southwestern United States and Mexico, contains a photosensitizing agent and causes poisoning, chiefly of sheep and goats.

Pokeweed (*Phytolacca americana*), native to eastern North America, contains a toxic alkaloid chiefly in the root. Purple cockle (*Agrostemma githago*), native of Eurasia and widely naturalized in most regions where winter wheat is grown, contains a toxic glucoside in its seeds. Monkshood (*Aconitzcm napellus*), a native of Europe, and *A. columbianum*, native of the mountain ranges of western North America, both contain toxic alkaloids. Larkspurs (*Delphinium* spp.) contain toxic alkaloids: several species native to western North America cause heavy losses when grazed by cattle.

Hellebore (*Helleborus niger* and *H. viridis*), native to Europe and introduced in North America, contain toxic glucosides. Opium poppy (*Papaver somniferum*), of Asiatic origin and widely introduced in warmer parts of the world, contains several alkaloids. Dutchmans-breeches (*Dicentra cucullaria*) and squirrel corn (D. *canadensis*), native to eastern North America, contain toxic alkaloids and cause blind staggers in cattle and sheep. Wild cherry (*Prunus serotina*), a common native tree in eastern North America, chokecherry (*P. demissa*) of western North America, the cherry laurel (*P. laurocerasus*) of Europe and other species contain a glucoside that may yield prussic acid upon hydrolysis. When the leaves of these plants are eaten by cattle or sheep, death may result quickly.

Several European and North American species of lupines (*Lupinus* sp.) contain toxic alkaloids. In western North America losses among cattle and sheep grazing on lupine seed pods may be large. A number of species of locoweeds (*Astragalus* sp. and *Oxytropis* sp.) native to North America in the region from the great plains westward to the Rocky mountains are poisonous and when eaten cause loco disease in cattle and horses. The plants appear to be "habit forming," and animals may develop a habit of seeking out locoweeds in preference to other vegetation. The disease may be acute from eating large amounts at one time, or chronic from eating small amounts over a long period. Some, but not all, locoweeds owe their toxic properties to selenium compounds absorbed from the soil.

Precatory bean (*Abrus praecatorius*), a native shrub of India, is widely introduced in subtropical regions.

Its seeds contain a toxic substance, abrin, and may poison cattle and sheep. In India immunity has been developed in animals by feeding them very small amounts of the abrin and gradually increasing the dose. Black locust (*Robinia pseudo-acacia*), a native tree of eastern North America and widely introduced in Europe, contains a toxic substance in its bark. Horses are sometimes fatally poisoned by eating the bark. Puncture vine (*Tribulus terrestris*), a more or less cosmopolitan weed in the warmer parts of the world, contains a photosensitizing agent and causes a disease, tribulosis, when eaten by animals.

China-tree (*Melia azedarach*), a native tree of India widely introduced in many warm regions of the world, including the southern United States, contains a narcotic poison, especially in its fruits. Many species of spurges (*Euphorbia* sp.) native to Africa, Europe and America contain toxic substances in their latex. These plants are not only poisonous when eaten but many of them arc poisonous to touch. Coyotillo (*Karwinskia humboldtiana*), a shrub native to Mexico and the southwestern United States causes a paralytic disease, "limberleg," when the leaves are grazed by cattle. St. Johnswort (*Hypericum perforatum*), native to Europe but widely naturalized in North America, Australia, and North Africa, contains a photosensitizing agent. This species and also *H. crispum* cause a disease osteoporosis or bighead, in cattle and sheep.

Water hemlock (*Cicuta virosa*), native to Europe, and *C. maculata* and *C. douglasi*, native to wet lands in eastern and western North America, contain a resinous substance, cicutoxin, especially in their roots. Only a small piece of root may kill a cow. Poison hemlock (*Conium maculatum*) and iool's parsley (*Aethusa cynapium*), both native to Europe and naturalized in North America, contain alkaloids in their roots and seeds. Mountain laurel (*Kalmia latifolia*) and sheep laurel (K. *angustifolia*), two native evergreen shrubs of eastern North America, frequently cause death of cattle and sheep when they eat the leaves. Indian hemp (*Apocynum cannabinum*) and dogbane (*A. androsaemifoliunz*), native North American herbs, produce a resinous material with toxic substances responsible for poisoning cattle and horses. Oleander (*Nerium oleander*) native to Asia but widely introduced in the warmer parts of the world, contains toxic glucosides. Various domestic animals have been poisoned by eating the leaves.

Whorled milkweeds (*Asclepias galioides, A. mezicana*) and related species native to western North America, have caused death of sheep and cattle grazing on the tops. Black nightshade (*Solanum nigrum*) and European bittersweet (*S. dulcanzara*) contain the alkaloidal glucoside solanine in the leaves and berries. Thorn apple (*Datura stramonium*) and related species, native to warmer parts of the world but now widespread, contain toxic alkaloids. Belladonna (*Atropa belladonna*) and henbane (*Hyoscyamus niger*), European species introduced into North America, are poisonous and are also grown as medicinal plants for their powerful alkaloids. Foxglove (*Digitalis purpurea*), native to Europe and naturalized in western North America, contains several glucosides, mostly in the leaves. Animals, and rarely people, are poisoned by eating the leaves. White snakeroot (*Eupatorium rugosum*), native to eastern North America, causes the disease trembles in cows and milk sickness in people. Cockleburs (*Xanthium* sp.), widespread in warmer parts of the world, are poisonous in the seedling stages. Ragworts (*Senecio jacobaea* and other species) cause a disease of the liver in cattle and horses in North America, South Africa, parts of Europe and New Zealand.

BIBLIOGRAPHY.—Plants poisonous by contact: J. C. White, *Dermatitis venenata* (Boston, 1887); F. J. Chittenden, "Plants causing skin irritation," *Gardeners Chronicle* III, 90:332–334 (1931); L. F. Weber, "External causes of dermatitis," *Archives of Dernzatology and Syphilology*, 35:129–179 (1937); W. C. Muenscher, *Poisonous plants of the United States* (1939).

Photodynamic plants: F. P. Mathews, "Photosensitization and the Photodynamic Diseases of Man and the Lower Animals," *Archives of Pathology* 23: 399–429 (1937); H. F. Blum, "Photodynamic Action of Light," *Physiological Reviews* 12: 23 (1932).

Seleniferous plants: O. A. Beath, "Seleniferous Vegetation in Wyoming," *Wyoming Agricultural Experimental Station Bulletin* 221 (1937); A. L. Moxon, "Alkali Disease or Selenium Poisoning," *South Dakota Agr. Exp. Sta. Bull.* 311 (1937).

General: L. H. Pammel, *Manual of Poisonous Plants* (1911); R. B. Thomson and H. B. Sifton, *A Guide to the Poisonous Plants and Weed Seeds of Canada and the Northern United States (1922)*; H. C. Long, *Poisonous Plants of the Farm* (1924); D. G. Steyn, *The Toxicology of Plants in South Africa* (1934); W. C. Muenscher, *Poisonous Plants of the United States* (1939); P. H. Allen, "Poisonous and Injurious Plants of Panama," *Trop. Med.* 23: *Suppl.* (1943).

(W. C. M.)

POISSY, a town of N. France, in the department of Seine-et-Oise, 17 mi. W.N.W. of Paris, on the railway from Paris to Rouen. Pop. (1936) 12.502. Poissy was the ancient *Pinciacum*. The ancient church, dating from the 12th century, and restored under Viollet le Duc, affords one of the earliest and best examples of transition from the Romanesque to the Pointed style. There are metalworks and construction of railway cars; printing and manufacture of footwear and furniture are carried on.

POISSY, COLLOQUY OF, a conference held in 1561 with the object of effecting a reconciliation between the Catholics and Protestants of France. The conference was opened on the 9th of September in the refectory of the convent of Poissy, the king himself being present. At the end of a month their difficult labours seemed on the point of success when the assemblage of prelates refused assent, and the conference broke up.

See H. Küpffel, *Le Colloque de Poissy* (Paris, *1868*); E. Lacheinmann in Herzog-Hauck, *Realencyklopädie f. protest. Theologie* (3rd ed., 1904), xv. 497.

POITIERS (pwă-tyā), a town of W. France, formerly capital of Poitou, and now the chief town of the department of Vienne, 61 mi. S.S.W. of Tours on the railway to Bordeaux. Pop. (1936), 41,384. Called *Limonum* at the time of the Roman Conquest, Poitiers afterwards took the name of its Gallic founders, the Pictones or Pictavi. Christianity was introduced in the 3rd century, and the first bishop of Poitiers, from 350 to 367, was St. Hilarius. Fifty years later the city had fallen into the hands of the Arian Visigoths, and became one of the principal residences of their kings. Alaric II. was defeated by Clovis at Vouillé, not far from Poitiers, in 507, and the town became a part of the Frankish dominion. This was the first occasion on which the peoples of northern and southern Gaul met in conflict near the town which was to see the so often join battle. By his victory in 732 over the Mohammedans at Moussais-la-Bataille in this region, Charles Martel proved the saviour of Christendom. Eleanor of Guienne frequently resided in the city and in 1199 entrusted it with communal rights. After the battle of Poitiers in 1356 (see below), Poitou was recognized as an English possession by the treaty of Brétigny (1360); but by 1373 it was recovered by Bertrand Du Guesclin.

Between the north-west of the plateau central and the Gâtine, both heights of old rock, lies the relatively low land called the Seuil du Poitou, giving a historic connection between the Paris basin and the basin of the Garonne. In this lowland streams have dissected valleys in the Jurassic rocks, and Poitiers stands on a promontory above the junction of the Boivre and the Clain (a tributary of the Loire by the Vienne); its situation has given it a peculiar importance in military and political history. The town is picturesque; and its streets are interesting for their remains of ancient architecture, especially of the Romanesque period, and the memories of great historical events. Till 1857 Poitiers contained the ruins of a Roman amphitheatre more extensive than that of Nîmes; remains of Roman baths, constructed in the 1st and demolished in the 3rd century, were laid bare in 1877; and in 1879 a burial-place and the tombs of a number of Christian martyrs were discovered on the heights to the south-east, the names of some of the Christians being preserved in paintings and inscriptions. Not far from these tombs is a huge dolmen (the "Pierre Levée"), 22 ft. long, 16 ft. broad and 6 or 7 ft. high, around which used to be held the great fair of St. Luke.

The cathedral of St. Peter, begun in 1162 by Henry II. of England and Eleanor of Guienne on the ruins of a Roman basilica, and completed by 1379, is in the Romanesque and Early Gothic styles. It consists of three naves almost equal in height and width, all of which decrease towards the west. The fine windows of the choir and the transepts preserve their stained glass of the 12th and 13th centuries. The choir stalls (1235–57) are among the oldest in France. The church of St. Jean near the cathedral is the most ancient Christian monument in the country. Built as a baptistery in the first half of the 4th century, it was enlarged in the 7th century, since when it has suffered little structural alteration.

The church of St. Radegonde, a great resort of pilgrims, commemorates the consort of Clotaire (d. 587), and preserves in its crypt the tomb of Radegonde, who founded at Poitiers the abbey of the Holy Cross, and two others reputed to be those of St. Agnès and St. Disciola. The choir and tower above the entrance are of the 11th century, while the nave (late 12th century) is in the Angevin style Notre-Dame la Grande (late 11th century) represents a much older collegiate church and has a richly sculptured Romanesque facade. The church of Moutierneuf (*Monasterium Novum*) was begun in 1077 by William VI., duke of Aquitaine and count of Poitiers, who is buried within its walls; and the choir (13th century modified by the erection of a "lantern") was solemnly consecrated by Urban II. in 1096. Restorations have been effected in the 19th century. The beautiful 11th century tower of St. Porchaire was restored in the 19th century.

Poitiers is the seat of a bishop, a prefect, a court of appeal and a court of assizes, and centre of an educational division (*académie*), and has tribunals of first instance and of commerce. It has a university with faculties of law, science and letters, a preparatory school of medicine and pharmacy and a school of theology. There are artillery practice-grounds and an airfield. Trade is in farm produce, wine, wool, honey, goose-quills and leather. The industries include the preparation of goose- and swan-skins, printing, and the manufacture of hosiery, brushes, oil, paint and candles.

Counts of Poitiem.—In the time of Charlemagne the countship of Poitiers, then part of the kingdom of Aquitaine, was represented by a certain Abbon. Renoul (Ranulph), created count of Poitiers by Louis the Pious in 839, was the ancestor of a family distinguished in the 9th and 10th centuries for its attachment to the Carolingian dynasty. One of his successors, Ebles the Bastard (d. 935), took the title of duke of Aquitaine; and his descendants retained the hereditary name of William. In accordance with the dying wishes of William X his daughter Eleanor was married in 1137 to Louis, the son of Louis VI of France. Sole heiress, she brought her husband Poitou, Saintonge, Aunis, a part of Touraine and Berry, Marche, Angoumois, Périgord, Auvergne, Limousin, Bordelais, Agénois and Gascony. After a divorce in 1152, Eleanor married the count of Anjou, Henry Plantagenet, who became king of England as Henry II. The west of France thus passed into the hands of England. Philip Augustus reconquered Poitou in 1204. When Charles VII ascended the throne he united the countship of Poitiers to the crown. During World War II, the town was occupied by the Germans in June 1940, and the demarcation line ran through the vicinity.

Battle of **Poitiers.**—This battle, fought on Sept. 19, 1356, between the armies of King John of France and of Edward the "Black Prince," was the second of the three great English victories of the Hundred Years' War. From Bordeaux the Black Prince had led an army of his father's Guienne vassals, with which was a force of English archers and men-at-arms, into central France and had amassed an enormous booty. King John, hitherto engaged against the army of John of Gaunt, duke of Lancaster, in Normandy, hurried south to intercept the raiding army and to bar its homeward road. After an unexpected encounter with the French rear, the Black Prince, by forced marching, was able to slip past the French, but reaching Maupertuis, 7m. S.E. of Poitiers, with the king's army in chase, he found himself compelled to choose between fighting and abandoning his spoil. He chose the former course, in spite of the enemy's great superiority in numbers (perhaps 16,000 to 6,500), and in order to give his trains time to draw off took up a defensive position on Sept. 18 with a slight hollow in front and a wood behind, between the Poitiers-Bordeaux main road and the River Maussion.[1] John, instead of manoeuvring to outflank the English, allowed the Cardinal Talleyrand de Périgord to attempt to negotiate a peace. This proving vain, the French army attacked without any attempt at manoeuvre or reconnaissance, and on a front so narrow that the advantage of superior numbers was forfeited. Moreover, King John ordered all but the leading line to dismount and to attack on foot (tactics suggested by the success on the *defensive* of the dismounted English men-at-arms at Crécy and the Scots at Bannockburn), and thus condemned the best part of his army to a fatiguing advance on foot across difficult country in full armour.

The French crossbow-men, who might have crushed the relatively few English archers present, were mingled with the mounted men in first line, but, as the latter charged, their advance masked the fire of the cross-bowmen in the first few seconds, besides leaving the others, dismounted, lines far in rear. Thus the first attack on the Black Prince's line, which was greatly strengthened by trees and hedges in front of it, was promptly brought to a standstill by the arrows of the archers lining a hedge which overlooked

[1]The view adopted is that of Oman, *Art of War in the Middle Ages.*, p. 631.

the hollow in front; and the earl of Oxford hastily drawing out a body of archers beyond the defenders' left, into the marshy valley of the Maussion, completed their rout by firing up the hollow into their flank. But it was not so easy to deal with the second line of dismounted men-at-arms, led by the dauphin, which was the next to arrive on the French side. The hedge indeed was held, and the assailants, unable to advance beyond the hollow, gave way, but to achieve this the prince had to use all but 400 of his men. Had the third body of the French advanced with equal spirit the battle would probably have ended there and then, but the duke of Orléans, who commanded it, was so demoralized by the retirement of the dauphin's division that he led his whole force off the field without striking a blow.

Thereupon the king himself advanced furiously with the fourth and last line, and as it came on, the situation of the English seemed so desperate that the prince was advised to retreat. But his determined courage was unshaken; seeing that this was the last attack he put his reserve into line, and rallying around this nucleus all men who could still fight, he prepared not only to repulse but to counter-attack the French. He despatched 60 men-at-arms and 100 archers under the Captal de Buch to ride round the flank of the enemy and to appear in their rear at the crisis of the fight. Though a mediaeval knight, he knew as well as Napoleon at Arcole that when the moral force of both sides has passed its culminating point even a materially insignificant threat serves to turn the balance. And so it fell out. When both lines were fighting hand-to-hand, the 60 horsemen of the Captal de Buch appeared in rear of the French. The front ranks fought on, but the rearmost Frenchmen melted away rapidly, and at last only a group of the bravest, with Ring John and his son Philip, a boy of 14, in their midst, mere left. This band continued their hopeless resistance for a time, but in the end they were killed or captured to a man. The rest of the French army, totally dispersed, was pursued by the victors until nightfall. Two thousand five hundred of the French, 2,000 of them knights and men-at-arms, were killed, including the Constable, one of the marshals, the standard-bearer and six other great lords. The prisoners included the king and his son Philip, the other marshal and 25 great lords, and 1,933 knights and men-at-arms as well as 500 others. The Black Prince then resumed his march to Bordeaux, making no effort to exploit his military ascendancy. And in this he was justified, for he had now in his hands a political key which could yield him all the possible profits of victory, without their military cost.

POITOU, one of the old provinces of France, also one of the great military governments of the kingdom, bounded on the N. by Brittany, Anjou and Touraine; on the S. by Angoumois and Aunis; on the E. by Touraine. Berri and Marche; and on the W. by the ocean. It was divided into Lower Poitou, which corresponded to the modern department of La Vendée, and Upper Poitou, now split into the departments of Deux-Sèvres and Vienne. The principal town in Upper Poitou was Poitiers the capital. Poitou (Poictou, Pictavia) takes its name from the Pictones or Pictavi, a Gallic nation mentioned by Caesar, Strabo and Ptolemy, and described by Strabo as separated from the Namnetes on the north by the Loire. It formed part of the territory known as Aquitaine (*q.v.*).

For the history *see* the *Mémoires* of the Société des Antiquaires de l'Ouest (1835 *sqq.*) and the documents published by the *Archives historiques du Poitou* (1872 *sqq.*); also L. Rédet, *Dictionnaire topographique de la Vienne* (1881).

POKEBERRY or **POKEWEED,** the popular name (from the American-Indian *pocan,* applied to any plant yielding a red or yellow dye) of Phytolacca decandra, a strong-smelling perennial herb, a native of North America, with ovate-lanceolate sharp-pointed leaves, racemes of small greenish-white flowers and flattish berries nearly $ in. in diameter, which contain a crimson juice. The young asparagus-like shoots are sometimes used as a pot-herb, but the roots are poisonous. The plant is often cultivated in Europe, and has become naturalized in the Mediterranean region.

POKER, a game of cards, for any number of players from two to eight. each for himself. The usual pack is 52 cards, to which the joker is sometimes added, or the pack may be "stripped" by deleting the 2s, 3s and 4s. When eight play, a pack with 11's and 12's is sometimes used. The suits have no rank, but the cards rank from the ace, king, queen, down to the deuce. Players are provided with chips of various colours and values; white being the lowest, then red, blue and yellow.

This game is evidently an adaptation of the Persian game of Âs nbs, as it was originally played with only 20 cards, dealt to four players, and went to the United States by way of New Orleans. Owing to its resemblance to the French game of "poque," and the German game of "pochen," the French colonists called it poque, and this spelling was mispronounced by the English-speaking players as po-que, easily converted into po-ker.

"Full-deck poker," with 52 cards, was not played until about 1830, but was still "straight poker" or "bluff," there being no draw to improve the hands until the early '60s, during the American Civil War. About this time straights were introduced, but they ranked below triplets, beating two pairs. This led to the straight flush in the early '70s, and shortly afterward the jack pot was introduced, so as to force cautious players to come in and bet, whether they had strong hands or not. This rendered useless much of the "scientific" playing of the old school.

A card is dealt face up to each player and the first one dealt a jack takes his choice of seats and deals the first hand. Sometimes, instead of the player dealt the first jack, the one dealt the highest card takes the deal and seat, the others in order after him to the left. At the end of each hour seats may be redistributed in the same way. If a newcomer enters, cards are dealt round, and he takes his seat to the left of the holder of the first jack.

There are two standard games: draw poker and stud poker. In draw poker the "age" (player on the dealer's left) puts up a white chip "blind," which may be "straddled" by the player on his left by putting up two chips, but this is seldom done. In "all jacks," no one can draw cards until someone has "opened" by declaring he has a hand as good as a pair of jacks. In this game everyone antes the same amount and there is no straddle. The man on the dealer's left is "under the gun."

Before play begins two things must be agreed upon: a betting limit, which is the amount by which any previous bet may be increased, and the value of the blind; of the ante in jack pots. As soon as the blind or the antes have been put up the cards are dealt.

Any player may shuffle the pack, the dealer last. The player to the right of the dealer cuts and the cards are distributed one at a time from left to right until each has five. It is a misdeal if a card is found faced in the pack, or more than five are given to more than one player; but a card faced in dealing must be taken. The players then examine their hands. Those wishing to draw cards in the regular game make the ante good by putting in twice as much as the blind or straddle, with the privilege of increasing it any amount within the betting limit. Each player to the left must then "call" this amount, raise it or throw up his hand. In jack pots, each player in turn to the left of the dealer examines his hand, and if he has a pair of jacks or better, he may "open," if he wishes to do so, by betting any amount within the limit. This opening is not compulsory, the man under the gun frequently passing with nothing but jacks, owing to the disadvantage of his position.

Those who wish to draw cards against the opener may call or raise his bet without any restrictions on what they may hold, even if they passed before the pot was opened. Those who do not draw cards should not abandon their hands until they have seen that the opener has the necessary qualification. This is to protect their interest in the pot, as the opener is required always to place his discard under the chips in the pool, whether he is splitting his openers or not. Modern poker, as played in the United States, is almost all jack pots.

The betting before the draw being settled, those still in the pool draw to improve their hands. beginning with the player on the dealer's left. A player may "stand pat" or take any number from one to five, discarding an equal number face down on the table before he is helped. Any card faced in dealing for the draw cannot be replaced until all the others are helped. The cards dealt, the player to the left of the age (or in jack pots the opener) makes the first bet or passes out. Each player to the left must then either call, raise or drop out. This continues until no one will call the last bet, or until two or more have bet an equal amount. If no one antes against the age, the next deal is a jack pot. If no one opens *a* jack pot, all put up another ante and the deal passes.

If the last raise is not called, the player takes the pool without showing his hand, unless he has opened a jack pot, when he must show his opening qualification. False openers forfeit all they have put into the pool. If drawn to, they must ante for all the others for the next deal; but if any have come in against the false openers, they stay and play for the pool. When two or more hands are shown for the pool, they decide it by the rank of the hands shown, a straight flush being the best possible hand, and no-pair the lowest. The following table shows the number of each class of hand that it is possible to hold, and the odds against any individual player's holding it before the draw, in his five cards:

Table of Poker Hands

Number	Class	Odds against
40	Straight flush	64,973 to 1
624	Four-of-a-kind	4,164 to 1
3,744	Full hand	693 to 1
5,108	Flush	508 to 1
10,200	Straight	254 to 1
54,912	Three-of-a-kind	46 to 1
123,552	Two pairs	20 to 1
1,098,240	One pair	$1\frac{1}{4}$ to 1
1,302,540	No pair	Even

A straight flush is any sequence of five cards in the same suit. A royal flush is ace, king, queen, jack and ten. Four-of-a-kind is any four of the same denomination and an odd card. A full hand is three of one kind and a pair. A flush is any five cards of the same suit. A straight is five cards in sequence of different suits. Two pairs are two each of different denominations, the rank of the hand being decided by the higher pair. One pair outranks a lower pair. If the pairs are equal, the next higher card decides the tie. In flushes, the rank of the various cards decides. If the hands are still tied in any case, they divide the pool. Any hand of more or less than five cards is foul.

In addition to the standard hands, there are four that are frequently played in the South in the United States, but which have been ranked by guess-work instead of the calculated odds against them, and therefore incorrectly. These are:—

Skip straight, such as 2, 4, 6, 8, 10, played to beat two pairs; but should rank between a straight and a flush, as the odds are 423 to 1 against it. A tiger, seven high and deuce low, without a pair, sequence or flush; sometimes called big or little dog, and played to beat a straight or lose to a flush, but should beat a flush and lose to a full hand; 636 to 1 against it. Round-the-corner straight, the ace connecting the deuce and king; played to beat the smallest possible straight, which would be 5 high, as A, 2, 3, 4, 5, is not ace high, but ace low. This should rank between a full hand and four-of-a-kind, as the odds are 848 to 1 against it. A blaze, any five picture cards, such as two kings, two queens and a jack; played to beat two pairs and lose to triplets, but should rank just below four-of-a-kind; 3,008 to 1 against it.

The chances of improving any of the regulation hands by drawing to them are as follows: Drawing to one pair, the odds against getting four-of-a-kind are 359 to 1; against a full hand, 97 to 1; against triplets, 8 to 1; against two pairs, 5 to 1; against any improvement, 24 to 1. Holding up a "kicker" such as an ace, drawing two cards only, it is 4 to 1 against any improvement.

Drawing to two pairs, it is 11 to 1 against filling the hand by getting the third to either pair. Discarding the smaller pair, the chances are practically the same as drawing to one pair. Drawing to straights: If open at both ends, it is 5 to 1 against filling; if an interior, 11 to 1 against filling. Drawing to triplets: Drawing two cards, it is $22\frac{1}{2}$ to 1 against getting four-of-a-kind; $14\frac{1}{2}$ to 1 against getting a pair; and $8\frac{1}{2}$ to 1 against either improvement. If you draw one card only, to mask the hand, it is 46 to 1 against your getting four-of-a-kind; 15 to 1 against matching the odd card; and 11 to 1 against either improvement, as compared to $8\frac{1}{2}$ to 1 if you draw two cards. Drawing to flushes: Drawing to four cards, it is 43 to 1 against filling; drawing to three cards, 23 to 1 against; drawing to two cards, 96 to 1 against. Players often take these chances with two or three high cards of the same unit.

While a flush is easier to fill than a straight, it is harder to get the four-card flush to draw to in the first place. There are about 500 ways to get a four-card straight; only 112 ways to get a four-card flush.

Drawing four cards to an ace it is 4 to 1 against getting the pair; 12 to 1 against aces up or better. Drawing three cards to an ace and king, it is 3 to 1 against making a pair of either. The chances for a flush, if they are of the same suit, have been given.

In drawing against openers in jack pots, one pair is as good as another; a psir of tens is no better than deuces, as either must improve enough to beat jacks. No one is obliged to open a jack pot, even with the qualification, and the man under the gun seldom opens on just jacks.

If two or more players have bet equal amounts, each is assumed to hare called the other, and both hands must be shown to the board, it being against the rules for one to throw in and say, "that's good." This is to prevent collusion.

Stud Poker.—This is the standard game to-day. One card is dealt face down to each player and then one to each face up. The one having the highest card showing, next to the left of the dealer, makes the first bet or throws up his cards, all having seen what they have "in the hole." Each player in turn then sees this bet, raises it or passes out. Another card is then dealt to each of the survivors, and the best hand showing bets first. This is continued until four cards are face up, and one still face down. The final bets made, the "hole" cards are exposed, the hands in the call are shown and the best hand wins.

High Low Stud.—In order to keep as many in the betting as long as possible, the highest hand shown in the call divides the pool with the lowest hand.

Peek Poker.—This is a variety of stud in which seven cards are dealt to each player, two face down, and two are discarded just before the show-down.

Straights and flushes are seldom played in any form of stud.

Deuces Wild.—This is a variation for any form of poker, in which the four deuces may be called anything, regardless of whether or not the player himself holds the actual duplicate of the card named. Four hearts to the ace and the deuce of any suit may be called an ace-ace high flush. In cases of ties natural cards beat wild ones; thus three kings and a deuce will beat three deuces and a king.

Wild Widow.—One card is dealt face up in the centre of the table, and all cards of that denomination are "wild."

Joker Poker.—This is sometimes called Mistigris. The joker is added to the pack and is "wild." When added to deuces wild there is an unbeatable hand, all wild cards. Five of a kind is not uncommon in playing wild, and beats a straight flush.

Stripped Pack Poker.—In order to upset the calculations of the experts, the 2s, 3s and 4s are sometimes deleted.

Table Stakes.—In this game each player puts a certain amount on the table in front of him, which cannot be changed after he has looked at his hand. He can "call a sight" for his pile if any player or players bet more.

Whisky Poker.—An extra hand is dealt face down, and each player in turn may take it in exchange for his own, leaving his cards on the table face up. Any following player may then exchange one card or take them all. If no one takes the widow while face down the dealer turns it face up, and the players draw or exchange. This continues until some player "knocks," without drawing, and after each of the others has had a draw, the hands are shown for the pool, to which each has equally contributed. See *Webster's* Poker Book (1925). (R. F. F.)

POKOMAM, a group of Indians speaking a Maya dialect who live in southern Guatemala. Their territory runs from the upper part of the Motaqua river to the border of Salvador. They inhabit to-day the departments of Chimaltenango (in part), Guatemala, Amatitlán and Jalapa in Guatemala, and at the time of the conquest they extended to Chalchuapa in Salvador. The principal towns where this tongue is spoken are San Martin Jilotepeque, Mixco, Petapa, Jalapa, Jilotepeque and Asuncion Mita. They number about 50,000, of whom over half speak their native tongue. The ancient capital of the Pokomam was the fortress of Mixco situated on a steep hill in the valley of Xilotepeque.

BIBLIOGRAPHY.—Thomas Gage, *The English-American, his travail by land and sea,* etc. *(1648)*; Domingo Juarros, *History of the Kingdom of Guatemala* (1823). (S. K. L.)

POLA, a seaport of Italy, the capital of the province of Pola, in the district of Venezia Giulia, 86 mi. S. of Trieste by rail. Pop. (1936) 34,090 (town), 42,259 (commune). It was the principal naval harbour and arsenal of the Austro-Hungarian monarchy until 1918, and is situated near the southern extremity of the peninsula of Istria. It lies at the head of the Bay of Pola, and possesses a safe and commodious harbour almost completely landlocked. An extensive system of fortifications, constructed on the hills which enclose the harbour, defends its entrance, while it also possesses a good roadstead in the large channel of Fasana.

The modern town of Pola lies round the base of a hill formerly crowned by the Roman capitol, and now by a castle of the 17th century. Besides the castle the chief buildings are the cathedral, burnt down in 1923 and reconstructed on the lines of a 6th cent. Ravenna basilica; the new garrison church, completed in 1898 in the basilica style, with a marble façade; and the Franciscan church dating from the 14th century. To the south-west, along the coast, extends the marine arsenal, which has now been dismantled; the large barracks are equally deserted. The chief interest of Pola centres in its fine Roman remains. The most extensive of these is the amphitheatre built in A.D. 198–211, in honour of the emperors Septimius Severus and Caracalla, which is 79 ft. high, 400 ft. long and 320 ft. wide, and could accommodate about 23,000 spectators. It is remarkable as the only Roman amphitheatre of which the outer walls have been kept intact. The history of Pola begins with its capture by the Romans in 178 B.C. It was destroyed by Augustus on account of its espousal of the cause of Pompey, but was rebuilt under the name of Pietas Iulia, and was mainly important as a harbour. Later it became the capital of the margraves of Istria, and was captured by the Venetians in 1148. In 1379 the Genoese, after defeating the Venetians in a great naval battle off the coast, took and destroyed Pola, which disappears from history for the next four hundred and fifty years. It remained under Venetian supremacy down to 1797, and fell under Austria in 1815.

See T. G. Jackson, *Dalmatia, the Quarnero and Istria,* vol. iii. (1887).

POLABS (*Po*=on, *Laba*=Elbe), the Slavs (*q.v.*) who dwelt upon the Elbe and eastwards to the Oder. Except the Lithuanians they were the last Europeans to be Christianized; their chief sanctuary was at Arcona on the Isle of Riigen. They were converted and conquered in the 12th century and Germanized. By the 17th century Slavonic survived only in a tiny patch in the east of Hanover about Liichow; its scanty remains are corrupt.

POLAND (POLSKA), an independent republic, formally constituted on March 21, 1921, out of territories which had belonged since 1815 to Prussia, Austria and Russia. The northern, western and southern frontiers, marching with Germany, Czechoslovakia and Rumania, were fixed, mainly on ethnological principles, by the Treaty of Versailles. The north-east and eastern frontiers march with the frontiers of Lithuania, Latvia and the Soviet Union, and were determined by political and historical as well as ethnological considerations after the Treaty of Riga.

Geology. — The oldest rocks in the country outcrop in the south, forming the Lysa Gora, slightly to the east of Kielce. They form part of the Palaeozoic platform. often known as "the Polish platform," against which the younger Carpathian fold mountains to the south were niched up. The general south-east to north-west trend of the fold mountains was turned first to east and west and then, with further resistance from the Bohemian mass, almost north-east to south-west. The plateau of Tarnowice and other regions in the two provinces of Piotrkow and Rielce have Triassic, Jurassic and Cretaceous outcrops. The south-eastern section of the country has extensive Cretaceous outcrops centred around Lublin. These are interspersed by Tertiary rocks, particularly in the neighbourhood of Lwów. The valleys of the Upper Dniester and Vistula have Quaternary material, while on the northern slopes of the Carpathians, and in Galicia generally, there are deposits of fertile loess—a factor potent in the history and early settlement of the region. The entire northern section of the country has a covering of boulder clay, containing much marshland and myriads of small shallow lakes. The extensive Pripet marshes on the east of Poland, near Pinsk, have played a very important part in differentiating Poland and Russia.

Physical Features. — The undulating plain which forms the main part of the territory of Poland has no natural boundaries on the east and west, but connects the lowlands of Germany with the great plain of Russia. It extends from the Carpathian mountains in the south to the Baltic sea; it touches the Dvina in the north-east and just reaches the Oder in the south-west. But the Polish plain is not uniform. In the south the Carpathians form a mountainous belt reaching its highest point in the Tatra. North of this is the Carpathian plain, extending from west to east along the Upper Vistula, the San and the Dniester. North of this plain lie the southern uplands comprising the Silesian hills, the Cracow Jura, the Galician plateau, the Lysa Gora, the Lublin hills and the Podolian plateau, a region too diversified to be called a plain, and rising to heights of over 2,000 ft. above the sea. North of these uplands lies the central Polish plain—Poznan, Mazovia, Podlasia and Polesie, intersected by great rivers, and bounded on the north by a second belt of uplands, 600 to 700 ft. above the sea, covered with lakes, marshes and swamps extending from Pomerania through the Mazovian lakes to White Russia. The Baltic coast forms the northern limit of these uplands. Whereas the network of lakes and rivers, and the resulting facility of communication by land and water, together with the fertility of the soil, have made the great plain from Poznan to Warsaw the cradle of Polish nationality; the southern uplands, with their greater security and the vast mineral wealth, have been equally important.

Rivers, Lakes **and** Canals.—The basin of the Vistula comprises the central part of Poland. The Vistula rises in the western Beskids, flows through Cracow and Sandomierz, is joined by the San and Wieprz, which water the provinces of Ewow and Lublin respectively, then by the Pilica. It flows through the Mazovian plain past Warsaw and Plock, being joined by the Bug, rising in the Podolian plateau, and its tributary, the Narew. The tributaries of the Narew rise in the Lake district, most of which is in Prussia, and are connected by the Augustów canal with the river Niemen. The Bug is also connected by the Royal canal with the Pripet, and so with the Dnieper. The Vistula continues its course through the ancient land of Chelmno, near Torun, Bydgoszcz and Grudzianz, being connected with the Oder basin by the Bydgoszcz canal. Its estuary, the object of long struggles between Poles and Germans, lies in the Free City of Danzig.

The inundations of the Vistula, serious even at Cracow, are dangerous after it enters the plain, when the heavy rains in the Carpathians raise its level or the accumulations of ice in the lower course obstruct the outflow.

The west of Poland belongs partly to the basin of the Oder. The Warta, 450 m. in length, rises in the southern uplands, and with its tributaries, the Prosna and Notec, forms the fertile plain of Great Poland, in which the earliest capitals, Gniezno, Poznan and Kalisz grew up in the district of lakes of which Goplo, So m. long and 100 ft. deep, is famed in legend and history.

In the far north-east, Poland touches the basin of the Dvina. Part of the province of Vilna is drained by its tributary, the Disna, and contains a great region of swamps and lakes, of which Lake Narocz ($31\frac{1}{2}$ sq.m.), is the largest lake in Poland The area between the Niemen, the Narew and the Jasiolda contains the largest forests in Poland, and rafts of timber float down 311 these rivers. South of the Niemen basin is the basin of the Pripct, a tributary of the Dnieper.

It is the region of dense forests and wide swamps, and is connccted by the Oginski carial with the Niemen, and by the Royal canal with the Bug. Its right tributaries, such as the Styr, water the Volhynian plain.

Lastly, the river Dniester and its tributaries drain the southeast part of Poland down to the Rumanian and Russian frontiers, comprising the provinces of Tarnopol and Stanislawów and the oilfields of Lwow.

Climate.—The climate of Poland is dependent on her proximity to the Baltic and the Carpathian mountains. Abundant rainfalls are caused by the predominating western oceanic winds. Consequently, the snow in Poland is not very thick, and spring sets in early. Frosts of $-4°$ to $-22°$ F. are not uncommon, however, and the rivers are generally icebound for two and a half to three months.

The average yearly temperature varies from 46° in Poznan to 32° F. in Pinsk. The character of the climate is more continental in the eastern provinces.

In Warsaw, the central capital, the earliest frost is about Oct. 18, the latest frost about March 15.

The absolute maximum temperature is 95.5°, the absolute minimum temperature $-37.6°$ F.

The annual rainfall is about 22.8 inches.

Flora.—The flora of Poland is characteristic of the transitional position of Poland between east and west. All the floral zones of Europe are found here. Deciduous forests merge into coniferous forests; the western flora of the Baltic meets the steppe flora of the Black sea. Of the original Polish trees the pine (*Pinus sylvestris*) is found almost everywhere, together with the birch and the alder.

The yew and the larch, once so common, have disappeared. The fir has entered Poland from Siberia and is common. Among western European trees the oak, beech, hornbeam, elm, ash, lime tree, aspen and maple are common, the beech not appearing east of Brest-Litovsk and the fir only north of Lwow. The oak—a highly venerated tree, especially in the Lithuanian region—grows in forests only on the most fertile land, but it is of common occurrence in conjunction with the beech and elm.

The lime appears in groves only in the east. It is the most popular tree with the Poles; judgment of old was pronounced under its shade, and the folk songs repeat its name.

Ivy is characteristic of all parts of Poland, while the willow and orchard trees—apple, pear, plum and cherry—are cultivated everywhere.

Fauna.—The indigenous fauna of Poland has disappeared in historical times. The reindeer, the sable and the wild horse survive in tradition. The aurochs or bison. preserved in the great Bialowieź forest, disappeared in 1918. The elk is heard of in the northeast, and the beaver, once so common, is found only in the marshes of Polesie.

The chamois and marmot are found in the Tatra mountains, while the Carpathians still form a refuge for the bear, the wild cat, the lynx, the badger and the wild boar. Otherwise the bear and wolf are uncommon except in the northeast.

The fox is ubiquitous, while the marten, polecat, etc., are not uncommon.

The avifauna is similar to that of central Europe, and is slightly to westward of the most frequented route of the migratory birds in Russia.

HISTORY

We possess no certain historical data relating to Poland till the end of the 10th century. The earliest Polish chroniclers are of little help to us. The only facts of importance to be gleaned from them are that Prince Ziemovit, the great-grandfather of Mieszko (Mieczyslaw) I. (962–992), wrested from the vast but tottering Moravian empire the province of Chrobacyja (extending from the Carpathians to the Bug), and that Christianity was first preached on the Vistula by Greek Orthodox missionary monks. Mieszko himself was converted by Jordan, the chaplain of his Bohemian consort, Dobrawa or Bona, who became the first bishop of Poznan. The Slavonic peoples, whose territories then extended to the Elbe, and embraced the whole southern shore of the Baltic, were beginning to recoil before the vigorous impetus of the Germans in the West and the acceptance of Christianity might give them a respite from further attack. This was thoroughly understood by Mieszko's son Boleslaus I. (992–1025), who aimed at securing the independence of the Polish Church as an additional guarantee of the independence of the Polish nation, and elevated the church at Gnesen in Great Poland into a metropolitan see, with jurisdiction over the new bishoprics of Cracow, Breslau and Rolberg, created in territory which he had recently conquered. Boleslaus was the first Polish prince to bear the royal title, and his reign resulted in the formation of a vast kingdom extending from the Baltic to the Carpathians, and from the Elbe to the Bug. In the next generation much of the territory which he had won was lost, and Poland itself was ravaged by neighbouring enemies, but under Boleslaus II. (1058–79) and Boleslaus III. (1102–39) some of the lost provinces, notably Silesia and Pomerania, were recovered and Poland was at least able to maintain her independence against the Germans. Boleslaus III., moreover, with the aid of St. Otto, bishop of Bamberg, succeeded in converting the heathen Pomeranian~(1124–28), and making head against paganism generally.

Yartitional Period, 1138–1305.—The last act of Boleslaus III. was to divide his territories among his sons, whereby Poland was partitioned into no fewer than four, and ultimately into as many as eight, principalities, many of which (Silesia and Great Poland, for instance) in process of time split up into still smaller fractions all of them more or less bitterly hostile to each other. This partitional period, as Polish historians generally call it, lasted from 1138 to 1305, during which Poland lost all political significance, and became an easy prey to her neighbours. The duke of Little Poland, who generally styled himself duke of Poland, or *dux totius* Poloniae, claimed a sort of supremacy among these little States, a claim materially strengthened by the wealth and growing importance of his dapital, Cracow, especially after Little Poland had annexed the central principality of Sieradia (Sieradz). But Masovia to the north, and Great Poland to the north-west, refused to recognize the supremacy of Little Poland, while Silesia soon became completely germanized and Pomerania broke away from the Polish suzerainty. To ards the middle of the 13th century a horde of Tatars under their prince Batu invaded Poland, burned Sandomir and Cracow, defeated the Silesian princes at Leignitz, and finally entered Hungary, where they routed King Bela IV. on the banks of the Sajo. This invasion had an important influence upon the social and political development of Poland. The only way of filling up the gaps in the population of the ravaged land was to invite foreign immigrants of a superior class, chapmen and handicraftsmen, not only given to peaceful pursuits and accustomed to law and order, but capable of building and defending strong cities. Such immigrants could naturally be obtained only from the civilized west, and on their own terms. Thus it came about that a new Germanic middle class element was introduced into Polish society. Immediately dependent upon the prince, from whom they obtained their privileges, the most important of which were self-government and freedom from taxation, these traders soon became an important factor in the State, counterpoising, to some extent, the influence of the nobility and developing the resources of the country.

Most of these German citizens were ultimately absorbed by the Polish population. But they were not the only Germans with whom the Polish State had now to deal. In the first year of the 13th century, a powerful crusading order, the Knights of the Sword, had been established in Livonia for the reduction of the pagan Letts, and, in 1208, the still stronger Teutonic Order was invited by Duke Conrad of Masovia to settle in the district of Kulm (roughly corresponding to modern East Prussia) to protect his territories against the incursions of the savage Prussians, a race closely akin to the Lithuanians. Conrad has been loudly blamed by Polish historians for introducing this foreign, and as it ultimately proved, dangerous element into Poland. But the unfortunate prince had to choose between dependence and extermination, for his unaided resources were powerless against the persistent attacks of the unconquerable Prussians. By the compact of Kruschwitz in 1230, the Teutonic Order obtained absolute possession of the maritime district between Pomerania acd Courland, and southwards as far as Torun. So far mere the Poles from anticipating any danger from the Teutonic Order, that, from 1243 to 1255, they actually assisted it to overthrow the independent Pomeranian princes, the most formidable opponents of the Knights in the earlier years of their existence. A second Tatar raid in 1259, less dangerous, perhaps, but certainly more ruinous, than the first invasion—for the principalities of Little Poland and Sandomir were systematically ravaged for three months—still further depressed the land, and, at this very time, another enemy appeared in the east—the Lithuanians. (See LITHUANIA.)

Casimir the Great, 1333–70.—At the very time when Lithuania was becoming a compact, united, powerful State, it seemed highly probable that Poland would be completely germanized, like Silesia, or become a part of the new Bohemian empire which Wenceslaus II. (crowned king of Poland in 1300) had inherited from his father, Ottakar II. From this fate she was saved by the valour of Wladislaus Lokietek, duke of Great Poland (1306–33), who reunited Great and Little Poland, revived the royal dignity in 1320, and saved the kingdom from annihilation by his great victory over the Teutonic Knights at Plowce in 1332. The whole reign of Wladislaus I. was indeed an unceasing struggle against all the forces of anarchy and disintegration; but the fruits of his labours were richly reaped by his son Casimir III. the Great (1333–70), Poland's first great statesman in the modern sense of the word, who, by a most skilful system of matrimonial alliances, reintroduced Poland into the European system, and gave the exhausted country an inestimably beneficial breathing space of 37 years. A born ruler, Casimir introduced a whole series of administrative and economical reforms. He was the especial protector of the cities and the peasants. It is to him that Poland owed the important acquisition of the greater part of Red Ruthenia, or Galicia, which enabled her to'secure her fair share of the northern and eastern trade. In default of male issue, Casimir left the Polish throne to his nephew, Louis of Hungary, who ruled the country (1370–82) through his mother, Queen Elizabeth, Wladislaus Lokietek's daughter. Louis well deserved the epithet of "great" bestowed upon him by his contemporaries; but Poland formed but a small portion of his vast domains, and Polish interests were subordinated to the larger demands of an imperial policy which embraced half Europe within its orbit.

On the death of Louis there ensued an interregnum of two years marked by fierce civil wars, instigated by duke Ziemovit of Masovia, the northernmost province of Poland, which continued to exist as an independent principality alongside of the kingdom of Poland. Ziemovit aimed at the Polish crown, proposing to marry the infant princess Jadwiga of Hungary, who, as the daughter of Louis the Great and the grand-daughter of Wladislaus Lokietek, had an equal right, by inheritance, to the thrones of Hungary and Poland. By an agreement with the queen mother of Hungary at Kassa in 1383, the Poles finally accepted Jadwiga as their queen, and, on Feb. 18, 1386, greatly against her will, the young princess was wedded to Jagiello, grand duke of Lithuania, who had been crowned king of Poland at Cracow, three days previously, under the title of Wladislaus II.

The union of Poland and Lithuania as separate States under one king had been brought about by their common fear of the Teutonic Order. Five years after the death of Gedymin (*q.v.*), Olgierd, the most able of his seven sons, had been placed upon the throne of Lithuania by his devoted brother Kiejstut, and for the next 32 years (1345–77) the two princes still further extended the sway of Lithuania, principally at the expense of Muscovy and the Tatars. Kiejstut ruled the western portion of the land where the Teutonic Knights were a constant menace, while Olgierd drove the Tatar hordes out of the south-eastern steppes, and compelled them to seek a refuge in the Crimea. During Olgierd's reign the southern boundaries of Lithuania touched the Black sea, including the whole tract of land between the mouth of the Bug and the mouth of the Dnieper. Olgierd was succeeded by his son Jagiello as grand duke in 1377, while Kiejstut was left in possession of Samogitia, Troki and Grodno; but the Teutonic Order, alarmed at the growth of Lithuania, succeeded in estranging uncle and nephew, and Kiejstut was treacherously assassinated by Jagiełło's orders, at Krewo, on Aug. 1j, 1382. Three weeks later Jagiełło was compelled to cede Samogitia, as far as the Dubissa, to the Knights, and, in the following year they set up against him Kiejstut's son Witowt. At this point Jagiello made peace with his cousin, restored him his patrimony, and made overtures to Poland for the hand of Jadwiga, and received the Polish crown along with it, as already mentioned.

Beginnings of the Polish Constitution.—Before proceeding to describe the Jagiełłonic period of Polish history, it is necessary to cast a rapid glance at the social and political condition of the country in the preceding Piast period.

The paucity and taciturnity of our sources make it impossible to give anything like an adequate picture of Old Poland during these centuries. External pressure, here as elsewhere, created a patriotic military caste, and the subsequent partitional period, when every little prince had his own separate court, still further established the growing influence of the *szlachta*, or gentry. The first authentic *pacta conventa* made between the Polish nobility and the Crown dates from the compact of Kassa (Sept. 17, 1374), when Louis of Hungary agreed to exempt the *szlachta* from all taxation, except two Polish groschen per hide of land, and to compensate them for the expenses of all military service rendered beyond the confines of the realm. The clergy received their chief privileges much earlier. It was at the synod of Leczyca, nearly a century before the compact of Kassa, that the property of the church was first safeguarded against the encroachments of the State. The beneficial influence of the Church of Poland in these early times was incalculable. To say nothing of the labours of the Cistercians as colonists, pioneers and church-builders, or of the missions of the Dominicans and Franciscans, the church was the one stable and unifying element in an age of centrifugal particularism. Its frequent synods represented the whole of Poland, and kept alive, as nothing else could, the idea of national solidarity. Moreover the clergy, to their eternal honour, consistently protected the lower from the tyranny of the upper classes.

The growth of the towns was slower. During the heroic Boleslawic period there had been a premature outcrop of civil life. As early as the 11th century Kruszwica, the old Polish capital. and Gnesen, the metropolitan see, were of considerable importance, and played a leading part in public life. But in the ensuing anarchic period both cities were utterly ruined, and the centre of political gravity was transferred from Great Poland to Little Poland, where Cracow, singularly favoured by her position, soon became the capital of the monarchy, and one of the wealthiest cities in Europe. At the end of the 14th century we find all the great trade gilds established there, and the cloth manufactured at Cracow was eagerly sought after, from Prague to Great Novgorod. Towards the end of the 14th century the Polish towns even attained some degree of political influence, and their delegates sat with the nobles and clergy in the king's councils. Even the peasants, who had suffered severely from the wholesale establishment of prisoners of war as serfs on the estates of the nobles, still preserved the rights of personal liberty and free movement from place to place. The only portion of the community which had no privileges were the Jews, first introduced into Poland by Boleslaus the Pious, duke of Great Poland, in 1264, when bitter persecutions had driven them northwards from the shores of the Adriatic. Casimir the Great extended their liberty of domicile over the whole kingdom (1334). From the first they were better treated in Poland than elsewhere, though frequently exposed to outbreaks of popular fanaticism.

Wladislaus II and the Teutonic Order.—The transformation of the pagan Lithuanian chieftain Jagiello into the Catholic king of Poland, Wladislaus II, was an event of capital importance in the history of eastern Europe. Its immediate and inevitable consequence was the formal reception of the Lithuanian nations into the fold of the church. What the Teutonic Order had vainly endeavoured to bring about by fire and sword. for two centuries, was peacefully accomplished by Jagiello within a single generation, the Lithuanians, for the most part, willingly following a prince of their own blood. The conversion of Lithuania menaced the very existence of the Teutonic Knights, whose dominion was now little more than a German military forepost, extending from Pomerania to the Niemen, and cutting off the central Slavs from the sea. But if the Order had now become a superfluous anachronism, it had still to be disposed of, and this was no easy task For if it had failed utterly as a mission in partibus, it had succeeded in establishing on the Baltic one of the strongest military organizations in Europe. In the art of war the Knights were immeasurably superior to all their neighbours. Skilfully taking advantage of the jealousies of Poland and Lithuania, accentuated as they were by the personal antagonism of Jagiello and Witowt (*q.v.*), they even contrived (Treaty of Salin, 1378) to extend their territory by getting possession of the province of Samogitia, the original seat of the Lithuanians, where paganism still persisted. By this time, however, the prudent Jagiello had become convinced that Lithuania was too strong to be ruled by or from Poland, and yet not strong enough to stand alone, and by the compact of Vilna (Jan. 18, 1401, confirmed by the compact of Radowo, March 10) he surrendered the whole grand duchy to Witowt, on the understanding that the two States should have a common policy. and that neither of thkm should elect a new prince without the consent of the other. The wisdom of this arrangement was made manifest in 1410, when Jagiełło and Witowt combined their forces for the purpose of delivering Samogitia from the intolerable tyranny of the Knights. The issue was fought out on the field of Tannenberg, or Griinewald (July 15, 1410), when the Knights sustained a crushing defeat, which shook their political organization to its very foundations. A few weeks after the victory the towns of Thorn, Elbing, Braunsberg and Danzig submitted to the Polish king, and all the Prussian bishops voluntarily offered him homage. But the excessive caution of Jagiello gave the Knights time to recover from the blow; the Polish levies proved unruly and incompetent; Witowt was suddenly recalled to Lithuania by a Tatar invasion, and thus it came about that, when peace was concluded at Thorn, on Feb. 1, 1411, Samogitia, finally surrendered in 1422, Dobrzyn, and a war indemnity of 100,000 marks payable in four instalments, were the best terms Poland could obtain from the Knights. The solidarity of Poland and Lithuania was still further strengthened by the Union of Horodlo (Oct 2, 1413) which enacted that henceforth Lithuania was to have the same order of dignitaries as Poland, as well as a council of State, or senate, similar to the Polish senate. The power of the grand-duke was also greatly increased. He was now declared to be the equal of the Polish king, and his successor could be elected only by the senates of Poland and Lithuania in conjunction. The Union of Horodlo also established absolute parity between the nobility of Poland and Lithuania, but the privileges of the latter were made conditional upon their profession of the Roman Catholic faith, experience having shown that difference of religion in Lithuania meant difference of politics, and a tendency Moscowwards, the majority of the Lithuanian boyars being of the Greek Orthodox Confession.

Had Wladislaus II. been as great a warrior as Witowt he might, perhaps, have subdued the Knights altogether. But he was essentially a diplomatist, and as such he was hampered by the suspicion felt towards him by the emperor Sigismund, who as king of Bohemia feared that his subjects would be attracted towards the new power which had arisen in the north-east. As emperor, Sigismund resented Wladislaus's encroachments upon territory formerly in German occupation, and though he was careful to avoid giving to Wladislaus any excuse for accepting the Bohemian crown, his influence mas inevitably on the side of the Teutonic Order. Nevertheless the Order never recovered the position which it had held before the battle of Tannenberg and the conversion of its possessions into a territorial State was only a question of time.

Wladislaus II. died at Lemberg in 1434, at the age of 83. During his long reign of 49 years Poland had gradually risen to the rank of a great power. The next ten years proved the stability of his work. After the death at Varna, in 1444, of his eldest son and successor, Wladislaus III., the kingdom which he had founded was consolidated by his second son, already grand-duke of Lithuania, who ascended the Polish throne as Casimir IV. in 1447, thus reuniting Poland and Lithuania under one monarch.

Casimir IV., 1447–92.—The difficulties which confronted Casimir were great. He instinctively recognized not only the vital necessity of the maintenance of the union between the two States, but also the fact that the chief source of danger to the union lay in Lithuania. For political reasons, during the earlier years of his reign, Casimir was obliged to reside for the most part in Lithuania, and his interest in the grand-duchy was always resented in Poland, where, to the very end of his reign, he was regarded with suspicion. In particular, he could never rely on adequate Polish support in the struggle which he inherited from his predecessors, with the Teutonic Order.

The struggle assumed a new form in 1454, when Casimir accepted the suzerainty offered to him by the Prussian League, which had ejected the authority of the Order, and needed a protector. The acquisition of the Prussian lands was vital to the existence of Poland. It meant the command of the principal rivers of Poland, the Vistula and the Niemen, and the acquisition of a seaboard with its corollaries of sea-power and commerce. Yet, except in the border province of Great Poland, which was interested commercially, the king received little support, military or financial, and it was only with his victory at Puck (Sept. 17, 1462) that he obtained any decisive success against the Order. The war was ended in 1466 by the second treaty of Thorn (Oct. 14) by which Poland recovered the provinces of Pomerelia, Kulm and Michalow, with the bishopric of Ermeland, numerous cities and fortresses, including Marienburg, Elbing, Danzig and Thorn. The territory of the Knights was now reduced to Prussia proper, embracing, roughly speaking, the district between the Baltic, the lower Vistula and the lower Niemen, with Königsberg as its capital. For this territory each grand-master within nine months of his election was in future to render homage to the Polish king, who undertook not to make war or engage in any important enterprise without Prussian consent. Prussia had now become a Polish province, and Poland had acquired a seaboard.

The whole foreign policy of Casimir IV. was influenced by the Prussian question. At the beginning of the war both the empire and the pope were against him. He therefore allied himself with George of Podiebrad, whom the Hussites had placed on the throne of Bohemia On the death of George (1471), Casimir's eldest son Wladislaus was elected king of Bohemia by the Utraquist party, despite the determined opposition of Matthias Corvinus, the king of Hungary, who thenceforward deliberately set about traversing all the plans of Casimir. He encouraged the Teutonic Order to rebel against Poland; he entertained at his court anti-Polish embassies from Moscow; he encouraged the Tatars to ravage Lithuania; he thwarted Casimir's policy in Moldavia. His death in 1490 came therefore as a distinct relief to Poland, and all danger from the side of Hungary was removed when Casimir's son Wladislaus, already king of Bohemia, was elected king of Hungary also.

Poland and the Turks.—It was in the reign of Casimir IV. that Poland first came into direct collision with the Turks. The Jagiellos, as a rule, prudently avoided committing themselves to any political system which might irritate the still distant but much-dreaded Turk, but when their dominions extended so far southwards as to embrace Moldavia, the observance of a strict neutrality became exceedingly difficult. Poland had established a sort of suzerainty over Moldavia as early as the end of the 14th century; but at best it was a loose and vague overlordship which the Hospodars repudiated whenever they were strong enough to do so The Turks themselves were too much occupied elsewhere to pay much attention to the Danubian principalities till the middle of the 15th century, and it was not till 1484 that they became inconvenient neighbours to Poland. In that year a Turkish fleet captured the strongholds of Kilia and Akkerman, commanding respectively the mouths of the Danube and Dniester. This aggression seriously threatened the trade of Poland, and induced Casimir IV. to accede to a general league against the Porte. In 1485, after driving the Turks out of Moldavia, the Polish king, at the head of 20,000 men, proceeded to Kolomea on the Pruth, where Bayezid

II., then embarrassed by an Egyptian war, offered peace, but as no agreement concerning the captured fortresses could be arrived at, hostilities were suspended by a truce. During the remainder of his reign the Turks gave no trouble.

The death of Casimir was followed by the temporary separation of Poland and Lithuania, and by a strong aristocratic reaction in Poland itself. Casimir's third son, John Albert, was elected king of Poland, and his fourth son, Alexander, became grand-duke of Lithuania. On the death of John Albert in 1501, Alexander succeeded him as king, and the union of Poland and Lithuania assumed a more definite character, the senate of each country agreeing that in future the king of Poland should always be grand-duke of Lithuania. The acquiescence of Lithuania was due essentially to a new danger which had arisen in the East. Till the accession of Ivan III. in 1462 MUSCOVY had been a negligible factor in Polish politics. During the earlier part of the 15th century the Lithuanian princes had successfully contested Muscovite influence even in Pskov and Great Novgorod. Many Russian historians even maintain that, but for the fact that Witowt had simultaneously to cope with the Teutonic Order and the Tatars, he would have extinguished struggling Muscovy altogether. But since the death of Witowt (1430) the military efficiency of Lithuania had sensibly declined; and the natural attraction of the Orthodox-Greek element in Lithuania towards Muscovy threatened the integrity of the grand-duchy. During the reign of Alexander, who was too poor to maintain any adequate standing army in Lithuania, the Muscovites and Tatars ravaged the whole country at will, and were prevented from conquering it altogether only by their inability to capture the chief fortresses. In Poland, meanwhile, Alexander had practically surrendered his authority to an incapable aristocracy, while the dependent States of Prussia in the north and Moldavia in the south made strenuous efforts to break away. Fortunately for the integrity of the Polish State the premature death of Alexander in 1506 brought upon the throne his capable brother Sigismund, the fifth son of Casimir IV. Eminently practical, Sigismund recognized that the first need of Poland was a standing army, that Poland, in order to hold her own, must in future follow the example of the West, and wage her warfare with trained mercenaries. The wide financial and military liberties of the Polish aristocracy for long prevented both the organization of an adequate national army and the development of a modern fiscal system. Much of the internal history of Sigismund's reign turns on the various proposals made towards these ends, most of which were defeated or mutilated by the aristocratic opposition in the diet. The long, open frontiers of the Polish kingdom invited invasion, and the misfortunes which fell on Poland at a later time are largely due to the failure of the defensive measures proposed by Sigismund and his advisers. Throughout his reign, the king was hampered by lack of resources. In 152j he was compelled to grant autonomy to the province of Prussia instead of annexing it; he was unable to succour his unfortunate nephew, Louis of Hungary, against the Turkish peril, or to prevent the occupation of one Lithuanian province after the other by the Muscovites.

The Cossacks.—To this period belong the first attempts to provide for the defence of the *dzikie pola,* or "savage steppe," as the vast plain was called which extended from Kiev to the Black sea. Thus, in the reign of Alexander, the fugitive serfs who had escaped into this wilderness (they were subsequently known as Kazaki, or Cossacks, a Tatar word meaning freebooters) were formed into companies (c. 1504) and placed at the disposal of the frontier *starostas,* or lord marchers, of Kaniev, Kamenets, Czerkask on the Don and other places. But these measures proved inadequate, and in 1533 the lord marcher, Ostafi Daszkiewicz, the hero of Kaniev, which he had successfully defended against a countless host of Turks and Tatars, was consulted by the diet as to the best way of defending the Ukraine permanently against such inroads. The veteran expert advised the populating and fortifying of the islands of the Dnieper. But nothing was done officially. The selfish prudence of Queen Bona did more for the national defence than the Polish State could do. To defend her immense possessions in Volhynia and Podolia, she converted the castles of Bar and Krzemieniec into first-class fortresses, and placed the former in the hands of her Silesian steward, who acquitted himself so manfully of his charge that "the Tatars fell away from the frontier all the days of Pan Pretficz," and a large population settled securely beneath the walls of Bar, henceforth known as "the bastion of Podolia."

The most important political event in eastern Europe during the reign of Sigismund was the collapse of the ancient Hungarian monarchy at Mohacs in 1526. After the death of King Louis in the battle, the emperor Ferdinand and John Zapolya, voivode of Transylvania, competed for the vacant crown, and both were elected almost simultaneously. In Poland Zapolya's was the popular cause, and he also found powerful support in the influential and highly gifted Laski family, represented by the Polish chancellor and his nephews John and Hieronymus. Sigismund, on the other hand, favoured Ferdinand of Austria. He argued that the best way to keep the Turk from Poland was for Austria to incorporate Hungary, in which case the Austrian dominion would be a strong and permanent barrier against a Muslim invasion of Europe. History has more than justified him, and the long duel which ensued between Ferdinand and Zapolya (see HUNGARY: History) enabled the Polish monarch to maintain to the end a cautious but observant neutrality. More than once, indeed, Sigismund was seriously compromised by the diplomatic vagaries of Hieronymus Laski, who entered the service of Zapolya (since 1529 the protégé of the sultan), and greatly alarmed both the emperor and the pope by his disturbing philo-Turk proclivities It was owing to Laski's intrigues that the new hospodar of Moldavia, Petrylo, after doing homage to the Porte, intervened in the struggle as the foe of both Ferdinand and Sigismund, and besieged the Grand Hetman of the Crown, Jan Tarnowski, in Obertyn, where, however, the Moldavians (Aug. 22, 1531) sustained a crushing defeat, and Petrylo was slain. Nevertheless, so anxious was Sigismund to avoid a collision with the Turks, that he forbade Tarnowski to cross the Moldavian frontier, and sent a letter of explanation to Constantinople. On the death of John Zapolya, the Austro-Polish alliance was still further cemented by the marriage of Sigismund's son and heir, Sigismund Augustus, with the archduchess Elizabeth. In the reign of Sigismund was effected the incorporation of the duchy of Masovia with the Polish crown, after an independent existence of 500 years. In 1526 the male line of the ancient dynasty became extinct, and on Aug. 26 Sigismund received the homage of the Masovians at Warsaw, the capital of the duchy and ere long of the whole kingdom.

(R. N. B.; F. M. S.; X.)

THE REFORMATION TO THE PARTITIONS

The Renaissance Era.—The reigns of Sigismund I. and his son Sigismund II. (1548–72) mark the transition from a splendid, but still essentially mediaeval phase of Polish civilization into the heyday of the Renaissance.

Already in the 15th century the University of Cracow had brought forth humanist scholars of European repute, and begun to attract distinguished lecturers and numerous students from abroad. Owing to Sigismund I.'s marriage to a Sforza of Milan, the royal court at Cracow became the home of the highest Renaissance art of Italy, and the royal castle on Wawel hill at Cracow, rebuilt by Italian architects and their Polish disciples, became one of the finest monuments of Renaissance style north of the Alps. Under Sigismund II., the third great spiritual factor of the age, next to humanist scholarship and Renaissance art—the doctrine of the Reformation--entered potently into Poland's intellectual life, uniting with Italian culture on the common ground of literature, and helping to produce the first great age of Polish poetry and prose. At the same time, the clash between the New Learning and the strong tradition of Poland's chivalrous Catholicism; the difficulties with the Scandinavian Powers and the rising empire of the Moscow tsars; the dilemma produced between the evolution of the Polish Parliamentary system, and the Renaissance tendency towards the strengthening of central Government authority: even a king of genius could be only partially successful in coping with all these tasks, and the reign of Sigismund II., in many respects one of the most brilliant in Polish annals, left the seeds of decay and failure behind it.

Reformation and Counter-Reformation.—The new king having shown his temper by marrying a lady of the noble house of Radziwill without asking for the opinion of the senate, the reign began in a storm of demands for constitutional guarantees to secure the parliamentary "gentry democracy" against the powers of the Crown and the nobility. The king resolutely allied himself with Austria abroad, and with the bishops and the nobles at home, against a threatened revolt of the gentry. In doing so, he had to take the bishops' side in the issue between the Reformation and Catholic orthodoxy, and he affirmed this by an edict against heresy in 1550. But this act only opened up the long-maturing dispute about the creation of a national Church after the recent example of Henry VIII. of England. The king, a man of enlightened mind, the first Polish monarch who habitually used the vernacular language instead of Latin at public functions, showed, in many ways a sympathetic understanding for the tendencies of the new era. The influence of the Bohemian Hussite movement of 100 years before, combined with nascent modern nationalism to inspire definite programmes for a Reformed Polish State Church with Polish ritual, independent of Rome, and with a priesthood subject to Government authority. The large Greek Orthodox element among the citizens of the eastern provinces of the monarchy furnished an additional stimulus, which gave strength to such demands as that for the abolition of clerical celibacy, in the Lutheran fashion. The bishops resorting to high-handed measures of repression, the Diet of Piotrków in 1552 voted, at the king's own suggestion, the suspension of clerical courts for a twelvemonth. This was afterwards extended, and solemnly renewed by another diet in 1555, during which Masses were actually said in Polish, and the Communion was administered in two kinds. A religious interim of about ten years followed, during which Protestantism in Poland flourished exceedingly. Presently reformers of every shade of opinion, even those who were tolerated nowhere else, poured into Poland, which speedily became the battle-ground of all the sects of Europe. Soon the Protestants became numerous enough to form ecclesiastical districts of their own. The first Calvinist synod in Poland was held at Pinczów in 1550. The Bohemian Brethren, expelled from their own country, ultimately coalesced with the Calvinist at the synod of Kozminek (Aug. 1555). In the diet itself the Protestants were absolutely supreme, and invariably elected a Calvinist to be their marshal. The king, however, perceiving a danger to the constitution in the violence of the gentry, not only supported the bishops, but quashed reiterated demands for a national synod. The diet of 1558–59 indicates the high-water mark of Polish Protestantism. From this time forward it began to subside, gradually but unmistakably, chiefly owing to the division among the reformers themselves. From the chaos of creeds resulted a chaos of ideas on all imaginable subjects, politics included. The Anti-Trinitarian heresy proved to be the chief dissolvent, and from 1560 onwards the relations between the Lutherans and the Calvinists, were fratricidal rather than fraternal: Jan Laski (*q.v.*), vainly strove to unite all Polish Protestants round the Helvetian standard; and a Federation of all Poles of the reformed faith—the "Concord of Sandomierz," 1570,—being predominantly Calvinist in character, met resolute Lutheran opposition and led to nothing.

BY JOHN BARTHOLOMEW & SONS

SEVENTEENTH CENTURY MAP PRESENTED TO CHARLES II

While the strong individualism of the Polish national character thus thwarted all endeavours at Protestant consolidation, the wars against Orthodox Moscow, effectively united Poles round their old Catholic banners; and the vigorous Protestant propaganda conducted from Königsberg by Poland's vassal, Prince Albert of East Prussia, appeared to the bulk of the nation under the guise of a German menace. These political factors told in favour of Catholicism: so did presently the wiser policy of Rome. Pope Pius IV., unlike his predecessor, adopted a conciliatory attitude towards the Polish Crown in the matter of disputed appointments of bishops. The new bishops were holy and learned men, very unlike the creations of Queen Bona Sforza, and capable papal nuncios reorganized the scattered and faint-hearted Catholic forces in the land. From one of the ablest of them, Giovanni Commendone, the king, at the diet of 1564, accepted the book of the decrees of the Council of Trent, and immediately afterwards issued decrees banishing the more extreme heretics from the country. In 1565, the Jesuits, the vanguard of the Catholic Counter-Reformation appeared in Poland.

At their best, the various forms of Protestantism had never won more than a scanty noble and intellectual *élite* of the nation; they had never taken root among the peasantry or the petty bourgeoisie. Whilst the gradual effacement of reformed creeds removed a powerfully creative intellectual and literary factor from Poland's life, the re-establishment of Catholicism restored to the republic that spiritual unity which was to be the chief source of national strength in the coming struggle against the aggression both of Orthodox Russia and of Lutheran Germany.

The Struggle for the Baltic Provinces.—Access to the Baltic had been a vital question since the dawn of the Polish State in the 10th and 11th centuries. Poland's expansion eastward, which began definitely in the 14th century through the acquisition of Red Russia by Casimir the Great, and was continued in the 15th through the dynastic union with Lithuania, made an extension of her foothold on the Baltic shore imperative. At the same time, the knights of the Teutonic Order (*q.v.*) had threatened to cut Poland off from access to the sea altogether. They had been beaten down by the earlier Jagiellons, and access to the sea secured by way of Danzig. But in the 16th century, the foe survived and began to regain strength in the secular and Protestant duchy of East Prussia, formally owning allegiance to Poland. Sigismund II. was naturally attracted by an opportunity to outflank this foe and to gain a separate outlet to the sea.

In the middle of the 16th century the ancient order of the Knights of the Sword, whose territory embraced Estonia, Livonia, Courland, Semgallen and the islands of Dago and Oesel, was tottering to its fall. All the Baltic powers were more or less interested in the apportionment of this vast tract of land, whose geographical position made it not only the chief commercial link between east and west, but also the emporium whence the English, Dutch, Swedes, Danes and Germans obtained their corn, timber and most of the raw products of Lithuania and Muscovy. Poland and Muscovy as the nearest neighbours of this moribund state, which had so long excluded them from the sea, were vitally concerned in its fate. After an anarchic period of suspense, lasting from 1546 to 1561, during which Sweden secured Estonia, while Ivan the Terrible fearlessly ravaged Livonia, Sigismund II., to whom both the grand-master of the Order and the archbishop of Riga had appealed more than once for protection, at length intervened decisively. At his camp before Riga in 1561, the last grand-master, who had long been at the head of the Polish party in Livonia, and who had embraced Protestantism, and the archbishop of Riga, gladly placed themselves beneath his protection, and by a subsequent convention signed at Vilna (Nov. 28, 1561), Livonia was incorporated with Lithuania in much the same way as Prussia had been incorporated with Poland 36 years previously, that is to say, as a new Protestant duchy, and as a fief of the Polish Crown, with local autonomy and freedom of worship.

BY JOHN BARTHOLOMEW & SONS

PARTITIONS IN THE 18TH CENTURY

Union with Lithuania, 1569.—The danger to Lithuania, revealed in the Baltic wars with Ivan the Terrible, as well as the apathy shown in these matters by the diet of Poland, must have convinced so statesmanlike a prince as Sigismund II. of the necessity of preventing any possibility of cleavage in the future between the two halves of his dominions. A personal union under one monarch had proved inadequate. A further step must be taken—the two independent countries must be transformed into a single state. The principal obstacle was the opposition of the Lithuanian magnates, who feared to lose their dominance in the grand-duchy if they were merged in the szlachta (gentry) of the kingdom. When things came to a deadlock in 1564, the king tactfully intervened and voluntarily relinquished his hereditary title to Lithuania, thus placing the two countries on a constitutional equality and preparing the way for fresh negotiations. The death, in 1565, of Black Radziwill, the chief opponent of the union, still further weakened the Lithuanians, but the negotiations, reopened at the diet of Lublin in 1569, at first also led only to rupture. Then Sigismund executed his master stroke. Knowing the sensitiveness of the Lithuanians as regards Volhynia and Podolia, he suddenly, of his own authority, formally incorporated both these provinces with the kingdom of Poland, whereupon, amidst great enthusiasm, the Volhynian and Podolian deputies took their places on the same benches as their Polish brethren. The hands of the Lithuanians were forced. Even a complete union on equal terms was better than mutilated independence. Accordingly they returned to the diet, and the union was unanimously adopted on July 1, 1569. Henceforth the kingdom of Poland arid the grand-duchy of Lithuania were to be one inseparable and indivisible body politic; all dependencies and colonies, including Prussia and Livonia, were to belong to Poland and Lithuania in common. The retention of the old duality of dignities was the one reminiscence of the original separation — and was only abolished in 1791, four years before the final partition of Poland.

The union definitely shifted Poland's political centre of gravity eastward: it created a common interest in the Russian menace to the long and naturally defenceless eastern frontier, and in the millions of Greek orthodox population in the eastern borderlands. Warsaw was appointed the future meeting-place of the joint diet, thus preparing the transfer of the capital from Cracow to Warsaw. The Union was the last great historical act of the Jagiellonian dynasty: it put the copingstone to the structure of a monarchy which, with growing consolidation, seemed to bear in it the promise of empire.

The Polish Constitution. — Simultaneously with the transformation into a great power of the petty principalities which composed ancient Poland, another and equally momentous political transformation was proceeding within the country itself.

The origin of the Polish constitution is to be sought in the *wiece* or councils of the Polish princes, during the partitional period (c. 1279–1370). The privileges conferred upon the magnates of whom these councils were composed, especially upon the magnates of Little Poland, who brought the Jagiellons to the throne, directed their policy, and grew rich upon their liberality, revolted the less favoured szlachta, or gentry, who, towards the end of the 14th century, combined for mutual defence in their *seymiki,* or local diets.

The first *seym* to legislate for all Poland was the Diet of Piotrków (1493), summoned by John Albert to grant him subsidies; but the mandates of its deputies were limited to 12 months, and its decrees were to have force for only three years. John Albert's second diet (1496), after granting subsidies the burden of which fell entirely on the towns and peasantry, passed a series of statutes benefiting the nobility at the expense of the other classes. These were followed by others of the same kind under his successor Alexander, which, by facilitating import and crippling export trade in the interests of the gentry, enfeebled and degraded the middle class and thereby seriously disturbed the social equilibrium of the State. Nevertheless, so long as the Jagiełło dynasty lasted, the political rights of the cities were jealously protected by the Crown against the usurpations of the nobility. The burgesses of Cracow, the most enlightened economists in the kingdom, supplied Sigismund I. with his most capable counsellors during the first twenty years of his reign (1506–26). Sigismund's predecessor Alexander had been compelled to accept the statute *nihil* novi (1505) which gave the seym and the senate an equal voice with the Crown in all executive matters. Under Sigismund I., some of the royal prerogatives were recovered; but in his later years the influence of the gentry returned, and the diet succeeded in controlling all the great offices of state. The Polish parliamentary system, vesting supreme powers in the two houses of the diet, was an established fact. Sigismund II. knew that only a strengthening of the central authority could save the State. But his endeavours to manoeuvre his way between the two rival powers of the magnates and the smaller gentry were, on the whole, unsuccessful. A patriotic party of "gentry democrats" arose, veiling its programme of democratic reforms under the conservative watchword of the "execution of the laws," and dealing further legislative blows at the trade of the towns and the social status of the middle class. The king, who at first sided with the great nobles against the "executionists," afterwards allied himself with the latter to curtail the power of the magnates by a repeal of former royal grants of land, and by the imposition of a tax on all tenants of Crown lands for the maintenance of the Army (1562–63). Beneficial as this was, it was only obtained at the price of further dependence of the Crown on the szlachta.

Interregnum, 1572–73. — The childless Sigismund II. died suddenly. Fortunately for Poland, the political horizon was unclouded. Domestic affairs, however, were in an almost anarchical condition. The Union of Lublin, barely three years old, was anything but consolidated, and in Lithuania it continued to be extremely unpopular. Worst of all, there existed no recognized authority in the land to curb its jarring centrifugal political elements. Civil war was happily averted at the last moment, and a national convention, assembled at Warsaw, in April 1573, for the purpose of electing a new king. Five candidates for the throne were already in the field. Lithuania favoured Ivan IV. In Poland the bishops and most of the Catholic magnates were for an Austrian archduke, while the strongly anti-German szlachta were inclined to accept almost any candidate but a German. It was easy, therefore, for the adroit and energetic French ambassador to procure the election of the French candidate, Henry, duke of Anjou. Well provided with funds, he speedily bought over many of the leading magnates. Having been one of the instigators of the St. Bartholomew massacre, he was looked at askance by the Protestants; the religious difficulty in Poland, however, had meanwhile been adjusted to the satisfaction of all parties by the compact of Warsaw (Jan. 28, 1573), which granted absolute religious liberty to all non-Catholic denominations without exception — a far more liberal measure than the Germans had made in the religious Peace of Augsburg 18 years before. Finally, early in April 1573, the election diet assembled at Warsaw, and Henry of Valois was elected king of Poland.

Henry **of** Valois, **1573–74.**—The election had been preceded by a correctura *iurum,* or reform of the constitution, which resulted in the famous "Henrician Articles" which converted Poland from a limited monarchy into a republic with an elective chief magistrate. The king was to have no voice in the choice of his successor. He was to marry a wife selected for him by the senate. He was to be neutral in all religious matters. He was not to lead the militia across the border without the consent of the szlachta, and then only for three months at a time. Should the king fail to observe any one of these articles, the nation was *ipso* facto absolved from its allegiance. Whatever its intrinsic demerits, the disastrous fruits of this reform were largely due to the precarious geographical position of Poland, and it must be remembered to Poland's credit that she alone with England preserved the tradition of parliamentary government in the increasingly absolutist Europe of the time.

The reign of Henry of Valois lasted 13 months. The tidings of the death of his brother Charles IX. determined him to exchange a thorny for what he hoped would be a flowery throne, and at midnight on June 14, 1574, he literally fled from Poland. Eighteen months later, the senate elected the Austrian prince Maximilian to the throne; but the "gentry democracy," at the suggestion of its new leader Jan Zamoyski, chose a prince of

Transylvania, Stephen Báthory, assigning him for husband to the last surviving princess of the Jagiełło dynasty, and enforced this election by arms.

Stephen **Báthory,** 1575–%.—The king elected by the "patriotic" party proved one of Poland's greatest kings. The glorious 11 years of his reign, too brief to be permanently effective, yet represent the high-water mark of Poland's international power, and the achievements of his genius both in foreign and domestic policy remain unsurpassed in Polish annals. *(See* STEPHEN, *King of Poland.)*

With the insight of a born statesman he focused his energy on two vital objectives: the maintenance of Poland's access to the sea by way of Danzig, and the defence of her newly-gained further sea-board in the north-east against the rising power of Moscow. Danzig, on Báthory's election, began to intrigue against him with the German emperor, who of course supported Báthory's Austrian rival, and with Russia and Denmark. In spite of a deplorable lack of understanding on the part of the Polish gentry for the issue at stake, Báthory, who had throughout the able and strenuous support of his chancellor Zamoyski, conducted a campaign against Danzig both by land and sed, and finally enforced its complete submission to his rule.

Before peace was made with Danzig, Ivan the Terrible had raided Livonia once more. Báthory for the first time in the history of Polish warfare using infantry rather than cavalry and calling peasants and burghers to arms together with the gentry, achieved in the operations against Russia the greatest military triumphs of his reign. In three successive expeditions he pushed his way north-eastward as far as Pskóv, and the tsar was fain to obtain the Pope's intervention by a promise of making Russia Catholic. As a result of Báthory's victories, Poland pushed Russia entirely away from the Baltic for a long time, and regained sway over nearly the whole of Livonia.

Brilliant as these foreign successes were, the greatness of Báthory's statesmanship is even more manifest at home. He conciliated in a most far-sighted way, by concessions and privileges, two of the monarchy's most important minority groups: the Ukrainian Cossacks and the Jews. The Cossacks were largely runaway serfs, who had organized into a sort of military republic on the vast and scantily inhabited plains of the "Ukraine" or "borderland," stretching from the south-east of the monarchy towards the Black sea along the river Dnieper. The Cossack community had been drawn into the Polish military system under Báthory's predecessors by registration and pay, and had already been granted exemption from taxation, as well as their own jurisdiction. Báthory, who needed them for his Russian wars, confirmed and enlarged these privileges. His successors used the Cossacks against the Russians, Turks and Tartars; but soon the Cossacks themselves were to grow into a factor of trouble for Poland, not without serious errors of policy on the Polish side.

The privileges which the Jews had obtained from former kings were augmented: from his day until 1764 the Polish Jews had a parliament of their own, meeting twice a year, with powers of taxation. It was also chiefly in the interest of the Jews that Báthory restricted, by special edict, the trading rights of Scottish pedlars, of whom as many as 30,000 were abroad in Poland at his time. Among other domestic measures, Báthory reformed the Polish judicial system by the creation of a supreme court of appeal for civil cases; and founded, in 1579, the University of Vilna as a bulwark of Western European culture in the East.

The growing Imperial ambitions of the house of Habsburg had developed into a menace to Poland's international position: they now threatened to outflank and encircle Poland on the southern side. Báthory proposed to counteract them by the project of a union with Russia and a joint crusade against Turkey under the auspices of the Pope. This grandiose plan would have given Poland again a firm footing on the shore of "her second sea"—the Black sea—which she had reached once before in the time of the Jagiełłos. But the idea was carried with Báthory to his grave on his sudden death in I j86

Sigismund III., **1587–1632.**—The Vasa period of Polish history, which began with the election of Sigismund, son of John III., king of Sweden and of a Jagiello princess, was the epoch of last and lost chances. The collapse of the Muscovite tsardom in the east, and the submersion of the German empire in the west by the Thirty Years' War, presented Poland with an unprecedented opportunity of consolidating, once for all, her hard-won position as the dominating power between central and eastern Europe: she might even have wrested the best part of the Baltic littoral from the Scandinavian powers, and pushed Russia back beyond the Volga. That this was not achieved, was partly due to the class spirit and blind selfishness of the Polish gentry. Apathetic towards vital problems of foreign policy, and unwilling to make material sacrifices to the cause of national defense, they persisted in a doctrinaire defense of "republican liberty" at the very time when the need of a strong central executive was more urgent than ever.

But other grave causes of failure were not wanting. One of them consists in the very personality of the new foreign-bred king: the tenacity with which he clung to his hereditary rights to the Swedish crown, involved Poland in unnecessary wars with Sweden at most inopportune times; and his bigoted devotion to the cause of Catholicism introduced a new spirit of religious fanaticism and persecution into the atmosphere of a country hitherto distinguished for toleration, while the same bigotry served Poland's interests very ill abroad. Poland's greatest statesman of the time, Jan Zamoyski, discovered in the earliest years of the reign that the king, who had married a Habsburg princess, was willing to surrender the crown of Poland to an Austrian archduke, and to return to his native Sweden in order to bring it back to the Catholic fold. Zamoyski, who had himself placed Sigismund on the throne by conquering a rival Austrian candidate, was naturally indignant, and the whole disgraceful affair of the king's secret negotiations with Austria culminated in his having to answer the charges of a special "Court of Inquisition" (1592)—the first time that the prestige of the crown in Poland was exposed to such an ordeal.

The Uniate Church.—It was only where the expansion of Catholicism served the interests of the Polish state that Zamoyski saw eye to eye with the king's Catholic zeal Thus, he became instrumental in creating, at the synod of Brześć in 1596, the Uniate Church as a half-way house for those of the republic's Greek Orthodox citizens who were willing to recognize the supremacy of Rome, but desired to preserve their accustomed Eastern ritual and Slavonic liturgy. The Uniate Church served the purpose of drawing a large section of the population of the Eastern border provinces out of the orbit of Russian and into that of Polish influences; but by the antagonisms which soon began between Uniates and Non-Uniates, it became in itself a source of new troubles for Poland Besides this, the pride of Poland's Roman Catholic prelates, who looked down on the Uniate hierarchy, forced the Uniate Church into the position of a "peasant religion" and contributed to making it the social nucleus of anti-Polish Ukrainian nationalism which it remains to-day. Even in Sigismund's time, Austria, competing with Poland for influence in the Eastern Balkans, began to seduce the Ukrainian element (represented in organized form by the military community of the Cossacks) against Poland—a policy which the same Austria was to resume later in changed form and under different conditions when mistress of Eastern Galicia.

War with Sweden, Moscow and Turkey.—The dispute over Sigismund's rights to the Swedish crown began, from the earliest years of the reign, to drag its weary course of alternate victories and defeats. At first the Estonia and Latvia of to-day were both territory and principal object of the strife; in the later stages, Gustavus Adolphus transferred the ground nearer to the heart of Poland by espousing the cause of the Calvinist elector of Brandenburg, who had come into possession of East Prussia and thus laid the foundation of a large Protestant power on the Baltic. The danger to Danzig and Poland's corn exports roused even the gentry from their apathy; but in spite of some brilliant victories by sea and land, an armistice towards the end of the reign was highly unfavourable to Poland.

Sigismund's persistent Swedish ambitions, his equally persistent

Austrian sympathies, but, more than all, his absolutist leanings and cherished plans for a drastic and arbitrary constitutional reform on foreign models and on anti-parliamentary lines, occasioned in 1606 an armed revolt of the Polish gentry against their king—the rokosz (or insurrection) of Nicholas Zebrzydowski, who was supported by the discontented Protestants. The rokosz was at last suppressed in 1607, but it left as its legacy such ruinous precedents as an enforced recognition of the doctrine of the subjects' right to depose their king (de *non* praestanda obedientia), and, being undertaken in justified defence of the native Parliamentary tradition against wholesale foreign innovations, it had the harmful effect of blocking the way towards any and every reform of the Parliamentary system.

Soon after the constitutional cataclysm of the rokosz Poland became embroiled in prolonged wars with Moscow. The motive was partly a vague conception of a Polish-Russian union as opposed to the king's Austrian propensities,—but partly also the very real desire of some border magnates for more and more land east of the Dnieper. An occasion was furnished by the extinction of the Rurik dynasty in Russia, and the subsequent struggle for the throne, particularly the emergence of one candidate—the ill-fated "false Demetrius"—whom certain Polish nobles, and finally also the king, supported. (See also ROMANOFFS.) The appearance of a second Demetrius after the fall of the first prolonged the strife. Throughout the campaigns against Moscow the king found himself at variance with some leading Polish statesmen and soldiers of the time, such as Zamoyski and, later, General Żółkiewski; he thought of the problem only in terms of conquest, of the establishment of Catholicism in Russia, apd of strong monarchical rule over the united kingdoms, while Żółkiewski, even at the height of military successes against Russia, had a union like that of Poland with Lithuania in his mind, and advocated tolerance of Russia's creed and social order. The Poles once actually held the Kremlin of Moscow for a time (1610), and once again laid siege to it (1617); Sigismund's son was elected tsar, and his opponent did homage to Sigismund as a prisoner. But a national insurrection in Russia and the establishment of the Romanoff dynasty checked the Polish advance, and only certain territorial gains (including Smolensk), as well as a good deal of influence of Polish customs and institutions on the Russian nobility, were definite results of the struggle in Sigismund's time. It was to be continued under his successors.

The wars with Moscow temporarily ended in armistice at the very moment (1618), when the Thirty Years' War broke out in Central Europe. In this Poland remained officially neutral, but Sigismund's favourable attitude towards the Habsburgs entangled Poland in renewed and long wars with Turkey, which the later Jagiellos and their first successors had managed to avoid. A definite success was attained against the Turks at Chocim (1621), a year after Żółkiewski's heroic death at Cecora,—but in the very same year the Swedish trouble began anew, and Sigismund's long and unlucky reign ended 11 years later amidst turmoil abroad and at home, set-backs to Polish power on all sides without, and of seriously increased Constitutional disorder within.

Wladislaus IV., 1632–48.—Sigismund's son, born in Poland and brought up as a Pole, enjoyed a popularity which had never been his father's share. As a crown prince, he had been successful in military operations against Moscow and Turkey; on his ascension to the throne he ingratiated himself with the gentry by some new concessions, including even exemption from income-tax. The "wisest of the Polish Vasas," as he has justly been called, intended to create a basis of public favour and confidence for the constitutional reforms which he planned.

But the international difficulties inherited from his father, diverted his energies largely into channels of foreign policy. The very first years of his reign are marked by new victories over Russia and the Turk; also by a new, and much more advantageous, truce with Sweden. He was less fortunate in a new conflict with Danzig—and with her supporter Denmark—over the tolls he intended to impose on the trade of the Baltic ports: no interest in these matters was to be awakened in the gentry, and the most powerful magnates—those of the Eastern border—thought more of expansion into the fertile Ukrainian regions than of sea power. Accordingly, the Polish navy, which had begun to develop in a promising manner under Sigismund III., was allowed to fall into permanent decay, and Wladislaus' plans for foreign action on a large scale were unrealized. He wavered in his diplomacy between Austrian and French influences, represented by his two successive queens; his tolerant and friendly attitude towards the Orthodox East caused serious trouble with the Vatican; and his projects of a great crusade against the Turks, although encouraged by the Venetian republic and acclaimed by the Southern Slav nations, in the end came to nothing.

The Cossack Revolt.—The chief obstacle which prevented Wladislaus' Turkish plans from maturing, was the impossibility of winning the help of the decisive factor—the Ukrainian Cossacks, who had become too numerous and powerful to be a willing instrument of Polish policy. Catholic intolerance towards this Orthodox population, in the time of Sigismund III., had combined with the proud and high-handed behaviour of Polish landowners to produce in the Cossacks a spirit of religious, racial and social enmity against the Polish element; the Polish parliament had not kept the financial terms of its compacts with the Cossacks; repressions inspired by the border magnates had infuriated them. Already in the earlier years of Wladislaus' reign terrible Cossack revolts had flared up, and been unwisely punished by abolition of ancient privileges. Now, instead of letting themselves be made the tools of Wladislaus' anti-Turkish plans, the Cossacks made common cause with the Tatars of the Crimea, who were the most immediate objective of the king's crusading plans; and the reign ended amidst a wave of Cossack insurrection, engineered by the sultan, assisted by Tatar hordes, and led by Bogdan Chmielnicki (*q.v.*), a country gentleman personally wronged by a Polish official, now the rising hero of Ukrainianism. It was only the resistance of the brave Polish burghers of Lwów (Lemberg) that stemmed the Cossack and Tatar tide from flooding the inner provinces of Poland; the same patriotic town was to arrest two other invasions—a Russian and a Transylvanian one—in the next few years. But the defence of Lwów only meant a respite, and on Wladislaus' death, his brother and successor, the last of the Polish Vasas, found himself faced by a powerful renewal of Chmielnicki's attack on central Poland.

John Casimir, 1648-68.—John Casimir, summoned to the throne from France. where he lived as a priest and had become a cardinal, was obliged to begin his reign by negotiating with his rebel subject Chmielnicki. But Chmielnicki's conditions of peace were so extravagant that the negotiations came to nothing. It was only after a second invasion of Poland, in 1649, by countless hosts of Cossacks and Tatars, that the compact of Zborów was concluded, by which Chmielnicki was officially recognized as Chief (*hetman*) of the Cossack community. A general amnesty was also granted, and it was agreed that all official dignities in the Orthodox palatinates of Lithuania should henceforth be held solely by the Orthodox gentry. For the next 18 months Chmielnicki ruled the Ukraine like a sovereign prince. He made Czehryń, his native place, the Cossack capital, subdivided the country into 16 provinces, and entered into direct relations with foreign powers. The Orthodox patriarchs of Alexandria and Constantinople were his friends and protectors. His attempt to carve a principality for his son out of Moldavia led to the outbreak of a third war between suzerain and subject in Feb. 1651. But fortune, so long Bogdan's friend, now deserted him, and at Beresteczko (1651) the Cossack chieftain was utterly routed by Stephen Czarniecki. All hope of an independent Cossackdom was now at an end; yet it was not Poland but Muscovy which reaped the fruits of Czarniecki's victory.

Chmielnicki, by suddenly laying bare the nakedness of the Polish republic, had opened the eyes of Muscovy to the fact that her ancient enemy was no longer formidable. Three years after his defeat at Beresteczko, Chmielnicki, abandoned by his Tatar allies and finding himself unable to cope with the Poles single-handed, very reluctantly transferred his allegiance to the tsar, and in the same year the tsar's armies invaded Poland. The mar thus begun, and known in Russian history as the Thirteen Years' War, far exceeded even the Thirty Years' War in grossness and brutality.

The Russian War and the Swedish Invasion.—In the summer of 1655, while the Republic was still reeling beneath the shock of the Muscovite invasion, Charles X. of Sweden. on the flimsiest of pretexts, forced a war to gratify his greed of martial glory, and before the year was out his forces had occupied the capital, the coronation city and the best half of the land. King John Casimir, betrayed and abandoned by his own subjects, fled to Silesia, and profiting by the cataclysm which, for the moment, had swept the Polish State out of existence, the Muscovites quickly appropriated nearly everything which was not already occupied by the Swedes. At this crisis Poland owed her salvation to two events—the formation of a general league against Sweden, brought about by the apprehensive court of Vienna, and a popular outburst of religious enthusiasm on the part of the Polish people. The first of these events, to be dated from the alliance between the emperor Leopold and John Casimir (1657) led to a truce with the tsar and the welcome diversion of all the Muscovite forces against Swedish Livonia. The second event, which began with the heroic and successful defence of rhe monastery of Czenstochowa by Prior Kordecki against the Swedes, resulted in the return of the king from exile, the formation of a national army, and the recovery of almost all the lost provinces from the Swedes, who were driven back headlong to the sea, where with difficulty they held their own. On the sudden death of Charles X., Poland seized the opportunity of adjusting all her outstanding differences with Sweden. By the peace of Oliva (1660), made under French mediation, John Casimir ceded Livonia, and renounced all claim to the Swedish crown. The war with Muscovy was then prosecuted with renewed energy and extraordinary success. In 1664 a peace congress was opened, and the prospects of Poland seemed most brilliant; but at the very moment when she needed all her armed strength to sustain her diplomacy, the rebellion of Prince Lubomirski involved her in a dangerous civil war, compelled her to reopen negotiations with the Muscovites and practically to accept the Muscovite terms. By the truce of Andruszowo (1667) Poland received back from Muscovy Vitebsk, Polotsk and Polish Livonia, but ceded in perpetuity Smolensk, Siewierz, Chernigov and the whole of the eastern bank of the Dnieper. The Cossacks of the Dnieper were henceforth to be divided between the dominion of the tsar and the king of Poland Kiev, the religious metropolis of south-western Russia, was to remain in the hands of Muscovy for two years.

The "truce" of Andruszowo proved to be one of the most permanent peaces in history, and Kiev, though only pledged for two years, was never again to be recovered. Henceforth the political influence of Russia over Poland was steadily to increase, without any struggle at all, although influences of Polish culture and manners, exercised chiefly through the academy of Kiev, still continued to permeate Russia for a time, until the advent of Peter the Great.

Growth of Political Corruption in Poland.—Poland had, in fact, emerged from the cataclysm of 1648–67 a moribund State, though her not unskilful diplomacy had enabled her for a time to save appearances. Her territorial losses, though considerable, were, in the circumstances, not excessive, and she was still a power in the opinion of Europe. But a fatal change had come over the country during the age of the Vasas. The period synchronized with, and was partly determined by, the new European system of dynastic diplomatic competition and the unscrupulous employment of unlimited secret service funds. This system, which dates from Richelieu and culminated in the reign of Louis XIV., was based on the old rivalry of the houses of Bourbon and Habsburg, and very soon nearly all the monarchs of the Continent and their ministers were in the pay of one or other of the antagonists. Poland was no exception to the general rule. To do them justice, the *szlachta* at first were not only free from the taint of official corruption. but endeavoured to fight against it. But they themselves unconsciously played into the hands of the enemies of their country by making the so-called *liberum veto* an integral part of the Polish Constitution. The *liberum veto* was based on the assumption of the absolute political equality of every Polish gentleman, with the corollary that every measure introduced into the Polish diet must be adopted unanimously. Consequently, if any single deputy believed that a measure already approved of by the rest of the house might be injurious to his constituency, he had the right to exclaim *nie pozwalam,* "I disapprove," when the measure in question fell at once to the ground. Subsequently this vicious principle was extended still further. A deputy, by interposing his individual veto, could at any time dissolve the diet, when all measures previously passed had to be re-submitted to the consideration of the following diet. Before the end of the 17th century the *liberum veto* was used so recklessly that all business was frequently brought t~ a standstill. Later it became the chief instrument of foreign ambassadors for dissolving inconvenient diets. as a deputy could always be bribed to exercise his veto.

THE AGE OF FOREIGN INFLUENCES

With the election of Michael Wiśniowiecki in 1669 a new era began. A native Pole was freely elected by the unanimous vote of his countrymen: but he was chiefly chosen for the merit of his father, a great border magnate who had victoriously kept down the Cossacks, and he proved to be a passive tool in the hands of the Habsburgs. In view of this the French party rallied round John Sobieski, a military commander of rising fame. The dissensions between the two camps cost Polsnd a new defeat at the hands of the united Turks and Cossacks. Sealed by a shameful treaty at Buczacz, this defeat was only wiped out by a brilliant victory of Sobieski's at Chocim, which also, after King Michael's early death, carried him to the throne against an Austrian candidate.

John III Sobieski, 1674–96.—Connected with France by marriage and by political sympathies, Sobieski, although he had half a lifetime of constant wars against the Turks behind him, at first, in accordance with French policy, stood for peaceful relations with Turkey, and directed his eyes towards the Baltic, attempting, with French help, to check the rising Hohenzollern power in that quarter. But his secret dealings with France turned his own subjects against him, while continuous Turkish invasions forced him into war, until an attack of unprecedented magnitude, aimed at the very heart of Europe, called forth that unprecedented outburst of Polish heroism—the gallant rescue of Vienna in 1683. That great act was the last noble reflex of the great crusading impulse of the middle ages; it was a unique service, rendered in the old chivalrous spirit by one nation to another in an age of Machiavellian diplomacy and growing national selfishness It won Poland offersof friendship from all the great powers. But its positive gains for Poland proved little. cessions of territory to Moscow did not buy any active support in further campaigns against Turkey, nor did the delivered Austria assist Poland in her endeavour to re-establish the Rumanian outpost against the Turk.

Augustus II, 1697–1733, and the Peace of **Karlowitz.**—On the death of John III no fewer than 18 candidates for the vacant Polish throne presented themselves. The successful competitor was Frederick Augustus, elector of Saxony, who cheerfully renounced Lutheranism for the coveted crown, and won the day because he happened to arrive last of all, with fresh funds, when the agents of his rivals had spent all their money. He was crowned, as Augustus II, in 1697, and his first act was to expel from the country his French rival, the prince of Conti, whose defeat was also partly due to the growing Russian influence which, from the accession of Peter the Great (1700), becomes a permanent factor in Polish domestic politics.

Good luck attended the opening years of the new reign. In 1699 the long Turkish war, which had been going on since 1683, was concluded by the peace of Karlowitz, whereby Podolia, the Ukraine and the fortress of Kamieniec Podolski were retroceded to the republic by the Ottoman Porte. But the permanent weakening of Turkey brought Poland little good, for the power of Russia soon became a greater menace to her than ever Turkey had been.

War with Charles XII of Sweden.—Shortly after the Peace of Karlowitz, Augustus was persuaded by the plausible Livonian exile. John Reinhold Patkul, to form a nefarious league with Frederick of Denmark and Peter of Russia, for the purpose of despoiling the youthful king of Sweden, Charles XII (*see* SWEDEN: *History*). This he did as elector of Saxony, but it was the unfortunate Polish republic which paid for the hazardous speculation of its newly elected king. Throughout the Great Northern War, which wasted northern and central Europe for 20 years (1700–20), all the belligerents treated Poland as if she had no political existence. Swedes, Saxons and Russians not only lived upon the country, but plundered it systematically. The diet was the humble servant of the conqueror of the moment, and the leading magnates chose their own sides without the slightest regard for the interests of their country, the Lithuanians for the most part supporting Charles XII, while the Poles divided their allegiance between Augustus and Stanislaus Leszczynski, whom Charles maintained upon the throne from 1704 to 1709. At the end of the war Poland was ruined materially as well as politically. Augustus attempted to indemnify himself for his failure to obtain Livonia, his covenanted share of the Swedish plunder, by offering Frederick William of Prussia Courland, Polish Prussia and even part of Great Poland, provided that he were allowed a free hand in the disposal of the rest of the country. When Prussia declined this tempting offer for fear of Russia, Augustus went a step farther and actually suggested that "the four eagles" (viz., the black ones of Austria, Prussia and Russia, and the white eagle of Poland) should divide the banquet between them. He died, however, before he could give effect to this shameless design.

Augustus III, 1733–63.—On the death of Augustus II, Stanislaus Leszczynski, who had, in the meantime, become the father-in-law of Louis XV, attempted to regain his throne with the aid of a small French army corps. Some of the best men in Poland, including the Czartoryski family, were also in his favour, and he was elected king for the second time. But there were many malcontents, principally among the Lithuanians, who solicited the intervention of Russia in favour of the elector of Saxony, son of the late king. A Russian army appeared before Warsaw and compelled a phantom diet (it consisted of hut 15 senators and 500 of the *szlachta*) to proclaim Augustus III. Stanislaus and his partisans were besieged by the Russians in Danzig, and with its surrender their cause was lost. He retired once more to his little court in Lorraine, with the title of king, leaving Augustus III in possession of the kingdom.

Augustus III left everything to his omnipotent minister, Count Heinrich Briihl, and Briihl entrusted the government of Poland to the noble family of the Czartoryskis, who had intimate relations of long standing with the court of Dresden. "The Family," as their opponents sarcastically called them, were to dominate Polish politics for the next half-century, and they were honourably determined to save the republic by a radical constitutional reconstruction which was to include the abolition of the *liberum veto* and the formation of a standing army.

Unfortunately, the other great families of Poland were obstinately opposed to any reform or, as they called it, any "violation" of the existing constitution. The Potockis, in particular, whose possessions in South Poland and the Ukraine covered thousands of square miles, hated the Czartoryskis, and successfully obstructed all their efforts. During the reigns of the two Saxon kings, every diet was dissolved by the hirelings of some great lord or, still worse, of some foreign potentate.

It was against this primitive state of things that the Czartoryskis struggled and struggled in vain. First they attempted to abolish the *liberum veto* with the assistance of the Saxon court where they were supreme, but fear of foreign complications and the opposition of the Potockis prevented anything being done. Then they broke with their old friend Brühl and turned to Russia. Their chief intermediary was their nephew Stanislaus Poniatowski, whom they sent, as Saxon minister, to the Russian court in the suite of the English minister Hanbury Williams, in 1755. The handsome and insinuating Poniatowski speedily won the susceptible heart of the Grand Duchess Catherine, but he won nothing else and returned to Poland in 1759 somewhat discredited. Nevertheless, the Czartoryskis looked to Russia again for support on the death of King Augustus III. They rejected with scorn and derision the pacific overtures of their political opponents, Prince Michal Czartoryski openly declaring that he preferred the tyranny of the Muscovite to the tyranny of his equals. He had in fact already summoned a Russian army corps to assist him to reform his country, nhich sufficiently explains his own haughtiness and the unwonted compliance of the rival magnates.

THE PERIOD OF THE PARTITIONS

The simplicity of the Czartoryskis was even more mischievous than their haughtiness. Their naïve expectations were very speedily disappointed. Catherine II and Frederick II had already determined (Treaty of St. Petcrsburg, 1764) that the existing state of things in Poland must be maintained, and as early as 1763 Catherine had recommended the election of Stanislaus Poniatowski as "the individual most convenient for our common interests." The personal question did not interest Frederick: so long as Poland was kept in an anarchical condition he cared not who was called king. Moreover, the opponents of the Czartoryskis made no serious attempt to oppose the entry of the Russian troops.

Stanislaus II Poniatowski, 1764–95.—Shortly afterwards Stanislaus Poniatowski was elected king and crowned. But at the beginning of 1766 Prince Nicholas Repnin was sent as Russian minister to Warsaw with instructions which can only be described as a carefully elaborated plan for destroying the republic. The first weapon employed was the dissident question. At that time the population of Poland was, in round numbers, 11,500,000, of whom about 1,000,000 were dissidents or dissenters. Half of these were the Protestants of the towns of Polish Prussia and Great Poland, the other half was composed of the Orthodox population of Lithuania. The dissidents had no political rights, and their religious liberties had also been unjustly restricted; but two-thirds of them being agricultural labourers, and most of the rest artisans or petty tradesmen, they had no desire to enter public life, and were so ignorant and illiterate that their new protectors, on a closer acquaintance, became heartily ashamed of them. Yet it was for these persons that Repnin, in the name of the cmprcss, now demanded absolute equality, political and religious, with the gentlemen of Poland. He was well aware that an aristocratic and Catholic assembly like the *Sejm* would never concede so preposterous a demand.

Early in 1767 the malcontents, fortified by the adhesion of the leading political refugees, formed a confederation at Radom, whose first act was to send a deputation to St. Petersburg, petitioning Catherine to guarantee the liberties of the republic. With a *carte blanche* in his pocket, Repnin proceeded to treat the diet as if it were already the slave of the Russian empress. But despite threats, wholesale corruption and the presence of Russian troops outside and even inside the chamber of deputies, the patriots, headed by four bishops, offered a determined resistance to Repnin's demands. Only when brute force in its extremest form had been ruthlessly employed, only when two of the bishops and some other deputies had been arrested in full session by Russian grenadiers and sent as prisoners to Kaluga, did the opposition collapse. The *liberum veto* and all the other ancient abuses were now declared unalterable parts of the Polish constitution, which was placed under the guarantee of Russia. All the edicts against the dissidents were, at the same time, repealed.

Confederation of Bar.—This shameful surrender led to a Catholic patriotic uprising, known as the Confederation of Bar, which was formed in 1768 at Bar in the Ukraine, by a handful of small squires. It never had a chance of permanent success, though, feebly fed by French subsidics and French volunteers, it lingered on for four years, until finally suppressed in 1772. But, insignificant itself, it was the cause of great events. Some of the Bar confederates, scattered by the Russian regulars, fled over the Turkish border, pursued by their victors. The Turks, already alarmed at the progress of the Russians in Poland, and stimulated by Vergennes, at that time French ambassador at Constantinople, at once declared war against Russia. Seriously disturbed at the prospect of Russian aggrandizement, the courts of Berlin and Vienna conceived the idea that the best mode of preserving the equilibrium of Europe was for all three powers to readjust their territories at the expense of Poland. Negotiations led to no definite result at first, till Austria took the first step by occupying, in 1769, the country of Zips, which had been hypothecated by Hungary to Poland in 1411 and never redeemed. This act decided the other confederates. In June 1770 Frederick surrounded those of the Polish provinces he coveted with a military cordon, ostensibly to keep out the cattle plague. Catherine's consent had been previously obtained.

First Partition, 1772.—The first treaty of partition was signed at St. Petersburg between Prussia and Russia on Feb. 6–17, 1772; the second treaty, which admitted Austria also to a share of the spoil, on Aug. 5–16 the same year. The consent of the *Sejm* to this act of brigandage was extorted by bribery and force in 1773. Russia obtained the palatinates of Vitebsk, Polotsk, Mscislaw: 34,616 sq mi. of territory, with a population of 550,000. Austria got the greater part of Galicia, minus Cracow: 32,045 sq.mi., with a population of 816,000. Prussia received the maritime palatinate minus Danzig, the palatinate of Kulm minus Torun, the northern half of Great Poland, and the palatinates of Marienburg and Ermeland: 14,025 sq mi., with a population of 378,000. In fine, Poland lost about one-fifth of her population and one-fourth of her territory.

In return for these enormous concessions the partitioning powers presented the Poles with a new constitution. The most mischievous of the ancient abuses, the elective monarchy and the *liberum veto,* were of course retained. Poland was to be dependent on her despoilers, but they evidently meant to make her a serviceable dependent. The government was henceforth to be in the hands of a "permanent council" of 36 members, 18 senators and 18 deputies, elected biennially by the *Sejm* in secret ballot, subdivided into the five departments of foreign affairs, police, war, justice and the exchequer, whose principal members and assistants, as well as all other public functionaries, were to have fixed salaries. The royal prerogative was still further reduced. The king was indeed the president of the permanent council, but he could not summon the diet without its consent, and in all cases of preferment was bound to select one out of three of the council's nominces. Still, the new organization made for order and economy, and enabled Poland to develop and husband her resources, and devote herself uninterruptedly to the now burning question of national education. The shock of the first partition had a certain salutary effect on national mentality. Already in the darkest days of Saxon rule important educational reforms had been carried out in the schools of the Piarist order by Stanislaus Konarski. Now, the dissolution of the Jesuit order in 1773, putting its rich possessions and the system of schools conducted by it into the hands of the state, gave Poland opportunity to secularize as well as modernize the whole educational fabric of the nation. This huge task was admirably performed by the *Commission of National Education,* the first ministry of education in Europe. It reorganized both the program of teaching and the structure of the schools—including the decayed Universities of Cracow and Vilna—in a thoroughly modern and truly enlightened way. Less progress was made with the cause of constitutional reform: the Chancellor Andrew Zamoyski indeed drafted a new comprehensive code of laws, in which a beginning was made with the emancipation of the peasant serfs and of the town population, but this was rejected by the gentry in the diet (1780).

In the meantime, important events in the international field seemed to give Poland another chance of re-asserting her independence against her despoilers. The death of Frederick the Great, in 1786, loosened the bonds of the alliance between Prussia and Russia. Russia, drawing nearer to Austria, undertook, jointly with her, a war against Turkey which proved unexpectedly hard; and Russia was at the same time attacked by Sweden. Prussia, having changed her policy and concluded an alliance against Russia with England and Holland, was now emboldened by Russia's difficulties to go farther: she invited Poland also to forsake the Russian alliance, and offered to place an army corps of 40,000 men at her disposal.

Reform of the Constitution, **1788–91.**—It was under these exceptional circumstances that the "four years' diet" assembled (1788). Its leaders, Stanislaw Malachowski, Hugo Kollontaj and Ignacy Potocki, were men of character and capacity, and its measures were correspondingly vigorous. Within a few months of its assembling it had abolished the permanent council; enlarged the royal prerogative; raised the army to 65,000 men; established direct communications with the western powers; declared its own session permanent, and finally settled down to the crucial task of reforming the 'constitution on modern lines. But the difficulties of the patriots were commensurate with their energies, and though the new constitution was drafted as early as Dec. 1789, it was not till May 1791 that it could safely be presented to the diet. Meanwhile Poland endeavoured to strengthen her position by an alliance with Prussia. Frederick William II stipulated, at first, that Poland should surrender Danzig and Torun; but the Poles proving obstinate, and Austria simultaneously displaying a disquieting interest in the welfare of the republic, Prussia, in 1791, concluded an alliance with Poland which engaged the two powers to guarantee each other's possessions and render mutual assistance in case either were attacked.

Rut external aid was useless so long as Poland was hampered by her anarchical constitution. The most indispensable reforms had been frantically opposed, the debate on the reorganization of the army had alone lasted six months. It was only by an audacious surprise that Kollontaj and his associates contrived to carry through the new constitution. Taking advantage of the Easter recess, when most of the malcontents were out of town, they suddenly, on May **3**, brought the whole question before the diet and demanded urgency for it. Before the opposition could demonstrate, the marshal of the diet produced the latest foreign despatches, which unanimously predicted another partition, whereupon, at the solemn adjuration of Ignacy Potocki, King Stanislaus exhorted the deputies to accept the new constitution as the last means of saving their country, and himself set the example by swearing to defend it.

The revolution of May 3, 1791, converted Poland into an hereditary limited monarchy, with ministerial responsibility and biennial parliaments. The *liberum* veto and all the intricate and obstructive machinery of the anomalous old system were forever abolished. All invidious class distinctions were done away with. The towns, in a special bill confirmed by the new constitution, got full administrative and judicial autonomy, as well as a certain measure of parliamentary representation; the personal privileges of the gentry, such as possession of land and access to office in the state and in the Church, were thrown open to the townsmen. The peasants were placed under the protection of the law, and their serfdom was mitigated, preparatory to its entire abolition. Absolute religious toleration was established. Provision was made for further periodical reforms by subsequent parliaments.

Russia Overthrows the Constitution.—The constitution of May 3 had scarce been signed when Felix Potocki, Severin Rzewuski and Xavier Branicki, three of the chief dignitaries of Poland, hastened to St. Petersburg, and there entered into a secret convention with the empress, whereby she undertook to restore the old constitution by force of arms, but at the same time promised to respect the territorial integrity of the republic. Entering Polish territory with Russian troops, the conspirators formed a confederation at the little town of Targowica in the Ukraine, protesting against the new constitution as tyrannous and revolutionary, and at the same time the new Russian minister at Warsaw presented a formal declaration of war to the king and the diet. The diet met the crisis with dignity and firmness. The army was at once despatched to the frontier; the male population was called to arms, and Ignacy Potocki was sent to Berlin to claim the assistanre stipulated by the treaty of March 19, 1791. The king of Prussia, in direct violation of all his oaths and promises, declined to defend a constitution which had never had his "concurrence." Thus Poland was left entirely to her own resources. The little Polish army of 46,000 men, under Prince Joseph Poniatowski and Tadeusz Kosciuszko, did all that was possible under the circumstances. For more than three months they kept back the invader, and, after winning three pitched battles, retired in perfect order on the capital (*see* PONIATOWSKI, and KOSCIUSZKO). But the king, and even Kollontaj, despairing of success, now acceded to the confederation; hostilities were suspended; the indignant officers threw up their commissions; the rank and file were distributed all over the country; the reformers fled nbroad; and the constitution of May 3 was abolished by the Targowicians as a "dangerous novelty." The Russians then poured into eastern Poland; the Prussians, at the beginning of 1793, alarmed lest Catherine should appropriate the whole republic, occupied Great Poland; and a diminutive'. debased and helpless assembly met at Grodno in order, in the midst of a Russian army corps. "to come to an amicable understanding" with the partitioning powers.

Second Partition of Poland.—After every conceivable means of intimidation had been unscrupulously applied, the second treaty of partition was signed at three o'clock on the morning of Sept. 23, 1793. By this *pactum subjectionis,* as the Polish patriots called it, Russia got all the eastern provinces of Poland, extending from Livonia to Moldavia, comprising a territory of 96,751 square miles, while Prussia got Dobrzyn, Kujavia and the greater part of Great Poland, with Torun and Danzig. Poland was now reduced to one-third of her original dimensions, with a population of about 3,500,000.

Kosciuszko and the Third Partition.—The focus of Polish nationality was now transferred from Warsaw, where the Targowicians and their Russian patrons reigned supreme, to Leipzig, whither the Polish patriots, Kosciuszko, Kollontaj and Ignacy Potocki among the number, assembled from all quarters. From the first they meditated a national rising, but their ignorance, enthusiasm and simplicity led them to commit blunder after blunder. The first of such blunders was Kosciuszko's mission to Paris, in Jan. 1793. He was full of the idea of a league of republics against the league of sovereigns; but he was unaware that the Jacobins themselves were already considering the best mode of detaching Prussia, Poland's worst enemy, from the anti-French coalition. Kosciuszko received an evasive reply, and returned to Leipzig empty-handed. In the meantime, certain officers in Poland had revolted against the reduction of the Polish army to 15,000, imposed upon the country by the Partition Treaty. Kosciuszko himself condemned their hastiness; but the march of events forced his hand, and in March 1794, he came to Cracow, proclaimed a national insurrection and assumed the powers of a dictator. He called the peasants to arms, and they responded nobly, in return for which he supplemented the provisions of the Constitution of 1791 by a manifesto giving them complete freedom. At first, Kosciuszko's arms were almost universally successful. The Russians were defeated in more than one pitched battle; three-quarters of the ancient territory was recovered, and Warsaw, and Vilna, the capitals of Poland and Lithuania respectively, were liberated. The first serious reverse, at Szczekociny, was more than made up for by the successful defense of Warsaw against the Russians (July 9–Sept. 6). But even during that heroic defense, mob lawlessness in Warsaw and violent dissensions in the supreme council and in the army, began to frustrate the superhuman efforts of the unfortunate but still undaunted dictator. The appearance of overwhelming masses of Russian troops, together with the open hostility of Austria as well as Prussia did the rest, and Kosciuszko's insurrection received its death-blow on the battlefield of Maciejowice, where he himself was wounded and taken prisoner. Warsaw was taken amidst a terrible massacre of the population in the suburb of Praga, and the remainder of the troops capitulated a few weeks later.

The greed of the victorious powers nearly led to a rupture between Austria and Prussia; but after some dissensions, the third partition of Poland was effected by successive treaties in 1795 and 1796. Austria bad to be content with Western Galicia and Southern Masovia, while Prussia took Western Masovia with Warsaw. Russia annexed all the rest, and was afterwards to tear even parts of their booty from the two others. Thus the name of Poland was wiped out from the map of Europe, to reappear only after more than a century.

(R. N. B.; R. DY.)

THE NAPOLEONIC PERIOD AND AFTER

After the third partition, the more high-spirited Poles. chiefly officers and soldiers of Kosciuszko's army, emigrated and formed, on Italian soil, the Polish Legions, which, during the nest ten years, fought the battles of the French republic and of Napoleon all over Europe and even outside it, from Egypt to the West Indies. They were commanded by Dombrowski, one of Kosciuszko's ablest generals; but Kosciuszko himself stood aloof, distrusting Napoleon.

The Grand Duchy of Warsaw.—In 1806 and 1807, when Napoleon defeated Prussia and engaged in a war with Russia, Polish soldiers once more appeared on Polish soil, and the hopes of the nation seemed near fulfilment. In fact, the peace of Tilsit resulted in the reconstruction of a Polish state out of the central provinces of Prussian Poland; but Napoleon's anxiety to conciliate Russia effectually prevented him from making his new creation large enough to be self-supporting. The grand-duchy of Warsaw, as it rvas called. originally consisted of about 1,850 sq.mi., to which Western Galicia with Cracow, about goo sq.mi. more, were added in 1809, in consequence of Napoleon's mar against Austria. The constitution was dictated by Napoleon: it was framed on the French model and on very advanced lines. Equality before the law (implying personal freedom of the peasant), absolute religious toleration, and highly-developed local autonomy, were its salient features. The king of Saxony, as grand duke, took the initiative in all legislative matters; but the administration was practically controlled by the French. In spite of being subject to most burdensome financial and military exigencies for the purposes of Napoleon's continuous wars, the srnall grand duchy contrived. durinn the, few years of its existence, to do much peaceful, productive. organizing work, especially in the educational and rconomic spheres.

Poland's hopes for greater things revived once more when Napoleon announced his war against Moscow (1812), as his "second Polish war." The grand duchy, by an immense effort: put an army corps of nearly 80,000 men into the field. But the calamity which overtook Napoleon in Russia, also sealed the fortunes of the duchy. The remainder of the Polish troops faithfully followed Napoleon in his campaign of 1813–14, during which the heroic leader of the Poles, Prince Joseph Poniatowski (nephew of the last king), perished in covering the Emperor's retreat from Leipzig. The duchy was occupied by the Russians.

The Congress Kingdom, 1815–31.—Tsar Alexander I had been united by youthful friendship to the most eminent Polish noble of his time, Prince Adam Czartoryski, and had even made him, on his accession, foreign minister of the Russian empire. On Napoleon's downfall the Poles, to whom Alexander did not spare promises and flatteries, entertained the highest hopes.

It was not Alexander's fault, indeed, if the Congress of Vienna, owing to jealousy among the great powers and to the entanglement of the Polish question with that of Saxony and other territories, did not end in a re-union of Poland, even under the Russian sceptre, but confirmed the division of the country between the three partitioning pourers. Cracow only, with a small surrounding territory, was erected into a free city republic. Great Poland, with Poznan for its centre and a population of 810,000, was left to Prussia. Austria remained in pcssession of Galicia with 1,500,000 inhabitants. The eastern borderlands, from Lithuania and White Russia to Volhynia and the Ukraine, continued to be incorporated in Russia. The remnant of central Poland only—about three-fourths of the territory of Napoleon's grand duchy of Warsaw—was constituted as the so-called Congress kingdom under the emperor of Russia as king of Poland. Guarantees of home rule in all parts of the divided country, and of free communication between them, were given by all powers concerned, only to prove soon more or less futile.

Polish Constitution, 1815.—Alexander, who had a sentimental regard for freedom, so long as it meant obedience to himself, had promised the Poles a constitution. That constitution was soon duly drafted and signed. It contained 165 articles divided under seven heads. The kingdom of Poland was declared to be united to Russia, in the person of the tsar, as a separate political entity. Lithuania and the Ruthenian Palatinates continued to be incorporated with Russia as the Western Provinces and were divided from the Congress kingdom by a customs barrier till the reign of Nicholas I. The kingdom of Poland thus defined was to have at its head a lieutenant of the emperor (*namiestnik*), who must be a member of the imperial house or a Pole. The first holder of the office, General Zajonczek (1752–1826), was a veteran who had served Napoleon. Roman Catholicism was recognized as the religion of the state, but other religions were tolerated. Liberty of the press was promised, subject to the passing of a law to restrain its abuses. Individual liberty, the use of the Polish language in the law courts, and the executive employment of Poles in the civil government were secured by the constitution. The machinery of government was framed of a council of state, at which the imperial government was represented by a commissioner plenipotentiary, and a diet divided into a senate composed of the princes of the blood, the palatines and councillors named for life, and a house of nuntii elected for seven years. Poland retained its flag, and a national army based on that which had been raised by and had fought for Napoleon. The command of the army was given to the emperor's brother Constantine, a man of somewhat erratic character, who did much to offend the Poles by violence (see Constantine Pavlovich).

The diet met three times during the reign of Alexander, in 1818, in 1820 and in 1825, and was on all three occasions opened by the tsar. But the tsar and the diet soon quarrelled. The third session of the diet (May 13 to June 13, 1825) was a mere formality. All publicity was suppressed, and one whole district was disfranchised because it persisted in electing candidates who were disapproved of at court. All Europe at the time was seething with secret societies organized to combat the reactionary governments of the Holy Alliance. In Poland, the National Freemasonry, or National Patriotic society as it was afterwards called, had a large membership, especially among the students and the younger officers. Outside Congress Poland, a similar student movement arose in the University of Vilna. Severe measures—imprisonment, deportation, and exile—were taken against students and graduates of Vilna (including the great poet Mickiewicz), and they added to the excitement in Warsaw.

No open breach occurred during the reign of Alexander I, nor for five years after his death in 1825. On the death of the unpopular Zajonczek in 1826, the Grand Duke Constantine became imperial lieutenant. His brother, the new tsar, Nicholas I, soon became entangled in a war with Turkey. Austria, as usual, desirous of profiting by Russia's difficulties, hegan to court the favour of the Poles. Nicholas was crowned king of Poland in Warsaw, in 1829, and personally opened the diet in 1830. But the diet, already in 1828, had refused to sentence to death a group of Polish conspirators accused of dealings with the Russian "decembrists" who had plotted Nicholas' overthrow—and in 1829 there was even an abortive Polish plot to murder him at his coronation in Warsaw. Fresh excitement was created in Poland by the outbreak of the revolution in France, in July 1830, and the revolt of Belgium: a rumour was current—not without justification—that Nicholas, acting in concert with the other autocrats of the Holy Alliance, intended to use the Polish army to coerce the French and Belgian revolutionaries.

The *Rising* of 1830.—On Nov. 29, 1830, a military revolt broke out in Warsaw. It was started by the young hotheads of the Officers' Training school, and began with the murder of several senior officers loyal to the government. Regiments of the army and masses of the civilian population began to join the rising; the weakness of Constantine allowed it to gather strength. He evacuated Warsaw and finally left the country. The war lasted from January till Sept. 1831. The Poles began with some chances of success: they had a well-drilled and well-equipped army of about 30,000 men, which they increased by recruiting to about 80,000. Against this, the Russians, with considerable difficulty, succeeded in putting only about 114,000 men into the field. Their ultimate success was partly due to the friendly attitude of Prussia, partly to the fact that the Polish diet, having proclaimed the deposition of the tsar at an early stage of the conflict, received no response to its appeal for western European protection. But to a large extent the defeat of the insurrection was caused by certain faults on the Polish side: want of ability and decision on the part of the generals, a succession of rapid changes in the command of the army, fierce party strife within the civil government in the capital, a deplorable outbreak of mob violence in Warsaw at a critical moment of the war; finally, an irresolute attitude of the insurrectionary parliament towards the peasant claims.

After the suppression of the insurrection, certain remnants of a constitution were still granted to Russian Poland by the "Organic Statute" of 1832, but they were soon rendered illusory: the administration avowedly aimed at destroying the nationality, and even the language, of Poland. The universities of Warsaw and Vilna were suppressed, the Polish students compelled to go to St. Petersburg and Kiev. The recruits from Poland were distributed in Russian regiments, and the use of the Russian language was enforced as far as possible in the civil administration and in the law courts. The customs barrier between Lithuania and the former Congress Poland was removed, in the hope that Russian influence would spread more easily over Poland. A hostile policy was adopted against the Roman Catholic Church. But though these measures cowed the Poles, they failed to achieve their main purpose. Polish national sentiment was intensified. The Poles in Russia, whether at the universities or in the public service, formed an element which refused to assimilate with the Russians. In Poland itself the tsar left much of the current civil administration in the hands of the nobles, whose power over their Peasants was hardly diminished and was misused as of old. The Polish exiles who filled Europe after 1830 maintained a constant agitation from abroad. The stern government of Nicholas was, however, so far effective that Poland remained quiescent during the Crimean War.

Alexander* II *and the Rising of 1863.—The reign of the new tsar Alexander II began with certain concessions to Poland in the political and educational field. Exiles were allowed to return, administrative pressure was lightened, the Church was propitiated, an "Agricultural society" was allowed to be formed and to discuss important affairs of the community, a medical faculty, and later on, a complete university, was re-established in Warsaw. Finally even, a Polish council of state and a Polish administrative apparatus for the kingdom began to be organized. In their later stages, these reforms were the work of Count Alexander Wielopolski, who was installed in high office, and stood for a national policy of loyal union with Russia. But his autocratic temper lost him the sympathies of the moderate elements of the gentry; while, on the ardent minds of the young, Wielopolski's methods acted like fuel heaped on fire. Religious ceremonies were used as the occasion for demonstrative political processions, there were collisions with the Russian troops, and victims fell in the streets of Warsaw. Wielopolski had the unhappy idea of causing the revolutionary youth of the cities to be recruited en *masse* for the Russian army; the plan became known, numbers of the young people fled into the forests, and a Revolutionary committee, on Jan. 22, 1863, started an ill-prepared insurrection.

The struggle of the ill-equipped and ill-organized insurgent bands against the Russian garrisons in the country dragged on in the form of guerrilla warfare throughout the country for nearly two years. A secret National government was set up in Warsaw, the movement spread successfully into Lithuania, and the insurrection occupied the diplomatic attention of western Europe. But the assistance promised by Napoleon III never became effective; the rising was crushed; wholesale executions, confiscations and deportations followed its suppression, and Poland was now definitely turned into a Russian province.

After the insurrection of 1831, no remnant of Poland's independent political existence had been left except the minute city republic of Cracow, created by the Congress of Vienna. For 30 years, this miniature state led a flourishing existence. When the ferment of the approaching European revolution of 1848 was stirring most continental countries to their depths, there were active preparations for another rising both in Austrian and Prussian Poland. For Austria the menace was diverted by a huge peasant revolt in Galicia, which led to a massacre of thousands of landowners by the peasantry. At the same time, Austria availed herself of the unrest among her Poles to obtain the consent of Russia and Prussia to the suppression of the city republic of Cracow. But it was only in 1848, amid the thunders of the "springtide of nations," that Cracow was finally occupied by Austria and incorporated into Galicia.

After the disaster of 1863, the Poles of Prussian, Austrian and Russian Poland developed along such widely different lines that there is, for the next 60 years, little unity leit in Poland's national history. Certain features, however, are common to the life of the three sections of the nation during this period. The gentry, shattered by the insurrectionary disasters, ceases to be the dominant class in the community; the professional intelligentsia of the towns swelled by influxes from the ruined gentry assumes that part; and gradually, towards the end of the 19th century, the peasant masses, now fully enfranchised, rise into importance.

The Poles in Prussia.—The regime in Prussian Poland during the first 15 years after the Congress of Vienna had been endurable. A Polish nobleman related by marriage to the Prussian dynasty—Prince Radziwill—was appointed lieutenant-governor of the province; there was a provincial assembly and local representative bodies both urban and rural. The landowners were allowed to organize for economic purposes, and the peasants were fully eniranchised in 1823. After the insurrection of 1830, a period of more oppressive government by a German provincial president, Flottwell, set in; he revived Frederick the Great's method of German colonization of the Polish province; and he began to Germanize the administration and the school system. A period of new concessions to the Poles, under Frederick William IV, was interrupted by the revolution of 1846–48. The constitution with which Prussia emerged irom the revolution put an end to the self-government of Prussian Poland. Another interval of relaxation, in the first years of William I, was soon succeeded by the period of Bismarck's and Bülow's resolutely anti-Polish policy—characterized by the *Kulturkampf,* the "Colonizing Committee," the Września scandal, the schools' strike, the Expropriation bill and the like, for an account of which *see* POZNAN. The result of the Prussian methods was to create a sturdy class of peasants and small bourgeoisie, disciplined and economically and culturally advanced; and a fellow-feeling arose between the peasants and the landowning gentry, such as was hardly known in other parts of Poland.

The Poles in Austria.— Austria, under the old autocratic regime, had oppressed its Polish province politically and exploited it economically in the most ruthless fashion, till the revolution of 1848 brought a change. But not until the defeat of Austria by Prussia in 1866 was it realized at Vienna that only a more liberal policy could hold the tottering, mixed monarchy together. The relation with Hungary having been placed on a federal footing, concessions had to be granted to the strong Polish element in Austria. The Poles became a dominant nationality in the Austrian empire. The numerical strength of the group oi Polish deputies in the Vienna parliament was such that no Austrian government could be formed without it. Galicia (as Austrian Poland was officially called), containing a large Ruthenian element in its Eastern half, was granted a special minister to represent its interests in the Vienna cabinet. It also got a provincial legislative assembly and a governor, who was invariably appointed from the ranks of the Polish aristocracy. With purely Polish administration schools and courts of law, Galicia became indeed almost an independent Polish state within Austria, and successfully defied the centralizing efforts of the Vienna bureaucracy. The Polish landowning class, who practically governed the country for the next few decades, managed its affairs in a one-sidedly agrarian spirit: the interests of the towns were not properly considered, hardly any attention was given to the development of industries, and Galicia remained economically backward. Even its oilfields were largely developed by foreign capital. On the other hand, political and cultural activities had more scope than in the two other parts of Poland: Galicia became the "Piedmont" of the Polish national movement, and Cracow, with its old university and new Academy of Sciences, an intellectual, artistic and literary centre ior the whole nation. With the growth of a new educated class, and the introduction of universal suffrage in Austria (1896) the social structure of the country began to change, its politics were strongly democratized, new economic tendencies got the upper hand, and Galicia was at last on the road of material advance when World War I began.

The Poles in Russia.—All self-government in Congress Poland was suppressed in 1863; all education was Russified in 1869, justice in 1873. On the other hand, the abolition in 1851 of the customs frontier between Russia and Poland had laid the foundation for an extraordinary industrial expansion: Russian Poland became the chief industrial region for all Russia. Its vast market in agricultural Russia was protected against western competition by high tariffs; the Russian government took every possible measure (such as the introduction of specially favourable railway tariffs) to assist this expansion. The Poles, being excluded from state service in their own country, busied themselves with productive occupations, and the upper and middle classes achieved a well-being far superior to anything enjoyed by their cousins in Galicia. A second result of this expansion was the growth in Congress Poland of a large and radical proletariat which made common cause with the Russian Social Democratic movement. In the country districts, the agrarian policy of the Russian government was expressly calculated to stir up ill-feeling between the Polish peasants, whom the government demonstratively took under their protection, and the country gentry, whom it was determined to punish in every way for the leading part they had played in the insurrections. The peasant of Russian Poland officially got his freedom from the tsar in 1864. Each peasant, whatever his tenure had been, and the mass of the landless proletariat, became freeholders. The landlords received compensation in the form of Russian Treasury bonds. which stood far below par, and the peasants got the right to use the landlords' pastures and woods.

In the sphere of education, the most thoroughgoing system of Russification set in after 1863. All the revived Polish schools of the Wielopolski period were made Russian again, including the University of Warsaw, and no effort was spared to produce in the minds of youth a distorted image of Poland's past. Secret patriotic education, however, counteracted this policy successfully both in town and country; and private Polish schools, struggling against great difficulties, kept the great Polish cultural tradition alive.

The civil government of Russian Poland was reorganized strictly on the model of the rest of the Russian empire, the Poles being debarred, however, irom certain liberal institutions which the Russians by that time possessed, such as municipal self-government and trial by jury. The Russian language was made compulsory in all official relations. and at a later time even in the records of private institutions. A corrupt Russian bureaucracy filled all government offices, a severe censorship strangled every free utterance of the nation in the press and in literature, and a drastic police regime kept the prisons filled with political offenders.

After Russia's defeat in the Japanese war of 1904, the outbreak of a revolution in 1905 kindled all Polish hopes once more. A constitution was granted to Russia, and 36 Polish deputies sat in the first Russian parliament. A certain measure of freedom in the educational field was obtained and eagerly used for the foundation of new schools by a Warsaw society called "the Mother oi Schools" (*Macierz Szkolna*). The peasants of Russian Poland spontaneously introduced the Polish language in their self-governing bodies. In the Duma itself, the Liberals were not averse to granting Poland a large measure of autonomy within Russia. At the same time, persecution in Prussian Poland increased under Bülow, while the Ukrainian national movement, developing in Austrian Poland especially since the grant of universal suffrage in 1907, was unwelcome both to Poles and Russians. Under these circumstances, Russian propaganda, reviving the Pan-Slav ideals of 30 years ago, could count on some success even among the Poles. There were gestures of reconciliation at two Slav congresses, in 1908 and 1910, the Czechs willingly acting as mediators. The idea of uniting all Poles with autonomy within the Russian empire was widely preached: it became the program of the national Democratic, or all-Polish, party, led by Roman Dmowski, the head of the Polish representation in the Duma.

Opposite to Dmowski and the followers whom he found even among Austrian Poles, there stood the irreconcilable revolutionaries, led by Joseph Pilsudski. Both the insurrectionary movements started by Pilsudski in 1905, and the Constitutional endeavours of Dmowski and his friends in the Duma, were soon stifled by the Russian reaction of the Stolypin period. Pilsudski was obliged to flee to Galicia, and began to organize active resistance to Russia from that base. In the Duma, the Polish representation was lowered irom 36 to 10 deputies. In the country, all the liberties gained after 1905 soon disappeared. The government's purchase of the railway line from Warsaw to the Austrian frontier resulted in the removal of all Polish railwaymen from the service and was a great blow to the Polish element. In 1912 the separation of the district of Chelm, in the southeast of Russian Poland, from the body of the province and its incorporation in Russia proper was received with indignant protests by Polish opinion as a new division of Poland.

THE POLISH PROBLEM DURING WORLD WAR I

World War I found the Poles estranged from one another, and without a united national policy. Pilsudski, the "activist," crossed the frontier from Galicia with a iew hundred of his armed band and engaged the Russian empire in battle as forerunner of the army of an independent and united Poland. But the Polish National committee. formed in Cracow on Aug. 16, aimed at uniting Galicia and Congress Poland as a third party in the Dual Monarchy and required the Polish Legion to take the oath to the emperor. In Warsaw, another Polish committee under Dmowski denied the right of the Cracow committee to speak in the name of the Polish nation; protested loyalty to the tsar; and attempted to form a Polish Legion on the side of Russia. Meanwhile the Grand Duke Nikolai Nikolaievich issued a proclamation (Aug. 14) in which he promised to unite the three parts of Poland in an autonomous state with the Russian empire. When the Russian army occupied a great part of Galicia the Russophil party in Galicia (the National Democrats) accepted this program.

In the summer of 1915, however, the Central Powers conquered all Congress Poland. After the fall of Warsaw on Aug. 5. 1915, governments were set up on behalf of Germany at Warsaw, and Austria-Hungary at Lublin. It was now the Russian solution that was platonic. But fresh difficulties confronted the Austrian solution. The Polish Socialist Party (P.P.S.) under Pilsudski declared that no recruiting should take place for Polish legions until an autonomous

Polish government had been formed to conduct it. Meanwhile Tisza, the Hungarian Minister President, had vetoed the Austrian trialist scheme, which was also opposed by Germany. Vienna, again, rejected the plans put forward by Germany, of annexing Congress Poland to Germany, or of forming an independent Polish buffer state in economic military and political alliance with the Central Powers.

Formation of a Polish State.—In hug. 1916, however, after the defeat of the Austro-Hungarian troops at Luck, the German supreme command acquired complete control of policy on the eastern front. Ludendorff believed it possible to gain a large Polish army if his ideas were adopted. Germany and Austria-Hungary issued a proclamation on Nov. 5, 1916, holding out a prospect of the restoration of an independent Congress Poland as a hereditary constitutional monarchy closely attached to the Central Powers. Francis Joseph promised Galicia increased autonomy within Austria-Hungary. The discussion of details was shelved; the military governments at Warsaw and Lublin continued to administer the country. The German governor, General von Beseler, arranged for the election of a diet with fairly extensive powers in local administration, education and justice. Meanwhile, by decree dated Nov. 26, 1916, a Provisional Council of State was appointed, which was solemnly opened on Jan. 14, 1917. Pilsudski began to work out the plans for a national Polish army. He refused, however, to raise it for German use; and actually the German plan of raising a Polish army failed completely.

In March 1917 the Russian dynasty fell. On March 30 the new Russian government recognized Poland's right to self-determination and promised the creation of a new Polish state. These events altered the attitude of the Allies towards Poland, particularly as they were now reinforced by the entry of the United States into the war. The answer of the Entente Powers to the peace proposals of the Central Powers issued on Jan. 10, 1917 had already declared their adhesion to the tsar's manifesto to his armies (Dec. 25, 1916) which had spoken of "the formation of a free Poland in all parts into which it is at present divided."

The danger still threatening Poland from Russia vanished with the breakdown of Kerensky's offensive (July, 1917). The Central Powers were now the only enemy. In May 1917, the Polish members of the Austrian *reichsrat* unanimously demanded "an independent united Poland with an outlet to the sea," and declared that the Polish case was one for "international consideration." At the same time, the Polish council of state in Warsaw asked the occupants for a wideniсg of its powers, and split up over the German demand for a recruiting appeal and an oath of loyalty. Pilsudski resigned from the diet with his adherents, and set about turning his secret military organization against Germany.

On July 22 Polish discontent was increased by the arrest of Pilsudski. On Aug. 25 the diet, now discredited with the people, resigned. On Sept. 12 Germany and Austria-Hungary introduced a new project of a regency of three, a cabinet and premier and council of state, chosen by the regency, and enjoying limited powers, the German and Austrian military governments retaining the right oi veto. The regency was appointed on Oct. IS; it consisted of the Archbishop of Warsaw, Dr. Kakowski, Prince Lubomirski, and Józef Ostrowski, a large landowner. The first prime minister, Jan Kucharzewski, was appointed on Nov. 26 and formed his first ministry on Dec. 7.

While Polish affairs were taking this course under Austro-German occupation, Dmowski was making propaganda for the Polish cause in France and England, and Paderewski was working tirelessly in America. In Nov. 1916, a great Polish National Department in Chicago had united all the organizations of the 4,000,000 Poles in America; and under Paderewski's influence, President Wilson, in his tentative peace message of Jan. 22, 1917, alluded to a "united, independent and autonomous Poland." In the course of 1917, a Polish corps was organized by General Dowbór-Muśnicki in Russia, and a Polish army, afterwards known as General Haller's army, began to be formed in France. The Polish National committee, founded at Lausanne in Aug. 1917, and since established in Paris, was gaining increasing influence in the councils of the Allies. Between Sept. 20 and Dec. 1, 1917, France, Great Britain, Italy and the United States had recognized it as the official representative of the Polish people. The thirteenth of President Wilson's Fourteen Points (Jan. 8, 1918) declared that a Polish state should be erected which should include the territories inhabited by indisputably Polish population "with an outlet to the sea and an international guarantee of its independence and integrity."

In the meantime, the utter collapse of the Russian army had led to peace negotiations between the Central Powers and the Bolsheviks. The Bolshevik delegates who arrived at Brest-Litovsk (*q.v.*) in Dec. 1917, recognized, in theory, the right of the Polish people to self-determination; hut Polish delegates were not admitted to the deliberations. By the treaty as concluded on March 3, 1918, soviet Russia renounced all claims over Poland; but the treaty (Feb. g, 1918) between the Central Powers and the Ukraine allotted to the Ukraine the disputed province of Chelm, while Austria-Hungary further pledged herself in a secret clause to form East Galicia and the Bukovina into a separate Crownland. These clauses became known; Polish opinion was infuriated beyond measure; the Polish cabinet resigned; the Polish club in the Austrian *reichsrat* went over to the Opposition; the remnant of Pilsudski's legions still fighting for the Central Powers mutinied. Some were interned, some fought their way to the coast and joined the new Polish army in France. The elections for the council of state in Poland were held in April and it was opened in Warsaw on June 22. Little interest was taken in the elections, and general feeling in Poland tended to ignore this body in favour of the National committee in Paris. Even before the breakdown of the German offensive in July 1918, the prime ministers of Great Britain, France and Italy had declared in favour of an independent and united Poland at Versailles on June 3, 1918.

The Declaration of Independence.—On Oct. 6, the Polish Regency Council and minister president published a manifesto to the Polish nation declaring its intention of dissolving the council of state, forming a representative national government and summoning a diet for a "free and united Poland." On Oct. 15 the Polish representatives of the *reichsrat* declared themselves to be "subjects and citizens of a free and re-united Polish State." On the same day the council oi Regency in Warsaw summoned the Galician Poles to Warsaw to take part in forming the new Polish government. A cabinet was hurriedly iormed on Oct. 22. On Oct. 28 a commission of Austrian Poles met in Cracow to wind up relations with Austria. Assuming its authority to extend throughout Galicia, it appointed its next meeting for Nov. 2 in Lwow, where a Ruthenian government had already been formed, thus early coming into collision with its neighbours. On Nov. 3 the cabinet proclaimed the Polish Republic. On Nov. 10 Pilsudski, who had been released from imprisonment on Oct. 7, arrived in Warsaw. The German troops of occupation were disarmed and expelled, and the Poles assumed the executive power in Warsaw on Nov. 11. The council of Regency declared on the same day that it appointed Pilsudski to the supreme command of all Polish troops and on November 14 resigned in favour of Pilsudski.

THE NEW POLAND

Of all the new or resurrected states of Europe, Poland was in many respects in the most difficult position. The territory of Congress Poland and Galicia had been devastated in the war. Most of the factories were closed for lack of raw material, where they had not been actually dismantled. The fields of the peasants had been laid waste, their livestock slaughtered, their farms burnt. Many districts were actually famine-stricken, others swept by epidemics. Communications were disorganized, rolling stock in a deplorable state. Marks, roubles and kronen circulated ireely, but their values were low and uncertain, and public and private finances were chaotic. Owing to the past policy of Prussia and Russia, a national bureaucracy existed only in Galicia. Thirty thousand German troops were still in the country. On the east. Bolshevik Russia was in a highly unsettled state and exercised an unsettling influence on the masses in Poland. Radical propaganda of all sorts was rife, and political parties were as numerous as they were, on the whole, futile.

Pilsudski, the old revolutionary, had begun by appointing a cabinet of the Left, composed mainly of Galician socialists and peasants' representatives, under the presidency of J. Moraczemski. But the propertied classes refused him their support, and his attempt to float an internal loan met with little response. In December, M. Paderewski, the second man in Poland enjoying almost unlimited prestige, arrived in the country, composed his differences with Pilsudski and became premier on Jan. 17, 1919. Prussian Poland had come under complete control of its Polish inhabitants by Jan. 9. West Galicia was incorporated; East Galicia was occupied by Polish troops, which had entered Lwow on Nov. 22. It was possible to hold elections for a constituent assembly on Jan. 26, 1919. The constituent *Sejm* met on Feb. 10. It passed a vote of confidence in Paderewski's cabinet, and confirmed Pilsudski in his position as head of the state without, however, exactly defining his position. Paderewski proceeded to Paris to urge Poland's claims; Pilsudski raised an army to defend them. General Haller's troops, returning from France, formed the nucleus of this force. Poland soon had an army of 600,000, which was shortly increased to 800,000. On May 8 an offensive was opened in East Galicia against the Soviet Russian and Ukrainian forces.

The Treaty of **Versailles** and Frontier Problems.—On June 28, 1919 the Polish delegation signed the treaty of Versailles, under which Poland agreed to accept an agreement with the Principal Allied and Associated Powers for the protection of national minorities in Poland, and for the protection of freedom of transit and equitable treatment of the commerce of other nations. This Minorities Treaty was signed on June 28, 1919. Under the Treaty of Versailles, Poland received the larger part of Poznan and part of West Prussia. A plehiscite was to determine the settlement of Masuria and Upper Silesia. Danzig (*q.v.*) was to be a free city under the protection of the League of Nations. This city was to he included within the Polish customs frontiers and its foreign relations and the protection of its citizens abroad were to be entrusted to Poland, who also received other economic rights in this territory and was to have free access to the sea. The actual details were settled later hy treaties between Poland and the free city, in 1920, 1921 and 1923. Art. 87 of the treaty assigned to the Allied and Associated Powers the duty of fixing Poland's eastern frontier. As a signatory to the Treaty of Versailles, Poland was an original member of the League of Nations. The treaty was not popular in Poland but the *Sejm* ratified it on July 30–31 by 285 votes to 41. During the next three pears, however, Poland was almost exclusively occupied with questions arising directly or indirectly out of it, which it will he convenient to take in order.

The industrial district of Teschen (*q.v.*), with important coal mines, was claimed by both Poles and Czechoslovaks. Each nation attempted to assume practical control, and there was some fighting. A plebiscite commission arrived in the district on Jan. 30, 1920, but on July 28, 1920 the Supreme Council fixed a line of demarcation through this district, cutting the town in two, and through the neighbouring districts of Zips and Orava. In East Prussia (see ALLENSTEIN-MARIENWERDER) the plebiscite was held on July 11, 1920. The bulk of the districts were allotted to Germany on the basis of the vote.

Upper Silesia was the scene of grave troubles (see SILESIA). Art. 88 of the Treaty of Versailles provided that the inhabitants of this area, except in its purely German portions, should vote by plebiscite for adherence to Germany or Poland. Allied troops occupied the districts in the meantime. At the polls, 717,422 votes were cast for Germany, 483.514 for Poland. The towns and industrial districts voted German. In consequence of a rumour that only two districts were to be assigned to Poland, Korfanty, a prominent Pole, occupied southeastern Upper Silesia with an armed force. A commission of the Council of the League of Nations on Oct. 20, 1921 awarded the southeastern districts, including 7570 of the aggregate material wealth of the disputed territory, to Poland. A convention signed at Geneva between Poland and Germany May 15, 1922 provided guarantees for the continuity of the economic life of the country and the protection of minorities during a transitional period of 1j years.

Hostilities Against the Ukraine and Russia.—The disturbances on Poland's eastern frontier were on a larger scale. Polish troops, on occupying Lwow in Nov. 1918, had expelled the East Galician government, which took refuge in Vienna. General Petlura, who formed a government in the Ukraine in the same month, proclaimed the union of the Republics of Ukraine and West Ukraine (East Galicia). The East Galician troops placed themselves under his command. Throughout 1919 fighting continued between the Polish and Ukrainian troops, the former remaining in de *jacto* possession of the disputed territory. On Nov. 20, the Peace Conference assigned Eastern Galicia to Poland for 25 years, with a provision for local autonomy; after 25 years, the League of Nations was to decide its future.

Simultaneously with the campaign in Eastern Galicia, Poland was engaged in war with soviet Russia. The German troops of occupation had evacuated the White Ruthenian and Little Ruthenian territory in Chelm and Volhynia in such a way that the Bolshevik troops were able to occupy it before the Poles, to whom the inhabitants appealed for aid, could come up. In this year soviet Russia was engaged in war with most of her neighbours and with various expeditions, such as those of Kolchak or Denikin. Polish forces, as the largest and most successful of those opposed to Russia, enjoyed considerable support in western Europe. All the Allies desired a strong Poland; hut British statesmen considered that this aim would be best achieved if Poland's frontiers mere not excessively extended. In the autumn, Russia suggested an armistice which was declined.

The "Curzon line," of Dec. 8, attempted to define Poland's eastern frontier. It drew a line roughly following the ethnographical frontier and thus running some way further west than the actual line then occupied by Polish troops. The district of Vilna (Wilno), which the Poles had occupied in April 1919, was assigned to Lithuania.

In the spring of 1920 efforts were made to secure peace with Russia, but came to nothing. On April 25, having settled differences with Petlura in the Ukraine by a treaty dated April 22, Poland opened a strong offensive. On May 8 the Polish troops entered Kiev. The soviet army, however, having defeated Kolchak and Denikin, concentrated against Poland and opened a counter-offensive. By July the Polish forces were in a serious position. Poland appealed to the Allies for mediation; and the Allies suggested that Poland should retire to the Curzon line and that representatives of Poland, Russia, Finland, Lithuania and Latvia should meet in London to arrive at a general peace settlement of eastern Europe. Russia refused this offer, but agreed to negotiate directly with Poland. The beginning of these negotiations, however, was delayed by Russia, who believed that the military situation would become more advantageous to herself with delay. The Russian forces were actually at the gates of Warsaw when the Allies at last became perturbed by the Russian advance, and a French mission under General Weygand arrived in Warsaw to assist the Polish General Staff. The government issued an appeal to the country, which responded nobly. On Aug. 14 Pilsudski opened a counter-offensive, and drove the Russians back in confusion. Poland, backed by the Allies, was now able to reject the crushing peace terms which the Russian delegates at Minsk had suggested. The conference was moved to Riga, where the preliminary treaty of peace was signed on Oct. 12. The final treaty was signed at Riga on March 18, 1921 and ratified by the *Sejm* on April 17.

Both parties recognized each other's sovereignty and agreed to refrain from propaganda and from harbouring organizations directed against the other party. All art collections, libraries, historical documents, etc., which had been carried out of Poland since the first partition, and all industrial installations evacuated during the Russian retreat in World War I, were to be restored to Poland. Russia was to pay 30,000,000 roubles in gold as Poland's share in the assets of the former Russian empire. A number of mixed commissions were set up to carry out the terms of this treaty; but considerable difficulty was experienced in recovering the art and literary treasures, and hardly any progress made in recovering the industrial material or obtaining cash payments.

The new eastern frontier of Poland ran southeast from the Latvian frontier, then mainly due south, passing some 18 mi. west of Minsk, and, further south, some 70 mi. east of Pinsk: in the neighbourhood of Ostrog it turned slightly southwest and continued so for some 25 mi.; thence it ran due south again till reaching the river Zbrucz: this it followed till its junction with the Dniester, which separates Poland from Rumania. The Zbrucz section of the frontier coincided with the Austro-Russian frontier of 1914, and the whole of the new eastern frontier of Poland roughly corresponded to the frontier left to the historical Poland after the second partition in 1793.

Vilna.—Simultaneously, Poland was embroiled with Lithuania over the question of Vilna (*q.v.*). This town and district had been occupied by Poland on April 19, 1919, hut were assigned to Lithuania by the Curzon line. Russia recognized Lithuania's claims to them by a treaty with Lithuania dated July 12, 1920; but afterwards, in the Riga Peace Treaty with Poland, she declared her *désintéressement* in the dispute. During their advance after the victory over Russia in 1920, Polish troops came into conflict with the Lithuanians. An armistice convention of Oct. 7 laid down a line of demarcation, which was to come into force on Oct. 10. On Oct. 9, however, the Polish General Żeligowski took possession of the disputed districts by a coup *de main*. The Polish government disowned the general but made no serious effort to recall him. The territory was first organized as an autonomous province under the name of "Central Lithuania," then, a plebiscite having declared in favour of Poland, it was incorporated in Poland as "the Palatinate of Vilna." Finally, the Conference of Ambassadors assigned Vilna and district to Poland on March 14, 1923. Lithuania refused to recognize this decision and continued to consider herself as in a "state of latent war" with Poland, till at the autumn session of the League of Nations in 1927, she was prevailed upon to declare the state of war ended. This only opened the way for negotiations concerning railway communication, river transit, consular representation and diplomatic relations; all these things had been non-existent between the two countries since 1920, to the great economic detriment and inconvenience of the population.

The Ambassadors' Conference on March 14, 1923, not only assigned Vilna to Poland, but recognized the whole of Poland's existing northern, eastern and southeastern frontiers in the name of the Allied Powers, the United States subsequently notifying the Polish government of their acknowledgment of this decision. Thereby, previous provisions for the future of East Galicia were repealed, and the province became an integral part of Poland.

Little Entente, France, Rumania and the Baltic States.—Surrounded by foes, Poland could not stand alone. The most important *bloc* in Central Europe formed after World War I was that of the Little Entente (*q.v.*). Although Poland had many interests in common with the members of this alliance, she was unable to join it. She had no quarrel with Hungary; but the long drawn out disputes with Czechoslovakia on the Teschen, Zips and Javorzina frontier questions prevented a close alliance with that power. Furthermore, Czechoslovakia had received a mandate over Carpathian Russia and hoped to establish a direct frontier with Russia. So long as the fate of East Galicia remained in abeyance, Czechoslovak and Polish interests were bound to conflict. A commercial treaty between Poland and Czechoslovakia was indeed signed in 1921, but important economic antagonisms continued to exist. and relations between the two states only began to grow more cordial in the Locarno period (1925 and after).

From the first, France had designated Poland as the ally which should take over Russia's role on Germany's eastern frontier. France gave Poland military assistance against Russia in 1920, and diplomatic support in the Silesian and East Galician questions, helping her to acquire most valuable coal and oilfields and industrial regions. France assisted Poland to organize and equip her army, lent her instructors and staff officers and made her generous loans for the purchase of war material. On Feb. 19, 1921 Pilsudski signed a Franco-Polish Treaty in Paris for the "maintenance of the treaties . . . the peace of Europe. the security of their territories and their common political and military interests." The Polish *Sejm* ratified this political treaty on May 30, 1922. It was supplemented by six conventions concluded at various times before 1925, viz., a military one (unpublished), and a series of others, relating to commerce, to the possessions and rights of individuals, to the exploitation of the Polish oilfields by French capital, to the immigration of Polish workmen into France (four successive agreements, 1919–25), and to consular and juridical matters.

The treaty of March 3, 1921 with Rumania provided chiefly for mutual assistance in case of attack from the east; a military convention followed. A definite alliance between Poland and the Baltic States proved impracticable as, quite apart from the antagonism between Poland and Lithuania. the smaller states could not contemplate anything hut a defensive attitude towards Russia. In July 1921, however, representatives of Poland, Finland, Latvia and Estonia met at Helsingfors and determined to hold periodical conferences to exchange opinions on matters of policy and discuss the possibility of joint action. Such conferences were held every year since, but dealt mostly with minor financial and economic problems. An attempt to reach a political agreement in 1922 failed owing to the opposition of the Finnish diet. In Jan. 1925, a multilateral arbitration treaty was signed between Poland and the Baltic States. Commercial treaties were concluded with all the Baltic States individually, and commercial, as well as non-aggression treaties with all the three Scandinavian countries.

In the course of several years, commercial treaties were concluded by Poland with a large number of states, and in the case of some of them, arbitration treaties followed. During the years 1922–27, commercial treaties were concluded with 24 states, viz., Rumania, Italy, Switzerland, Austria, Yugoslavia, Japan, Belgium (and Luxembourg), Turkey, Finland, Great Britain (and the Dominions, treaty of July 1, 1924), Denmark and Iceland, Sweden, France (latest treaty, July 10, 1925), the United States (Feb. 10, 1925), Hungary, Greece, Czechoslovakia, Bulgaria, Norway, Estonia, Persia and Latvia.

The Minorities Questions. — Within her frontiers the new Poland, like the old, included a considerable proportion of minorities non-Polish in speech and race. They made up nearly one-third of the whole population (including approximately 3,883,000 Ruthenians, 2,123,000 Jews, 1,057,000 White Ruthenians, 1,036,000 Germans, 72,000 Lithuanians and 210,000 Russians, Czechs, Tatars, etc.), sufficient, under the system of proportional representation and *scrutin* de liste, to give the bloc of national minorities 89 deputies in the first regular *Sejm* of 444 deputies.

The Polish Minorities Treaty of June 28, 1919, signed by Poland at Versailles and guaranteed by the League of Nations, secured that all bona *fide* inhabitants of the districts allotted to Poland be admitted to Polish nationality and citizenship in the fullest sense (except in the case of recent German colonists); guaranteed the minorities the right to use their own language; to maintain their own institutions, to receive primary instruction in their own language, and where the proportion was considerable to receive "an equitable share in the enjoyment and application of public funds." The Jews are included among the "racial, religious or linguistic minorities"; Yiddish is recognized as a language, and the Jews are granted special protection as regards education and the keeping of the Sabbath.

The most difficult minorities questions, after the Jews, proved to be those of the Ukrainians. On Sept. 26, 1922 the *Sejm* passed a general law on provincial self-government which established local bodies (dietines) for dealing with purely local affairs. This law granted a small measure of autonomy to East Galicia, but not enough to prevent complaints.

Serious disputes arose, not only with the Ukrainians, but also with the German minorities. In 1924 a more conciliatory spirit began to prevail. On July 10 of that year a bill was passed providing for the use of Ukrainian, White Ruthenian and Lithuanian in government offices, law courts and schools in districts where the majority of population speaks one of those languages. In the summer of 1924 the government concluded a kind of pact with the Jewish leaders by which the government promised to promote the religious and educational interests of the Jewish community, while the Jewish leaders pledged themselves to abstain from anti-Polish propaganda abroad. But it was only the resolutely liberal policy of the government of Marshal Pilsudski from 1926 onward that achieved a greater measure of success in reconciling the minorities to Polish rule.

The Agrarian Question. — The first period of Poland's independent existence bore the marks of its origin, which had been to some extent revolutionary. The franchise promulgated in 1918 for the elections to the Constituent Assembly allowed the often untutored wishes of almost the entire adult population of Poland to find expression. The Constituent Assembly, which counted 337 members, was, in consequence, composed mainly of peasants (who form two-thirds of Poland's population). Between a group of only 32 socialists and of 107 nationalists, the peasants formed a sort of Centre Party, soon themselves divided into a right and a left wing.

The land reform bill was introduced in the *Sejm* on July 10, 1919, and was passed by a single vote in a House of about 360. It proposed the nationalization of forests and limited the amount of land to be held by an individual in Poland to from 148 to 248 ac., although in the borderlands a higher limit of 988 ac. was fixed. The land thus available was to be used for increasing "dwarf holdings" to economic small holdings and settling the landless in new small holdings. The reform, however, was not carried through as originally intended. It was impossible in any case to put through expropriation on a large scale, for financial reasons. The bill became a convenient asset in the political bargainings of the over-numerous parties of the Sejm. In 1925, it provided for the distribution of about 50,000 ac. a year to a period of 10 years. The maximum which an owner could retain was 148 ac. in the industrial centres, 740 ac. in the border provinces and 435 ac. in other areas. A series of remarkably good harvests fortunately diminished somewhat the acuteness of the problem.

The Labour Question. — Labour inspection was introduced on Jan. 3, 1919, the organization of the Labour Inspection Bureaux being slowly extended until the whole country was covered in 1923. The duties of labour inspectors include that of arhitration. Working hours were regulated by the Statute of Dec. 8, 1919, by an amendment to this statute of Feb. 14, 1922 and by various other statutes. The working day, with certain exceptions, is limited to 8 hours and the working week to 46 hours. The Decree of Feb. 8, 1919 introduced the freedom of coalition and defined the status of trade unions, which after that date grew rapidly in numbers and importance. At a later period, Poland took a very important part in the work of the International Labour Organization, being among the states to ratify most readily the draft conventions prepared by that office. Nevertheless, the position of workmen in Poland long remained distressful.

Constitution and Administration. — Under the constitution of March 17, 1921, amended in some of its articles on Aug. 2, 1926, Poland was a republic. The legislative power was vested in a diet (Sejm) and a senate, which were summoned, adjourned and dissolved, but not without their own consent, by the president. The diet was composed of paid members elected for five years, upon a system of proportional representation. Suffrage was universal, all who enjoyed full civic rights and who were over 21 being qualified to vote; soldiers on active service were excluded. Citizens over 25 were eligible for election to the diet, members of the civil service could not be elected for the district in which they held office. The minimum age for voting in senatorial elections was 30, while no one under 40 was eligible for election. Bills went to the senate after being passed by the diet and if no objection was raised within 30 days the bill became law. Taxes and customs duties could be established only by law and a supreme board of control superintended the management of state finance. The executive power was exercised by the president and a council of ministers who were responsible for his official actions. He was elected for seven years by the National Assembly, that is the diet and senate acting together.

For purposes of administration Poland was divided into 16 palatinates, which again were subdivided into districts, and urban and rural communes. The palatine or the *wojewoda* represented the executive government in the palatinate, the starosta in the district. Local legislation was to be exercised by *dietines* ("seymiki") in the palatinates, and by district councils in the districts. Economic autonomy was established by means of chambers of agriculture, commerce, industry, etc.; judicial control over the whole administration was vested in a supreme administrative tribunal.

Poland was reconstructed out of provinces of three empires in which widely different systems of law were operative. A codifying commission began to work out a body of uniform codes of law for the whole republic; in the meantime, Russian, German and Austrian codes remained in force in the different parts of the country. Gradually, many domains of legal relations were covered by parliamentary legislation, and, after 1926, by presidential decrees. A supreme court of justice in Warsaw was established at an early date, but it was only in 1928 that the country found itself in possession of a unified judicial organization and a uniform code of judicial procedure. Judges were nominated by the president, and irremovable except by judicial decision. Justices of the peace were locally elected by the people. Over property in land, forests and mineral wealth, however, a certain amount of state control was extended by special provisions of the constitution. State protection was given to labour, and insurance against unemployment, illness and accident was guaranteed. The exercise of religion was free, as far as it was in accordance with the law. The Roman Catholic religion, the predominant denomination of the country, was placed by the constitution in a privileged position.

The First Parliament. — The constituent Sejm had 13 political parties, as well as two independent members, and it was difficult to ensure a stable government. The resignation of Paderewski (Nov. 1919), was being followed by a succession of quickly changing cabinets, always based on unstable coalitions—chiefly between the Peasant Centre and either the Nationalist Right or the mainly Socialist Left. A cabinet under the former Galician peasant leader Witos (the first of three of which he was to be the head) succeeded at a critical moment in rousing the country—chiefly by lavish promises of agrarian reform to the peasants—to shake off the Bolshevik invasion. Another cabinet, headed by Professor Ponikowski, in 1922, being a non-party one, was unhampered by political conflict; accordingly, its foreign minister, Skirmunt (afterwards Polish ambassador in London), and its finance minister, Dr. Michalski, achieved certain successes—the latter by introducing a capital levy and temporarily stabilizing the currency.

Towards the end of 1922, the prolonged legislative period of the Constituent Assembly came to an end. An electoral law was passed on July 28, and in November, elections for the upper and lower house of the first regular parliament were held. They ended by distributing power in the chamber pretty evenly between the Nationalists (16.3) and the peasant groups (150); the Socialists obtained only 41 seats, but the National Minorities, by organizing a bloc for electioneering purposes, got 83 (of whom 36 were Jews) and accordingly, in spite of the large abstention of the Ukrainian element from the elections, became an important and occasionally a decisive factor in the parliamentary system.

The first business of the two houses of the new parliament was jointly to elect a president of the republic. Marshal Pilsudski refused to stand. The parties of the Left, supported by the National Minorities and the Witos Peasant Party, secured the election of Narutowicz, a friend of Pilsudski. who had acted as minister of foreign affairs in several cabinets. Polish nationalism was infuriated by the election of a president through the votes of the National Minorities, including the Jews; and on December 16 a fanatic assassinated H. Narutowicz. The new president was Wojcieshowski, an old member of the Polish Socialist party. General Sikorski became premier.

Financial Collapse and Reforms.—Poland's position in the early part of 1923 was still very unsettled. The Polish mark was affected by the collapse of the German currency. Relations with Russia remained unsatisfactory, being especially troubled by the soviet's persecution of Catholic priests. A government formed in the spring by Witos, on the basis of an alliance between the Peasant Party and the National Democrats, had to struggle against the resolute opposition of the Left and the National Minorities; in spite of an excellent harvest, the government proved unable to cope with the continued, disastrous fall of the mark; there was serious unrest in the country, culminating in riots at Cracow on November 6; and the government was obliged to resign on December 11. It was followed by a non-party one under Grabski, who, as prime minister and minister of finance, made financial reform his principal task. The political parties now at last agreed to subordinate all other problems to those of financial reconstruction. On Jan. 3, 1924, Grabski's government was granted emergency powers for the purpose. Fulfilling partly the recommendations of a British financial adviser, Mr. Hilton Young (now Lord Kennet), Grabski strenuously reorganized the financial system of the country. A bank of Poland was once more created on a basis of private subscription. The budget was balanced by draconic reductions in expenditure, the printing of paper money stopped, the currency became stabilized at the disastrous rate of exchange which it had reached (1,800,000 marks to the gold franc), and finally, a new currency unit, the zloty, was Introduced and declared equal to the gold franc. The drastic manner in which this financial reform was accomplished, inevitably brought about its revenge. The too high level at which the value of the new currency had been fixed, caused a period of heavy economic depression. The balance of the budget proved impossible to maintain, and finally the zloty fell to about half its value. The consolidation of the Polish debt to America (Nov. 14, 1924) and to Great Britain (Dec. 10, 1924) produced a favourable impression; but both an Italian and an American loan which the administration managed to obtain, were unsatisfactory; and the trading aw-ay of one asset of the state after another--such as the tobacco monopoly and the monopoly of matches—disquieted opinion at home. It was not till the force of events had corrected the errors of Grabski, that his achievements could be turned to profitable account by his successors, and the great work of financial stabilization completed.

Religious Matters.—One of the most important agreements concluded by Grabski was the Concordat reached with the Holy See on Feb. 10, 1925. The Catholic Church was granted absolute freedom of execution of her authority and jurisdiction in Poland; the assistance and support of the state being assured her in this respect. The state's interests in connection with nominations for the higher ecclesiastical posts were adequately protected. In religious education, the competencies of church and state were exactly defined. The division of Poland into ecclesiastical provinces was carried out in such a way that no portion of Polish territory remained subject to the jurisdiction of a bishop residing outside the borders of the state. An autocephalous Orthodox Church also established in Poland received the blessing of the Synod and of the Oecumenical Patriarchate in Constantinople on Nov. 11, 1924. The Protestant Church in Poland was likewise placed beyond reach of political influences from abroad.

Security.—Skrzyński, Poland's foreign minister for the second time in Aug. 1924, took an active part in the work of the Fifth Assembly of the League (Sept. 1924). The rejection of the Geneva protocol by Britain in 1925 alarmed Polish opinion. So did the German proposals to France in the spring of 1925, which treated the problems of Germany's western and eastern frontiers separately. The Polish thesis was that the question of security in western Europe was in'separably connected with that of the stability of frontiers in the east, as both were established by the Treaty of Versailles and any new agreements would have to be in strict accordance with the Peace Treaties and with the existing alliances.

Poland's relations with Germany were further troubled, firstly by the breakdown of negotiations for a commercial treaty, followed by a tariff war, secondly by a failure of the arrangements to receive the German natives of Poland who had not opted for Polish nationality, whom the Polish government called upon to leave Poland on or before July 31, 1925. Danzig was a perennial cause of friction. Its economic importance for Poland, its racial bonds with Germany, were never forgotten by either party.

The Locarno pact (*q.v.*) signed on Dec. 1, 1925, brought forward a fresh solution to the problem of Poland's security. Poland and Germany signed an arbitration treaty which included the recognition of the inviolability of the existing treaties, the recognition of the integrity of each contracting party's rights, and the elimination of war as a means of settlement of disputes and conflicts. In a separate treaty of guarantee between France and Poland, France is referred to as the guarantor of the Polish-German arbitration agreement. France undertook in the case of an unprovoked attack by Germany against Poland to abandon no means of assistance at her disposal and within the limits of the Covenant and of the agreements with Poland. Polish opinion was not easily reconciled to the idea of the Locarno pact. The arrangements mere accepted, but there was some feeling that Poland was being abandoned by France, which even brought about a temporary *rapprochement* with soviet Russia. Soon afterwards the breakdown of his financial policy caused the resignation of Grabski.

On Nov. 20, Count Skrzynski formed a new coalition cabinet. The treasury was almost empty, the shortage of private capital was very great, unemployment was rife, and the zloty continued to fall. The year 1926 opened amid violent controversy. The Socialists proposed economies on the aimy budget, but would not hear of a reduction in the number of railway employees, asked for a rise in salaries in the lower branches, and demanded a large program of public works to relieve unemployment. The Right, on the contrary, desired a reduction of civilian expenditure, while maintaining the army at full strength. Another storm-centre of embittered dispute was the question of re-instating Marshal Pilsudski in the position of commander-in-chief of the army. He had resigned the office of chief of staff during the government of the Nationalist-Peasant coalition.

In foreign affairs, the Skrzynski administration w-as under the shadow of a growing feeling of international insecurity for Poland. A large German espionape organization was discovered in Poland. When, a month after the ratification of the Locarno Treaty, the League of Nations proceeded to elect Germany a permanent member of the Council, the Polish delegates claimed a permanent seat for Poland as well. It was not till after a good deal of dramatic friction in the League that a solution was found—Germany getting a permanent, and Poland a so-called "half-permanent" seat in the Council. Apart from securing for Poland this important place in the League, the Skrzynski government endeavoured to strengthen Poland's international position by regional understanding with her neighbours: the alliance with Rumania was renewed; an exchange of visits took place between Skrzyński and Dr. Beneš, and a number of conventions, including an important political treaty, was concluded with Czechoslovakia; finally, as a result of Skrzyński's visit to Vienna, a new arbitration treaty was signed with Austria.

MARSHAL PILSUDSKI'S RULE, 1926-35

Meanwhile internal dissensions intensified while the conclusion of a new Russo-German treaty in Berlin (March 1926) increased the general nervousness. Pilsudski, in his retreat, was looked up to by large masses of the people as the only man who could secure a better future for the country. His adherents and opponents formed two opposing camps in the army. In parliament, the Right, since the days of his provisional presidency, had used every legislative device to limit his power and influence. Now, in the dispute over his commandership, the Right desired to frame the Army Organization bill in such a way as to bring the army under the direct control of parliament, while Pilsudski insisted on complete independence of the commander-in-chief.

Matters came to a crisis, when, owing to the dissensions over the budget, the Socialist ministers left the cabinet, and Count Skrzynski himself resigned in consequence. After a prolonged period of negotiations Witos succeeded in forming a ministry. Rumours were current that he meant to rely exclusively upon the support of the Right, and to settle the question of the commandership in the sense demanded by the Nationalists. Thereupon, on May 12, Pilsudski suddenly entered Warsaw at the head of troops. The government proclaimed him a rebel. The concentration of government troops in Warsaw, however, was hampered by a strong strike movement in the country, chiefly among the railwaymen; and after two days of heavy fighting in the streets of Warsaw, Pilsudski was master of the capital. The government resigned, and the president of the republic abdicated. Rataj, the marshal of the *Sejm*, became acting head of the state, in accordance nith the terms of the constitution. A provisional cabinet under Professor Bartel was appointed, pending the election of a new president. By May 17, the country was quiet, and when the two chambers met for the presidential election, there resulted an overwhelming majority in favour of Pilsudski. He, however, refused the office in favour of his nominee, Professor Ignacy Mościcki, a scientist not formerly engaged in politics, who was duly elected. Pilsudski himself became minister of war, and a few months later, officially assumed premiership in the cabinet.

Pilsudski met with little opposition when he proceeded to reform the constitution in the sense of limiting the powers of parliament, and strengthening the executive. In doing this, he stopped short, however, of the more thorough-going dictatorship established in Italy. Many points in state organization which it had proved impossible to get settled by parliament. were now settled by decree. Many personal changes were made in the higher posts both of the civil administration and of the army: they were not always improvements as far as professional efficiency was concerned, but they invariably strengthened the government's grip of the country. The freedom of political discussion in the press was curtailed by two severe decrees. On the whole, however, the home policy of the new government was liberal and democratic enough to cause no discontent among the masses.

Inflation, which had begun to reappear, was stamped out; the budget was strictly balanced, and reserves created. The urgent need for an increase in the salaries of the state servants was satisfied only gradually and by very economic instalments. This policy of circumspection, coupled with a fairly good harvest in 1926 and the favourable effect of the English coal strike that year on Polish coal export, produced good results: the rate of exchange of the zloty ceased to waver, and remained *de facto* stabilized at about 43.60 to the £, or 8.90 to the $. The government engaged the services of the American currency expert Professor Kemmerer, and the principal recommendations of his mission concerning reforms in financial administration were carried into effect by presidential decree. An American loan of $70,000,000 was obtained by Poland in autumn, 1927, and was used principally for the final stabilization of the currency system. The appointment of an American adviser as a member of the board of directors of the Bank of Poland established a useful permanent connection with American capital. In spite of frequent provocation, peace with Russia was steadily maintained; even after the murder of the soviet envoy in Warsaw by a Russian emigrant student, a rupture was avoided, and negotiations towards the conclusion of a commercial treaty were begun. Similarly, everything was done to produce better relations with Germany, although incidents which might have caused quarrels were frequent. With Germany also, negotiations for a commercial treaty were opened in 1927.

Constitutional Reform.—A year and a half after Marshal Pilsudski's *coup d'état,* a new parliamentary election became due in Poland. He had left the outward structure of the parliamentary system intact. The practical impotence, however, to which his rule reduced the sometime all-powerful parliamentary parties, had a profound effect on them. The largest groups began to disintegrate, and when the elections approached, as many as 35 different factions appeared in the field with lists of candidates of their own. This "pulverization of the party system" was the result of splits in the larger groups on the one issue that remained dominant under the circumstances, viz., the question: *for* Pilsudski or *against* him. In the midst of this re-shuffling of all former groupings, the government created a non-party *bloc* of its supporters of various shades of opinion. From the elections held on March 4 and 11, 1928, only the Socialists emerged with a substantial increase in the number of their seats (by about one-third); the other parties which had once been strong factors—the Peasant and the Nationalist Party—dwindled down to insignificant handfuls of deputies; the national minorities, largely placated by Pilsudski's liberal policy, did not form a solid anti-government *bloc,* as they had done in 1922, and therefore achieved no marked success, even in the eastern borderlands; the Jews, in particular, torn by dissensions between the Zionist intelligentsia and the Orthodox masses, lost heavily; and in the midst of all these considerably diminished factions, the government *bloc* entered parliament as the strongest of all groups. (R. Dy.)

The opposition, however, remained so strong that a normal co-operation of the parliament with Pilsudski proved impossible. In the autumn of 1930, the growing tension resulted in the arrest of some of the party leaders, who were imprisoned at Brzesc and treated there very badly. New elections held in November gave to the government *bloc* an absolute majority and after long discussion the draft of a revised constitution was voted, not without encroachment upon the existing rules of procedure.

That new constitution, finally sanctioned on April 23, 1935, was based on the following principles: the state being considered as the "common good" of all the citizens, the executive becomes considerably strengthened at the expense of the legislature; the president appoints and dismisses the prime minister and the commander of the army, can dissolve the parliament, and is responsible to none; the six "organs of the state"—government, diet, senate, army, courts of justice, and court of supervision—are accordingly under the president's control; the powers of the parliament are strictly limited, and the number of its members reduced to 208 in the lower and 96 in the upper house, one-third of the latter being nominated by the president. As a whole, it may be regarded as intermediary between plain democracy and personal government.

Bilateral Treaties.—During the first six years of Pilsudski's regime, A. Zaleski being minister of foreign affairs, Poland's policy was chiefly based upon the League of Nations and the close alliance with France. Poland which had proposed to the League's Assembly of 1927 a resolution outlawing wars of aggression, not only signed the Kellogg Pact of the next year, but even anticipated its realization by a special agreement with soviet Russia, in 1929. In 1932 that "protocol" was developed into a pact of non-aggression, which clearly expressed an imminent change in the methods of Poland's foreign policy. At the Disarmament conference of the same year, the Polish delegation had played an active part, submitting an elaborate plan of "moral disarmament"; but it became obvious that the idea of collective security had failed, and Poland sought better guarantees in bilateral agreements with her neighbours.

After 1932 this method was developed by the new minister of foreign affairs, Colonel Beck, and found its strongest expression in another 10 years' non-aggression pact, concluded on Jan. 26, 1934, with Germany. There was of course a reservation that the new treaty was not to affect Poland's previous engagements, particularly her alliance with France. Nevertheless it seemed to involve a change in Poland's general attitude, which might be explained by her opposition to the planned four-power pact and her tendency to greater independence in foreign policy. Seeing that nobody in Europe was prepared to fight the new Hitler regime, Pilsudski found it necessary to accept a direct understanding with Poland's western neighbour also, holding the balance between Russia and Germany.

1935–39

After Pilsudski's death on May 12, 1935, the form of government which he had established continued without much change. The voting regulations, as applied at the elections of 1935, without having been defined in the new constitution itself, again raised much discontent; but attempts were started to come to some co-operation with various groups of the opposition. The government *bloc* was dissolved and replaced by a "Camp of National Unity," the work of Colonel Koc. Both President Mościcki, who had been re-elected in 1933 for another 7 years' period, and Marshal Smigly-Rydz, Pilsudski's successor as commander of the army (who was appointed "the second person" in the republic), exercised their authority with moderation and in a conciliatory spirit. Such an appeal to internal unity was indeed indispensable in face of the increasing danger of the international situation.

The Origin and Outbreak of the War.—That danger resulted from the policy adopted by Germany. After the annexation of Austria and the destruction of Czechoslovakia, it was clear that Hitler wanted to isolate each of Germany's eastern neighbours to be attacked one after the other. Soon after Munich, when Poland had seized the opportunity to claim the contested territories in the Cieszyn (Teschen) region, there began a new tension between her and Germany. Yet on Jan. 30, 1939, Hitler reaffirmed the importance of the German-Polish non-aggression pact as a contribution to the peace of Europe; but he had already decided to annex the Free City of Danzig, and on March 27 he officially requested the Polish government to accept that solution as well as the construction of an extraterritorial motor road through the Polish province of Pomorze, the so-called "Corridor." Touched in her vital interest and realizing that it was a first challenge against her independence, Poland refused. making counter-proposals which were never taken into serious consideration. And as soon as Poland had exchanged with Great Britain reciprocal guarantees of independence and integrity, Hitler took it as a pretext to denounce, in his speech of April 28, the non-aggression pact of 1934.

During the next four months he tried to provoke Poland by various incidents in Danzig and started a propaganda campaign against an alleged ill-treatment of the German minorities in Poland. But it was not before having concluded, on August 23, a far-reaching "non-aggression" treaty with the soviets that he finally decided to attack Poland. Two days later a close alliance was signed between Poland and Great Britain which made it absolutely clear that Britain, as well as France, would support her ally in case of war; but in spite of a patient conciliatory effort made by British diplomacy, and proposals of a peaceful settlement put forward by various powers and accepted by Poland, Hitler invaded Poland on September 1.

Poland, which had postponed the general mobilization to the last moment, was unable to stand against the overwhelming German forces, the long open frontier stretching from East Prussia to Slovakia being already occupied by German troops; nevertheless she made a courageous resistance in the centre of the country until Sept. 17, when soviet Russia invaded her territory from the east, under the pretext that the Polish state, with which she had concluded and recently extended a non-aggression pact, was no more in existence. Even then in various regions desperate fighting was continued, and Warsaw, although hideously bombed, like so many other open places, defended itself heroically until September 27. The next day a German-Russian treaty was signed in Moscow involving a new partition of Poland: the eastern provinces, including purely Polish territories, were incorporated in the soviet republics of White Ruthenia and the Ukraine; the western part was left within the German sphere of influence, and the provinces which had belonged to Prussia before 1914 were annexed at once, not without a barbaric massacre of their Polish inhabitants. In the centre also, where Hitler tried in vain to form a pseudo-Polish "government" under his control, cruel persecution followed the hostilities.

Even before leaving Polish territory, President Mościcki resigned and designated W. Raczkiewicz as his successor. The new president appointed a new government, the former having been interned in Rumania. General Sikorski became prime minister, Zaleski minister of foreign affairs; and both president and government were established at Angers, France. The Polish army was also reconstituted in France, to fight with the Allies, while some Polish warships, having escaped, joined the British navy. (*See* World War II.) (O. Ha.; X.)

POLAND IN WAR

General Sikorski not only accepted the portfolio of military affairs, which later, in 1942, was given to the noted historian General Marian Kukiel, but also became the commander-in-chief of the reorganized Polish army. This was possible owing to the favourable circumstance that part of the Polish army passed into Hungary and Rumania, and succeeded in assembling in France, where their ranks were swelled by mobilization among the pre-war Polish emigrants in that country. The Polish army numbering nearly 100,000 was ready for battle by the spring of 1940. Some of its units had already distinguished themselves in the distant Norwegian expedition of the allies, especially in the battle of Narvik; but the Polish soldier covered himself with fresh glory, above all, in the share he took in the defense of France.

The collapse of France was likewise a heavy blow for Poland. In spite of fresh losses and the capitulation of one of the allies, the Polish army did not even now dream of ceasing to fight. About 15,000, who had heroically protected the retreat of one of the French armies, had to cross into Switzerland, where they were interned. A part of the Polish army was transported to England, where at the end of June 1940, the Polish government together with the president transferred themselves. The Polish troops, quartered chiefly in Scotland, undertook the defense of a certain part of the British coast, the Polish airmen began increasingly to distinguish themselves, acting with the royal air force, and simultaneously Polish divisions, dispersed through the world, as of old in the Napoleonic wars, have appeared in Palestine and on the fields of the Egyptian-Libyan battles, while Polish volunteers have not been absent even from the Greek front.

The break between Hitler and Stalin, between naziism and communism, whose joint action against Poland brought both attacks against this country, that of Sept. 1 and that of Sept. 17, 1939, started a new war on Polish soil and brought still more devastation and hardship to an already inhumanly suffering country. The war between Germany and Russia confronted the Polish government with a difficult decision. Taking into consideration the foremost necessity of defeating Germany and the common interests of all the allies, Poland not only agreed to make peace with Russia on July 30, 1941, but concluded with her a close alliance on Dec. 4 of the same year and decided effectively to assist the Russians.

Poland's hope for the complete restitution of her freedom and integrity received the strongest possible support by the second great event of 1941: by America's entry into the war after the aggression of Pearl Harbor on Dec. 7.

To that so-called "New Order" which the totalitarian powers desired to impose upon Europe, Poland, in co-operation with her allies, opposed her own political conception evolved from her history of a thousand years, especially from the epochs of her political greatness. It was clear that this conception could only be realized after a British-American victory. The declaration given out in common by the Polish and Czechoslovakian governments at the end of the Year 1940, proved that Poland had a full comprehension of the necessity of these independent states joining into federal unions, and that she-was conscious of her share of responsibility for precisely such a settlement of that most threatened part of Europe between Germany and Russia, in which the central key position had for centuries fallen to Poland. The promise of a closer Polish-Czechoslovakian collaboration towards that object had a deep significance, removing the unfortunate misunderstanding between these two nations, and at the same time offering a distinct encouragement to other nations of that region to join, obviously on the principle of equality for all, the projected federal system. Moreover, at the International Labour conference held in Washington one year later, these two nations decided closely to co-operate with two others, Yugoslavia and Greece, which concluded a similar agreement. Part of the Polish soldiers released from Russian prison camps reached England and the middle east by the end of 1942. Early in 1943 the Polish army numbered over 130,000. (J. Ci.)

BIBLIOGRAPHY.—1. *Political History.* The epoch-making book of Michal Bobrzyriski, *Dzieje Polski w zarysie* (2 vols., 1877; 4th edition, Warsaw, 1927) gave expression to the views of the so-called "Cracow School" whose leading idea was that inward political decay was the principal cause of the fall of Poland. These views have since been counterbalanced by those of the "Warsaw" and the "Lwow" (Lemberg) school, which placed emphasis on outside aggression. An up-to-date presentment of Polish history is given in a history of Poland which forms part of a *Polish Encyclopaedia* published by the Polish Academy at Cracow, *Historja polityczna Polski* (vol. I., 1920; vol. II., 1923).

2. *Constitutional History.* Stanislaw Kutrzeba, *Historja ustroju Polski w zarysie,* vol. I., Poland (7th ed., 1935), vol. II., Lithuania (2nd ed., 1920), vols. III.–IV., post-partition history, 2nd ed. (1920, Lwow).

3. *Economic History.* Jan Rutkowski, *Zarys gospodarczych dziejdw Polski* (Poznan, 1923).

4. *History of Manners.* Wladyslaw Eozinski, *Życie polskie w dawnych wiekach* (Lwow, 1907, 6th ed., 1922).

5. *History of Education.* Antoni Karbowiak, *Dzieje wychowania i szkół w Polsce w wiekach Srednich* (vols. I.–II., St. Petersburg, 1898–1904, vol. III., Lwow, 1923), for the middle ages; for the modern period, *see* the chapters on Poland in the general history of education by Stanislaw Kot, *Historja wychowania* (Warsaw, 1924 bibl.).

6. *History of Polish Law.* Przemyslaw Dombkowski. *Prawo prywatne polskie* (2 vols., Lwow 1910–11); Julian Makarewicz, *Polskie prawo karne* (Lwow 1919).

7. *Military History.* Tadeusz Korzon, *Dzieje wojen i wojskowości w Polsce* (3 vols., Cracow 1912).

8. *Sources.* Collections of sources published by the Polish Academy at Cracow: *Monumenta Poloniae historica* (1864–93, 6 vols.); *Scriptores rerum Polonicarum* (1872 ff., 23 vols., in progress); *Monumenta medii aevi* (1874 ff., 19 vols., in progr.); *Acta historica* (1878 ff., 14 vols., in progr.); *Corpus iuris polonici* (1906 ff., 4 vols., in progr.); *Monumenta Poloniae Vaticana* (1913 ff., 6 vols., in progr.); *Monumenta Poloniae palaeographica* (1902–10); *Źródła do dziejów Polski porozbiorowej* (1907 ff., 17 vols., in progr.). At Lwow there were published *Akta grodzkie i ziemskie* (1868 ff., 23 vols., in progr.); in Warsaw: *Źródła dziejowe* (1876–97, 24 vols.).

9. *Bibliography.* Ludwik Finkel, *Bibljografja historji polskiej* (Cracow, 1891–1910, 3 vols., supplt., 1914).

10. *Periodicals. Kwartalnik historyczny* (Lwow, since 1887); *Przegląd historyczny* (Warsaw, since 1905); *Reformacja w Polsce* (Cracow, since 1921) devoted to studies of the Reformation.

11. *History of Poland since 1914.* Anonymous (M. Bobrzynski): *Wskrzeszenie Palistwa polskiego* (2 vols., Cracow, 1920); Stanislaw Kutrzeba, *Polska odrodzona* (Cracow, 1922); Roman Dmowski, *Polityka polska i odbudowanie Państwa* (Warsaw, 1925); Marjan Seyda, *Polska na przełomie dziejów* (Poznan, 1927); K. W. Kumaniecki, *Odbudowa państwowości polskiej, najwazniejsze dokumenty* (Cracow, 1924).

12. *Books on Polish History in German, French and Italian.* R. Roepell, *Gesclzichte Polens* (vol. i., 1840), continued by J. Caro (vols. ii.–iv., 1–2, 1863–88) and E. Zivier (vol. v., 1915, carries the story down to 1572); Henri Grappin: *Histoire de Pologne des origines à 1922* (1922); Fr. Tommasini, *La risurrezione della Polonia* (1925, by the first Italian Minister in Warsaw after 1918); Casimir Smogorzewski, *La Pologne restaurée* (1927); O. Halecki, *La Pologne de 963 à 1914* (1933); St. Filasiewicz and K. Lutostański, *Recueil des actes diplontatiques, traités et documents concernant la Pologne* (2 vols., I. Neufchatel, 1918; II. Paris, 1920).

13. *Books on Polish History in English.* Roman Dyboski, *Outlines of Polish History* (1925, bibl.); Charles Sarolea, *Letters on Polish Affairs* (Edinburgh, 1922); Alexander Skrzynski, *Poland and Peace* (1923); Roman Dyboski, *Poland Old and New* (1926); R. L. Buell, *Poland, the Key to Europe* (1939); W. J. Rose, *Poland* (1939); *The Cambridge History of Poland* (2 vols.); O. Halecki, *A History of Poland* (1943).

14. *Encyclopaedic Accounts of Contemporary Poland. The Polish Handbook* (1925); *Alnzanach Polonais* (1926); *Das heutige Polen* (text in German, French and English, Vienna, 1927). An up-to-date outline is given under "Polska" in the *Encyklopedia Nauk Politycznych,* iv., 3 (Warsaw, 1939); *All About Poland,* edit. J. H. Retinger (London. 1941).

POPULATION

The population of Poland in 1931 was 31,927,773. In 1939 it was estimated at 35,100,000. The detailed population returns for 1931 are shown in the subjoined table:

provinces	Area in Square Km.	Population	Density per Square Km.
Bialystok	32,134	1,640,374	51·0
Cracow	17,448	2,297,027	131·6
Kielce	25,741	2,935,680	114·0
Lwow	28,391	3,127,138	110·1
Lodz	19,034	2,632,434	138·3
Lublin	31,123	2,468,391	79·3
Nowogródek	23,169	1,054,846	45·5
Polesie	36,825	1,133,398	30·8
Pomorze	16,386	1,086,144	66·3
Poznan	26,528	2,112,871	79·6
Silesia	4,230	1,298,851	307·1
Stanislawów	16,909	1,475,954	87·3
Tarnopol	16,332	1,599,574	97·9
Vilna	28,948	1,272,851	44·0
Volhynia	35,729	2,081,501	58·3
Warsaw	29,463	3,710,739	125·9
Total	388,390	31,927,773	82·2

In regard to population Poland occupies sixth place among the countries of Europe, coming after Russia, Germany, Great Britain, France and Italy. The chief feature of recent years has been the movement of the rural population to the towns, of which 51 in 1931 had a population of over 25,000. The largest towns are Warsaw, the capital, with 1,289,000 inhabitants (est. 1939); Lodz, with 672,000; Lwow, with 318,000; Poznan, with 272,000; Cracow, with 259,000; and Vilna, with 209,000. The population is most dense in the industrial areas of Silesia, Lodz and Warsaw, and in the fertile agricultural districts of Cracow, Lwow, Tarnopol and Kielce; but it is far more scattered in the eastern provinces.

According to nationalities the population was made up as follows in 1931:—

Nationality	Total No.	Percentage
Poles	22,000,000	68·9
Ukrainians	3,200,000	10·1
Jews	2,700,000	8·6
Ruthenians	1,200,000	3·8
White Ruthenians	1,060,000	3·1
Germans	700,000	2·3
Lithuanians	100,000	0·3
Czechs	47,000	0·1
Others	920,000	2·8
	31,007,000	100.

In Poland the Poles form over two-thirds of the population, constituting the great mass of the inhabitants of all the western and central provinces, with a German minority in Silesia, Poznan and Pomorze. The Poles are in a minority in the Ruthenian provinces of Stanislawów, Tarnopol, Volhynia and Polesie, while the nationality of the White Ruthenians of Vilna and Nowogrodek is a matter of dispute, those who are Catholics being claimed as Poles. The Jews are scattered over the whole territory, being particularly numerous in Warsaw and Lodz and in the towns of the eastern provinces.

With the exception of the Kashubes of Pomorze, who are a relic of the old Pomeranians, the Polish people form one ethnological group. Certain peculiarities of geography or history give local differences to the Mazovians, who are well built, sturdy folk, drab in costume, tenacious of their ancient customs, democratic and great colonists; to the Gdrale or highlanders of the Carpathians; to the Kurpie of the Narew basin; and to the Poles of Silesia. But the attempts of hostile politicians to claim wide differences of dialect and custom have not been justified. The Poles are more uniform in language and customs than any other great nation.

POLES ABROAD

There are some 8,500,000 Poles living outside the frontiers of Poland, either as autochthonous inhabitants, or as emigrants who left their country in search of work. Of those autochthonous Poles living on the borders of Poland there are some 80,000 in former Czechoslovakia. In Lithuania there are about 200,000 around Kovno (Kaunas) and Kiejdany; in Latvia there are 75,000 near the Polish frontier and around Riga and Mitava, while there are 80,000 in Rumania in the former province of Bukovina.

The number of Poles in the U.S.S.R. reaches the figure of 1,000,000, half of them being autochthonous in White Russia and Ukraine, the remainder being the descendants of those Poles who for various reasons, mainly political, settled in the eastern province of the Russian empire.

The greatest centre of Polish immigration in Europe is France. In the year 1929 it was estimated that there were 800,000 Poles in France, but later, owing to the economic crisis, this number dropped to about 600,000. About two-thirds of these Poles work in the mines and textile mills in the northeastern departments of France, around Lens and Lille, while there are not a few living in Alsace.

Many Polish industrial workers are also found in and around Paris and Lyons. About one-third of the Polish immigrants work on the land, mainly in the southwestern districts, of which the centre is Toulouse. They are (1939) granted adequate educational facilities by the French government, and about 35,000 Polish children are taught in their own language. Three daily newspapers are published in the Polish language, as well as about a dozen other periodicals.

In Belgium there are about 35,000 Polish workers, mostly miners, concentrated in the province of Limburg. They also have schools for about 3,300 children.

Lastly, Holland accounts for 4,000 Polish workers, Denmark has 12,000, Yugoslavia 25,000 and Hungary 7,000, without counting the smaller groups of Poles in Bulgaria, Esthonia and Luxembourg.

Outside of Europe, the biggest Polish colony is in the United States. It is estimated that there are some 4,000,000 Poles, many of them settled in America for several generations, preserving their language and customs although remaining at the same time loyal citizens of the country which gave them their opportunities. The great majority of these Poles are industrial workers, while about one-fifth are farmers and agricultural workers.

The largest Polish population is in Chicago, where there are approximately 500,000 men and women. The estimated Polish population of other centres is as follows:

Detroit	200,000
Milwaukee	125,000
Cleveland	110,000
Buffalo	100,000
Philadelphia	75,000
Pittsburgh	75,000
New York	70,000
Toledo	40,000

The Polish agricultural population is to be found chiefly in the states of Texas, Michigan, Wisconsin, Missouri and North and South Dakota.

The Poles in America have formed important associations, the largest of which is the National Union of Poles ("Związek Narodowy Polski") with a membership of over 300,000, the Polish Roman Catholic association ("Zjednoczenie Polskie Rzymsko-Katolickie") with 160,000 members, and the Association of Polish Women, with about 60,000 members. About 800 Polish Catholic parishes exist in America, served by more than 1,000 clergymen, with some 600 primary schools and 20 higher schools, while many American universities have special Polish lecturers.

There are about 65,000 boys and girls in the Polish scout movement in the U.S.A. The "Polish-American Council" in Chicago, Ill., is the chief Polish organization in the United States.

Ninety-six Polish periodicals are published in the U.S. in Polish, including nine daily newspapers.

In Canada there are about 150,000 Poles, chiefly agricultural workers in the provinces of Ontario, Manitoba, Alberta and Saskatchewan. The Polish industrial workers are centred in Winnipeg, Toronto and Ottawa. The Canadian Poles have a number of Polish schools (about 30) and Polish organizations. They publish only three periodicals, as they read mainly those published in tne United States.

In Brazil there are about 300,000 Poles settled principally in the state of Parana (200,000), but there are also many in Rio Grande del Sul and in Santa Catharina. The centre of the Polish movement in Brazil is the town of Curitiba in Parana.

In the Argentine there are 70,000 Poles, mostly industrial workers. Apart from Buenos Aires, the greatest number of Poles are in the province of Missiones. There is only one daily paper and six periodicals, while there are very few Polish schools, attended by about 350 children.

In Paraguay there are about 18,000 Poles, mostly farmers in the country near the town of Fram. The number of Poles in other South American republics does not reach more than 1,000 or 2,000 in each country.

Two thousand Poles live in Australia—in Brisbane, Sydney and Ipswich, while a few thousand are in South Africa, and about 1,000 in Morocco and Algiers.

Owing to the unsettled political and economic conditions in China, it was impossible to obtain exact facts and figures in 1943, but there must be some scores of thousands of Poles in that country, especially in Shanghai and Charbin.

ECONOMIC AND FINANCIAL CONDITIONS

The economic organization of Poland by a political unit was kept in suspense, after 1918, until some definite basis could he created both for external and internal relations. In foreign affairs the essential preliminary of defined frontiers was not obtained until the defeat of the Bolshevist armies, in Aug. 1920, had been crowned by the Treaty of Riga (March 1921), and not put beyond question until Polish Upper Silesia was taken over in July 1922. At home a constitution and administration had to be created in the midst of the war with the bolshevists, and the damages of World War I repaired.

Agriculture.—Although industry has developed rapidly in Poland, agriculture is still the predominant occupation of her population, 65% of whom earn their living by the cultivation of the soil. World War I caused such devastation in all parts of Poland except the western provinces, that agriculture received a blow from which it recovered only shortly before World War II. It is estimated that 500,000 habitable wooden buildings and 1,248,000 agricultural buildings were destroyed, of which from 6; to 72% have been reconstructed. It must be remembered that the war in Poland lasted till 1921. The second great influence on Polish agrarian conditions was the Russian revolution, which caused the Polish government to make wide promises of land to peasants and ex-service men, such as were made in all central Europe. The Agrarian Act of 1920 was modified in 1925. It establishes a great area of land to be devoted to agrarian reform and parcellation among the peasants. This consists, firstly, of the vast state domains taken over from the governments of Russia, Prussia and Austria; secondly, of ecclesiastical lands and lands owned by public institutions; thirdly, of all other estates of an area larger than 444½ ac. (988½ ac. in Volhynia, Polesie and Nowogródek) in the country, and 148 ac. in urban or industrial areas. Peasant appropriations have gone steadily forward. The total area of land reallocated in accordance with the provisions of this act amounted to 200,000 hectares in 1926 and up to 2,654,800 hectares in the period 1920–38.

As is natural, small estates predominate, forming over 50% of the whole area, and being concentrated chiefly in Galicia and the former "Congress Kingdom." Large estates predominate in the western and eastern provinces. Large estates number 19,457 and occupy an area of 14,186,600 hectares, while small estates number 3,298,500 and occupy 24,646,200 hectares. Thus the greater part of agricultural land in Poland is owned by peasant proprietors, though there is still a large class of greater landowners. The area of land suitable for agricultural purposes shows that corn-growing is the chief feature of Polish agriculture:—

	Ha.	Per cent of total area
Arable land	18,307,800	48.6
Meadows	3,838,000	10·2
Pastures	2,528,600	6·7
Forests	8,943,762	24·1
Waste land	3,924,800	10·4

The chief agricultural products are rye, oats, wheat, barley and potatoes. The yields in 1937 and 1938 compared with those in the same territory before World War I were as follows:—

	Yield in thousands of metric tons		
	1909–13 average	1937	1938
Wheat	1,653	1,926	2,171
Rye	5,625	5,637	7,253
Barley	1,466	1,363	1,371
Oats	2,772	2,342	2,656
Potatoes	24,423	40,221	34,558

The farmers are greatly aided by government loans at low interest rates for the purchase of machinery, implements and artificial fertilizer.

The ravages of World War I were nowhere more seriously felt than in the destruction of livestock. The re-stocking of farms and estates, however, made excellent progress in 1925-27, so that in the latter year there were already a larger number of horses, cattle, pigs and sheep than in 1913. The export of live cattle and meat is rapidly growing. The export of packed meat rose from 2,000 metric tons in 1934 up to 17,000 metric tons in 1938. The export of bacon rose from 1,000 metric tons in 1928 to 21,000 metric tons in 1938.

Forests cover 24% of Polish territory and total 8,943,762 ac., of which 2,834,000 ac. are government owned. Pine trees form 65% of the forests and predominate in the western and central provinces. In the southeast deciduous trees prevail, of which the oak is the most important. Fir and beech trees appear in the southern provinces. The largest forests are those of Bialowieźa, where the trees are mostly 200 years old (pines, oaks of great height and diameter. elms. firs and alders), Augustów, Grodno, Kurpie, Tuchole, Polesie and the East Carpathian forest.

Manufactures and Mines. — Poland, as an economic unit, suffers from the diversity of origin of her industries. Poznan and Pomorze were utilized by Prussia as granaries and developed few industries. Galicia similarly found it hard to compete with Austrian and Czech factories, and remained predominantly agricultural. The "Congress Kingdom," on the other hand, developed certain industries in its days of independence, 1815-31, and after its incorporation in Russia produced a great textile industry for the Russian and eastern markets.

Polish industry adapted itself to new conditions within a comparatively short time. The ruined factories were rebuilt, a number of new industrial establishments were created, as well as new branches of industry — for example, the manufacture of aeroplanes, railway coaches and locomotives, chemical and electro-technical works, and the industry working for national defense.

The economic world crisis, 1929-33, strongly affected the Polish industry, causing a drastic decrease of production. The crisis did not, however, affect very much the technical development of Polish industry, some branches of which, as for instance, the chemical, electrotechnical, paper, textile and metal industries, began to produce many new articles which replaced those which hitherto had been imported from abroad. As a result of such activities, the foreign trade of Poland showed a decrease of the import of manufactured goods, and a steady increase of the import of raw material and semi-finished goods. There were in Poland 222,000 industrial establishments in 1935 The majority of them were small undertakings, and less than 9,000 establishments employed over 15 workmen each. At the beginning of the year 1939 approximately 800,000 workmen were employed by larger undertakings.

Besides industrial establishments there exist in Poland approximately 360,000 artisans' workshops which play a rather important part in the production of the country.

The largest decrease in industrial production caused by the economic crisis occurred in Poland in the years 1932 and 1933. From the middle of 1933 industrial production began to rise, which was particularly noticeable during the year 1936 and the beginning of 1937. The index of industrial production (taking as base-year 1928=100) reached the figure 119 in 1938 (annual average).

Metal Industry. — The metal industries in Poland operate 1,753 plants and employ approximately 156,000 workmen and 17,000 engineers and clerks. In the production of pig-iron Poland ranks ninth in Europe and eighth in the production of steel. The output of Poland's iron foundries surpasses the requirements of the home market and consequently a large part of its iron products is exported.

There are in Poland 16 iron foundries, 102 iron-casting foundries, 65 non-ferrous metal and casting foundries, 121 plants of machine parts, 104 plants of agricultural machinery, 87 plants of rolling stock, and a variety of other metal industry works.

The chief items of metal industry production in 1938 were:

Pig-iron	880,000	tons
Steel	1,441,000	"
Hot rolled iron	1,075,000	"
Drawn iron wire	80,000	"
Galvanized iron sheets	41,000	"
Zinc sheeting	30,000	"
Metal bedsteads	88,000	"
Iron wire nails	37,000	"
Goods wagons	579	"

Other metal products were: steam boilers, internal-combustion engines, pumps, wood and metal-working machines, agricultural and textile machines, electrical machines, radio receivers, telephone apparatus, etc.

A large quantity of the products of Polish metal industry is exported to foreign countries. In 1936, 356,671 tons of various metal products were exported, including 142,355 tons of iron and steel, 50,410 tons of tinware, 27,154 tons of rails and 65,290 tons of zinc.

Textile Industry. — The textile industry of Poland, developed in the second part of the 19th century, was almost entirely destroyed by World War I. After 1919 the ruined mills were restored, modern machinery installed, the quality of products improved. The home market was greatly developed and new branches of the textile industry *e.g.*, the silk industry, were created.

In the cotton industry on Dec. 31, 1935, there were 1,870,000 spindles and 47,000 looms; in the woollen industry 799,000 spindles and 14,000 looms; in the linen industry 36,500 spindles and 1,700 looms; in the jute industry 27,000 spindles and 1,700 looms; and in the silk industry 2,400 looms.

The textile industry in Poland is centred in three main groups— Lodz, Bialystok and Bielsko.

Lodz produces cotton goods, woollen rugs, haberdashery, natural and artificial silk, laces, curtains and embroideries. Bialystok specializes in woollen rugs, haberdashery and garments. Bielsko produces high quality combed-wool fabrics. The largest linen mills are in Warsaw, Zyrardów, Częstochowa and Cracow. Most of the plants producing knitted goods and hosiery are located in Lodz and Warsaw

In 1937 the output of yarn in Poland was 138,100 tons, of which 77,500 tons was cotton yarn. The production of textile fabrics was 95,300 tons, of which 51,500 tons was cotton fabrics. The output of knitted goods, excluding gloves and stockings was 2,924 tons. The total number of textile plants was 2,387, employing 157,067 manual and 6,617 white collar workers.

The export of textile raw materials and goods from Poland amounted in 1936 to 42,718 tons and in 1938 to 26,000 tons.

Chemical **Industry.**—The chemical industry of Poland is particularly developed in those branches of chemical production which have a basic importance for other national industries. The important fertilizer industry is centred in two state-owned factories: Moscice, near Tarnow, and Chorzow in Silesia. The production of fertilizers (nitrogenous, phosphorous and potassium) not only meets the demands of Polish agriculture but leaves a considerable surplus for export. Besides fertilizers, the chemical industry of Poland comprises: the coal derivative industry, dyestuffs, wood distillation, artificial fibre, oil, soap and scent, paint and lacquer, explosives, celluloid, plastic, compounds and rubber goods. The value of the total output of chemicals in Poland was in 1935 more than $150,000,000. The chemical industry of Poland employs 54,000 workers.

Poland's export of chemical products in 1938 included: potassium salt fertilizers, artificial silk, superphosphates, henzol, zinc white, tar, carbide, soda ash, ammonium, sulphate, oil cakes, explosives, oilcloth, glue, potassium carbonate, ammonium chloride and carbonate.

The value of the export of Polish chemicals amounted in 1938 to 195,000 tons, about $6,000,000.

Glass, Ceramics and Earthenware. — These industries operate 2,053 plants employing over 84,000 workers. There are in Poland: 1,099 brick-yards, 157 tile and ceramic works, 156 concrete and cement works, 69 glass works. 38 potteries and 170 quarries. Polish glassware is exported to 55 European and oversea countries, and Polish chinaware to over 40 countries.

Paper Industry. — The production of paper in Poland amounted to 113,000 tons in 1932, 128,000 tons in 1933, 136,000 tons in 1934, 142,000 tons in 1935, and 205,000 in 1938. The chief types of paper exported from Poland are: cigarette paper, wrapping paper, duplex boards, pasteboards and cardboards, grease-proof paper, etc.

Timber Industry. — The timber industry of Poland produces and exports the following articles: railway sleepers, telegraph-poles, pitprops, pulpwood, masts, battens, piles, hewed-edged wood, barrels, staves, beams, boards and planks. The timber manufacturing industries of Poland produce the following commodities: packing cases, flooring, barrels for wine, butter, edible fats, herring, cements, cobblers' materials, bentwood furniture, plywood and veneers.

Export of timber and wooden goods from Poland:

1935	1,733,046	tons
1936	1,678,575	"
1937	1,693,000	"
1938	1,688,000	"

Leather **Industry.**—The chief items of production were (1938): sole leather, 23,604 tons; butts for belts, 624 tons; saddlery and harness leather 400 tons; Upper Russian leather, 1,000,000 tons; calf skin and calf leathers 1,320,000 sq.m.; sheep skins, 814,000 sq.m. and 123 tons of bristles.

Footwear **Industry.**—The mechanical production of footwear amounted in 1938 to approximately 2,800,000 pairs of leather shoes, 2,400,000 pairs of boots, 2,900,000 pairs of rubber footwear and 2,700,000 pairs of galoshes. The production of the individual shoemakers has been certainly much larger than that of the footwear factories, but no detailed figures concerning it are (1943) available.

Crude Oil and **Oil** Products. — Poland is one of the three great oil-producing countries in Europe. The oil industry of Poland is the oldest in the world, dating back as far as 1853. Polish oilfields cover an area of over 9,000 sq.mi. along the Carpathian mountains. The chief centre of oil production is the Boryslaw region. The richest deposits of earth gas are in the Stryj and Jaslo district in southeastern Poland. The output of crude oil in 1936 reached 511,000 tons and the production of oil by-products was 450,000 tons, of which 40% was exported chiefly to the countries of central Europe. Oil refineries are concentrated around Drohobvcz. Deposits of paraffin wax are worked at Boryslaw. The possibilities of the Polish oilfields have not yet (1943) been fully examined and exploited. Prospecting for new oilwells was started with the application of modern methods of drilling and good results were being obtained. Foreign capital represented 87% of the stock invested in the oil industry in Poland.

Rock and Brine Salt.—The salt deposits in Poland are to be found in the Sub-Carpathian district and in the Warsaw (Ciechocinek), Poznan and Silesia districts. Over 50% of the salt output is rocksalt in the salt mines of Wapno near Inowroclaw (better qualities), of Wieliczka (near Cracow) and Bochnia. The balance is brine salt.

One of the oldest and richest salt mines of Europe is that of Wieliczka near Cracow. It has been known since 1040. It is state property. The excavations are on eight different levels, 3.5 mi. long and 1 mi. wide and nearly 400 ft. deep. The passages total more than 60 mi. The production of salt in 1938 was 643,000 tons.

Potassium Salts.—The deposits of potassium salts in Poland are very rich and are estimated at 450,000,000 tons. The production of potassium salts amounted in 1938 to 567,000 tons. Potassium salts are an important factor in the development of Polish agriculture and the chemical industry. They are mined in Kalusz, Holyn and Stebnik (southern Poland). The production ranked third in Europe (after Germany and France).

Ores.—Iron-ore deposits are located in the south of Poland, in the district of Kielce, near the Cracow coal basis, and in the district of Radom. They contain 35% Fe. The production of pig-iron was 394,000 tons in 1935, and 879,000 tons in 1938. The production of steel was 946,000 tons in 1935, 1,145,000 tons in 1936, 1,451,000 tons in 1937, and 1,441,000 tons in 1938. Zinc and lead ores are located chiefly in Upper Silesia and the voivodships of Kielce and Cracow. Approximately 90% of the total production is mined in Upper Silesia.

In 1935 Poland produced 85,000 tons of zinc and 19,000 tons of lead. in 1936, 93,000 tons of zinc and 15,000 tons of lead, and in 1938, 108,000 tons of zinc and 20,000 tons of lead. Poland occupied the fifth place in the world production of zinc, ranking after the United States, Belgium, Germany, Canada.

Other Minerals.—Among other deposits Poland possesses copper, sulphur, lime, chalk, fireproof clay, kaolin, building stones, coloured sandstones, marbles (in Silesia and in southern Poland), and granites (in Tatra mountains). The production of cement is an important branch of industry in Poland. In 1934 it amounted to 721,000 tons, in 1935 to 843,000 tons, in 1936 to 1,052,000 tons and in 1938 1,719,000 tons. The production of lime reached 554,000 tons in 1935 and in 1937, 769,000 tons.

There are also numerous mineral springs in Poland. Their main groups are salt, alcalic-oxalic, alcalic-salt and sulphuric waters. Most of them are found in southern Poland and some in the central voivodships (Ciechocinek, Inowroclaw). The Polish mineral springs are of great importance for the development of the health resorts.

Of industries depending on agriculture, the sugar industry is the most important, Poland coming after Germany, France and Czechoslovakia as a sugar-producing country. There were 62 sugar factories in 1938, producing 450,000 tons. Distilling is an important industry, since Poland has the second largest potato crop in Europe.

Coal.—The Polish coal district is near the junction of the Polish-German and Czechoslovakian frontiers. The area is not geologically

Mining of Coal in the Polish Coal Basins

Coal basins	1935	1936	1937	1938
	(in millions of tons)			
Silesia	21·1	22·1	27·4	28·8
Dąbrowa	5·4	5·6	6·5	6·7
Cracow	2·0	2·0	2·3	2.6
Total	28.5	29·7	36.2	38·1

uniform but falls into three distinct districts: (1) Silesia is the richest of the three, has coal of very good quality and easily workable; (2) Dąbrowa has coal of medium quality and, (3) Cracow basin produces coal of inferior quality. Of the coal produced, Silesia supplied 75%, Dqbrowa 18% and Cracow 7% of the total output.

About 60% of the capital invested is foreign, German capital being predominant in Silesia, French in Dqbrowa and Polish capital in Cracow.

In 1928, 117,000 men were employed in coal mines, but this number dropped to 75,000 in 1934. This considerable decrease was partly the result of the introduction of new methods of mining. While in 1934 a workman's daily output was 633 kg., in 1929 it was 1,264 kg. and in 1933 it rose to 1,571 kg., nearly two and a half times more than it was 10 years before.

In the world's coal production Poland stood seventh, ranking after the following countries (figures for 1936):

World	1,249,000,000 tons
U.S.A.	443,000,000 "
Great Britain	232,000,000 "
Germany	158,000,000 "
U.S.S.R.	124,000,000 "
France	45,000,000 "
Japan	42,000,000 "
Poland	30,000,000 "

The consumption of coal in Poland was divided between the industries (50 to 60%), the railways (about 15%) and private consumption. It was about 621 kg. per head of the population.

Of the 38,000,000 tons of coal produced in Poland in 1938, 26,000,000 were sold on the home market, and 12,000,000 exported to foreign countries. As a coal-exporting country Poland occupies the third place in Europe, after Great Britain and Germany. The exports went mainly to the Scandinavian, central and western European countries. In spite of the competition the Polish coal industry succeeded in maintaining its exports within the last few years, as shown by the following figures: coal exports in 1932, 10,223,000 tons; in 1933, 9,098,000 tons; in 1934, 9,880,000 tons; in 1935, 8,906,000 tons; and in 1938, 11,669,000.

Mining and Foundry Production in Poland

Products	1935	1938
	(in thousands of tons)	
Coal	28,545	38,100
Crude oil	515	507
Rock and brine salt	5'5	643
Potassium salts	384	567
Iron ore	332	879
Zinc ore	138	498*
Lead ore	6	44*
Pig-Iron	394	879*
Steel	946	1,441*
Zinc	85	108
Lead	19	20
Hot-rolled products	674	1,074*
Tubes. drawn and welded	60	80

*Including Cieszyn Silesia.

TRANSPORT IN POLAND

The Polish nation has always been conscious of the importance of communications in the national life of the country. As early as the second half of the 18th century two canals—Królewski and Ogińskiego—were built, connecting the Baltic and the Black sea, through the Vistula and Dnieper and their tributaries. Between the years 1815 and 1863 the construction of metalled roads was started by the autonomous Polish government in the territory of the old Kingdom of Poland. The roads built during that time were even in 1943 in considerable use.

The first railway line in Poland, the so-called "Warszawa-Vienna" railway, was constructed by the same autonomous Polish government in the years 1815–1848. The length of this line was about 160 mi. Thus it can be seen that the traditions of the Polish communications system date back to the 18th century, *i.e.*, the beginning of the modern era in communication.

In 1918 Poland possessed a railway system consisting of three independent networks which had not only a varied rolling stock but different gauge lines. During the six years of war, moreover, 40% of railway bridges, 81% of water pumps, 63% of stations, 51% of goods stores and 48% of railway workshops were destroyed. The lines and the sleepers were in a bad condition.

During the 20 years, 1918–38, all war damages were repaired, the rolling stock renewed and increased, and 1,100 mi. of standard gauge railways and 225 mi. of narrow gauge railways built, to improve the railway system. The signal system was improved, and most stations (1943) possess all modern traffic safety devices. The total length of all the railways in Poland amounts to 12,580 mi. (20,118 km.), of which the narrow-gauge railways amount to 1,400 mi. (2,250 km.). The goods traffic on the standard gauge railways amounted in 1938 to 75,125,000 tons.

Roads.—In 1918 the total length of roads in Poland amounted only to about 27,315 mi. (43,700 km.), or to 11 km. per 100 sq.km. of the area. The roads were mostly in a bad condition, and 75% of the bridges were made of timber. The expansion of the road system to suit the national needs of the country, and the modernization of the existing roads was a problem which needed an enormous capital outlay.

The construction and modernization of roads in Poland began on a large scale only in 1934, and was increasing with every year. The length of new roads in Poland, constructed after 1920, was over 12,000 mi. (20,000 km.), this being an increase of 50% from 1918 on, and amounting to 16 km. of roads per 100 sq.km. of area. Poland is constructing 800 mi. (1,300 km.) of roads every year.

Airways.—Polish airways were established at the same time as in the western European countries. The airlines were operated mainly by the Polish company "LOT," which runs services connecting Warsaw with Berlin, Helsinki, Bucharest and Palestine.

FOREIGN TRADE

The official Polish foreign trade statistics, which are available in full from the year 1923, are shown in the table on p. 151.

The favourable balance of 136,000,000 zlotys in 1923 was due to

Foreign Trade Statistics of Poland, *1923-38*

	Imports to Poland	Exports from Poland	Balance of trade	Imports to	Exports from
	(in million zlotys)			(in thousand tons)	
1923	1,920	2,056			
1924	2,542	2,177	—365	3,197	17,678
1925	2,755	2,188	—567	3,711	15,770
1926	1,539	2,246	+707	2,738	13,603
1927	2,892	2,515	—377	4,903	22,304
1928	3,362	2,508	—854	5,165	20,356
1929	3,311	2,813	—298	5,088	20,723
1930	2,246	2,433	+187	3,571	18,922
1931	1,468	1,879	+411	2,931	18,703
1932	862	1,084	+222	1,787	13,504
1933	827	960	+133	2,356	12,985
1934	799	975	+176	2,555	17,565
1935	861	925	+ 64	2,573	13,442
1936	1,003	1,026	+ 23	3,066	12,964
1937	1,254	1,195	— 59	3,685	14,997
1938	1,300	1,185	—115	3,310	15,597

the depreciation of currency in Poland, which favoured export and made import less attractive. A new, stabilized currency was introduced in 1924, and this was at once reflected in the balance of trade; the rise in internal prices made export less profitable, and caused a decline in the outgoing trade (wholesale prices in Poland were 26% higher in 1924 than in 1923, and increased by a further 15% during the first half of 1925). On the other hand, the volume of imports rose owing to the greater competitive power of foreign goods. The outcome of the years 1924–25 was an adverse balance of 932,000,000 zlotys. This, no doubt, contributed to the subsequent collapse of the Polish currency. The rising tide of imports depleted the country's reserves of gold and foreign exchanges, and it became apparent that the zloty had been stabilized at too high a level. The failure of the harvests in 1924 aggravated the situation. The great reduction in treasury receipts which followed obliged the authorities to countenance a mild inflation of token money. After the collapse of the currency during the second half of the year 1925, the zloty was stabilized at a parity 42% below the original one.

During the year 1926 nominal and gold prices fell, with the result that Polish exports increased greatly (to 2,246,000,000 zlotys), while imports dropped (to 1,539,000,000 zlotys), yielding a favourable balance of 707,000,000 zlotys, which to a great extent offset the adverse balance for the years 1924–25.

A decided period of recovery ensued during 1927. Industrial output and commodity turnover grew in volume from month to month. Imports to Poland increased considerably (from 1,539,000,000 zlotys in 1926 to 2,892,000,000 zlotys in 1927); exports also rose, but at a much slower rate, with the result that in 1927 there was an adverse balance of trade, amounting to 377,000,000 zlotys. Conditions during 1928, the peak year of that period of prosperity, were still better, but an unfavourable balance of 854,000,000 zlotys was returned. The total adverse balance for these two years of prosperity and recovery, therefore, came to 1,231,000,000 zlotys. At that time Poland received very substantial foreign credits (in 1927, excluding other types of credit, 614,000,000 zlotys of foreign long-term credits, and in 1928, 327,000,000 zlotys long-term and 891,000,000 zlotys short-term credits), which were largely used for investments purposes. Of the total imports of 1928, which amounted to 3,362,000,000 zlotys, 885,000,000 zlotys represented raw materials and finished goods for the smelting industry, 312,000,000 zlotys for the chemical industry, 263,000,000 zlotys for the leather and tanning industry, 840,000,000 zlotys for the textile industry, and 102,000,000 zlotys for the paper industries; hence over 70% of the total imports was in respect of various kinds of raw materials, semi-manufactures, finished goods and plants for these industries. In the same year investment goods, such as machines, electrical equipment, transport vehicles, etc., were imported to the value of over 527,000,000 zlotys or 16% of the total import trade.

Business conditions in 1929 took a definite turn for the worse. The number of investment undertakings declined and imports fell off to some extent. Exports, however, grew in volume, particularly export of cereal and meat products, following on good harvests and a large increase in livestock. These changes in both divisions of trade resulted in the adverse balance being reduced to 298,000,000 zlotys.

During the years of 1930 to 1936, Poland's foreign trade balance was uniformly favourable. In this connection, however, two phases can be distinguished: the period ending in 1934, when Poland's foreign trade turnovers shrank from year to year, and that which began in 1935, when a gradual revival in trade set in. Since 1935 the increase in imports proceeded along with an increase in the rate of investment and it was expected that the growth in imports would continue to be marked for some time to come in view of investment activity. Exports, however, found difficulty in keeping pace with rising imports, the result being that the years 1937 and 1938 showed an adverse balance of trade. It will be noted that the turnover of Polish foreign trade was in common with most countries in the world, still considerably below the level of the pre-depression period.

One of the most striking features of Poland's foreign trade was its marked concentration on European countries, which together were responsible for 77.1% of the imports and 97.3% of the exports from Poland in 1928. This domination of Poland's foreign trade by European countries was gradually weakened by the policy of increasing direct trade with overseas countries and this was shown by the fact that Europe's share had fallen to 65.8% of the imports and to 84.5% of the exports in 1938.

The reduction in Germany's share is just as striking, for while Germany (including Austria) was responsible for about one-third (33.5%) of the imports and almost one-half (46.7%) of the exports in 1928, her share had diminished in 1938 to less than one-quarter of Poland's imports and exports—23.0% and 24.1% respectively.

Trade with Czechoslovakia showed a similar but less marked downward trend, the imports having fallen from 6.3% in 1928 to 3.1% in 1938, while the exports showed an even greater diminution from 11.8% to 3.6% in 1928 and in 1938 respectively. In contrast to the marked decline in German and Czechoslovak trade, the United Kingdom had steadily increased its influence throughout the greater part of the period—its share of the import trade having risen from 9.37 in 1928 to a maximum of 14.1% in 1936 and declined somewhat to 11.4% in 1938. Its share in Poland's export trade showed approximately similar trends, rising from 9.0% in 1928 to a maximum of 21.6% in 1936, falling slightly to 18.2% in 1938.

In spite of this important increment in the trade of the United Kingdom which was accompanied by a lesser but none the less significant rise in Belgium's trade, west and central European countries were then exerting less influence on Polish foreign trade than formerly.

On the other hand, south and southeast European countries were now playing a greater part. These countries practically doubled their share in Poland's foreign trade—their contribution having risen from 4.3% in 1928 to 7.6% of the imports in 1938, and from 5.5% of the exports in 1928 to 10.0% in 1938. In relation to the imports the rise was fairly evenly spread throughout these countries but was most marked in the case of Bulgaria, Greece and Yugoslavia. On the other hand, the increase in the exports was mainly due to considerably larger deliveries to Italy, Bulgaria and Turkey.

The Baltic lands took an increasing share in Poland's import trade—their proportion of the imports having risen from 4.9% in 1928 to 6.2% in 1938. This increase is attributable mainly to Sweden. On the other hand, the importance of the Baltic lands in Poland's export trade diminished slightly from 12.9% in 1928 to 11.4% in 1938 in spite of successive advances made by Sweden.

Extra-European countries, of course, played a correspondingly larger part in Poland's foreign trade throughout the period, but the advance was greatest in connection with Poland's exports, which increased from only 2.7% in 1928 to 15.5% in 1938. On the other hand, their share in Poland's import trade increased to a lesser extent from 22.9% to 34.2% in the same period. The majority of the increased proportion of Poland's imports provided by these extra-European countries was accounted for by quite substantial increases between 1928 and 1938 in the trade from Africa (0.9%—4.7%), Asia (3.6%—7.0%), Oceania (0.7%—2.7%) and South America (3.2%—6.5%).

In contrast to this general upward trend the proportion of Poland's import trade supplied by North America fell slightly from 14.2% in 1928 to 12.7% in 1938—a decline which can he attributed mainly to the lesser dependence of the Polish textile industry on United States cotton.

On the other hand, the marked rise in Polish exports to extra-European countries was much more universal with the exception of Oceania, which played a very minor role. During the period 1928–38, North America (mainly U.S.A.) led, and its share of Poland's exports increased from 0.8% to 5.4%, South America and Asia, with 2.8% each, were approximately equal in 1938, and these figures were a great advance on those for 1928 which were 0.4% and 0.3% for South America and Asia respectively. Similarly Africa took a larger share in Poland's export trade, which rose from only 0.2% in 1925 to 1.8% in 1938.

Thus, regarded broadly, Poland's foreign trade during this period was marked by a weakening of the former dominance by European countries and Germany in particular, accompanied by an expansion of Poland's trade in other parts of the world.

The increased share of the United States in Poland's foreign trade was confined mainly to Polish exports, which rose from 0.8% in 1928 to a maximum of 8.4% in 1937 and declined somewhat to 5.3% in 1938. Their share of Poland's imports was, however, slightly lower than formerly, 13.9% in 1928 and only 12.2% in 1938, and was below the maximum of 15.1% attained in 1934.

This slight diminution in Polish imports from the United States was to a large extent due to smaller imports of U.S.A. cotton and cotton-waste, tobacco, and fruits..which have not been balanced by larger imports of scrap-iron, machinery and electrical equipment and transport materials. The major items in the 1937 list of Polish imports from the United States were, accordingly, arranged as follows: cotton and cotton-waste, 46.7%; scrap-iron, 20.5%; machinery and electrical equipment, 6.6%; transport materials, 6.2%; copper and copper sheets, 3.9%; raw iurs, 2.5%; together accounting for 86.4% of the total.

The relatively great increase in Poland's exports to the United States was largely attributable to increased shipments of animal products from Poland,. which was, of course, directly associated with the expansion and improvement of the Polish animal industry.

THE PORT OF GDYNIA

The creation of the port of Gdynia is one of the most outstanding technical accomplishments of recent years. In 1924, when the port of Danzig proved insufficient for Poland's overseas trade, Poland decided to build another port in the bay of Gdynia, at that time a small fishing village. In ten years the Port of Gdynia became one of the largest harbours in Europe.

The overseas trade of Poland was steadily increasing. While in 1922 only 7.3% of Poland's foreign trade went by sea, in 1938 the percentage was 77.8% in bulk and 64.3% in value. The rapid shifting of Poland's foreign trade on to the sea-route resulted in the equally rapid increase of the turnover of goods in the ports of the Polish customs area, Gdynia and Danzig. These ports had in 1936 a turnover of 14,695,000 tons. Of that amount the share of Gdynia was 7,272,946 tons (76.2% of the whole bulk of Poland's foreign trade).

Gdynia's Overseas Goods *Traffic*

Year	No. of ships	Turnover of goods—tons
1924	58	10,167
1938	12,990	9,173,438

Owing to its favourable geographical position at the junction of the system of transit routes in central Europe, Gdynia served as a port not only for its immediate Polish hinterland, but also for the farther hinterland of Czechoslovakia, Rumania, Hungary, Austria and other countries. The shortest and most convenient route for goods traffic from the Scandinavian and Baltic countries to Rumania, the near and far east, and from North America to Rumania, the Baltic. states, southwest Russia and the near east passed through Gdynia. Of Gdynia's regular shipping lines, 12 were to Baltic ports, 12 to Baltic and North sea ports, 7 to English ports, 3 to French, 7 to Mediterranean, 2 to the near east and Palestine, 5 to North America, 3 to South America, 1 to South and West Africa and 1 to Asiatic ports.

The construction of the Port of Gdynia, which began in 1924 had reached the following stage in 1938; the length of the breakwaters is 3,948 m. (2 mi.), of the wharves 12,867 m. (over 7 mi.), the greatest depth is 12 m. (39 ft.). The whole harbour covers an area of 1,010 hectares (2,495 acres), of which the water space occupies 335 hectares (827 ac.). The length of railway tracks is 222 km. (138 mi.), the area covered by warehouses over go ac.

CONSTITUTION AND ADMINISTRATION

Poland is an independent, democratic republic (Rzeczpospolita), with a constitution based on the charter of April 23, 1935. The revival of a Polish state,·as a successor of the Polish kingdoms which disappeared in 1795 and 1830, was recognized by the Treaty of Versailles and the Treaty of Riga, but was originally the spontaneous act of the Poles after the collapse of the German and Austro-Hungarian empires in 1918. The constitution is based mainly on general contemporary ideas. The executive consists of the president of the republic, elected for seven years by an assembly of electors, elected by popular vote. He is the official representative of the republic, the head of the army, and nominates the ministers. But the real executive power is in the hands of a council of ministers responsible to the president of the republic. The parliament consists of two chambers: the senate and the Sejm. Elections to both chambers take place every five years by general ballot. Every citizen of either sex over the age of 24 has the right to vote in the elections to the Sejm. The senate with one-third of its members appointed by the president of the republic and two-thirds elected by citizens over 30 years of age, has a right of rejecting a bill passed by the Sejm.

The judiciary is independent of the executive. There are district and provincial courts and a supreme court for the whole republic. The republic is divided into 16 provinces (Wojewodztwa), which are divided into districts (Starostwa). The lowest unit of local administration is the rural commune (Gmina). Silesia has a special autonomous system.

EDUCATION

For administrative purposes the educational system in Poland was divided into nine school regions; those of: Cracow, Lublin, Lwow, Brzesc, Poznan, Warsaw, Wilno (Vilna), Rowno and Torun. Each circuit was controlled by a curator. The curators were responsible to the minister of education, who was in charge of the entire educational system of Poland.

The schools may be classified in the following groups:

1. Nursery schools.—These schools had to provide physical and mental care for children of three to seven years of age.

2. *Primary* schools.—The obligatory term of education was seven years, beginning with the year during which the pupil attains his eighth birthday. The schools were divided into seven classes. The educational program provided for three degrees of primary education: (1) the elementary course of general instruction, (2) a development of the first degree, and (3) a social and economic preparation of the pupils.

3. Secondary schools.—The period of study in secondary schools was six years. The school for general education was composed of a 4-year course in grammar schools and of a 2-year course in lyceums. To the grammar schools pupils over 12 years of age were admitted and to the lyceums pupils over 16 years of age.

Lyceums (state, municipal and private schools) were divided into four groups: humanistic, classic, mathematic-physical and scientific.

4. Professional schools.—The aim of the professional schools was to provide professional education (theoretical and practical) in the various lines of life for the youth of both sexes. The elementary and secondary professional schools in Poland adapted their programs and practical exercises in workshops, studios, laboratories and commercial offices to the practical requirements of the economic life. The professional schools possessed so many different categories and sections that they practically took into consideration all branches of industry and of trade, providing trained workers of all degrees. An artisan, a factory workman, a technical foreman, a dressmaker and milliner, a shop-assistant, a trained-clerk, all these positions were filled by those who received their education at the Polish professional schools, and they applied in practice the knowledge acquired at school. The building and fitting-up of machinery and motors, railways, motor-cars and aeroplanes; applied chemistry; electro-technic; wireless; mining and smelting; the building trade; gardening; agriculture; cattle-breeding; manufacture of foodstuffs; women's professions; home and foreign trade; road building; the study of foreign languages; etc. were on the program of professional schools, where great attention was paid to the intellectual and physical development of the young. It was only after the recovery of her independence that Poland could start the education of adults on a large scale, and then the government, communal institutions and social organizations were co-operating to this end.

The term of attendance in trades' schools was as follows: two to three years' course in the lower grade, two to four years' course in the secondary schools grade after graduation from primary school, two to three years' course of lyceum grade from a grammar school, supplementary courses upon graduation from primary school. In teachers' lyceums the course lasted three years and the pupils were admitted upon graduation from three classes of secondary school. In the teachers' colleges (pedagogia) the course lasted two years for pupils who completed their studies in the lyceum. Teachers of secondary education were university graduates.

5. Academic schools.

1. The Jagiellon university in Cracow (founded in 1364)
2. The Stefan Batory university in Vilna (1578)
3. The Jan Kazimierz university in Lwow (1668)
4. The Pilsudski university in Warsaw (1817)
5. The University of Poznan (1919)
6. The Engineering University college of Lwow (1844)
7. The Engineering University college of Warsaw (1901)
8. The High School of Agricultural Economy in Warsaw (1919)
9. The Academy of Veterinary Science in Lwow (1881)
10. The Mining academy in Cracow (1915)
11. The Academy of Arts in Cracow (1818)
12. The Academy of Arts in Warsaw (1922)
13. The Stomatologic academy in Warsaw (1920)
14. The Commercial high school in Warsaw (1906)
15. The Catholic university in Lublin (1918)
16. The Free university in Warsaw (1906)
17. The Academy of Commerce in Cracow (1915)
18. The Academy of Foreign Trade in Lwow (1922)
19. The Academy of Commerce in Poznan (1926)
20. The Academy of Political Science in Warsaw (1915)

"Non Academic" high schools which correspond to universities, but did not have similar rights:

1. High School of Journalism in Warsaw (1911)
2. School of Political Science in Vilna (1930)
3. School of the Eastern Institute in Warsaw (1933)

	Number of schools in 1935	Number of pupils in 1935 (in thousands)
Nursery schools	1,876	98
Primary	27,955	4,686
Secondary	770	166
Teachers colleges	187	12
Trades' schools	714	71
Lower aericultural	143	5
Continuation trades' schools	637	84
Academicschools.	24	48

The national minorities had a number of schools in which instruction was given in their respective languages. During the school-year 1937–38 the Ukrainians had 16 nursery schools, 461 primary schools, 24 secondary schools, 1 teachers' college, and 5 trades' schools. They also had the following number of bilingual schools (Polish and Ukrainian! : 3,064 primary schools and 2 secondary schools.

Instruction in the White Ruthenian language was given in 1 secondary school. The Germans in Poland had 49 nursery schools, 394 primary schools, 15 secondary schools, and 6 trades' schools. Yiddish was the language of instruction in 40 nursery schools, 226 primary, 12 secondary, 1 teachers' college and 14 trades' schools. Lithuanian was the language of instruction in 23 primary and 1 secondary school, Czech in 18 primary schools and Russian in g primary and secondary schools.

In the school-year (1934–35) the following number of pupils belonging to national minorities received in Poland instruction in their own language or bilingual schools (in round figures):

Ukrainians	473,000	White Ruthenians	2,300
Germans	72.000	Russians	1,700
Yiddish and Hebrew	70,000	Czechs.	1,000
Lithuanians	1,500		

Religious Denomination of Pupils in Poland
(School-year 1934–35)

Religious denominations	Primary schools	Secondary schools	Teachers' training schools	Trade schools	Academic schools
	(in percentage of the total number of pupils)				
Roman Catholic Latin Rite	68·5	73·0	86·6	76·4	76·4
Greek Catholic Rite	9·4	3·9	4·8	2·2	3·1
Protestant	2·2	2·7	2·1	2·0	2·7
Greek Orthodox	10·5	2·3	2·4	3·1	2·7
Hebrew.	9·1	18·0	4·0	16·2	14·8
Other	0·3	0·1	0·1	0·1	0·3
Total	100·0	100·0	100·0	100·0	100·0

The state and local governments spent the sum of 462,000,000 zlotys on public instruction in the school year 1938–39.

The average number of schools for 100,000 inhabitants (1930–31) was:

Nurseryschools	5·1	Teachers'trainingschools	0·7
Primary	86.3	Trade schools	2.5
Secondary	2.4	Academic schools	0·1

In the school year 1935–36, 4,681,345 pupils received primary instruction and 181,138 secondary instruction; in 1936–37, 4,743,605 pupils received primary instruction and 200,391 pupils secondary Instruction.

Number of Graduates in Schools in Poland, 1934

Primary schools	257,261
Secondary schools	14,836
Nursery-school teachers' traihing'schools	247
Teachers' training colleges	5,054
Trade instructors' training schools	199
Trade schools	23,156
Academic schools	6,400

SCIENTIFIC AND CULTURAL INSTITUTIONS IN POLAND

1. Scientific institutions.—The most important scientific institution in Poland is the Academy of Science in Cracow, founded in 1872. It is composed of 81 active members and 96 correspondents, of whom 54 are Poles and 42 foreigners. A president and a general secretary are at the head of the institution. The academy has three sections (philological, historical-philosophical and mathematical-scientific) and a number of special commissions. It maintains Polish scientific stations in Paris and Rome. The academy publishes reports of its activities in its own organ, The Annual, and issues also several other regular or occasional publications.

Similar societies exist in Lwow and Warsaw. The Lwow Scientific society dates from 1901. Besides the three sections (philological, historical-philosophical and mathematical-scientific), it has a history of art section.

The Warsaw Scientific society was re-opened in 1907 as a continuation of the erstwhile Royal Society of the Friends of Science, founded in the beginningof the 18th century. It comprises honorary, ordinary, and active members and correspondents, 20 of each of the 3 first categories in 4 sections: (1) Philology, history of literature, and art; (2) Historical, social and philosophic sciences; (3) Mathematics and natural sciences; (4) Biological sciences. Other sections and commissions maintain and conduct special establishments for scientific research. The society publishes works of its members and other scientific investigators and issues an annual and a report of the proceedings of the society.

There are also Societies of Friends of Science in Poznan and Vilna, and similar societies in Danzig, Katowice, Lublin, Plock, Przemysl and Torun.

Special societies exist in all the larger centres of Poland, such as the Historical society, the Polish Philosophic society, the Mathematical society, Botanic, and other societies. Their activities mostly cover the whole republic. The state institutes of research are the Chief Statistical office, the Military institute, the State Geological institute, the Curie-Sklodowska Radium institute and others. Private institutes are the Institute for the Investigation of National Problems, the East European Scientific Research institute, etc. There are also non-Polish societies, the most important of which is the Szewczenko Scientific Society in Lwow (founded 1873) in which Ukrainian scientists are grouped and organized on the model of the academy, the German societies: the Nistorische Gesellschaft fur Posen in Poznan, the Copernicus-Verein in Torun, the Jewish societies: the Society for the culture of Judaic Science in Warsaw and a Jewish Scientific institute in Vilna.

Besides these societies there are also some private institutions in Poland for the encouragement of science. The most important is the National Ossoliński Institute in Lwow (founded 1818), which publishes scientific works and school books, and maintains its own library and museum. Another institute is the Mianowski Fund in Warsaw (founded 1881, reformed 1930). Its object is to encourage science and literature, to help students engaged in research, and to publish works by authors of merit.

2. Archives.—Polish archives belong to the state, to local boards, religious bodies and to private owners. The state archives are under the authority of a chief director and are controlled by the ministry of education. The archives contain ample records of the activities of central and local authorities of the former Polish commonwealth, documents from the periods of partition and acts from the registers of various state offices. There are five of them in Warsaw and others in Bydgoszcz, Grodno, Kielce, Cracow, Lublin, Lwow, Piotrkow, Plock, Poznan, Radom and Vilna. About 60 archives of local boards, about 62 Catholic church and convent archives, 7 non-Catholic, 7 of synagogues, and 8 private archives are maintained in different towns.

3. *Libraries.*—The largest libraries in Poland are under state administration or that of state institutions (for instance, of academic schools). The state takes care of introducing rational methods of organization, of collecting printed publications, systematically and in complete editions, and also of supplying the libraries with the most important scientific appliances. The largest Polish library, containing the whole collection of present Polish publications, is the National library in Warsaw. It was opened in 1928, after several years' preparatory work, and includes the collections of Polish books retrieved from Russia as well as Polish libraries repatriated from foreign countries (the Załuski library, the Batignolles, Rappersvil and other libraries). There exist old libraries with priceless treasures of Poland's intellectual achievement dating from centuries back, as for instance: the Jagiellon library in Cracow (593,794 vols.), the Cracow university library, the Warsaw university library (797,000 vols.), the John Casimir library in Lwow (369,000 vols.), the Wróblewski library in Vilna (122,000 vols.). While the National library has the character of a central library possessing all publications appearing in the republic, these as well as the University library in Poznan and those in Torun and Katowice are of a more limited character containing all the publications of the respective districts. There is also a number of most valuable private book collections, either belonging to foundations or to individual book-lovers. Such are the Krasinski, the Zamoyski, the Przeździecki libraries, and also the Public library in Warsaw; the Ossoliński and Baranowski libraries in Lwow, the Czartoryski and the Cathedral libraries in Cracow; the Wielkopolska and Friends of Science library in Poznan, the Łopaciński library in Luhlin, etc

All the higher schools, state and private, possess libraries. The Bibliographical institute in the National library, besides its work in cataloguing, occupies itself with the international exchange of publications.

There are 22 state scientific libraries containing 3,158,400 vols., 15 local government scientific libraries with 469,380 vols., 22 theological libraries of various confessions with 579,760 vols., 28 social, foundation and private larger libraries with 1,290,000 vols., and 14 military-scientific libraries 268,000 vols. The total number of volumes in all libraries, including primary and secondary schools' libraries, amounts to about 20,000,000.

In 1933 the Polish Academy of Literature was founded in Warsaw, with 15 members.

4. *Museums.*

Multi-departmental	58
Art	24
Historico-cultural	19
Natural sciences	13
Archaeological	5
Ethnographical	14
Technical	7
Military	2
General and not specified	33
Total	175

CO-OPERATIVE MOVEMENT IN POLAND

On Jan. 1, 1938 there existed in Poland 13,741 co-operative societies belonging to the following unions:—

	Branches
1. Union of Agricultural and Credit Co-operative societies in Warsaw	5,261
2. Union of Consumers' Societies of Poland in Warsaw	1,254
3. Union of Military Co-operative societies in Warsaw	240
4. Union of Co-operatives and Associations of Workers	432
5. Volhynian Union of Co-operative societies "HURT"	26
6. Ukrainian Auditing Union of Co-operative societies in Lwow	3,097
7. Audit Union of Ruthenian Co-operative societies in Lwow	2,058
8. Union of German Co-operative societies (2)	768
9. Union of Jewish Co-operative societies (a)	78

In 1937 the Polish Co-operative societies had 2,157,000 members, the Ukrainian 661,000, the Jewish 141,000, and the German, 57,000.

The total balance-sheets of all the above co-operative societies amounted in 1935 to 1,122,258 zlotys, of which the capital owned was 227,294,000 zlotys. The credit co-operative societies extended to their members loans amounting to 585,478,000 zlotys and sold goods of a total value of 451,164,000 zlotys.

The number of Credit and Savings Co-operative societies in Poland was: in 1928, 4,586; in 1929, 5,925; in 1936, 5,423.

BIBLIOGRAPHY.—*Polish Cartographtcal Quarterly Review* (Lwow); A. B. Boswell, *Poland and the Poles* (1920); V. Bugiels, *La Pologne et les Polonais* (1926); Lord Eversley, *The Partitions of Poland* (1915); W. Nalkowski, *La Pologne, Entitd géographique* (1926); E. Pittz (editor), *Poland* (authorized English version of *Petite Encyclopddie polonaise*) (1919); P. Roth, *Die Entstehung des polnischen Staates* (1926); A. L. Goodhart, *Poland and the Minority Races* (1920).

On economic conditions: *see* Reports of British and other commercial attachds; files of *Economist; L'Europe nouvelle;* Eugenjusz Kwiatkowski, *The Economic Progress of Poland* (1928). On finance: *see* E. Hilton Young, *Report on Financial Conditions in Poland* (1924); G. Zdziechowski, *The Finances of Poland in 1924 and 1925* (1925); *Bulletin of Polish Ministry of Finance*, and *Publications of the League of Nations, Financial Section*. The whole ground is covered in *The Polish Handbook*, edit. F. B. Czarnomski (1925). The best statistical information is in the publications of the League of Nations, and the official *Informations Statistiques; All About Poland*, edit. J. H. Retinger, LL.D. (London, 1941). (A. B. Bo.; F. H. N.; J. Cl.)

DEFENSE

Recruitment and Service.—All men in Poland, irrespective of nationality, are liable to be called up for service when they have completed their 21st year. This service is for 24 to 25 months in the regular army, according to the arm of the service, but only 18 months are spent with the colours. This is followed by service in the reserve up to the age of 40, during which period 14 weeks training are performed. From 40 to 50 years service in the territorial army follows, without further training. Certain exemptions and postponements are allowed for family and professional reasons, and volunteering is permitted for those not called up between the ages of 17 to 28. Each arm of the service has a cadet school for officers and there is also one for non-commissioned officers. There are also pre-military cadet corps for youths. Personnel not posted to the active army are subject (with a few exemptions) to a special military tax, collected either as a "basic tax" or as a sur-tax on income tax.

Strength and Organization.—The budget effectives in the regular army (1938) numbered 273,886, including 18,733 officers. The other armed forces organized on a military basis are the state police force of about 32,000, frontier defense corps of about 27,000, and customs guard of about 6,000.

The regular army is organized in 30 infantry divisions and 2 divisions of mountain troops; with 4 divisions and 12 independent brigades of cavalry. The Polish infantry division contains 3 regiments of infantry and 1 of field artillery. Each regiment contains a signal platoon, a battalion of pioneers, and 3 battalions of infantry or mountain troops. Battalions are organized in 3 companies and 1 machine-gun company. The Polish cavalry division contains 3 brigades, each comprising 2 regiments of cavalry, 2 groups of horse artillery, 1 pioneer sauadron and 1 automatic rifle sauadron (a special feature). independent cavalry brigades contain only 1 group of horse artillery and no automatic rifle squadron. Artillery regiments are (1) field, (2) heavy field, (3) mountain, (4) heavy, (5) anti-aircraft, (6) horse, or (7) foot artillery. Of these, Nos. (1) (2) (4) are organized in 3 groups each of 3 batteries; Nos. (3) and (5) in 2 such-groups, and No. (7) in 3 batteries. One group in each anti-aircraft regiment is motor-drawn. There is also an armoured train group with 3 trains. The engineer troops contain units charged with field engineering, railway work, signals, wireless telegraphy, motor transport, electro-technical work, and heavy bridging. Attached to the infantry there is a tank regiment containing a signal section, 3 tank battalions each of 3 companies, and a tank park.

Higher Command.—The supreme head of all the armed forces of Poland is the president of the republic, who presides over the committee of national defense, which contains the ministers for war, foreign affairs, interior, industry and commerce, and finance, the inspector general of the army and such other persons as the president, on the recommendation of the cabinet, may nominate. The committee can form no decisions without first hearing the opinion of the inspector general of the army. There are 10 military areas, each under a general officer with the title of "army corps area" commander. These areas are I. Warsaw, II. Lublin, III. Grodno, IV. Lodz, V. Cracow, VI. Lwow, VII. Poznan, VIII. Torun, IX. Brzesc, and X. Przemysl.

The army is distributed by units, on a population basis, over the above military areas. Of the other forces on a military basis the state police force is distributed in 3,273 communal police detachments in the smaller towns and villages and in 184 police commissariats in the larger towns, all under the chief of state police, who receives his orders from the minister of the interior. The frontier defense force carries out the duties of state and frontier guards on the eastern frontier where it guards the frontier, all members having had previous military training, and being armed as soldiers. The commander has the powers of an army corps area commander, and is under the minister of the interior. The customs guard, under the minister of finance, is responsible for the economic protection of the other frontiers, under the direction of commissions of customs.

Military Education.—Working under the chief of the general staff, there is a higher military college, a higher intendance college (military administration) and institutes of military geography and of military publications. Central institutions and military schools are under the area commanders except for use of material and technical training. One of the line companies of every infantry battalion forms a regimental non-commissioned officers school and there is also a central cadet school used for the training of non-commissioned officers. Besides the above-mentioned cadet-schools to provide officers for all arms of the service, there is a central musketry school and training centres for cavalry, artillery, engineers, railway engineers, and signallers, to provide for advanced training and specialization. There are also tank and motor schools and a gendarmerie school. For higher training of senior officers there is the "centre of higher military studies," the "higher school of military science," and the "higher intendance school" mentioned above.

Army Air Forces.—The army air force is administered by the air department of one of the under secretaries of state in the war ministry. The air service group is organized in 3 companies and a school company. The cost of military aviation which stood at 22,441,000 zlotys in 1926, was reduced to 13,633,000 in the estimates for 1927–28.

See also League of Nations *Armaments Year-book* (Geneva 1938). (G. G. A.; J. Cl.)

Navy.—The Polish navy consists of:

(a) The directorate of the navy;	(d) The Naval Officers' school;
(b) The high sea fleet;	(e) The various naval establishments;
(c) The river flotilla;	(f) 1 battalion of naval infantry.

The high sea fleet includes a fleet high command which is under the minister for military and naval affairs.

The naval port of Gdpnia is under the fleet high command. The naval port of Pinsk is under the commander of the river flotilla.

Budgetary effectives are (1938):

463	officers
5,628	noncomm. officers and men

In 1939 Poland had:

4 modern destroyers:	Błyskawica Grom Wicher Burza
5 submarines:	Orzeł Sep Wilk Ryś Zbik
5 torpedo-boats:	Kujawiak Krakowiak Podhalanin Slązak Mazur

miscellaneous: 11 units (gunboats, surveying vessel, transport, minesweepers, minelayer, training ship, submarine depot ship).

The river flotilla consisted of six monitors and eight river gunboats. (J. Cl.)

POLAR BEAR: *see* BEAR; CARNIVORA.

POLAR BODY: *see* CYTOLOGY.

POLARITY or **POLARIZATION.** For electrolytic polarization see BATTERY; ELECTROLYSIS; for optical see LIGHT.

POLAR REGIONS: *see* ARCTIC REGIONS; ANTARCTIC REGIONS.

POLDER, the Dutch name for a piece of artificially-drained low-lying land reclaimed from the sea or other water and protected by high embankments (*see* HOLLAND).

POLE (FAMILY). The family of the Poles, earls and dukes of Suffolk, which, but for Richard III's defeat at Bosworth, might have given the next king to England, had its origin in a house of merchants at Kingston-upon-Hull. The Poles were among the first English peers whose fortunes had been founded upon riches gained in trade. William atte Pole (d. *c.* 1329), a merchant of Ravensrode, settled in Hull. His sons, Sir Richard and Sir William atte Pole, were both famous for their wealth. Sir Richard (d. 1345), the king's butler in 1327, removed to London, and is styled a London citizen in his will. The male line of this, the elder branch of the Poles, failed with a grandson, John Pole, whose daughter was Joan, Lady of Cobham, the Kentish heiress, whose fourth husband was Sir John Oldcastle the Lollard.

Sir William atte Pole (d. 1366), the second son of William, joined his brother in advancing large sums to the government while keeping safely apart from politics. The first mayor of Hull, he sat for Hull in five parliaments, and was advanced to be knight banneret and a baron of the exchequer. He was counted "second to no merchant in England," but after his time his descendants left the counting-house, his four sons all serving in the French wars. The eldest son, MICHAEL POLE, 1st earl of Suffolk, who had fought under the Black Prince and John of Gaunt, became (1383) chancellor of England. In 1385 he was created earl of Suffolk, a grant from the Crown giving him the castle and honour of Eye with other East Anglian lands formerly held by the Ufford earls. In 1386 the opposition, led by Gloucester, the king's uncle, pulled him down. He was dismissed from his chancellorship, impeached, and convicted. Richard was forced to send his minister into ward at Windsor until the parliament was dissolved, when Suffolk once more appeared as the leader of the king's party. But the opposition was insistent, and Suffolk fled over sea to Calais. He died an exile in Paris in 1389.

The exile's son Michael, 2nd earl, was restored in 1397, died of dysentery at Harfleur, and his son Michael was killed at Agincourt. Michael was succeeded as 4th earl by his brother William. *(See* SUFFOLK, WILLIAM DE LA POLE, DUKE OF.)

John Pole (1442–1491), the only son of the 4th earl, should have succeeded to the dukedom, his father having died unattainted. But the honours were apparently regarded as forfeited, and the dukedom was formally restored to the boy in 1455, the earldom of Pembroke being allowed to lapse. He married King Edward IV.'s sister Elizabeth. The marriage confirmed him a partisan of the White Rose. Before he was of age he was steward of England at his brother-in-law's crowning, and at Queen Elizabeth's crowning he bore her sceptre. Having held many offices under Edward IV. he was ready to bear a sceptre at Richard's coronation, and, after Bosworth, to swear fealty to the Tudor dynasty and to bear another sceptre for another Queen Elizabeth. He died in 1491, having safely kept his lands, his dukedom, and his head through perilous years. *(See* SUFFOLK, EARLS AND DUKES OF and POLE, RICHARD DE LA.)

Another family of the name of Pole, having no kinship with the house of Suffolk, owed their advancement and their fall to a match with a princess of the royal house. Sir Richard Pole, a Buckinghamshire knight, was the son of Geoffrey Pole, a squire whose wife, Edith St. John, was sister of the half-blood to the mother of Henry VII. About 1490 or 1491 he married the Lady Margaret, daughter of George, duke of Clarence. He died in 1505, and in 1513 King Henry VIII. created the widow countess of Salisbury, as some amends for the judicial murder of her brother, the Earl of Warwick. Four years later, the barony of Montague was revived for her eldest son Henry. Until the king's marriage with Anne Boleyn, the countess of Salisbury was governess of her godchild, the Lady Mary. When her son, the famous Cardinal Pole, published his *Pro ecclesiasticae unitatis defensione* the whole family fell under the displeasure of the king, who resolved to make an end of them. The Lord Montague was the first victim, beheaded in 1539 on a charge of treasonable conversations, on evidence of his brother, Sir Geoffrey Pole. In 1541 the aged countess, attainted with her son Montague, was also executed. Sir Geoffrey Pole fled the country, and joined the cardinal in exile. He returned with him at Mary's accession, both dying in 1558. His sons Arthur and Edmund, taken in 1562 as plotters against Queen Elizabeth. were committed to the Tower of London, where they died after eight years of imprisonment.

See T. Rymer's *Foedera;* C. Frost, *History of Hull* (1827); *Chronicon de Melsa* (Rolls Series); G. E. C., *Complete Peerage; Testamenta Eboracensia* (Surtees Soc.); Hon. and Rev. H. A. Napier, *Swincombe and Ewelme* (1858); *Dict. Nat. Biog. s.v.* "Pole."

POLE, **REGINALD** (1500–1558), English cardinal and archbishop of Canterbury, born at Stourton Castle, Staffordshire, was the third son of Sir Richard Pole and Margaret, countess of Salisbury, niece of Edward IV. Intended for the Church, he was sent for five years to the grammar school founded by Colet at Sheen. Here he had Linacre and William Latimer as teachers. In his thirteenth year he went to Magdalen College, Oxford, and two years after took his degree in arts. In 1517 Henry VIII. appointed his young kinsman to a prebend in Salisbury, and soon afterwards to the deaneries of Wimborne and Exeter. He was a friend of Sir Thomas More, who says that Pole was as learned as he was noble and as virtuous as he was learned. In 1519, at the king's expense, he went to Padua, the Athens of Europe, according to Erasmus; and there, where Colet and Cuthbert Tunstall had also been educated, he came into contact with the choicest minds of the later Italian Renaissance, so forming his friendships.

In 1525 he went to Rome for the Jubilee, and two years after returned to England and was initiated by Thomas Cromwell into the mysteries of statesmanship, that master telling him that the main point consisted in discovering and following the will of princes, who are not bound by the ordinary code of honour. When the divorce question arose, Pole seems at first to have been in its favour. He probably took the same view that Wolsey had, viz., that the dispensation of Julius II. was insufficient, as of two existing impediments only one had been dispensed. When, however, the king raised the theological argument which ended in disaster, Pole could not accept it; and, after the failure of Campeggio's mission, when the king asked him for his opinion, he excused himself on the score of inexperience, but went by Henry's order to Paris (1530) to obtain the judgment of the Sorbonne, insisting on the presence of a colleague to do the necessary business. On his return to England he spoke strongly against the project to the king, wha sought to propitiate him by the offer of the sees of York or Winchester, which were kept vacant for ten months for his acceptance. There was a stormy interview at York Place; but eventually Henry told him to put into writing his reasons against the divorce. This was done, and, recognizing the difficulties of the situation, the king gave him leave to travel abroad, and allowed him still to retain his revenues as dean of Exeter. In 1535, which saw by the deaths of Bishop Fisher and Sir Thomas More a change in Henry's policy, Pole received orders to send a formal opinion on the royal supremacy, and the king promised to find him suitable employment in England, even if the opinion were an adverse one. The parting of the ways had been reached. Pole's reply, which took a year to write, and was afterwards published with additions under the title *Pro ecclesiasticae unitatis defensione,* was sent to England (May 25, 1536), meant for the king's eye alone. It contained a severe attack upon the royal policy, and a warning of temporal punishment at the hands of the emperor and the king of France if Henry did not repent of his cruelties and return to the Church. Pole was again summoned to return to England to explain himself, but declined until he could do so with honour and safety; but he was on the point of going at all risks, when he heard from his mother and brother that the whole family would suffer if he remained obstinate.

Paul III., who had prepared a bull of excommunication and deposition against Henry, summoned Pole to Rome in October, and two months after created him cardinal. In January 1537 he received a sharp letter of rebuke from the king's council, together with the suggestion that the differences might be discussed with royal deputies either in France or Flanders, provided that Pole would attend without being commissioned by any one. He replied that he was willing and had the pope's leave to meet any deputies anywhere. Paul III. in the early spring of that year named him legate a *latere* to Charles V. and Francis I., to secure their assistance in enforcing the bull by helping a projected rising in England against Henry's tyranny. The mission failed, owing to the mutual jealousy of the sovereigns. Francis feared to allow his presence in France, and Pole passed over to Flanders, and awaited in vain royal deputies. In August 1537 the cardinal returned to Rome. There he was appointed to the commission established by Paul III. for considering the reforms necessary for the church and Roman curia. The report *Consilium delectorium cardinalium* is, in its plain-spoken directness, one of the most noteworthy documents of the history of the period. Towards the end of 1539, after Henry had destroyed the shrine of St. Thomas Becket, another attempt was made to launch the bull of deposition, and Pole again was sent to urge Charles V. to assist. Once more his efforts were in vain, and he retired to his friend Sadoleto at Carpentras. As Pole had escaped Henry's power the royal vengeance fell on his mother, who was executed on May 27, 1541.

On Aug. 21, 1541, the cardinal was appointed legate at Viterbo, and for a few years passed a happy and congenial life amid the friends that gathered round him. Here he came into close relations with Vittoria Colonna, Contarini, Sadoleto, Bembo, Morone, Marco Antonio, Flaminio, and other scholars and leaders of thought; and many of the questions raised by the Reformation in Germany were eagerly discussed in the circle of Viterbo. The burning question of the day, justification by faith, was a special subject of discussion. Pole's own attitude to the question of justification by faith is given by Vittoria Colonna, to whom he said that she ought to set herself to believe as though she must be saved by faith alone and to act as though she must be saved by works alone. In the excited temper of the times any defender of justification by faith was looked upon by the old school as heretical; and Pole, with the circle at Viterbo, was denounced to the Inquisition. Though the process went on from the pontificate of Paul III. to that of Paul IV., nothing was done against the cardinal until the time of the latter pope.[1]

While at Viterbo his rule was firm but mild; and he regained many heretics, such as his friend Flaminio, by patience and kindliness, to a reconsideration of their opinions. During this time also he was still engaged in furthering a proposed armed expedition to Scotland to aid the papal party, and in 1545 he was again asking help from Charles V. But the Council of Trent (*q.v.*) required all his attention. In 1542 he had been appointed one of the presiding legates and had written in preparation his work *De concilio;* and now in 1545, after a brief visit to Rome, he went secretly, on account of fear of assassination by Henry's agents, to Trent, where he arrived on May 4, 1545. At the council he advocated that dogmatic decrees should go together with those on reform as affording the only stable foundation. His views on the subject of original sin, akin as it is to that of justification, were accepted and embodied in the decree. He was present when the latter subject was introduced, and he entreated the fathers to study the subject well before committing themselves to a decision. On June 28, 1546, he left Trent on account of ill-health and went to Padua. While he was there frequent communications passed between him and the council and the draft of the decree on justification was sent to him. His suggestions and amendments were accepted, and the decree embodies the doctrines that Pole had always held of justification by a living faith which showed itself in good works. This effectually disproves the story that he left the council so as to avoid taking part in an adverse decree.

On the death of Henry (Jan. 28, 1547), Pole was excepted from the general pardon. At the conclave of 1549 Pole received two-thirds of the votes, but by a delay, he lost the election and Julius III. succeeded. He then retired to Magazzano on the Lake of Garda and occupied himself in editing his book *Pro unitate ecclesiae,* with an intended dedication to Edward VI.

On the accession of Mary he was appointed legate to the new queen, and began his negotiations. But he was still under attainder; and the temper of England was not yet ripe for the presence of a cardinal. The project of the queen's marriage was also an obstacle. A marriage between her and Pole, who was then only a deacon, was proposed by some, but this was opposed by the emperor. The marriage with Philip, of which Pole did not approve, having taken place (July 25, 1554), and Rome yielding on the practical difficulties of the lay holders of Church lands, Pole was allowed to return to England as cardinal. On his landing he was informed that the attainder had been reversed; and he was received with joy by Mary and Philip. He proceeded to parliament and there absolved the kingdom and accepted in the pope's name the demands respecting ecclesiastical property. He rectified the canonical position of those who had been ordained or consecrated since the breach with Rome. Those ordained in schism, indeed, but according to the old Catholic rite, were absolved from their irregularity, and, receiving penance, were reinstated; those ordained under the new rite were simply regarded as laymen and dismissed without penance or absolution. Pole was not responsible for the cruel persecution by which the reign was disfigured. On Nov. 4, 1555, Pole opened, in the chapel royal at Westminster, a legatine synod, consisting of the united convocations of the two provinces, for the purpose of laying the foundations of wise and solid reforms. In the *Reformatio Angliae* which he brought out in 1556, based on his Legatine Constitutions of 1555, he ordered that every cathedral church should have its seminary. He also ordered that the Catechism of Caranza, who, like him, was to suffer from the Inquisition for this very book, should be translated into English for the use of the laity. On Cranmer's deprivation, Pole became archbishop of Canterbury; and, having been ordained priest two days before, he was consecrated on March 22, 1556, the day after Cranmer suffered at Oxford. But the clouds began to gather round him. His personal enemy Caraffa had become pope under the name of Paul IV. and was biding his time. When Rome quarrelled with Spain, and France, on behalf of the pope, took up arms, England could no longer observe neutrality. Paul IV. deprived Pole of his power both as legate a *latere* and *legatus natus* as archbishop of Canterbury (June 14, 1557); he also reconstituted the process of the Inquisition against the cardinal, and summoned him to Rome to answer to the crime of heresies imputed to him. Mary, who had been warned by her ambassador to the pope that prison awaited Pole, prevented the breve ordering the cardinal to proceed to Rome from being delivered, and so Pole remained in England. Broken down as much by the blow as by ill-health the cardinal died at Lambeth on Nov. 17, 1558, twelve hours after Mary's death and under the unmerited disgrace of the papacy in defence of which he had spent his life. He was buried at Canterbury near the site of the shrine of St. Thomas Becket.

The chief sources for Pole's biography are his life written in Italian by his secretary Beccatelli, which was translated into Latin by Andrew Dudith as *Vita Poli cardinalis* (Venice, 1563), and his letters *(Epistolae Reginaldi Poli)* edited by Girolamo Quirini and published in 5 volumes (Brescia, 1744–57), a new edition of which is in preparation at Rome with additions from the Vatican Archives. *See* also the State Papers (foreign and domestic) of Henry VIII., Edward VI. and Mary; the Spanish and Venetian State Papers; vol. i. of A. Theiner's *Acta genuina S.S. Oecumenici Caecilii tridentini* (1874); the *Compendio dei processi del santo uffizio di Roma da Paolo III. a Paolo IV.* (Società romana di storia patria, *Archivio,* iii. 261 *seq.)*; T. Phillipp's *History of the Life of R. Pole* (Oxford, 1764–67); Athanasius Zimmermann, S.J., *Kardinal Pole sein Leben und seine Schriften* (Regensburg, *1893)*; Martin Hailie, *Life of Reginald Pole* (1910); and F. G. Lee, *Reginald Pole.*

POLE, RICHARD DE LA (d. 1525), pretender to the English crown, was the fifth son of John de la Pole (1442–1491), 2nd duke of Suffolk, and Elizabeth, second daughter of Richard, duke of York and sister of Edward IV. His eldest brother John de la Pole, earl of Lincoln (*c.* 1464–1487), is said to have been named heir to the throne by his uncle Richard III., who gave him a pension and the reversion of the estates of Lady Margaret Beaufort. On the accession of Henry VII., however, Lincoln took the oath of allegiance, but in 1487 he joined the rebellion of Lambert Simnel, and was killed at the battle of Stoke. The second brother Edmund (c. 1472–1513) succeeded his father while still in his minority. His estates suffered under the attainder of his brother, and he was compelled to pay large sums to Henry VII. for the recovery of part of the forfeited lands, and also to exchange his title of duke for that of earl. For his negotiations with the German King Maximilian in Tirol, Henry seized his brother William de la Pole, with four other Yorkist noblemen. Two of them, Sir James Tyrell and Sir John Wyndham, were executed, William de la Pole was imprisoned and Suffolk outlawed. Then in July 1502 Henry concluded a treaty with Maximilian by which the king bound himself not to countenance English rebels. Presently Suffolk fell into the hands of Philip, king of Castile, who imprisoned him at Namur, and in 1506 surrendered him to Henry VII. on condition that his life was spared. He remained a prisoner until 1513, when he was beheaded at the time his brother Richard took up arms with the French king.

Richard de la Pole joined Edmund abroad in 1504. and remained at Aix as surety for his elder brother's debts. The creditors

[1]Within the institution of the Inquisition his name continued to be regarded as that of a heretic and misleader of others, as is proved by the mass of evidence accumulated against him in the *Compendium inquisitorum (v archivio della società di storia patria* Rome, 1880).

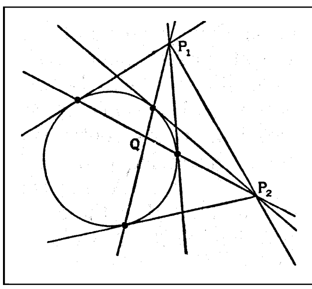
threatened to surrender him to Henry VII., but, more fortunate than his brother, he found a refuge with King Ladislas VI. of Hungary. He was excepted from the general pardon proclaimed at the accession of Henry VIII., and when Louis XII., went to war with England in 1512 he recognized Pole's pretensions to the English crown, and gave him a command in the French army. In 1513, after the execution of Edmund, he assumed the title of earl of Suffolk. In 1514 he was given 12,000 German mercenaries ostensibly for the defence of Brittany, but really for an invasion of England. These he led to St. Malo, but the conclusion of peace with England prevented their embarkation. Pole was required to leave France, and he established himself at Metz, in Lorraine, and built a palace at La Haute Pierre, near St. Simphorien. He had numerous interviews with Francis I., and in 1523 he was permitted, in concert with John Stewart, duke of Albany, the Scottish regent, to arrange an invasion of England, which was never carried out. He was with Francis I. at Pavia and was killed on the field on Feb. 24, 1525, so ending the male line.

See *Letters and Papers Illustrative of the Reigns of Richard III. and Henry VII.*, edited by J Gairdner (2 vols., "Rolls Series," 24, 1861); *Calendar of Letters and Papers, Foreign and Domestic, of the Reign of Henry VIII.;* and Sir William Dugdale, *The Baronage of England* (London, 1675).

POLE, WILLIAM (1814–1900), English engineer, was born at Birmingham on April 22, 1814. He spent some years as a professor of engineering in Bombay, returning to England in 1848, and in 1859 was appointed to the chair of civil engineering in University college, London. He was secretary to the Royal Commission on Railways (1865–67); the duke of Richmond's Commission on London Water (1867–69), also taking part in the proceedings for establishing a constant supply; the Royal Commission on the Disposal of London Sewage (1882–84); and the departmental committee on the science museums at South Kensington in 1885. In 1871 he was appointed consulting engineer in London to the Japanese Government. He was elected F.R.S. in 1861 for some investigations into colour-blindness. Music was also one of his chief interests, and in 1867 he took his doctor's degree, acting for many years as examiner for musical degrees at the University of London. In 1879 he published his *Philosophy of Music.* He died on Dec. 30, 1900.

POLE. For pole star *see* POLE STAR; for polar regions *see* ARCTIC REGIONS; ANTARCTIC REGIONS; for magnetic poles *see* MAGNETISM. *See* also BATTERY; CRYSTALLOGRAPHY; GEODESY; GEOMETRY; POLE VAULTING; SPHERE.

POLE AND POLAR, in mathematics. If from a point *P* outside a circle the two tangents to the circle be drawn, the line joining the points of contact is called the *polar* of the point *P,* and *P* is called the *pole* of the secant line. If *P* is on the circle, the two tangents coincide and the polar of P is the single tangent at P. For Q, a point inside the circle, draw two secants to the circle through it. The line joining their poles is called the polar of Q. If the polar of P passes through Q, the polar of Q passes through *P.* The same principle applies to any conic. In space there is a corresponding theory of points and polar planes as to a sphere or any fixed quadric surface. The idea is due to Brianchon, who first applied it in 1806, but it was developed by Poncelet, and presented in final form in 1829. More recently the concept has been extended to other curves and surfaces, and to other configurations.



POLECAT, the name given to any member of the Musteline genus *Putorius (see* CARNIVORA). Polecats are confined to the northern hemisphere. The European polecat, P. *foetidus,* inhabits the whole of the central and northern parts of the continent, though now rare in Britain. It is well known in its domesticated, albino variety as the ferret (*q.v.*). The wild polecat is dark brown above and black below, the face being variegated with white. The fur is long coarse, and of little commercial value. it is more powerful than the marten (*q.v.*) but less active, and rarely climbs trees. Its food consists of small mammals and any birds it can catch, especially poultry. It also eats snakes, lizards, frogs, fish and eggs. It is extremely blood-thirsty and hunts at night. From three to eight young are produced in April or May, after a two months' gestation. It is very tenacious of life and has a fetid smell.

It is replaced in north Asia by an allied species, *P. eversmanni,* and on the central plateau of the United States by a third form, P. *nigripes,* with creamy-yellow fur, brown legs and black feet and tail. *A* smaller species, *P. sarmaticus,* whose fur is white marbled with reddish spots above, extends from east Poland to Afghanistan. All these animals resemble P. *foetidus* in habits.

POLENTA, DA, the name of a castle in Romagna, from which came the noble and ancient Italian family of Da Polenta. The founder of the house is said to have been Guido, surnamed l'Antico or the Elder, who wielded great authority in Ravenna in the 13th century. His grandson Guido Novello upheld the power of the house and was also *capitano del popolo* at Bologna; he was overthrown in 1322 and died in 1323. In 1321 he gave hospitality to the poet Dante, who immortalized the tragic history of Guido's daughter Francesca, unhappily married to Malatesta, lord of Rimini, in an episode of the *Inferno*. Guido's kinsman Ostasio I. was lord of Cervia and Ravenna from 1322 to 1329, and, after being recognized as a vassal of the Holy See, again became independent and went over to the house of Este, whom he served faithfully in their struggles with the Church until his death in 1346. His son Bernardino, who succeeded him as lord of Ravenna in 1346, was deposed in 1347 by his brothers, Pandolfo and Lamberto II., but was reinstated a few months later and ruled until his death in 1359; he was famous for his profligacy and cruelty. His son Guido III. ruled more mildly and died in 1390. Then followed Ostasio II. (d. 1396), Obizzo (d. 1431), Pietro (d. 1404), Aldobrandino (d. 1406), all sons of Guido III. Ostasio III. (or V.), son of Obizzo, was at first allied with the Venetians; later he went over to the Milanese, and, although he again joined the Venetians, the latter never forgave his intrigue with their enemies, and in 1441 they deprived him of his dominions. He died in a monastery in 1447.

POLESIE (*i.e.,* "along the forest"), the largest and most sparsely populated province of Poland. Area, 14,219 sq.mi. Pop. (1931) 1,131,000. The bulk of the inhabitants are Ruthenians—the so-called Polesians or Pinchuks, forming a special branch of the Ukrainian nationality, and belonging to the Orthodox Eastern Church. Polesie was taken by the U.S.S.R. in 1939 and by Germany in 1941.

Polesie forms an eastward extension of the central Polish plain sloping up to the northern highlands and the plateau of Podolia. It forms the basin of the Prypet, a tributary of the Dnieper, into which flow numerous slow rivers from the Lithuanian forests of the north, and from the uplands of the south. The falls of the Lower Dnieper hinder the drainage of Polesie, and the deepening of the channel of the Dnieper tends to dry up the Pinsk marshes. In spring the whole country is flooded and has the appearance of a sea. In reality it consists partly of marshes and lakes, partly of damp meadows with islands of clay or sand, on which most of the villages are built. In such a dreary plain the main feature is the vegetation, which consists of wide pine forests on the sand or on the swamps, with invading firs from the north, of mixed forests and birch groves, and of damp meadows grown with grasses, reeds and stunted willows. It is the only remaining home of the beaver in Poland, and the elk is still found there. The inhabitants maintain a precarious existence mainly by fishing and hunting. With few horses. there is a special breed of cattle.

Polesie originally formed the early Russian principality of Turov or Pinsk. Conquered by the Lithuanians in 1320, it became, after the union with Poland in 1569, the province of Brest Litovsk. The north-west portion formed part of the estates of the great Polish magnates, the Radziwills and Sapiehas. Wolczyn was the seat of the Czartoryski family. The chief towns are Brest Litovsk, pop. (1931) 50,733, the capital; Pinsk, the seat of an ancient Orthodox bishopric; Kobryn, Kamenets Litovsk and Luninets, a junction of the two railways which traverse the marshes.

POLE STAR or **POLARIS,** the star nearest the pole in the northern hemisphere. (See ASTRONOMY: The Celestial Sphere.) It is the brightest star in the constellation Ursa Minor (*q.v.*), hence its Bayer equivalent α, Ursae Minoris.

POLE VAULTING, the art of springing over an obstacle with the aid of a pole. Originally a means of passing over obstacles as dikes and brooks, pole vaulting, for height, with the object of clearing a bar supported by two uprights set not less than 12ft. apart, has become a purely competitive athletic sport. The chief requirements of the athlete are great skill and courage, a high degree of co-ordination, speed and strength, and a good grip.

Up to the end of the "eighties" all the world's record holders in the sport came from the small town of Ulverston, in Lancashire. They gained their records by means of the extraordinary method they had evolved. It was not really "pole vaulting," but rather "pole climbing." This has now been barred.

The pole now employed is of female bamboo, no longer spiked, but has a plugged end which is thrust into a slide-way sunk in the ground a foot in front of a line directly below the cross-bar, and, moreover, a soft sand-pit, top-dressed with sawdust, is provided for the vaulter to land in.

The modern pole vaulter approaches the take-off very fast, carrying the pole with his hands about 3ft. apart. As the stride next before the spring is completed he thrusts the point of the pole into the slide-way, and lets the lower hand slip up the pole until it touches the upper hand. He is thus enabled to exert the full pulling power of both arms to raise his body and help the swing-up of his legs. It is noteworthy that this trick, efficiently performed, enabled Gold, former holder of the U.S.A. Western Conference record, to clear 12ft. 10in., although the grip of his upper hand upon the pole was no higher than 11ft. 2in., or 1ft. 8in. below the height he actually cleared.

Modern vaulters may be divided into two classes: (1) Those who prefer the single action in which the legs swing upwards and to the side in one single bound. This style requires great speed, and, using it, Charles Hoff (Norway) cleared 13ft. 11$\frac{3}{8}$in. (Finland, Sept. 27, 1925). (2) Those who prefer the double action. In this style the athlete's feet reach a point above the bar before the pole has arrived at a vertical position. At this stage the vaulter shoots his legs still higher by means of a strong arm-pull on the pole. He next turns his body face downwards by means of kicking one leg forward and the other back, and converts his pulling force into a pushing force. The bar lies in the concavity of the stomach, so that the feet, on one side, and his head and shoulders on the other side, are below the level of the bar. The athlete finally carries his body clear of the cross-bar by pushing strongly upwards from the upright pole. In this style, Sabin W. Carr, Yale university (U.S.A.) in 1927 established a world's record of 14ft., which R. Lee Barnes, U.S.A. (1928), using the single action, increased to 14ft. 1$\frac{1}{2}$in.

The use of the bamboo pole has added approximately a foot to the records, and modern methods have been responsible for another 18in. or so. An astounding improvement in performance has taken place recently and, although only U.S.A. and Japanese vaulters, so far, have exceeded 14ft., all the eleven men who tied for sixth place in the Olympic Games at Berlin in 1936 cleared 4 metres (13ft. 1$\frac{1}{2}$in.), a height which would have won the title at any of the previous Olympic celebrations except those of 1932. The finalists included F. R. Webster, the first British representative to reach an Olympic Pole Vault final.

N. Dole, U S A. (1904), was the first man to beat 12ft.; M. S. Wright, Dartmouth college, U.S.A. (1912), the first to clear 13ft.; while Sabin W. Carr, Yale university, U.S.A. (1927), was the first to clear 14ft. F. R. Webster (Cambridge university) was the first British athlete to exceed 13ft.

Records in 1936:—World's, K. Brown, U.S.A., 14ft. 5$\frac{1}{8}$in.; Olympic, E. Meadows, U.S.A., 14ft. 3$\frac{1}{4}$in.; G. Varoff, U.S.A., 14ft. 6$\frac{1}{2}$in. (awaiting acceptance); English record, F. R. Webster, 12ft. 9in. A Britjsh vaulter, A. W. Kinally, cleared 12ft. 6in. in 1936, the record standing at 11ft. 9in. in 1930.

BIBLIOGRAPHY.—F. A. M. Webster, *Athletes in Action* (1931); *Why—The Science of Athletics* (1936); Lawson Robertson, *Modern Athletics* (1932); Webster and Heys, *Exercises for Athletes* (1932); *Athletic Training for Men and Boys* (1933). (F. A. M. W.)

POLIANTHES, one of the florists' flowers, commonly called tuberose, probably derived from P. tuberosa, which is unknown as a wild plant. (See TUBEROSE.)

POLICE. The term police designates that executive civil force of a state to which is entrusted the duty of maintaining public order and of enforcing regulations for the prevention and detection of crime. In a perfect system of civil administration the function of the police should be to curb the liberty of the subject only when it degenerates into licence—and any material variation from the standard is to be deprecated as being arbitrary and tyrannical. A civil organization, established by authority, for maintaining the essential tranquillity of the state and the security of its citizens in their lawful occupations is of high antiquity and has place alike in Egyptian, Greek and Roman law. In Rome, however, it was not until the time of Augustus that the police became a special institution in the city. In the hands of his unworthy successors it speedily became a terrible instrument of tyranny, justifying the dictum of Chateaubriand "la police par sa nature est antipathique à toute liberté." Upon the fall of Rome all traces of police administration disappeared under barbarian rule, only again to be revived in the capitularies of Charlemagne, which contain a large number of police regulations concerning weights and measures, tolls, markets, the sale of food, grain and cattle, the burial of the dead and measures to be taken in time of famine and pestilence. A recrudescence of anarchy on the death of the emperor of the west destroyed all these, but soon after the settlement of the Normans in France, that enterprising race established a highly repressive police system calculated to restore public safety at the expense of public liberty, and this system formed the basis of the police code introduced by William the Conqueror into England. Prior to the Norman conquest and for some time thereafter, the system of "frank pledge" was of general obligation in England. This provided that each district tithing should be divided up into associations of ten persons who were jointly answerable for the good behaviour of, or damage done by, any one of themselves. It seems probable (so far as London is concerned) that the existing police regulations of the Saxon kings, modified perhaps by an infiltration of Norman ordinances, were continued after the conquest, the charter of William the Conqueror to the city dated 1078 providing "I acquaint you that I will ye be all law-worthy as ye were in King Edward's days" An ordinance of the 13th year of Edward I (set out in the Liber Albus) enacts that strict watch and ward should be kept in London "by strong men with good arms" for the maintaining of the king's peace. In 1585 an act was passed for the better governance of the city and borough of Westminster and this statute was re-enacted and extended in 1737, to be succeeded in 1777 by another act containing wider and stricter provisions.

In spite of repressive measures until the end of the 18th century the conditions alike of London and the provinces were deplorable. Robbery and violence were rampant everywhere, highwaymen infested the roads, footpads lurked in the streets, whilst, but too often, both watchmen and innkeepers were accessories to the commission of crime. At the commencement of the 19th century it was computed that there was one criminal to every 22 of the population. Such was the state of affairs when, in 1829, Sir Robert Peel laid the foundation of that arganization on which is based the existing metropolitan police system. At first it encountered much opposition and was denounced as an insidious attempt to enslave the people by arbitrary and tyrannical methods. This unfavourable impression, however, soon diminished, especially as the conviction of criminals and speedy reduction in the number of offences evidenced the efficiency of the new force. Subsequent Acts of parliament extended the system throughout Great Britain. Statutes passed in 1839 and 1840 permitted the formation of a paid county police, to be appointed by the justices of the peace for the county.

The Police Act 1856 made the existence of an adequate force compulsory throughout England and Wales, whilst in Scotland the Police Act 1857 and the Burgh Police (Scotland) Act 1892 provided and regulated a satisfactory and sufficient police force throughout its counties and burghs.

The Criminal Investigation Department, now one of the most active and efficient branches of the police executive came into existence after the establishment of the present system. It is in direct descent from the old "Bow Street runners" who upon special requisition in the case of serious crime, varied their customary duties at the Bow Street Police Office (as it was then called) by acting as detective officers, either in London or the provinces. The first "detectives" appointed in the new department numbered only three inspectors and nine sergeants to whom, however, six constables were shortly added as "auxiliaries"; this number was subsequently enlarged as the manifold advantages of the system became more and more obvious. The system now attracts candidates of superior capacity and education.

The latest statistics (Dec. 31, 1934) show the strength of the metropolitan police to be 19,405, including the Criminal Investigation Department and the Thames (river) Police. The establishment of women police in the metropolitan district comprises (in addition) 1 superintendent, 3 inspectors, 7 sergeants and 45 constables; there were also 16,156 special constables attached to the Reserve on Aug. 31, 1934. The city of London has its own police establishment (about 1,200) under a commissioner and assistant commissioner; its functions extend over an area of 677 statute acres containing two courts of summary jurisdiction, those of the Guildhall and Mansion House, where the lord mayor and aldermen are the magistrates.

The total strength of the regular police force in England and Wales at the date of the latest available report is 58,303, not including 142 attested and 19 non-attested police women.

In 1931 Lord Trenchard succeeded Lord Byng as Chief Commissioner of the Metropolitan Police, and at once initiated certain reforms, the chief outcome of which was the new Police College at Hendon, opened in May 1934 as the basis of a new system of recruitment to the higher posts in the force. Another innovation was the recruitment of about 30% of the constables for a term of 10 years only, instead of 25 years or more.

British India is divided into police districts in which the general system of regular police resembles in most respects that of the police of Great Britain. There are, however, certain variations in minor details in the various provinces.

The total strength of the police at the last available date (1924) was 14,083 officers and 182,099 men. All are in uniform, drilled and trained in the use of firearms and may be called upon to perform *quasi* military duties. Many of the superior and nearly all of the inferior officers and men are Hindus. In Bombay they are chiefly Muslims.

The actual organization of the police force is not specifically dealt with by the Indian Penal Code, although it contains many provisions essential to efficiency and confers legal powers on the executive not only to take evidence but also to compel the attendance of witnesses. (W. W. P.)

THE UNITED STATES

Police organization in the United States had its origin in colonial days. The office of constable, invested with the powers and duties prescribed by the English common law, was established by the inhabitants of townships in the several Colonies. To this day the office of constable remains in rural localities and in many cities. His duties in 1929, however, are largely limited to the service of civil court processes. The first step in evolution from constable to modern police system came in colonial times with the establishment of night watches in the larger cities as a supplementary force and under supervision of constables. In New York the first police arrangements were set up in 1658 by the Dutch colonists, who maintained watchmen under the control of the local burgomaster. When New York passed to English control, a watchmen's organization under the command of a high constable assisted by subconstables was established.

The province of Massachusetts by legislation passed in 1699 provided that, in places where no military watch was in existence, the elected justices of the peace, acting in concert with the selectmen of a town, could order the establishment of a Suitable watch which would keep the peace from nine o'clock in the evening unti! sunrise of the next day and designate the places where such watch should be stationed. Provision was also made for a "ward" on Sunday and weekdays. All able-bodied male citizens above the age of 16 years and having certain property qualifications were made liable to keep watch and ward, the watch being night service and the ward day service, upon designation by the local governmental officers. At first no compensation was attached to the office of watch and ward, but later the way was opened for a paid force of regular watchmen. The night watch scheme spread throughout the larger cities of the Atlantic seaboard, and by 1800 had become well established.

With the rapid growth in population of cities and mixture of peoples resulting from heavy immigration, the problem of policing became increasingly complex. The night watch was not equal to its responsibilities under such conditions. Loosely organized, untrained, poorly disciplined, without good *esprit* de corps, the watch was held in low repute by the public. Employment on the watch was determined quite generally on the basis of political partisanship. A day force was created in New York which numbered only 16 regular men in 1844 and 108 special Sunday officers. In addition to these there were employed at that time about 100 mayor's marshals and 34 constables, two of whom were elected to serve for each of the 17 wards of the city. The night watch consisted of more than 1,100 men. A day watch was created in Philadelphia in 1833 and one for Cincinnati in 1842. The existence of two independently controlled police forces, one for day and the other for night, led inevitably to friction.

The New York State legislature enacted, in 1844, a law providing for a consolidated "day and night police." This action forms the basis of what is known as modern police organization in the United States. Police forces were consolidated and reorganized under a single executive head during the next few years in Boston, Philadelphia, Chicago, New Orleans, Baltimore, Newark and Providence. Even after these reorganizations the police were for a time without distinctive uniform and it was not until 1856 that the police forces in New York and Philadelphia adopted a standard uniform. The development of municipal police forces in the United States from this time on was, with a few exceptions, accompanied by a considerable degree of experimentation in respect to the fashioning of administrative control. Police organizations frequently were made the focus of political manoeuvring. Short terms of office for heads of police departments and, in many cases, for the lower offices and even the rank and file were the evil products of this political change. At first the common council of cities shared with mayors in the appointment of the police personnel and direction of their work. Later the mayor came to exercise a larger share of the control. About 1895 the civil service principle was widely adopted as a remedy for merely political changes.

On the administrative side, the control of the police organizations in earlier days was generally vested in a board of police commissioners ranging from three to four in number. These boards were usually appointed by the mayor, sometimes subject to the approval of the common council. It was held to be desirable to have bi-partisan control of police affairs in order to guard against domination by one party and the board form offered an opportunity for such a party representation. In a number of instances legislation was passed which took the appointing from the mayor and lodged it with the governor of a State. Generally, however, these moves were held to be in violation of the principle of local home rule. New York, Chicago, Detroit and Cleveland tried and abandoned the State control plan. In 1929, State control over appointment of the police commissioners is found in Boston, Baltimore, St. Louis, Kansas City and St. Joseph, Mo. There is no attempt at inspection of standards of police service by the State nor does the State contribute any moneys to the service. The only benefit expected from State control is that the governor will perhaps appoint administrators free from local political obligations

After 1900 a wide-spread change in the form of municipal government was brought about in cities of the United States. The commission form of government provides a commission of from five to seven men elected to manage municipal affairs, both legislative and executive. Under this arrangement, one of the elected commissioners is designated as director of public safety, having under his immediate charge police and fire administration and sometimes other more or less related functions. A chief of police serves as executive head of the police force under supervision of the director. Important cities having this form of government are Buffalo, Newark, New Orleans, Omaha, St. Paul and Portland, Ore. Unfortunately it does not guarantee exclusion of politics or permanent tenure.

In more recent years an improvement over commission government has come with the adoption of commission-manager charters. Under this scheme the commission serves as a local legislative body and appoints a manager who assumes entire charge of administering municipal departments. The manager in turn appoints a chief of police and all recruits to the police service generally in accordance with civil service regulations. The police have benefited almost without exception by this change. Among the larger cities having the commission-manager plan are included Cleveland, Cincinnati and Dayton in Ohio, Rochester, N.Y., and Norfolk, Va. In all some 300 cities and towns have adopted the city manager plan. In New York, Chicago, Philadelphia, Detroit, San Francisco and hundreds of other cities, the police are under control of the mayor and his appointees.

Despite all of the change in administrative devices, the plan of internal organization of police departments has remained much the same in all cities. The New York police system has served as the general pattern after which most police forces in the United States have been modelled. A uniformed patrol is distributed over cities on beats or territories as a first line of defence and protection against crime and disorder. The detective bureau is organized as a separate unit having to do with detection of the more serious crimes and apprehension of offenders. Special units of plain clothes operatives devote their attention chiefly to suppression of gambling, prostitution, illegal sale of narcotics and liquor law violations. Traffic regulation (*q.v.*) is a pressing problem in cities of the United States, and requirements in this direction have called for the employment of a large number of men. Policewomen are being employed in increasing numbers to look after the protection of women and children. Most large cities have training schools for instruction of new recruits and in some cases advanced instruction is given to older members of the force. Considerable progress has been made in the keeping of records, installation of systems of communication by signal and in the use of motor equipment in patrol and emergency service. Laboratories for scientific criminal investigation and identification are rapidly coming into vogue. With the passing of political interference definite progress is being made in the direction of professionalizing police service, and a higher type of man is being attracted to the service.

State constabularies have been created in Pennsylvania, New York, Massachusetts, Connecticut, Texas, West Virginia, Michigan, New Jersey, Colorado, Maryland and Delaware. These organizations recently established were built upon the experiences of municipal forces and so have avoided many difficulties and started on a generally high level of efficiency. Their work lies chiefly in patrol of rural areas and regulation of traffic on important rural highways. There is no Federal police force designated as such. In the Treasury Department of the Federal Government there are units comprising investigators armed with police powers who look after violations of the prohibition law, smuggling through customs, illegal narcotic importation and counterfeiting. A corps of investigators is maintained by the Post Office Department in tracing theft from the mails, illegal use of mails, etc. The Department of Justice maintains a criminal identification section. The Federal Congress has control over the Washington, D.C., municipal police force. (R. B. F.)

POLICE COURTS, courts of summary jurisdiction held in London and certain large towns in England and Wales by specially appointed and salaried magistrates.

Police magistrates are appointed by the Crown. They must have been practising barristers for seven years or stipendiary magistrates for some place in England or Wales. One police magistrate has the same powers as two justices.

The precedent of appointing salaried magistrates was adopted in certain provincial towns under particular acts, and in 1863 the Stipendiary Magistrates Act enabled towns and boroughs of 25,000 inhabitants and upwards to obtain a stipendiary magistrate. There are at the present time (excluding metropolitan magistrates' courts) 18 stipendiary magistrates' courts throughout England and Wales.

In the United States there are no so-called police courts in the Federal system of courts except in the District of Columbia, where the President appoints, subject to confirmation by the Senate, two judges of the police court. In the various States, police courts, the presiding official of which is either a judge or a magistrate, have been created for many cities. They are elected by the voters, and try the violators of municipal ordinances.

POLICE POWER, in American constitutional law, the reserved or inherent powers of the States to legislate for the health, safety and morals of the community. The requirements of the 14th amendment of the U.S. Constitution that no State shall deprive any person of life, liberty or property without due process of law and the interpretation of that amendment by the Supreme Court to give it a supervisory jurisdiction over all State legislation restricting the exercise of individual rights, brought to the forefront the concept of police power as a basis for sustaining the exercise of novel State legislation. The ultimate test of constitutionality under the due-process clause being the arbitrariness to the judicial mind of the State legislation, the relationship between the legislation and the admitted power of State governments to act for the protection of the community in ways reasonably adapted to secure those ends becomes of acute and decisive importance.

Resolving this relationship in terms of traditional concepts of constitutional law, legislation provided that it falls within the police power of the States even though it interferes with property or personal rights does not then run afoul of the due-process clause of the 14th amendment. The ultimate question, of course, remains, namely the extent of the police power viewed in the light of the object sought to be effected by the legislation and the means devised to secure that object. The extent of the police power remains as the least defined of State powers. With a political collectivistic philosophy gradually supplanting the individualistic philosophy of an earlier age, illustrated by the increasing regulatory activities of government, the content of police power becomes an ever-broadening one. Supreme Court decisions reflect this change in later cases that overruled earlier decisions declaring unconstitutional State legislation seeking to protect interests not then deemed within the legitimate scope of governmental regulation.

The extent of the police power is generally said to embrace the protection of the health, safety and morals of the community. Regulation of the practice of trades directly related to the health of the community, restrictions upon the use of property for sanitation purposes, prohibition of immoral amusements, requiring the installation of equipment designed to protect the safety of employees or the public, the regulation of traffic, the regulation of hours of labour, are all types of governmental activity within the recognized domain of State legislation. The police power, however, extends to purposes not so clearly related to the health, safety or morals of the community. The conservation of natural resources, zoning legislation, the protection of the public against fraud and waste, the enforced destruction of property adapted for illegal uses but capable of permitted uses, are examples of the uncharted scope of the police power. It is commonly said that the police power may not be exercised purely for aesthetic purposes, but as a better understanding of the organization of society may illustrate an intimate relationship between the promotion of aesthetical ends and general social welfare, the concept of police power may well be enlarged to include purely aesthetic considerations. The Federal Government is said to possess no general police power. Inasmuch as the Federal Government is one of limited powers and no general power for the protection of the health, safety and morals of the nation is granted to it under the Constitution, such a statement is accurate. But the Federal Government in the exercise of its granted powers may and does act for the promotion of ends within the concept of police power, and in this sense it has full freedom to protect the health, safety and morals of the community.

There are certain important differences between the exercise of the police power and other inherent State powers. The power of eminent domain, constitutionally restricted to employment for a "public use," can only take property by the payment of just compensation. The exercise of the police power may involve an equal "taking" of property but carries no obligation to compensate for such a taking. Again under the U.S. Constitution no State may pass legislation impairing the obligation of contracts already entered into. State action under the police power may, however, impair the obligation of contracts without conflicting with the constitutional prohibition, thus "taking" contract as well as property rights without compensation, (*See* CONSTITUTION AND CONSTITUTIONAL LAW.)

See Freund, *Police Power* (1904); Burclick, *Law of the American Constitution* (1922); Mott, *Due Process of Law* (1926).

(J. M. LA.)

POLIGNAC, an ancient French family, which had its seat in the Cevennes near Puy-en-Velay (Haute Loire). It can be traced to the 9th century, but in 1421 the male line became extinct. The heiress married Guillaume, sire de Chalançon (not to be confused with the barons of Chalançon in Vivarais), who assumed the name and arms of Polignac.

The first historically important member was Cardinal MELCHIOR DE POLIGNAC (1661–1742), a younger son of Armand XVI., marquis de Polignac, who became a distinguished diplomatist. In 1695 he was sent as ambassador to Poland, where he brought about the election of the prince of Conti as successor to John Sobieski (1697). In 1712 he was sent as the plenipotentiary of Louis XIV. to the Congress of Utrecht. During the regency he became involved in the Cellamare plot, and was sent to Flanders for three years. From 1725 to 1732 he acted for France at the Vatican. In 1726 he received the archbishopric of Auch, and he died at Paris in 1742.

Prince JULES DE POLIGNAC (1780–1847), son of Count Jules (d. 1817), played a conspicuous part in the clerical and ultra-royalist reaction after the Revolution. Under the empire he was implicated in the conspiracy of Cadoudal and Pichegru (1804), and was imprisoned till 1813. After the restoration of the Bourbons he held various offices, received from the pope his title of "prince" in 1820, and in 1823 was made ambassador to the English court. On Aug. 8, 1829, he was called by Charles X. to the ministry of foreign affairs, and in November became president of the council. His appointment was taken as symbolical of the king's intention to overthrow the constitution, and, with the other ministers, he was held responsible for the policy which culminated in the issue of the Four Ordinances which were the immediate cause of the revolution of July 1830. On the outbreak of this he fled for his life, but was arrested at Granville and condemned to perpetual imprisonment. The sentence was commuted to one of exile by the amnesty of 1836. During his captivity he wrote *Considérations politiques* (1832). He spent some years in England, but was permitted to re-enter France on condition that he did not live in Paris. He died at St. Germain on March 29, 1847.

POLIGNY, a town of eastern France, in the department of Jura, 18 m. N.N.E. of Lons-le-Saunier on the P.L.M. railway. Pop. (1936) 3,417. Under the name of *Polemniacum* the town seems to have existed at the time of the Roman occupation. It lies in the valley of the Glantine at the base of a hill crowned by the ruins of the old castle of Grimont, once the repository of the archives of the county of Burgundy. The church of Montivillard dates from the 12th century and has a fine Romanesque tower. The church of St. Hippolyte, early 15th century, and a convent-church serving as corn market are of some interest. Poligny has a national school of dairy instruction.

POLISH LANGUAGE. Together with Polabian—a now extinct language spoken by the Slavs of the Elbe before they became Germanized—Sorb or Wendish, and Czechoslovak, Polish belongs to the western branch of the Slavonic languages. The nearest relative of Polish is Polabian, with which it forms the Lech group, but in view of the fragmentary character of the remains of that language (a few words and sentences inexactly recorded), it is difficult to state with any detail more than the purely phonological agreements. Those which are shared by the Lech languages and Sorb are: extreme palatalization of consonants before front vowels, the absence of the vowels *r̥* and *l̥*, a particular development of *or* and *ol* between consonants, and the tendency to lose the old distinctions of quantity. In all these points there is a contrast with Czechoslovak which to some extent bridges the gap between the western and the southern branches; but the characteristic features of West Slavonic are naturally common to Polish and Czechoslovak. The features which are generally considered as belonging to common West Slavonic are: the development of *tj* and *dj* to *c* and *dz* (Polish and Slovak still have *dz*, but in Czech the sound has become *z*); the palatalization of consonants before *i*, *e*, *ę* and *ĭ* (only partially carried out in Czech, but Slovak agrees more completely with Polish); passage of *l* before back vowels and consonants to a sound like that in English "wall" (preserved also in Slovak dialects and in Old Czech, but the German *l* prevails in the modern language), loss of *j* between vowels, with compensatory development of a long vowel; shortening of long vowels which originally had a falling intonation; and the tendency to throw the stress away from the final syllable.

Polish is softer than Czech to the ear, owing to the predilection for palatal and sibilant sounds. The sentence melody, in spite of a regular accent on the penultimate, is in no way disagreeable, and the consonantal groups, which at first seem frightening, are easily pronounced after some practice. The survival of the old nasal vowels imparts to Polish an acoustic effect not unlike that of French.

The Slavonic inflexional type has been well preserved: there are seven cases in both singular and plural (the dual has almost disappeared). The verb is of the normal type, except that it has lost the imperfect and aorist. A peculiar feature in the syntax of Polish is the impersonal passive construction, where the logical subject is put in the accusative after the neuter of the participle. The vocabulary of Polish has been considerably influenced by earlier Czech and also by German and Latin, but in the main the Slavonic character has not been seriously affected, and the number of words from other languages is negligible.

Polish dialects are usually divided into two broad divisions. The group to which the literary language belongs has preserved the old pronunciation of *sz* and *ż* (as in English "ship" and "azure" respectively), while the other has altered them to *s* and *z*. Scholars are disagreed on the question of Kašube, which is spoken by fewer than a quarter of a million people in the neighbourhood of Danzig. In its modern form, it is very close to Polish, especially from the point of view of vocabulary, but it has several features which make it possible that at an earlier stage it was more closely connected with Polabian.

BIBLIOGRAPHY.—The historical grammar of Benni, Łoś Nitsch, Rozwadowski and Ułaszyn (*Gramatyka języka polskiego—Cracow*, 1923) is authoritative. It is slightly smaller than and covers a somewhat different field from the *Polish Language and its History* (in Polish), which is part III. of the *Encyklopedja Polska* (1915). Another excellent historical grammar is that by J. Łoś, *Gramatyka polska.* The grammar by St. Szober (Lwów—Warszawa, 1923) is the best descriptive work. The *Grammaire de la langue polonaise*, by A. Meillet and Mme. de Willman-Grabowska (Paris, 1921) is the best sketch in a western language. The most complete dictionary is that of S. B. Linde (*Slovnik języka polskiego*, Lwów, 1854–60), in 6 volumes. The *Handwörterbuch der deutschen und polnischen Sprache* in 4 vols., by Konarsky, Inlender, Goldschneider and Zipper (1st edition, 1904), is good but bulky. The *Dictionnaire complet français-polonais et polonais-français by W.* Janusz (Lwów, 1908) is excellent, and better than A. B. Chodźko's *Doktadny slownik polsko-angielski* (Berlin, 1912). *A Polish Phonetic Reader* by Arend-Choiński (London, 1924) supplements the larger works of Benni and other Polish phoneticians.

(N. B. J.)

POLISH LITERATURE. The Polish language belongs to the western branch of the Slavonic tongues, and exhibits the closest affinities with Czech, Slovak and Lusatian Wendish.

The earliest connected specimens of Polish prose are: the fragmentary Holy Cross Sermons, and the complete Psalter of *St.* Florian, both preserved in 14th century mss. which are probably copies of earlier originals. The beginnings of poetry are represented by the *Bogurodzica* song, a hymn in honour of the Virgin, often sung by the Poles of the middle ages when going into battle. Legend ascribed the origin of the song to St. Adalbert (Wojciech), in the 10th century. The oldest ms. of the song is dated 1408.

The 15th century brings a fuller development of religious poetry. A number of devotional songs are preserved, being mostly translations of Latin or Czech hymns. Many of these songs are the work of Ladislas of Gielniów, a Bernardine preacher, and of other friars of the same order.

The secular lyrics of the 15th century which have come down to us are not numerous but varied in contents, some being didactic in vein, such as the verses on table manners, some amatory and some in the nature of historical ballads on important public events; the victory over the German Knights in 1410, the defeat of Poles and Hungarians at the hand of the Turks in the battle of Varna (1444), Tartar invasions and other disasters, a riot of the Cracow citizens who kill an unpopular nobleman (1461)—such are the facts commemorated. The coming controversies of the Reformation period cast their shadows before them in a vivid poem by Andrew Galka, on the doctrines of Wycliffe, which had become known through the Hussite movement in Bohemia.

Prose works in the 15th century are scarce: Polish 15th century prose is largely devotional: its longest specimen is a translation of the Bible made for Sophia, queen of Poland, about 1455; several books of the Old Testament only are preserved.

Latin Literature in Mediaeval Poland.—If literature in Polish is scanty, Latin literature in Poland throughout the middle ages is fairly abundant, especially in the field of history. The first chronicle of Poland written in Latin is an early 12th century work by an anonymous foreign monk, whom tradition called "Gallus." It tells the story of Poland from the beginnings of the Polish State in the middle of the 10th century till 1113. A hundred years later, a continuation of this chronicle was undertaken by Vincent Kadlubek, bishop of Cracow.

In the 13th and 14th centuries, the number of chronicles increases: we may single out that of Jan of Czarnków (d. 1389), which gives a vivid account of conditions in later 14th century Poland. A great centre of intellectual and literary activities was created by the foundation of the University of Cracow. The university was originally erected as a legal college in 1364; in 1400 it was reorganised on a broader basis, mainly through the efforts of Queen Jadwiga, who, by her marriage with Duke Jagiello, united Poland and Lithuania in a powerful monarchy. It is in the shadow of Cracow university that Poland's most distinguished mediaeval historian, Johannes Dlugosz or Longinus (1415–1480) undertakes his great Latin work on the history of the country. Through diligent study of the royal and ecclesiastical archives, which were open to him, and of the works of native and foreign historians, Dlugosz produced in his *Historia* Poloniae the first monumental work of Polish historiography which unites critical scholarship with literary excellence. History is supplemented by the lives of saints, ever popular in the middle ages.

Latin poetry in mediaeval Poland, as in other European countries, is represented by church hymns as well as by the Latin carollings of the *clerici* vagantes. As the Renaissance approaches, the ground for the elegant Latin versification of the humanist scholars is prepared.

Early Polish Printed Books.—A printing-press was in existence at Cracow about 1474. But it was only about 1500 that a permanent printing office was established at Cracow by Jan Haller, followed by a number of others. Among the books they printed, Latin are still in the majority; but Polish books begin to appear in increasing numbers. A large part of them is devotional. Fiction, as elsewhere, is represented by "chap-books" on such subjects of international popularity as the fabulous histories of Alexander the Great and the stories collected in cycles like the Gesta Romanorum or the Seven Sages. Among the translators who provided this sort of literary food, Bernard (Biernat) of Lublin (*c.* 1515), takes a prominent place, chiefly by his rhymed paraphrase of Aesop's Fables and the romantic Life of Aesop. Next to him stands Jan of Koszyczki, who paraphrased the ancient jests associated with the names of King Solomon and his legendary opponent, the shrewd peasant Marculf: these humours of *Marchołt,* as he is called in Polish, are a fine specimen of racy popular speech. So are some religious songs, especially Christmas carols, interlarded, in the fashion of the time, with jocular details from contemporary life. With such literature, still essentially mediaeval in character, we may rank even the elaborate and widely-read Chronicle of the World (1551), written in Polish by Martin Bielski, as well as his Satires and his allegorical play *Justinus* and *Constantia,* the first morality in Polish.

Humanism and the Reformation.—A period justly called "the golden age" of Polish literature was prepared by the spread of Renaissance humanist culture, and of the doctrines of the Reformation. Poland, like other countries, began to produce Latin prose and poetry during the 16th century. The witty and licentious, satirical and erotic epigrams of Bishop Andrew Krzycki (d. 1537), the serious political and moral epistles of the diplomat Joannes Dantiscus (a burgher of Danzig, d. 1548), the tender elegies of Clement Janicki (Janicius), dead in his prime in 1543, rank with the best Latin poetry of modern Europe. The mediaeval historical work of Dlugosz is surpassed in grace by the humanist Latin of Martin Kromer's History of Poland (1555). Poland's greatest political thinker of the period, Andrew Frycz-Modrzewski, used Latin for his work De *republica* enzendanda (1551), a systematic treatise on social philosophy; and as late as the 17th century a Polish jesuit, Mathew Sarbiewski (d. 1640), became known throughout Europe as "the Christian Horace" for the beauty of his Latin religious lyrics. On their travels abroad, Polish students not only perfected their Latin and Greek, but witnessed the new growth of vernacular literatures based on classical models, and this awakened the ambition to rival foreign achievements by Polish verse and prose. Such ambitions were stimulated by a Protestantism which favoured the vernacular. After the council of Trent and the coming of the Jesuits (1564–1565), Protestantism began to decay: but what it had done for national literature remained effective. The Catholic Polish bible of Bishop J. Wujek (1599) has greatly influenced language and style.

The Poets of the Golden Age.—The year 1543 is a landmark, being the date of the appearance of the first important work of Nicholas Rej of Naglowice (1505–1569). After a somewhat idle youth he wrote a long series of poetical works. He turned Calvinist in middle age, and produced a translation of the Psalms. His principal and most mature works—the Image of an Honest Man's Life, in verse, and the more elaborate prose Life of an Honest Man—present his moral ideals, being those of a good-natured country gentleman. The latter work is also known as The Mirror.

Rej's popularity was outshone by the fame of Jan Kochanowski (1530–1584). He resided in Paris, where he met Ronsard. Returning to Poland, he became in 1564 secretary to the king. His less important early works, among which a paraphrase of Vida's poem on the Game of Chess may be singled out, were followed by epigrams called *Trifles* ("Fraszki") and by numerous Songs varied in tone, idea and form like the Odes of his master Horace, yet instinct with modern sentiment. In a longer poem, The Satyr, he deals with the serious political problems of Poland in his time, in *St.* John's Eve (Sobótka) he delights us with pictures of nature and country life. Kochanowski's only dramatic work, The Dismissal of the Grecian Envoys (Odprawa poslow greckich) (Eng. tr. Noyes and Merrill, Berkeley, Cal., 1918), is a verse tragedy in the Greek style, with choruses, on a subject from Iliad iii. Another work of Kochanowski's, his verse paraphrase of the Psalms, remains one of the masterpieces of religious lyrical poetry in Polish, only rivalled among his works by the Treny or Laments for his little daughter Ursula who died in childhood (Eng. tr. Prall, Berkeley, Cal., 1920). Another great lyrist of the period, Nicholas Sep Szarzyński (1550–1581) died in his prime. He introduced the sonnet into Polish poetry. The long descriptive and satirical poems, in Polish and Latin, by the townsman Sebastian Klonowicz (1545–1602) are interesting as illustrations of the social life of Poland. Simon Szymonowicz (or Simonides, 1554–1642), a burgher of Lwów, and an elegant Latin poet and dramatist, acquired fame as a Polish writer by his Pastorals which imitate Theocritus and Virgil, but contain vivid scenes from Polish life.

Prose Classics of the 16th Century. — Simultaneously with poetry, Polish prose rises into excellence. The religious and political controversies of the hot-blooded prelate Stanislas Orzechowski (1515–1566) were conducted in a style of admirable vigour. The version of Castiglione's *Il* Cortegiano, by Lucas Górnicki (1566) is a fine monument of Polish prose style. Ecclesiastical eloquence found its master in the Jesuit Peter Skarga (1536–1612), indefatigable as the protagonist of the Catholic cause in Poland. His Lives of Saints have remained a religious classic; but his Parliamentary Sermons published in 1597 are the crown of his life's work. It is here that Skarga, exposing the faults of the Polish national character and foretelling the downfall of the State, challenges comparison with the Hebrew prophets.

FROM BAROQUE TO CLASSICISM

The Age of Baroque. — The 17th century, although a period of wars and invasions, is rich in literary production. Italian models, with all the extravagance of the seicento manner, give to 17th century Polish literature, variety and colour, but at the expense of unity and moral elevation. Important works, censored by the clergy, have come to light only in recent times.

Poets of the 17th Century. — The military events of the period, together with the influence of Tasso's epic (translated into Polish, as was also Ariosto's, by Peter Kochanowski) inspired a number of epic poems dealing with contemporary history. The principal poet of the period, Wacław Potocki (1625–96) composed an enormous epic on the Chocim campaign of 1621 against the Turks and followed it up with The New *Mercury* and The *Turks'* Defeat at *Chocim* on the victories of John Sobieski. He also left behind in ms. two large collections of minor verse, The Garden and Moralia, and both illustrative of all aspects of the Polish life of his time. Potocki is also the author of a huge body of religious verse, and of several verse romances both original and translated. Potocki was preceded by Samuel Twardowski (1600–60) author of three interminable rhymed chronicles on the stormy events of the time. A fantastic verse story of his, The *Beaute*oars Pasqualina, is noteworthy as a paraphrase from Montemayor. A bitter satirist appeared in Christopher Opaliński (1610–56). His brother Lucas (1612–62) is also a satirist, and a better poet, as well as a political writer of merit. He wrote also an Art of Poetry. Vespasian Kochowski (1633–1700), in importance next to Potocki, surpasses him in artistic refinement. Having fought in many Polish wars, he told the story of some of them in voluminous epics. But neither these nor his long religious poems are as important as his *Polish* Psalmody, modelled on Kochanowski's verse Psalter, but written in poetic prose and embodying much of the poet's own inner life. A poet of peculiar charm and grace meets us in the person of Andrew Morsztyn (1613–93), who translated Tasso's Aminta, Corneille's Cid, and Marini's Psyche, and represents, in his own lyrics, the first instance of the deep influences of Italian and French literature. Simon Zimorowicz (1608–29), a burgher of Lwów, who died young, shines like a meteor by the freshness and poetic sentiment of his love lyrics *Roxolanki.* His elder brother Joseph Bartholomew (1597–1677), gives us delightful glimpses both of town and country life, and interesting accounts of quiet as well as of stormy times, in his Idylls.

18th Century Prose. — Among prose writers, we may single out: the Dominican preacher Fabian Birkowski (1566–1636), a baroque successor to Skarga; the learned and voluminous Latin and Polish writer Simon Starowolski (1585–1656), whose Latin works include the first history of Polish literature; Count Andrew Maximilian Fredro (1620–1697), whose Proverbs are a collection of maxims and observations comparable with the works of the French moralists of the time; Stanislas Heraclius Lubomirski (c. 1640–1702) who wrote several comedies based on Italian and Spanish originals, and finally, John Chrysostom Pasek (1630–1701), the king of Polish diarists, whose adventures in war and peace are embellished beyond the truth, yet simply and spontaneously narrated.

The Saxon Period. — The era of baroque is prolonged into the sad period of political decay and intellectual stagnation covered by the reigns of Augustus II. and III. (1697–1763). Specimens of literature worth recording, like the unpretending verse of Poland's first poetess Elizabeth Druzbacka (1695–1765), are isolated in this age. But even this darkest period of Polish civilisation is illuminated by such efforts as Stanislas Konarski's (1700–1773) reform of the secondary schools conducted by the Piarist fathers and his proposals for a thorough reform of Polish literary style (De *emendandis* eloquentiae *vitiis*, 1744).

The Era of Enlightenment: Poets. — The reign of the last king of Poland, Stanislas Augustus Poniatowski (1764–1795), is a period of literary development. Both the general atmosphere of the age of rationalism, and the peculiar conditions of Poland — the imminent danger of ruin to the commonwealth — gave the literature of the period a predominantly didactic character: satire, as elsewhere in Europe, is prominent. Thus, the representative writer of the age, Ignatius Krasicki (1735–1801) was, above all, a satirical poet. Krasicki is a typical eighteenth century prelate of the sort not uncommon in western Europe at the time. After his early heroic-comic poem, *Myszeis,* on the battle of the rats and mice against the cats, he soon rose to a higher level in his epic satire on monastic life, Monochomachia. This was followed by a biographical novel, The Adventures of *Doświadczyński,* which contains a good deal of satire on the Polish gentry. A second novel, Pan Podstoli, is more didactic in design: it draws Krasicki's picture of the ideal country gentleman. The high-water mark of Krasicki's work is reached in his Satires, the supreme achievement of 18th century classicism in Poland. They are followed by Epistles, but his most popular work is his Fables, which has made him the La Fontaine of Poland. His voluminous prose works include the first Polish survey of universal literature.

The poet next to him in the favour of his contemporaries, Stanislas Trembecki (1735–1812) is Krasicki's equal in clearness and expressiveness of language, but otherwise inferior to him. Trembecki excels in his Fables and Epistles by perfection of phrase and melody of verse. The fiery satirist Kajetan Wegierski (1755–84), who died in his prime after a youth of dissipation, was perhaps more deeply influenced than others by the French writers of the age, whom he loved to translate. The later poets of the period mark the transition from rationalism to romantic sentiment and include Francis Karpiński (1741–1825), and Francis Kniaznin (1750–1807).

Prose Writers of the 18th Century. — Bishop Adam Naruszewicz (1733–96), owes his chief title to fame to his ponderous history of mediaeval Poland, the first scholarly treatment of the subject. Stanislaw Staszyc (1755–1826), a liberal-minded priest, began his career with powerful pamphlets advocating political and social reform, and continued it after the partitions of Poland as a scientist and an organiser of research and industry. His fellow-reformer, Father Hugo Kollontaj (1750–1812), surpassed him as a political journalist and in his later work, as a philosopher.

The Theatre. — It was for school theatres that Francis Bohomolec wrote his comedies (1755–60), based on French models, chiefly Molière. At the same time, Wacław Rzewuski (1706–1779), wrote tragedies from Polish history in the French classical style for the private theatre at his residence. But it was only with the foundation of the first public theatre in Warsaw in 1765 that Polish dramatic literature got a permanent footing; and the manager of that theatre, Wojciech Boguslawski, himself a popular playwright, is the real creator of Poland's theatrical tradition. It was for this theatre that Francis Zoblocki (1754–1821) wrote his satirical comedies, drawing for subject-matter on obscure French sources, but presenting Polish figures and Polish ways. The Dandy's *Courtship* (Fircyk w zalotach) is his masterpiece. The famous comedy The Return of the Deputy (Powrót Posła) by Julian Ursyn Niemcewicz (1757–1841), was written to help the cause of political reform. Niemcewicz himself, aide-de-camp to Kościuszko, made his mark in many fields of literature. His *Songs of Polish History* (Spiewy historyczne) are still read and recited in schools. His *Fables* and *Satires,* comedies and tragedies belong to the 18th century, but by his translations of English ballads and romantic poems, as well as by his novels he heralds the coming of a new age. His *Memoirs* are a valuable chronicle of the transition period.

THE NINETEENTH CENTURY

The Romantic Era.—Soon after the disappearance of the old Polish State the vitality of the nation was manifested not only by military effort during the Napoleonic Wars, but also by intellectual and literary achievements. The University of Vilna (which had received its charter in 1579) entered on a flourishing period soon after 1800: the great poet Mickiewicz came from the ranks of its pupils. In the South-Eastern part of the borderlands, the Lyceum or public school of Krzemieniec in Volhynia displayed similar activities. In Warsaw itself a "Society of Friends of Learning" came into being in 1800, and a *Dictionary of the Polish Language* by Samuel Linde was among its many undertakings. Warsaw remained the capital of literary taste, and in the first decades of the century, the classicism of the former age still reigned there. It is represented by the poet and critic Kajetan Kozmian the author of Polish Georgics (*Ziemianstwo),* and bishop J. P. Woronicz (1757–1829) who, in his didactic poem *Sybilla,* drew comforting conclusions from a philosophical survey of Poland's history.

The strong didacticism of the classicist era also inspires the literary activities of Mme. Clementina Hofman (née Tanska), who produced the standard works of Polish educational fiction.

At the very end of its period classicism still gives Poland one great writer in Count Alexander Fredro (1793–1876) the author of the best Polish comedies. A soldier under Napoleon, he saw the masterpieces of French classical comedy in Paris and followed Molière. His first piece, *Pan Geldhab,* a satire on *nouveaux riches,* was produced in 1821. He wrote about twenty other comedies, and then abandoned production for fifteen years. At his death, however, he left behind a number of further plays in ms. His best-known works are: *Zemsta* (The revenge), which satirizes the mania for litigation among country gentlemen; *Śluby panieńskie* (Girlish Vows); *Damy i huzary* (Ladies and Hussars, Eng. trs. Noyes, 1925); *Mąz i zona* (Husband and Wife); *Dozywocie* (The Life Interest) and *Pan Jowialski* (The old Story Teller). The comedies, mostly in verse, portray the Polish country gentry to which Fredro belonged.

Midway between the classicists and the romantics stands the curious figure of Casimir Brodzinski (1791–183j). His verse idyl *Wiesław,* in which the manners of the peasants of the district of Cracow are portrayed, is classical in style and diction, but romantic in sentiment. His essay on *Classicism and Romanticism* and on *The Spirit of Polish Poetry* (1818) proclaimed the importance of national tradition and popular elements for literature, and in his lecture *On Polish Nationality* (1831) he partly anticipated the notion, fully developed by the great romantics, of Poland as a "chosen people." The boldness of new ideas was combined with supreme power of poetic achievement in Adam Mickiewicz (*q.v.*) (1798–1855), who soon became the acknowledged leader of the Romantic Movement.

Juljusz Słowacki (1809–49) is in many ways more representative of the essence of Romanticism than Mickiewicz. His genius develops under the influence of Byron. *Podróz na Wschdd* (A Voyage to the East), is a poem in the manner of *Childe Harold.* Slowacki's fantastic verse play *Kordjan* combines reminiscences of a Warsaw conspiracy against the tsar in 1829 with the influence of *Manfred* and of *Hamlet.* Mickiewicz's *Ksiegi Pielgrzymstwa* (Books of Pilgrimage), written in biblical prose for the comfort of Polish exiles in France, are paralleled by Slowacki's *Anhelli,* in which the Polish emigrant community in western Europe is represented under the allegorical disguise of a body of exiles in Siberia. It is, however, under the direct influence of Shakespeare that Slowacki attained his supreme poetic triumphs in drama.

His verse tragedies, *Balladyna* and *Lilla-Weneda* are placed in a legendary, pre-historic Poland: *Mazepa* takes place at the court of a Polish noble of the 12th century. The Polish world of the 12th and 18th centuries is the scene of two further plays of Juljusz Słowacki, *Horsztyński* and *Zbota Czaszka* (The Golden Skull), both unfortunately incomplete. The influence of Victor Hugo gives a sensational tinge to *Beatrix Cenci.* From Shakespeare and Victor Hugo, Słowacki passes under the influence of Calderon: he deals in Calderonian style with events from 18th century Polish history in his dramas *Ksiadz Marek* (Father Mark) and *Sen Srebrny Salomei* (The Silver Dream of Salomea). The last years of Slowacki's short life were spent among the Polish emigrants in Paris. The political and religious doctrines, the illusions, disillusionments and quarrels which agitated that little world, are mirrored in Slowacki's satirical epic *Beniowski,* which occupies, in his career, the place of *Don Juan* in Byron's. The mystical creed, which possessed the poet entirely in his latest years, inspired one of his most sublime works, the unfinished epic *Król Duch* (The Spirit King). The poet's complete spiritual philosophy of the mystical period is embodied in a prose treatise *Genesis z Ducha* (The Genesis from the Spirit), which curiously anticipates, in some of its ideas, the theory of evolution.

Zygmunt Krasinski (1812–1859)[1], long considered the equal of Mickiewicz and Słowacki, rose to an extraordinarily high level in his precocious early work. He became absorbed in meditations on the social revolution which after 1830 seemed to be threatening all Europe, and he put his vision of it, at the age of 21, into a drama *Nieboska Komedja* (The Un-Divine Comedy) (Eng. tr. Kennedy and Uminska, 1923). Krasinski's second work, the drama *Iridion* (Eng. tr. Noyes, 1927), placed in Rome in the second century of our era, has for its subject an attempted revolt of the Greeks against the Roman Empire. The attitude of the Christians, who refuse to fight, is the cause of failure. Krasinski links up his subject with philosophical speculations on the historical mystery of Poland's sufferings. His creed in this matter is embodied in a visionary poem called *Przedświt* (The Dawn), in which he extols the passive heroism of his oppressed country as the earnest of victory in the ideal sphere. These ideas are repeated in several didactic lyrics called *Psalmy Przyszłości* (Psalms of the Future). Krasiński's waning talent spent itself on political, religious and philosophical pamphlets and lyrics.

All the three great Romantic poets had come, for a time under the spell of an emigrant thinker named Andrzej Towianski (1799–1878) who had woven religious and patriotic mysticism together into the creed of a new sect, making of Poland a "messiah among nations." Krasiński's thought, in particular, also shows close relation to that of August Cieszkowski (1814–1894), the most distinguished and independent of a group of Polish philosophers who were disciples of Hegel. ("Our Father," selections in English by Dr. W. Rose, 1924.)

It is only in the 20th century that another Polish metaphysician of the Romantic period, Joseph Maria Hoene-Wronski (1778–1853), who wrote mainly in French, has won an increasing amount of international recognition.

Among the lesser romantic poets, the so called "Ukrainian school" forms a group apart. Its earliest representative, Antóni Malczewski (1793–1826), preceded even Mickiewicz as the author of a Byronic tale in verse. His romance *Marja* (Mary, 1825), breathes all the charm of chivalrous tradition and melancholy steppe landscape associated with Poland's south-eastern border.

Byronic colours are laid on more thickly by Seweryn Goszczynski (1803–1876) in his verse tale *Zamek Kaniowski* (Kaniow Castle), full of the horrors of age-old class war between the Ukrainian peasantry and the Polish borderland gentry. In his later work, he became a forerunner of realism.

The third most prolific singer of Ukrainian traditions and landscape in Polish poetry, Joseph Bohdan Zaleski (1802–1886), is a lyrical poet of great melody, but fatal facility. In his most ambitious effort, the philosophical poem *The Spirit of the Steppe* (Duch od stepu) he endeavours to reconcile the Romantic dreams

[1]*See* the study by Monica M. Gardner: *The Anonymous Poet of Poland* (Cambridge, 1919).

of the high dignity of Poland's sufferings with a moral and Christian view of her past errors and contemporary fate.

Another region of Poland's historical domains, the Masovian plains in the centre of the country with their purely Polish peasantry, are the subject of the lyric poetry of Teofil Lenartowicz (1822–1893): although he spent his later years as a sculptor in Florence, he never ceased to sing of Polish country life.

His counterpart is Wincenty Pol (1807–1872), who sings with equal persistence of the old-world life of the country gentry. A soldier in the insurrection of 1831, he commemorates this in a series of stirring and popular songs (*Pieśni Janusza*): a Professor of geography in his later days, he produces a picturesque descriptive account of Poland in verse (*Pieśn* o Ziemi Naszej) and several geographical works in very vivid prose.

What the Ukrainian group did for the South-East, and Lenartowicz and Pol for central Poland, was done for the North-Eastern domains of the historical Poland (Lithuania and White Ruthenia) by Ludwik Wladyslaw Kondratowicz, known as Syrokomla (1823–1862). A son of the minor gentry of those lands, he is at his best when drawing on his memories of his own youthful surroundings (as in the two charming longer poems on the Early Life and School-Days of Jan Debordg).

The romantic inspiration still produced a poet of action in Mieczyslaw Romanowski (1834–1863), who died a hero's death in the ranks of the insurgents of 1863. He had shown promise in a longer narrative poem of Polish town life in past ages (*Dziewczę z Sącza*), but this bears clear traces of the influence of Mickiewicz' epic masterpiece. It is echoes also of the song of the great Romantic masters that we catch everywhere in the poetry of Kornel Ujejski (1823–1897). He had made his mark, at the age of twenty with the verse tale Marathon. Not long afterwards, the national disaster of the Galician peasant riots of 1846 inspired him to write a series of elegies entitled The Lamentations of Jeremiah (Skargi Jeremiego), one of which, the Choral Song became the anthem of national woe. Before fading away utterly, the Romantic flame once more leaps up wildly in the enigmatic and convulsive, but intensely inspired poetry of Cyprian Norwid (d. 1885). The poet lived in disregard and neglect, and only came into his own long after his death through the efforts of a 20th century critic (Z. Przesmycki).

Of novelists of the romantic period, the very spirit of romance seems incarnate in Michael Czajkowski, who began active life as a Polish insurgent in 1831 and ended it as a Mussulman and a pasha in the Turkish Army. His novels, chiefly from the history of Poland's 18th century wars, are marred by wild improbabilities and artificial glitter. Higher literary value distinguishes the works of Count Henry Rzewuski (1791–1866), especially his stories from 18th century Polish life The Memoirs of *Severin Soplica* and November (*Listopad*).

We are on the road from romance to realism in the novel and plays of Joseph Korzeniowski (1797–1863). His drama The Carpathian Mountaineers (*Karpaccy* Gdrale) is aglow with the colours of folk-lore, his comedies, such as The Jews (Zydzi) or Miss and Mrs. (*Panna mężatka*) take us out of the region of old-fashioned comic types into the sphere of modern individualism in character-drawing, and his novels, e.g., The Schemer (*Spekulant*) or The *Neighbourhood* (*Kollokacja*) are satiric.

The transition from romance to realism is shown in Joseph Ignatius Kraszewski (1812–1887), whose untiring pen produced over 500 volumes of fiction, history, criticism and other literary matter. His historical novels have made him the Scott of Poland: but he deals with Polish contemporary life as well. The picture of the decay of the land-owning aristocracy in *Morituri* shows deep insight. Of his historical novels, those relating to the "Saxon period" of the early 18th century—such as *Brühl* or Countess Kosel—are the best. His influence on readers and other novelists has been enormous.

In the field of the historical novel, Kraszewski is almost equalled in popularity by Zygmunt Kaczkowski (1826–96), who excels in stories of the troublous partitions of Poland. Another popular novelist is Theodor Tomasz Jez (whose real name was Zygmunt Milkowski, 1824–1915), an insurrectionary soldier and an exile, who has described the history and folk-lore of the Balkans.

Of historians and essayists, Joachim Lelewel (1786–1861), laid the foundation of modern Polish historical research. Among his followers Karol Szajnocha (1818–68), is conspicuous for the literary qualities of his work, as shown chiefly in his monographs of Jadwiga and *Jagiełło* and of Two Years of *Polish* History (viz., 1647–48). History and literary criticism are combined in the brilliant writings of Maurycy Mochnacki, who became the historian of the insurrection of 1830. In Juljan Klaczko, Poland produced a distinguished student of Dante and of renaissance art: but his writings were mainly in French.

The Period of Realism.—The disaster of the second Polish insurrection, in 1863, produced violent reaction against all Romantic dreams both in politics and in literature. The mood of realism was fostered from abroad by the progress of natural science, of economic development, and of political liberalism in Western Europe. The few eminent poets of this age of prose make themselves the heralds of its ideals. The representative lyrist of the positivist generation, Adam Asnyk (1830–97) passed in his own career from the romantic exaltation of national martyrdom to the advocacy of positive social work for popular education. he even became the founder of the "People's School Society" (1891). His mature lyrics are lyrics of thought rather than feeling, and even in his nature poetry reflection predominates over enthusiasm. Feeling abounds in the verses of his most distinguished contemporary in Polish poetry, the poetess Marie Konopnicka (1840–1916): both in her lyrics and her short stories, the dominant note is one of profound pity for the poor. In her long epic, Mr. Balcer in Brazil (Pan Balcer w Brazylji), she tells the story of the sufferings of Polish peasant emigrants in the Brazilian forest.

The outstanding modern journalist, Aleksander Świętochowski (1849–1938) waged fearless war, both in his articles and his dramas, for the liberal ideals. His younger contemporary, Andrew Niemojewski (1864–1921) was chiefly preoccupied, in his journalism and his poetry, with the new industrial problem.

In the sphere of the novel, Madame Eliza Orzeszko (1842–1910), represents peasants, Jews, great industrialists, but she always returns to the life of the Polish country gentry in her native Lithuania. Bolestaw Prus (real name: Aleksander Gtowacki, 1847–1912) is, like Dickens, whom he resembles by his humour, a child of the city: the scene of his best social novels, like The Puppet (Lalka) and *The* Emancipated Woman (Emancypantki), is laid in his beloved Warsaw. But he also gave a touching account of the peasant's attachment to the soil in The *Outpost* (Placówka). In his largest work, The Pharaoh, he performed a *tour* de force by expressing modern ideas in a story of ancient Egypt. Poland's greatest modem writer is Henryk Sienkiewicz (*q.v.*) (1846–1916), whose Quo Vadis became known to all the civilised world, while his epic novels from Polish history—The Trilogy and The Knights of the Cross—together with the great historical paintings of Jan Matejko revived the romantic sense.

Younger novelists have imitated the extremes of the roman naturaliste in the fashion of Zola. Adolf Dygasiński (d. 1903) tells depressing stories of peasant poverty in Russian Poland: but he achieved his highest successes in his accounts of animal life in the Polish country-side, chiefly in The Feast of Life (Gody Zycia). The high-water mark of *naturalisme* in Poland is reached in the numerous plays and novels of Mme. Gabrielle Zapolska (d. 1923), an actress.

The historical verse play was cultivated with some effect by the illustrious Cracow scholar J. Szujski (1835–83), who, however, is notable chiefly as the author of a monumental History of Poland. He became one of the founders of the so-called "Cracow School" of moralising historians, represented beside him with distinction by Walerjan Kalinka (1826–86). Among later members of this group, the historian and iurist Michael Bobrzynski (1849–1935) must be mentioned. While the Cracow school chiefly stressed the faults which contributed to Poland's ruin, Warsaw historians like Tadeusz Korzon (d. 1917) and Władysław Smoleński (d. 1925) consciously emphasized the positive achievements of the nation. The stormy history of Poland in the 18th century found an able exponent in Ludwik Kubala (d. 1918), whose vivid pages inspired Sienkiewicz. More recently, the history of Poland's struggles for independence during the 19th century has been treated with brilliant talent in the writings of Professor Simon Askenazy. In recent decades, Count Stanislas Tarnowski, president of the Polish Academy (d. 1917), Professor Peter Chmielowski in Warsaw (d. 1905) and Professor Aleksander Briickner in Berlin (1856–) won distinction.

POLISH WRITERS OF RECENT TIMES

The "Young Poland" Group.—During the last decade of the 19th century a whole group of young exuberant talents appeared together in the forefront of Poland's literary life Dissatisfied with the utilitarian character of the art and poetry of the preceding period, they organised themselves into an independent body. soon known as "The Young Poland," with the view of working out a new theory of art, based on absolute individual freedom in form and matter. True to this principle, practically every one of them tried his best to find his own way of expression. The first among these young poets to gain fame was Kazimierz Tetmajer (b. 1865), whose love lyrics are comparable to the best work of the French Parnassians. The modern poetry of France and Belgium found a gifted and congenial interpreter in the person of Zenon Przesmycki, who wrote under the name of "Miriam" (b. 1861). The most forceful individuality of this group was Stanislaw Przybyszewski (1868–1927), who, having spent several years among the young Scandinavian and German writers, came back to Poland in 1898 to become at once the leader of the group and the editor of their organ, a weekly called Zycie (Life). His dramas full of fatalistic terror, and his prose poems, dealing with the mysteries of love and death, became the fashion of the day.

The art editor of the new weekly was Stanislaw Wyspianski (1869–1907), a painter of great originality, who became also the foremost Polish dramatic poet of his age His leading idea was to unite in the theatre the arts of painting, of architecture, and of poetic drama. Gradually his attention turned to national subjects, and especially to the problem of national strength and weakness, which is the root of the three dramas, Warszawianka (The Song of Warsaw), *Lelewel,* and *Noc* Listopadowa (The November Night). The Legion, a play of which the tragedy of Mickiewicz as the leader of Polish romanticism is the subject-matter—links the past with the present. In three powerful dramas—*Wesele* (The Wedding, 1901), *Wyzwolenie* (Deliverance), and *Akropolis,* he deals with Poland's deliverance

Jas Kasprowicz (1860–1926) was no doubt the greatest Polish lyrical poet of his day. With him, as with Thomas Hardy, the problem of evil and human suffering is the predominant subject. This problem finds expression in Chrystus (Christ), Na *Wzgórzu* Smierci (On the Hill of Death), and finally in the cycle of hymns *Ginącemu Światu* (To the Perishing World). In his later years, the poet attains the wisdom of a resigned sage, which speaks from every line of his last volumes called Ksigga Ubogich (The Book of the Poor) and *Mój* Swiat (My World).

The mood of spiritual calm is also the dominant note of Leopold Staff (b. 1878), who started his poetical career with *Sny* o *Potędze* (Dreams of Might): but struggles with the eternal mysteries are not absent even from his later volumes, e.g. Ucho Igielne (The Eye of the Needle, 1927).

Novelists.—Brought up under Russian oppression, Stefan Zeromski (1867–1925) indulges in pessimism. The most typical of his novels are "*Ludzie Bezdomni*" (The Homeless), *Popioły* (Ashes), dealing with the Napoleonic period, and the story-cycle *Wiatr* Od *Morza* (The Wind from the Sea)—with his final work, *Przedwiośnie* (Before Springtime) in which he gives a threatening picture of the new Poland.

The winner of the Nobel Prize for literature in 1924, Władyslaw Stanislaw Reymont (1868–1925) was a born realist. His early ambition was to draw a picture of life in a big industrial city. After a stay at Łódz, he produced a novel called *Ziemia Obiecana* (The Promised Land, Eng. tr. M. H. Dziewicki, 1927) which caused him to be hailed by critics as "The Polish Zola." Like Zola, but on a larger scale, he afterwards wrote a novel of peasant life: as the result of five years of incessant work there appeared his tetralogy "*Chłopi*" (The Peasants, Eng. tr. by M. H. Dziewicki, 1924). This great epic novel gives a rich and vivid picture of Polish peasant life especially in the Tatra mountains

The most talented representative of exoticism in Polish literature is Waclaw Sieroszewski (b. 1858) whose prolonged stay in political exile among the native tribes of north-eastern Siberia resulted in a series of fascinating short stories. An artist of rare subtlety and literary skill is Waclaw Berent (b. 1873). His novels *Próchno* (Rot) and *Ozimina* (The Winter Crop) contain a penetrating analysis of the late 19th century mood: his later work, Żywe *Kamienie* (Living Stones) is a rich and interesting picture of mediaeval life. Among disciples of Sienkiewicz, the most talented is Józef Weyssenhoff (1860–1932), whose hunting stories *Soból i* Panna (The Sable and the Girl, Eng. tr. Mme. K. Zuk-Skarszewska, 1928) describe Poland's Eastern borderland.

Literature in Poland After the World War.—With the reunion of Poland. her literature must lose influence as a national force. But even during the War, there came into being two notable groups of young poets, one in Poznan (the capital of the western provinces of Poland), another in Warsaw. The latter soon surpassed the former, and became the centre of a boldly aggressive and joyous view of life. Among these young poets the most promising are J. Tuwim, K. Wierzyński, J. Lechoń, A. Słonimski, and J. Iwaszkiewicz,

Another group, headed by E. Zegadlowicz and calling itself Czartak, looks for inspiration to the quietness and retirement of country life, and to the simple piety and legendary traditions of the folk In Miss I. K. Illakowicz the new Poland possesses a poetess of great lyrical charm, The terrible experiences of the war, and of Bolshevism on the Eastern border, found expression in some notable works by such writers as Mme. Z. Kossak-Szczucka (Pozoga—The Blaze—Eng. tr. 1926). The wanderings of Polish exiles in war-time over the vast territories of European and Asiatic Russia have born literary fruit in the vigorous and racy stories of F. Goetel, as well as in the spirited yarns of wild adventures in Mongolia by F. Ossendowski. Otherwise, the novels written since the War, like the comedies and dramas—the works of W. Perzyński and others—deal with daily reality. The tradition of poetic drama, in the fashion of Slowacki and Wyspianski, is kept up by the verse plays of K. H. Rostworowski, E Zegadlowicz and L. H Morstin. The reflective post war mood is shown most ably in the novelist Julius Kaden Bandrowski.

BIBLIOGRAPHY.—*In* Polish: A. Bruckner, *Dzieje Literatury Polskiej* w *zarysie* (z vols., 3rd ed, 1925, two different abridged versions, 1924 and 1928); *Dzieje literatury* pieknej *w Polsce,* II. vols., a co-operative work published by the Polish Academy at Cracow as vols. XXI. and XXII. of its *Polish* Encyclopaedia [Encyklopedja Polska] (1st ed. 1918, 2nd ed. 1928); Gabrjel Korbut: Literatura Polska (3 vols, 1921–27, full bibliographies). *In* English: R. Dyboski, Periods of Polish Literary History and Modern Polish *Literature* (Oxford, 1923–24)

Editions of Polish literary classics' Bibljoteka *pisarzów polskich* (published by the Polish Academy at Cracow), comprising chiefly works of earlier centuries; Bibljoteka Narodowa, edited by Prof. St. Kot (Cracow), a series of reprints of standard works of all periods, with scholarly introductions. (R. Dy.)

POLISH SUCCESSION WAR (1733–1735), the name given to a war which arose out of the competition for the throne of Poland between the elector August of Saxony, son of August II. (the Strong), and Stanislaus Leszcynski, the king of Poland installed 30 years before by Charles XII. of Sweden and displaced by August the Strong when Charles's projects collapsed. The claims of Stanislaus were supported by France, Spain and Sardinia, those of the Saxon prince by Russia and the empire, the local quarrel being made the pretext for the settlement of minor outstanding claims of the Great Powers amongst themselves The war was therefore a typical 18th century "war with a limited object," in which no one but the cabinets and the professional armies were concerned. It was fought on two theatres, the Rhine and Italy. The Rhine campaigns were entirely unimportant, and are remembered only for the last appearance in the field of Prince Eugène and Marshal Berwick—the latter was killed at the siege of Philippsburg—and the baptism of fire of the young crown prince of Prussia, afterwards Frederick the Great. In Italy, how ever, there were three hard-fought — though indecisive — battles. Parma (June 29, 1734), Luzzara (Sept. 19, 1734) and Bitonto (May 25, 1735), the first and last won by the Austrians, the second by the French and their allies. In Poland itself, Stanislaus, elected king in Sept. 1733, was soon expelled by a Russian army and was afterwards besieged in Danzig by the Russians and Saxons (Oct. 1734–June 1735).

POLITIAN (1454–1494). Angelo Ambrogini, known in literary annals as Angelo Poliziano or Politianus from his birthplace, was born at Montepulciano in Tuscany on July 14, 1454. His father, Benedetto, a jurist of good family and distinguished ability, was murdered by political antagonists for adopting the cause of Piero de' Medici in Montepulciano; this circumstance gave his eldest son, Angelo, a claim on the family of Medici. At the age of ten the boy came to study at Florence, where he learned Latin under Cristoforo Landino, and Greek under Argyropulos and Andronicos Kallistos. From Marsilio Ficino he imbibed the rudiments of philosophy. His genius for scholarship and poetry was early manifested. At 13 years of age he began to circulate Latin letters; at 17 he sent forth essays in Greek versification; at 18 he published an edition of Catullus. In 1470 he won for himself the title of *Homericus juvenis* by translating four books of the *Iliad* into Latin hexameters. Lorenzo de' Medici, who was then the autocrat of Florence and the chief patron of learning in Italy, took Poliziano into his household, made him the tutor of his children, and secured him a distinguished post in the University of Florence. Before he reached the age of 30, Poliziano expounded the humanities with almost unexampled lustre even for that epoch of brilliant professors. Among his pupils could be numbered the chief students of Europe, the men who were destined to carry to their homes the *spolia opima* of Italian culture. Not to mention Italians, it will suffice to record the names of the German Reuchlin, the English Grocyn and Linacre, and the Portuguese Tessiras.

Poliziano published the notes of his courses on Ovid, Statius, the younger Pliny, Quintilian, and the writers of Augustan histories. He also undertook a recension of the text of the *Pandects* of Justinian, which formed the subject of one of his courses; and this recension, though it does not rank high in the scale of juristic erudition, gave an impulse to the scholarly criticism of the Roman code. His versions of Epictetus, Herodian, Hippocrates, Galen, Plutarch's *Eroticus* and Plato's *Charmides* delighted contemporaries by a certain limpid fluency of Latin style and grace of manner which distinguished him also as an original writer. Of these learned labours the most universally acceptable to the public of that, time were a series of discursive essays on philology and criticism, first published in 1489 under the title of *Miscellanea.* They had an immediate, a lasting and a wide renown, encouraging the scholars of the next century and a half to throw their occasional discoveries in the field of scholarship into a form at once so attractive and so instructive. Poliziano was not, however, contented with these simply professorial and scholastic compositions. Nature had endowed him with literary and poetic gifts of the highest order. These he devoted to the composition of Latin and Greek verses, which count among the best of those produced by men of modem times in rivalry with ancient authors. The *Manto,* in which he pronounced a panegyric of Virgil; the *Ambra,* which contains a beautiful idyllic sketch of Tuscan landscape, and a studied eulogy of Homer; the *Rusticus*, which celebrated the pleasures of country life in no frigid or scholastic spirit; and the *Nutricia,* which was intended to serve as a general introduction to the study of ancient and modern poetry — these are the masterpieces of Poliziano in Latin verse, displaying an authenticity of inspiration, a sincerity of feeling, and a command of metrical resources which mark them out as original productions of poetic genius rather than as merely professorial lucubrations. Exception may be taken to their style, when compared with the best work of the Augustan or even of the Silver age. But what renders them noteworthy to the student of modern humanistic literature is that they are in no sense imitative or conventional, but that they convey the genuine thoughts and emotions of a born poet in Latin diction and in metre moulded to suit the characteristics of the singer's temperament.

Poliziano's principal Italian works are the stanzas called *La Giostra,* written upon Giuliano de' Medici's victory in a tournament; the *Orfeo,* a lyrical drama performed at Mantua with musical accompaniment; and a collection of fugitive pieces, reproducing various forms of Tuscan popular poetry. *La Giostra* had no plan, and remained imperfect; but it demonstrated the capacities of the octave stanza for rich, harmonious and sonorous metrical effect. The *Orfeo* is a slight piece of work, thrown off at a heat, yet abounding in unpremeditated lyrical beauties, and containing in itself the germ both of the pastoral play and of the opera. The Tuscan songs are distinguished by a "roseate fluency," an exquisite charm of half romantic, half humorous abandonment to fancy, which mark them out as improvisations of genius. It may be added that in all these departments of Italian composition Poliziano showed how the taste and learning of a classical scholar could be engrafted on the stock of the vernacular, and how the highest perfection of artistic form might be attained in Italian without a sacrifice of native spontaneity and natural flow of language.

Beyond the sphere of pure scholarship and pure literature Poliziano did not venture. He was present, indeed, at the attack made by the Pazzi conspirators on the persons of Lorenzo and Giuliano de' Medici, and wrote an interesting account of its partial success. He also contributed a curious document on the death of Lorenzo de' Medici. Otherwise, his uneventful life was passed as a house-friend of the Medici, as the idol of the learned world, and as a simple man of letters to whom (with truly Tuscan devotion to the Saturnian country) rural pleasures were always acceptable. He was never married; and his morals incurred suspicion, to which his own Greek verses lend a plausible colouring. He died, half broken-hearted by the loss of his friend and patron Lorenzo de' Medici, on Sept. 24, 1494.

For the life and works of Politian, *see* F. O. Mencken (Leipzig, 1736), a vast repertory of accumulated erudition, Jac. Mahly, *Angelus Politianus* (Leipzig, 1864); Carducci's ed. of the Italian poems (Florence, Barbera, 1863); Del Lungo's ed. of the Italian prose works and Latin and Greek poems (Florence, Barbera, 1867); the *Opera omnia* (Basle, 1554); Gresmell, *Life of Politian* (1805); Roscoe, *Lorenzo de' Medici* (10th ed., 1851); J. Addington Symonds, *Renaissance in Italy* (1875–86), and translations from Poliziano's poems in Symonds's *Sketches and Studies in Italy* (1879). (J. A. S.; X.)

POLITICAL ECONOMY: *see* ECONOMICS.

POLITICAL PENSIONS: *see* PENSIONS, POLITICAL.

POLITICAL SCIENCE, ARTICLES ON: *see* CONSTITUTION; LEGISLATURE; PARLIAMENT; CONSERVATIVE PARTY; WHIG AND TORY; REPUBLICAN PARTY; DEMOCRATIC PARTY, etc.

POLK, JAMES KNOX (1795–1849), 11th president of the United States, was born in Mecklenburg county, N.C., on Nov. 2, 1795. In 1806 he crossed the mountains with his parents and settled in what is now Maury county, Tennessee. He graduated from the University of North Carolina in 1818, studied law in the office of Felix Grundy (1777–1840) at Nashville, Tenn., in 1819–20, was admitted to the bar in 1820, and began to practise in Columbia, the county seat of Maury county. After two years of service (1823–25) in the State house of representatives. he represented his district in the National house of representatives from 1825–39. In the party conflicts which succeeded the presidential election of 1824 he sided with the Jackson-Van Buren faction. and soon became recognized as leader of the Democratic forces. He was speaker from 1835 until 1839, when he retired from Congress to become governor of Tennessee. His administration (1839–41) was successful, but he was unable to overcome the popular Whig movement of that period, and was defeated in 1841 and again in 1843. When the Democratic national convention met in Baltimore in 1844 he was mentioned as a possible candidate for the vice presidency, but was suddenly brought forward as a "dark horse" and selected to head the ticket. Finding it impossible under the two-thirds rule to nominate their candidate, the followers of Van Buren brought forward Polk, who was popular in the South, in order to defeat Lewis Cass and James Buchanan. George Bancroft, the historian, has asserted that this suggestion came originally from him, and Gideon J. Pillow, Polk's intimate friend, did much to bring about the nomination.

The unequivocal stand of Polk and his party in favour of the immediate annexation of Texas and the adoption of a vigorous policy in Oregon contrasted favourably with the timid vacillations of Henry Clay and the Whigs. Polk was elected, receiving 170 electoral votes to 105 for his opponent Clay. In forming his cabinet he secured the services of James Buchanan of Pennsylvania as secretary of State, Robert J. Walker of Mississippi as secretary of the treasury, William L. Marcy of New York as secretary of war, and George Bancroft, then of Massachusetts, as secretary of the navy. There is no doubt that each of these men, and Bancroft in particular, influenced the policy of the administration, yet the historian, James Schouler, who has made a careful study of the Polk papers, is doubtless correct in saying that the president himself was "the framer of the public policy which he carried into so successful execution, and that instead of being led (as many might have imagined) by the more famous statesmen of his administration and party who surrounded him, he in reality led and shaped his own executive course." Bancroft's opinion is that Polk was "prudent, far-sighted, bold, exceeding any Democrat of his day in his undeviatingly correct exposition of Democratic principles."

The four chief events of President Polk's administration were the final establishment of the independent treasury system, the reduction of the tariff by the Walker bill of 1846, the adjustment of the Oregon boundary dispute with Great Britain by the treaty concluded on June 15, 1846, and the war with Mexico and the consequent acquisition of territory in the south-west and west. The first three of these were recommended in his first annual message, and he privately announced to Bancroft his determination to seize California. The independent treasury plan originated during Van Buren's administration as a Democratic measure; it had been repealed by the Whigs in 1841, and was now re-enacted. Protectionists contend that the tariff legislation of 1846 was in direct violation of a pledge given to the Democrats of Pennsylvania in a letter written by Polk during the campaign to John K. Kane of Philadelphia. Briefly summarized, this letter approves of a tariff for revenue with incidental protection, whereas the annual message of Dec. 2, 1845, criticizes the whole theory of protection and urges the adoption of a revenue tariff just sufficient to meet the needs of the Government, conducted on an economical basis. It is difficult to determine whether this was always his idea of incidental protection, or whether his views were changed after 1844 through the influence of Walker and the example set by Sir Robert Peel in Great Britain, or whether he was simply "playing politics" to secure the protectionist vote in Pennsylvania.

The one overshadowing issue of the time, however, was territorial expansion. Polk was an ardent expansionist, but the old idea that his policy was determined entirely by a desire to advance the interests of slavery is no longer accepted. As a matter of fact, he was personally in favour of insisting upon 54° 40' as the boundary in Oregon, and threw upon Congress the responsibility for accepting 49° as the boundary. He approved the acquisition of California, Utah and New Mexico, territory from which slavery was excluded by geographical and climatic conditions. Furthermore a study of his manuscript diary shows that he opposed the efforts of Walker and Buchanan in the cabinet, and of Daniel S. Dickinson (1800–66) of New York and Edward A. Hannegan (d. 1859) of Indiana, in the Senate, to retain the whole of Mexico, territory in which slavery might have thrived. At the close of his term (March 4, 1849) Polk retired to his home in Nashville, Tenn., where he died on June 15, 1849.

See John S. Jenkins, *James Knox Polk* (1850), and L. B. Chase, *History of the Polk Administration* (1850), both of which contain some documentary material, but are not discriminating in their method of treatment. George Bancroft contributed a good short sketch to J. G. Wilson's *Presidents of the United States* (1894). He made copies of the Polk manuscripts and was working upon a detailed biography at the time of his death in 1891. These copies, now deposited in the Public library, New York city, contain a diary in 24 typewritten vols., besides some correspondence and other private papers. They have been used by James Schouler in his *Historical Briefs* (1896), and by E. G. Bourne in an article entitled "The Proposed Absorption of Mexico in 1847–1848," published in the *Annual Report of the American Historical Association for 1899*, i. 157–169 (1900). Bourne discusses the part which Polk took in preventing the complete absorption of Mexico. *See* also the *Diary of James K. Polk . . . 1845 to 1849* (1910), edit. by M. M. Quaife; R. L. Schuyler, "Polk and the Oregon Compromise of 1846," *Pol. Sci. Quart.*, vol. xxvi. p. 443–461 (Lancaster, Pa., 1911); E. I. McCormac, *James K. Polk* (1922); J. S. Bassett, *The Southern Plantation Overseer as Revealed in His Letters* (1925); A. Nevins, ed., *Polk: The Diary of a President, 1845–49* (1929). (W. R. SM.)

POLK, LEONIDAS (1806–1864), American general, was born at Raleigh, N.C., on April 10, 1806. He was educated at West Point, but afterwards studied theology and took orders in the Protestant Episcopal Church in 1831. In 1838 he became missionary bishop of the South-west, including Arkansas, Indian Territory, Louisiana, Alabama and Mississippi; in 1841 he was consecrated bishop of Louisiana. His work in the Church was largely of an educational kind, and he played a prominent part in movements for the establishment of higher educational institutions in the South. At the outbreak of the Civil War in 1861 he resigned his bishopric and entered the Confederate army. His rank in the hierarchy and the universal respect in which he was held in the South, rather than his early military education, caused him to be appointed to the important rank of major-general. He fortified the post of Columbus, Ky., the foremost line of defence on the Mississippi, against which Brigadier-general U. S. Grant directed the offensive reconnaissance of Belmont in the autumn. In the following spring, the first line of defence having fallen, Polk commanded a corps at Shiloh in the field army commanded by Albert Sidney Johnston and Beauregard. In Oct. 1862 he was promoted lieutenant-general, and thenceforward he commanded one of the three corps of the army of Tennessee under Bragg and afterwards was in charge of the Department of Alabama, Mississippi and East Louisiana. He was killed in the fighting in front of Marietta, while reconnoitring near Pine Mountain, Ga., on June 14, 1864.

See W. M. Polk, *Leonidas Polk, Bishop and General* (new ed., 1915).

POLKA, a lively dance of Bohemian origin, which at one period (about the middle of the 19th century) enjoyed extraordinary popularity throughout Europe. It is danced to music written in $\frac{2}{4}$ time. (See DANCE.)

POLLACK (*Gadus pollachius*), a fish that is distinguished from others of the cod genus by the long pointed snout, and the prominent lower jaw, without a barbel; the colour is greenish, with yellow markings. It ranges from Norway to the Mediterranean, but is most abundant southwards; it prefers rocky ground, and is piscivorous. It attains a weight of over 20 pounds.

POLLAIUOLO, the name of the brothers Antonio and Piero, sons of the goldsmith, Jacopo Pollaiuolo, Florentines who contributed much to Italian art in the 15th century, and of Simone, architect, the nephew of Antonio.

ANTONIO (1429–1498) distinguished himself as a sculptor, jeweller, painter and engraver, and did valuable service in perfecting the art of enamelling. He was apprenticed to Bartoluccio Ghiberti, a goldsmith (step-father of the great Ghiberti). It was not until later that Antonio took to painting. His chief achievement in that art is the "Martyrdom of St. Sebastian" (1475) in the National Gallery, London, in the execution of which he was helped by his brother. Here, too, is the fine small panel of "Apollo and Daphne." In the Uffizi, Florence, is his "Labours of Hercules." He aimed, above all, at the representation of the human figure in action, and he ranked as the foremost draughtsman of his time. He is said to have been one of the first artists who had recourse to dissection in his anatomical studies. But it was as a sculptor and metal-worker that he achieved his greatest successes. The museum of Florence contains the bronze group, "Hercules strangling Cacus," and the terra-cotta bust, "The Young Warrior." In 1489 Antonio took up his residence in Rome, where he executed the tomb of Sixtus IV. (1493). He died on Feb. 4, 1498, having just finished his mausoleum of Innocent VIII.

PIERO (1443–1496) was a painter, probably the pupil of Alesso Baldovinetti. His principal works were his "Coronation of the Virgin," an altarpiece painted in 1483, in the choir of the cathedral at San Gimignano; his "Three Saints," an altarpiece, and "Prudence" are both at the Uffizi Gallery.

SIMONE (1457–1508), nephew of Antonio Pollaiuolo, a celebrated architect, was born in Florence and went to Rome in 1484; there he entered his uncle's studio and studied architecture. On his return to Florence he was entrusted with the completion of the Strozzi palace, begun by Benedetto de Maiano, and the cornice on the façade has earned him lasting fame. His highly coloured accounts of Rome earned for him the nickname of *il* Cronaca (chronicler). About 1498 he built the church of San Francesco at Monte and the vestibule of the sacristy of Santo Spirito. In collaboration with Guiliano da Sangallo he designed the great hall in the Palazzo Vecchio. He was a close friend of Savonarola.

See Vasari, Vite (ed. Milanesi); Giovanni Morelli, *Italian* Masters in German Galleries (1883); and Maud Cruttwell, *Antonio* Pollaiuolo (1907).

POLLAN (*Coregonus pollan*), the only Irish fish of the genus Coregonus, with three forms inhabiting respectively Lough Neagh, Lough Erne and the Shannon. The jaws are equal in front. (See SALMON AND SALMONIDAE.)

POLLARD, ALBERT FREDERICK (1869–), English professor of history, was born at Ryde on Dec. 16, 1869, and educated at Felsted school and at Jesus college, Oxford. He was elected a fellow of All Souls college, Oxford, in 1898. From 1893 to 1901 he was assistant editor of the *Dictionary* of National Biography. From 1903 to 1931 he held professorial chairs of English history and constitutional history in the University of London, and in 1927 was appointed Honorary Director of the Institute of Historical Research.

His publications include Thomas Cranmer and the English Reformation (1898; new ed., 1926); Henry VIII. (1902); Factors in Modern History (1907; new ed., 1926); Evolution of Parliament (1920); Factors in American History (Cambridge, 1925).

POLLARD, ALFRED WILLIAM (1859–), English scholar, was born in London on Aug. 14, 1859, and educated at King's college school, London, and St. John's college, Oxford. In 1883 he entered the British Museum as assistant in the department of printed books, of which he became assistant keeper in 1909, and keeper from 1919–24. In 1916 he was appointed Sandars reader in bibliography in the University of Cambridge, and in 1919 professor of English bibliography at King's college, London, and held that chair until 1932.

His publications include Bibliographica (1894–96); Early Illustrated Books (1893); An Essay on Colophons (1905); Shakespeare's Folios and Quartos (1909); A New Shakespeare *Quarto* (Richard II. 1598) (1916); A Short Title Catalogue of English Books (1475–1640) with *G*. R. Redgrave and others (1926).

POLLENTIA, an ancient town of Liguria, Italy, 10 m. to the north of Augusta Bagiennorum, on the left bank of the Tanarus. Its position on the road from Augusta Taurinorum to the coast at Vada Sabatia, at the point of divergence of a road to Hasta (Asti) gave it military importance. Decimus Brutus managed to occupy it an hour before Mark Antony in 43 B.C.; and it was here that Stilicho on March 29, 403, fought the battle with Alaric which, though undecided, led the Goths to evacuate Italy. Considerable remains of ancient buildings still exist.

POLLINATION, a term used in botany for the transference of pollen (see FLOWER) to the stigma (the receptive surface) of the ovary of the flower. Such pollination brings about the fertilisation of the ovules in the ovary and their subsequent development into seeds; there are, however, a few cases in which parthenogenesis occurs, *i.e.,* the ovules develop without fertilisation. As the pollen-bearing parts of the stamens are rarely in contact with the stigma at the time when both of these are ripe, some mechanism is clearly necessary to bring the pollen to the stigma. The means in question is usually wind or insects, though sometimes other agencies such as water or birds may be responsible. The great variety in the form, colour and scent of flowers has been developed in relation to the particular agency of insects. Apart from the mechanism of pollination we can distinguish two types—self-pollination (autogamy) in which pollen is transferred from the stamens of one flower to the stigma of the same flower; and cross-pollination (allogamy) in which pollen is transferred to the stigma of another flower on the same plant (geitonogamy) or to the flower of another plant of the same species (xenogamy). Occasionally hybridization is possible, the pollen of one plant bringing about fertilisation of the ovary of the flower of another species or, more rarely, of the flower of a plant belonging to another genus; cases of hybridization between genera are known for example in cycads (see GYMNOSPERMS) and in orchids.

Cross Pollination and **Dichogamy.**—Cross pollination is the only possible method in the case of unisexual flowers whether the plant is *monoecious* (*i.e.,* with staminate and pistillate flowers on the same plant), as in birch, beech, elder, oak, or dioecious (*i.e.,* with staminate and pistillate flowers on different plants) as in the case of willows and poplars. In hermaphrodite flowers, bearing both stamens and carpels, either self-pollination or cross pollination can occur. It is interesting to note however, that many flowers have special arrangements to ensure that the pollinating mechanism, whatever it may be, causes cross pollination and not self-pollination. One of the commonest methods to achieve this is a separation in time of the sexes—the stamens dehisce and shed their pollen either before or after the stigma is receptive. This separation in time—and it may apply to the separate male and female flowers on the same plant—is known as dichogamy. When the stamens ripen first it is known as *protandry,* the more common case, while when the stigma is ready first, it is known as *proterogyny.* Protandry is very common in insect-pollinated (*entomophilous*) flowers, as in nearly all members of the Compositae (*q.v.*) and Umbelliferae, many Labiatae (such as dead-nettle [Lamium] and *Salvia*), the Caryophyllaceae, the large willow-herb (*Epilobium angustifolium*), etc. Proterogyny is found in the horse chestnut (*Aesculus*), the autumn crocus (*Colchicum*), many Araceae, and in wind-pollinated anemophilous flowers such as plantain (Plantago), meadow rue (Thalictrum) and many grasses, though here separation in time is very short and many are self-pollinated as wheat, barley and oats. It is often accepted that cross-pollination is of greater value to the plant than self-pollination in respect of weight and number of seeds; the question is, however, one of some difficulty. The numerous provisions in flowers for aiding cross-pollination and hindering self-pollination suggest the superiority of the former process, but there are numerous plants which normally and for generations are self-pollinated.

WIND POLLINATION (ANEMOPHILY)

The method of pollination of the earlier and more primitive flowers was probably by the wind, the insect pollinated flowers being derived from them in later stages of evolution. Some flowers such as plaintain and meadow rue mentioned above, are almost certainly anemophilous by reduction, all their congeners being entomophilous; other cases are *Poterium* among the Rosaceae and Kerguelen's Land cabbage (*q.v.*) among the Cruciferae.

Characters of **Anemophilous** Flowers.—These are such as might be expected. The flowers are usually inconspicuous (the corolla being commonly absent) for there is no advantage in their being easily seen, and they are without the scent or nectar so common in flowers visited by insects. Furthermore there is usually no tubular formation of the flower and no irregularities. On the other hand these wind-pollinated flowers form large quantities of pollen, since the greater proportion when consigned to the air must necessarily be lost. The large quantity of pollen produced by pines and other conifers is well known; in these plants the numerous stamens are massed in male cones often of considerable size, though smaller than the female cones. In other families, such as the grasses, Cyperaceae, Urticaceae, the number of stamens in each flower is small but the anthers are large. Again, in these flowers the pollen is dry and powdery and does not stick together in small masses as in entomophilous flowers; this enables the pollen to blow about easily. The pollen in this type of flower must be easily removed by the wind; the absence of floral envelopes facilitates this and so do the pendulous catkins (hazel, plane, etc.) which can sway in the wind. In addition the filament of the stamen is usually long so that the anthers hang out of the flower, and are also versatile (see FLOWER) so that the pollen is easily shaken from them.

Another common characteristic of the flowers in question is that the stigma is much larger and rougher than that of entomophilous flowers and it is freely exposed to the air so as to increase the chance of reception of the pollen; in maize, for example, the stigma is of very great length. In many catkin-bearing plants the flowering stage occurs before the leaves appear, so that accidental interception of pollen by the leaves is avoided. As already stated dichogamy is quite common in anemophilous flowers but proterogyny is much more common than protandry.

INSECT POLLINATION (ENTOMOPHILY)

The special characteristics of entomophilous flowers are the attractive colour of the floral envelope, the presence of scent and of nectar, and of pollen which is not powdery but sticky and is present in comparatively small quantities. The entomophilous is the most common type of pollination in flowering plants and special floral conformations and irregularities adapted to insect visitors are characteristic of the higher families of flowering plants, as will be seen below. The evolution of flowers and of insects must have gone hand in hand; such groups as Lepidoptera (butterflies and moths) and Hymenoptera (bees, wasps, etc.) could not have existed without the more elaborate and honey-bearing flowers and vice versa. Hermann Muller (see Bibliography) has divided flowers into various classes according to their degree of specialisation for different insects, so that a brief survey of the types of insects concerned must be given.

Types of Insects.—There are five important classes of insects which visit flowers. The *Hemiptera* (bugs, etc.) have a few flower-visiting species but they show no special adaptation to flowers; the Coleoptera (beetles) have many species which visit flowers but they have only short tongues (only a few species with a length of 3 to 6 mm.) and so are able to reach only honey which is fully exposed. The Diptera (flies) include many species which visit flowers. The short-tongued ones (with tongues under 4 mm.) show no special adaptation to a diet of floral origin and are not usually clever enough to find any nectar which is not fully exposed in the flower; many of these flies have also other sources of feeding. The long-tongued flies (such as hover flies or drone flies) have tongues from 4–12 mm. and confine themselves to a diet of nectar, and are clever in discovering it when concealed. The *Hymenoptera* (bees, wasps, sawflies, ants, etc.) include a very large number of flower-visiting forms. Bees are the only long-tongued members of the group, and it is bees which have played the most important part in the evolution of the more complex flowers. The hive bee (*Apis*) and the humble-bee (*Bombus*) have long tongues (over 6 mm.) while most of the other bees have shorter tongues, *i.e.,* less than 6 mm. The "cleverness" of bees, combined with the length of their proboscis, enables them to find and reach nectar which is deeply concealed in the flower. Bees do not confine themselves to sucking nectar from the flower; they also collect pollen (some flowers provide only pollen and no nectar), which is carried in small masses attached to the hairs of the hind legs. The Lepidoptera (butterflies and moths) are insects with tongues usually about as long as those of bees, but the hawk moths may have tongues, when unrolled, of enormous length. The British hawk moth, *Sphinx convolvuli,* has a tongue 80 mm. ($3\frac{1}{5}$ in.) long and some tropical moths a tongue of 300 mm. (12 in.).

Classes of Flowers.—The entomophilous flowers have been divided by H. Muller into nine classes based on the structure of the flower and its relation to particular insects.

(i.) Class A. Flowers *with* Exposed Nectar.—In this class come most Umbelliferae, many Saxifragaceae, the bedstraws (*Galium*), ivy (Hedera) and such trees as maple, elder and lime. The flowers are wide open and usually small and the visitors are mostly short-tongued; they are rarely visited by bees and butterflies. Such flowers run the risk of the nectar being washed away by rain.

(ii.) Class AB Flowers with Partially Concealed Nectar.—In this class fall the buttercups (*Ranunculus*), the Cruciferae, the strawberry (Fragaria) and the willows (*Salix*). The nectar is protected and concealed by the position of the stamens, by the development of hairs or scales, or by the flower being partially tubular, as in wallflower where the sepals stand erect and give a tubular form to the lower part of the flower.

(iii.) Class B. Flowers with *Fully* Concealed Honey.—In this class are the flowers of many Carophyllaceae (such as *Gypsophila,* Geranium), *Polemonium,* blackberry (*Rubus*), eyebright (*Euphrasia*) mint (Mentha), heather (*Calluna*). In these the nectar may be concealed by the stamens, by the calyx, by the receptacle becoming hollowed, or by the petals being united to form a sympetalous corolla. The insect visitors are the smaller bees with a few of the longer tongued flies. This type of flower is clearly the most effective of the classes so far mentioned. The bees show a high degree of skill in reaching the concealed honey and mostly confine themselves during a given flight to one or a few species of flower, and thus avoid the great waste of pollen caused by shorter tongued insects, which are liable to carry it indiscriminately from the flower of one species to another.

(iv.) Class B' is an extension of Class B and includes the flowers of the Compositae, most Dipsaceae and some Campanulaceae, in which the flowers have the same length of tube, etc., as Class B, but are aggregated into an inflorescence, which by the uninstructed might be mistaken for a flower, and which acts like a single flower as a unit of attraction.

(v.) Class F. Lepidoptera Flowers.—This includes those flowers in which the floral tube has been so deepened that short-tongued insects are excluded altogether and in many cases only Lepidoptera can reach the nectar. The alpine moss campion (*Silene* acaulis), for example, is adapted to butterflies, while the bladder campion (S. *inflata*) is adapted to moths and emits a scent at night. To the latter class belong also the honeysuckle (*Lonicera*), tobacco plant (*Nicotiana*), evening primrose (Oenothera), and night-scented stock and many others.

(vi.) Class H. Bee Flowers, are those which are visited mostly by long-tongued bees, the depth of the tube being 6 to 15 mm. The flowers are also often markedly zygomorphic (*i.e.,* having a special kind of irregularity; see FLOWER), providing a landing place for the bee; others are of such a shape that (as in the snapdragon and broom) it requires an insect like the humble-bee which is not only "clever" but of considerable size and weight in order to open the flower.

(vii. and viii.) The D and K classes of flowers include those adapted to small insects; they are pollinated by flies, beetles and small bees.

Lastly, there is (ix.) the Class Po, Pollen Flowers. These provide no nectar, but abundant pollen for which the flower is visited, mainly by bees; examples are Clematis, meadowsweet (*Spirea*), rock rose (Helianthemum) dog rose (Rosa *canina*), poppy. In some flowers, such as Cassia, some stamens provide "food-pollen" for insects, other stamens supply the fertile pollen for fertilization.

Nectar, Colour and Scent.—Nectar is a watery fluid secreted by certain parts of the flower and sometimes by other parts of the plant, as in the case of the extra-floral nectaries. It contains a sugar (glucose) sometimes to as much as 25%. It is from the nectar that the bee makes honey, which is a manufactured product with nectar as the raw material. As has already been indicated the position of the nectaries (the nectar-secreting glands) is very various; they may be fully exposed or hidden and deeply enclosed. In some cases the nectar is secreted by one organ and collected in another as in Viola, where it collects in the spur but is secreted by appendages of the stamens. In other cases there is no free nectar but the insect must pierce with its proboscis the juicy, sapid cells, which in the case of some orchids line the spur.

The importance of colour in attracting the attention of insects is obvious, but it does not follow that the flowers most striking or attractive to our eyes are those most conspicuous or alluring to the insect. The problem of the colour-sense of insects has been investigated by a number of workers and it seems clear that bees at least can distinguish some colours, such as blue and yellow, and do not merely depend on the different brightness between, say, a deep purple flower and a light yellow one. In the different flower classes (A to H) already defined, there is a tendency to a progression in colour; the simpler flowers in the A and AB classes tend to be white or yellow, while in the B class blues and purples are found. In class H, the bee flowers, blues and purples predominate, while in class F, the butterfly and moth flowers, pale tints of pink and purple are most common. The special colour markings on flowers, such as the yellow eye of forget-me-not (*Myosotis*), the darker lines on the petals of the violet and pansy, appear to assist the insect to find the nectar and are known as honey guides.

Scent is obviously of great importance and the olfactory sense of some insects such as moths is very much greater than ours. J. H. Fabre showed that moths when out of sight of honeysuckle would fly straight to it from a distance of several hundred yards. K. van Frisch has investigated elaborately the olfactory sense of the honey bee. Bees which had been drilled by association of oil of orange with sugar. could pick out this scent from 43 other ethereal oils. As stated by M. Skene (see p. 172) the general conclusion is "that colour is the guide to the flower, and that scent is useful in enabling the bee, flying among the many flowers of similar colour, to pick out the species it has formed the temporary habit of visiting." In this it is helped by the sense of form.

SPECIAL MECHANISMS OF ENTOMOPHILOUS FLOWERS

Pollination of Sage.—Such a plant as the sage (*Salvia pratensis*) has a typical humble-bee flower. The bee alights on the platform formed by the lower lip of the sympetalous corolla and pushes its head down the tube to reach the nectar at the bottom. Each of the two stamens is of special shape; the connective is very large and two-armed, and is hinged to the short filament. The longer arm bears a half anther while the short arm is sterile, the whole stamen having a lever mechanism. The bee, in probing for the honey, comes in contact with the short arm of the lever and in pressing this down brings the half anther at the end of the longer arm down upon its back where the pollen becomes deposited. The flower is protandrous and in a later stage the style elongates and is brought into the same position as occupied by the back of the bee when in contact with the anther. Cross pollination is thus brought about when the bee passes from a younger to an older flower.

Papilionaceous Type.—The Leguminosae (Pea family) show a very interesting series of pollination mechanisms. In this familiar type of flower to which the pea and gorse belong, the essential parts of the flower are enclosed in the keel. The nectar is secreted by the inner sides of the lower part of the staminal tube; one of the ten stamens is usually free and at its base are two openings leading to the nectar. The nectar is thus not only carefully concealed but is also at a considerable depth. Cleverness and length of proboscis are thus required so that as might be expected these flowers are bee flowers. An insect visiting the flower alights on the wings, thus depresses them and, as they are joined to the keel, this is depressed also. The stigma and stamens are thus forced out, the stigma usually first so that it has the chance of brushing off pollen from the under-side of the bee and thus being cross pollinated.

There are four different types. (1) Flowers in which the stamens and stigma return within the keel so that repeated visits are possible; examples are the clovers, melilot (*Melilotius*) and laburnum. (2) Flowers that are explosive, since the style and stamens are confined under tension in the keel and when it is depressed they are released with suddenness, thus scattering pollen on the undersurface of the bee. Only one insect visit is thus effective. Examples are broom (Genista), gorse (Ulex), lucerne (Medicago). (3) Flowers which display a piston mechanism—the pollen is shed early and the heads of the five outer stamens act as a piston so that the weight of the bee on the keel squeezes a narrow ribbon of pollen through the pore at the apex of the keel. A further pressure causes a protrusion of the stigma which is thus brought in contact with the bee. Examples are lupin (*Lupinus*), rest harrow (*Ononis*) and bird's foot trefoil (Lotus *corniculatus*). (4) Flowers which show a brush mechanism, for the pollen is again shed early and the style, which is provided with a brush of hairs, sweeps the pollen in small portions out of the tip of the keel. Flowers of this type usually allow of repeated insect visits.

Pinch Trap Flowers.—This type of flower is found in the Asclepiadaceae. The pollen is massed together into pollinia and pairs of these are attached to a sort of clip in which the leg of the insect (bees, wasps, etc.) becomes caught. The pollinia are thus carried away to another flower and are likely to come in contact with its stigmatic surface. Pitfall *flowers* are shown by the cuckoo pint (*Arum maculatum*), a common British plant, and by *Aristolochia* and *Asarum*. In A. *maculatum* there is a spathe surrounding a spadix which bears a fringe of stiff downwardly projecting hairs at the top. These hairs allow the entry of insects but not their return; the insects are thus trapped for a time in the spathe and pollinate the pistillate flowers; later the hairs wither and exit becomes possible. Flies are the common visitors.

Piston Mechanism of **Compositae.**—The flowers of this family show a very efficient pollination mechanism which. with the economy of material resulting from the massing of the flowers into heads and the effective method of seed dispersal, probably explains the dominant position of the family.

Pollination of Fig.—The fig shows a very remarkable interrelationship between an animal and plant. The flowers in the fig are unisexual and are borne in numbers together on the inside of the hollow inflorescence, which opens to the outside by a pore. The swollen and fleshy infructescence (as the inflorescence becomes) is the edible fruit; each "seed" being the product of a single flower and in reality a fruit. The female of a small wasp (*Blastophaga*) enters the inflorescence and deposits eggs in special "gall flowers" incapable of setting seed. The larvae are hatched out and undergo metamorphosis. The male wasps fertilise the female and then die without leaving the inflorescence. The female wasps leave the gall flowers and crawling out through the pore become dusted with pollen from the male flowers in the neighbourhood of the pore. They then enter other figs and pollinate the female flowers, which set seed. The fig and wasp are thus mutually dependent. When Smyrna figs were introduced into California it was found necessary to introduce the caprifig (non-edible fig) containing the wasp Blastophaga.

Pollination of Yucca.—This is another case of the complete interdependence of a flower and a moth. The large white flowers of this plant emit their perfume especially at night and are visited by a moth (*Pronuba* yuccasella). The female moth (see YUCCA-MOTH) collects pollen from the anthers of the flower and kneads it into a pellet about three times the size of its head. It flies to another flower and, piercing the ovary wall with its long ovipositor, lays a few eggs between the ovules. After this it climbs down the style of the hanging flower and presses the ball of pollen into the stigma; by this means fertilisation is ensured. Only a certain proportion of the seeds are destroyed by the developing insects, which, when mature, eat through the fruit wall, drop to the ground and remain dormant in a cocoon until the next flowering season, when the moth emerges. This seems to be the only method of pollination, for in the absence of the moth the plant is said to be completely sterile.

Pollination of Orchids.—The orchids show many and complicated adaptations to pollination by insects. A great impetus to their study was given by the publication in 1862 of Darwin's monograph on the various pollination mechanisms exhibited by this group. As is well known, in this flower there is generally only one stamen. which is two-lobed, and the pollen is in the form of two stalked masses, the pollinia which the insect carries away stuck to its head. As the insect flies away, the pollinia, if not already properly oriented, execute such a movement as brings them into position to touch the stick stigma of the next flower that is visited. There are, however, a great many variations in the details of this process. Nectar is not usually secreted by the orchid flower, but to obtain a sweet juice the insect has to pierce a special tissue. usually that of the labellum (the posterior petal), which is often spur-like.

Heterostylism.—In some cases the plant bears more than one type of flower. The primrose (*Primula vulgaris*) and the cowslip (P. *veris*) are dimorphic, *i.e.*, some plants have flowers with a long style bearing a knob-like stigma at the mouth of the corolla tube and the five stamens stand half-way down the tube: in others the flower has a short style with a stigma half-way down the tube while the stamens stand at the top. These two types of flower are known as "pin-eyed" or long-styled and "thrum-eyed" or short styled, respectively. From their correspondence in position, the insect tends to transfer pollen from the thrum-eyed to the stigma of the pin-eyed and *vice versa*. These two types of pollination are spoken of as "legitimate," and Darwin showed that this type produces more seed and more vigorous progeny than "illegitimate" pollination of thrum-eyed stigma by thrum-eyed pollen or pin-eyed stigma by pin-eyed pollen. In trimorphic plants such as the loosestrife (*Lythrum Salicaria*), there are three types of flower, short-styled, long-styled and those with styles of intermediate length. In each type the stamens are in two groups of different lengths; in the first type the stamens are long and intermediate, in the second type they are short and intermediate, and in the third they are short and long. Eighteen possible methods of pollination are possible, six being "legitimate" and 12 "illegitimate." Legitimate unions are found to yield a larger amount of seed than illegitimate.

POLLINATION BY AGENCIES OTHER THAN WIND AND INSECTS

In some water plants the pollen is brought to the stigma by the agency of water. In *Najas* the pollen grains sink in the water and are caught by the stigma. In the eel-grass (*Zostera*), the American water-weed (*Elodea canadensis*), and others, the pollen floats on the surface and so reaches the female flowers. In *Vallisneria*, the male and female flowers are on separate plants and the male becoming detached and floating free on the surface of the water, may reach and become entangled with the fixed larger female flowers, with the result that the anthers come in contact with the projecting stigmas.

In some cases animals other than insects are responsible for pollination. In some countries pollination by birds (humming birds, honeysuckers and sun birds) plays a considerable part. These *ornithophilous* flowers, as they are called, are not very different from insect flowers, many bird flowers being also visited by insects. A landing place is, however, not necessary, as the birds sip the nectar while hovering. The flowers are scentless, and the styles, stigma and filament often rigid. The colour red seems to be predominant in flowers of this type. Examples of ornithophilous flowers are *Strelitzea regina* in South Africa, species of *Salvia* and *Erythrina* in South America. In Java, species of *Freycznetia* and in Trinidad *Bauhınia megalandra*, are said to be pollinated by bats.

SELF POLLINATION (AUTOGAMY)

Self pollination is effected in various ways. In the simplest case the anthers are close to the stigmas, covering these with pollen when they open; this occurs in a number of small annual plants, also in *Narcissus, Crocus*, etc. In snowdrop and other pendulous flowers the anthers form a cone around the style and the pollen falls on to the underlying stigmas, or in erect flowers the pollen may fall on to the stigmas which lie directly beneath the opening anthers (e g , *Narthecium*). In very many cases the pollen is carried to the stigma by elongation, curvature or some other movement of the filament, the style or stigma, or some other part of the flower, or by correlated movements of two or more parts. For instance, in many flowers the filaments are first directed outwards so that self pollination is not possible, but later incline towards the stigmas and pollinate them (*e.g.*, numerous Saxifragaceae, Cruciferae and others); or the style which first projects beyond the anthers, shortens later on, so that the anthers come into contact with the stigmas (*e.g.*, species of Cactaceae); or the style bends so that the stigma is brought within the range of the pollen (e g , species of *Oenothera, Epilobium*, most Malvaceae, etc.). In *Mirabilzs Jalapa* and others the filaments and styles finally become intertwined, so that pollen is brought in contact with the stigma. Self-pollination frequently becomes possible towards the end of the life of a flower which during its earlier stages has been capable only of cross-pollination. This is well seen in the case of the flowers of the Compositae, where the stigma lobes later bend round and come in contact with the pollen held by the brush of the style below.

Cleistogamy.—The extreme case of autogamy is that of cleistogamous flowers which must necessarily be self-pollinated. The sweet violet (*Viola odorata*), the wood sorrel (*Oxalis acetosella*), *Lamium amplexicauli* and other British plants bear, in addition to the ordinary flowers, small bud-like flowers (cleistogamous flowers) which never open. The pollen germinates in the anthers and the pollen tubes pierce the walls and so reach the stigmas and the ovules are fertilised. Some plants such as *Salvia cleistogama* produce only cleistogamous flowers.

BIBLIOGRAPHY.—The classical compendium on flower pollination In English is P. Knuth, *Handbook of Floral Pollination* (Oxford, 1906, original German edition, 1898–1905). where a great mass of data is brought together. Good brief reviews of the subject are given in M. Skene, *The Biology of Flowering Plants* (1924) ; Kerner and Oliver, *The Natural History of Plants* (1895); the earlier editions (*e.g.*, the 2nd of 1904) of J. C. Willis, *A Dictionary of Flowering Plants*. Most text books of botany give some review of the subject. The earliest work on the subject was C. K. Sprengel's book entitled *Das entdeckte Geheimnis der Natur in Bau und in der Befrucktung der Blumen* (Berlin, 1793) ; Sprengel's first observation in this field was that of the presence of hairs in the throat of the corolla of a species of *Geranium*, which, he concluded, were for the purpose of preventing the nectar being washed out by rain; from this he was led on to consider the function of corolla markings such as the yellow centre of forget-me-not which he interpreted as honey guides to the insects. For the distinction of flower classes *see* H. Müller, *The Fertilisation of Flowers* (London, 1883). For the colour sense and olfactory sense of bees *see* K. von Frisch, *Der Farbensinn und Formensinn der Btene* (Jena, 1914) and *Über den Geruchsinn der Biene* (Jena, 1919). For a review of ornithophilous flowers *see* F. Werth, "Kürzer Überblick uber die Gesamtfrage der Omithophilie," *Bot. Jahrb.* (1915).

(V. H. B.)

POLLIO GAIUS ASINIUS (76 B.C.–A.D. 5; according to some, 75 B.C.–A.D. 4), Roman orator, poet and historian. In 54 he impeached unsuccessfully C. Porcius Cato. In the civil war Pollio sided with Caesar, was present at the battle of Pharsalus (48), and commanded against Sextus Pompeius in Spain. He subsequently threw in his lot with M. Antonius, for whom he governed *Gallia Transpadana*. In superintending the distribution of territory amongst the veterans, he saved Virgil's property from confiscation. In 40 he helped to arrange the peace of Brundisium by which Octavian (Augustus) and Antonius were for a time reconciled. In the same year he was consul; it was now that Virgil addressed the famous fourth eclogue to him. Next year Pollio conducted a successful campaign against the Parthini, an Illyrian people who adhered to Brutus, and celebrated a triumph on Oct. 25. From the spoils of the war he constructed the first public library at Rome, in the Atrium Libertatis, also erected by him (Pliny, *Nat. hist.* xxxv. 10). Thenceforward he withdrew from active life and devoted himself to literature He seems to have maintained an attitude of independence, if not of opposition, towards Augustus. He died in his villa at Tusculum, regretted and esteemed by all.

Pollio was a distinguished orator; his speeches showed ingenuity and care, but were marred by an affected archaism (Quintilian, *Inst.* x. 1, 113; Seneca, *Ep.* 100). He wrote tragedies also, which Virgil (*Ecl.* viii. 10) declared to be worthy of Sophocles, and a prose history of the civil wars of his time from the first triumvirate (60) down to the death of Cicero (43) or later. His writings are lost except a few fragments of his speeches (H. Meyer, *Orat. rom. frag.*, 1842), and three letters to Cicero (*Ad. Fam.* x. 31–33).

See Plutarch, *Caesar, Pompey;* Vell. Pat. ii. 36, 63, 73, 76; Florus iv. 12, 11; Dio Cassius xlv. 10, xlviii. 15; Appian, *Bell. civ.;* V. Gardthausen, *Augustus und seine Zeit* (1891), i.; P. Groebe, in Pauly-Wissowa's *Realencyclopiidie* (1896), ii pt. 2; Teuffel-Schwaben, *Hist. of Roman Literature* (Eng. trans.), § 221; M. Schanz, *Geschichte der römischen Literatur*, pt. 2, p. zo (2nd ed, 1899) ; Cicero, *Letters*, ed. Tyrrell and Purser, vi. introd. p. 80; E. D. Pierce, *A Roman Man of Letters* (New York, 1922).

POLLOCK, the name of a great English legal family. The well-known members are: SIR JONATHAN FREDERICK **POLLOCK** (1783–1870), chief baron of the exchequer. Born on Sept. 23, 1783 in London, the son of David Pollock, saddler, of Charing Cross, he was educated at St. Paul's and Trinity college, Cambridge, and was called to the bar in 1809. He took silk in 1827, and in 1831 was member of parliament for Huntingdon He was attorney-general in 1834, and again in 1841; in 1844 he succeeded Abinger as chief baron of the exchequer, and sat until 1866, when he retired. He died at Hatton, Middlesex, on Aug. 23, 1870. His greatest judicial triumph was in *Egerton* v. *Brownlow.*

See Sir F. Pollock (2nd Bart.) *Personal Remembrances* (1887).

SIR FREDERICK POLLOCK (1845–1937), born on Dec. 10, 1845, was educated at Eton and Trinity college, Cambridge. He was called to the bar in 1871, and was Corpus professor of Jurisprudence at Oxford from 1883–1903. He was made a Privy Councillor in 1911 and in 1914 became judge of the admiralty court of Cinque ports. In 1920 he was made a King's Counsel. His legal textbooks are standard; he wrote certain legalarticles for the Encyclopaedia Britannica. He edited the *Law Quarterly Review* from 1885 to 1919 and was Editor of the *Law Reports,* 1895–1935.

His works include *Principles of Contract* (1876, 9th ed. 1921); *Digest of the Law of Partnership* (1877, 12th ed. 1930); *The Law of Torts* (1887, 13th ed. 1929); *Possession in the Common Law* (with Sir *R.* S. Wright, 1888); *History of English Law* (with Prof. F. W. Maitland, 1895, 2nd ed. 1898); Selden's Table Talk (for Selden Society, 1927); *Spinoza, his Life and Philosophy* (1880, 2nd ed. reissued with additions, 1912); etc., etc.

POLL-TAX. A tax levied on the individual, and not on property or on articles of merchandise, so-called from the old English poll, a head. Raised thus *per capita,* it is sometimes called a capitation tax. The most famous poll-tax in English history is the one levied in 1380, which led to the revolt of the peasants under Wat Tyler in 1381, but the first instance of the kind was in 1377, when a tax of a groat a head was voted by both clergy and laity. In 1379 the tax was again levied, but on a graduated scale. John of Gaunt, duke of Lancaster, paid ten marks, and the scale descended from him to the peasants, who paid one groat each, every person over 16 years of age being liable. In 1380 the tax was also graduated, but less steeply. For some years after the rising of 1381 money was only raised in this way from aliens, but in 1513 a general poll-tax was imposed. This, however, only produced about £50,000, instead of £160,000 as was expected, but a poll-tax levied in 1641 resulted in a revenue of about £400,600. During the reign of Charles II., money was obtained in this way on several occasions. For some years after 1688 poll-taxes were a favourite means of raising money for the prosecution of the war with France.

In the United States the term "poll-tax" is generally understood as one which must be paid before the individual can vote. It was introduced into America by the British in the 17th century and was one of the grievances that led to the Mecklenburg Declaration of Independence in 1775. The tax disappeared for the most part after the American Revolution but was revived by southern States after adoption of the 15th amendment to the Constitution in 1870 which declared that the suffrage should be extended to all citizens regardless of "race, colour, or previous condition of servitude." Eight States in 1939 imposed a poll-tax ranging from $1 to $2, as follows: Arkansas, Alabama, Georgia, Mississippi, South Carolina, Tennessee, Texas, and Virginia. Florida repealed its poll-tax law in 1937, but a similar proposal in Arkansas was defeated by a large majority in 1938.

See S. Dowell, *History of Taxation and Taxes in England* (1888), vol. iii., and W. Stubbs, *Constitutional History* (1896), vol. ii. (For Am. Tax *see* C. B. Fullebrown, *Taxation,* 1914; E. *R.* Seligman, *Essays in Taxation,* 1925.)

POLLUX, IULIUS, of Naucratis in Egypt, Greek grammarian and sophist of the 2nd century A.D. He taught at Athens, where, according to Philostratus *(Vit. Soph.),* he was appointed to the professorship of rhetoric by the emperor Commodus on account of his melodious voice. His only surviving work is the *Onomasticon,* a Greek dictionary in ten books, which supplies much rare and valuable information on classical antiquity.

The chief editions of the *Onomasticon* are those of W. Dindorf (1824), with notes of previous commentators, I. Bekker (1846), containing Greek text only, and Bethe (1900). There are monographs on special portions; by E. Rohde (on the theatrical terms, 1870), and F. von Stojentin (on constitutional antiquities, 1875).

POLLUX or **POLLUCITE,** a rare mineral, consisting of hydrous caesium and aluminium silicate, $H_2Cs_4Al_4(SiO_3)_9$, and, being the richest source of caesium, in demand for the construction of thermionic valves. Caesium oxide (Cs_2O) is present to the extent of 30%–36%, the amount varying somewhat owing to partial replacement by other alkalis. chiefly sodium. It crystallizes in the cubic system, it is colourless and transparent, and has a vitreous lustre. There is no distinct cleavage, and the fracture is conchoidal, so that the mineral closely resembles quartz in general appearance. The hardness is $6\frac{1}{2}$ and the specific gravity 2.90. It occurs sparingly, together with the mineral "csstor" *(see* PETALITE), in cavities in the granite of Elba, and with beryl in pegmatite veins at Andover and Hebron in Maine. (L. J. S.)

POLO, MARCO (*c.* 1254–1324), Venetian traveller, was grandson of Andrea Polo of San Felice, and son of Nicolo Polo. The three Polos were presumably "noble," for Marco the traveller is officially so styled (*nobilis vir*). The three sons of Andrea Polo were engaged in commerce; the eldest suggests, by his will, a long business partnership with Nicolo and Maffeo.

About 1260, Nicolo with his wife and Maffeo were at Constantinople. The two brothers were led in their trading operations to the Crimea, and eventually to Bukhara, where they joined some envoys returning from a mission from Kublai Khan, with whom they journeyed to Cathay *(See* CHINA.) It was the first time that the khan had met Europeans and he was delighted with the Venetian brothers, whom he sent back to the pope, with letters requesting the despatch of a body of educated men to instruct his people in Christianity and the liberal arts Kublai saw the value of Christianity as a political weapon, and it was only when Rome failed him that he fell back upon Buddhism as his chief civilizing instrument.

On arriving at Acre in April 1269, the brothers learnt that no new pope had been appointed after the death of Clement IV. in the previous year; they therefore returned to Venice. The papal interregnum being exceptionally long the brothers resolved after two years, to start again for the East, taking with them Nicolo's son, Marco. They were furnished with letters authenticating their delay, but hearing of the papal election soon after their start, they returned to execute Kublai's mission. The new pope, however, could supply but two Dominicans, who soon lost heart and turned back.

Leaving Acre about Nov. 1271, Polo's book indicates that the party proceeded to Hormuz (Hurmuz) at the mouth of the Persian gulf, with the purpose of going on to China by sea; but that, abandoning their plans, they returned northward through Persia. Traversing Kerman and Khurasan they went on to Balkh and Badakshan and ascended the upper Oxus through Wakhan to the plateau of Pamir (a name first heard in Marco's book). These regions were hardly described again by any European traveller (save Benedict Goes) till the expedition in 1838 of Lieut. John Wood of the Indian navy. Crossing the Famir the travellers descended upon Kashgar, Yarkand and Khotan (Khutan). These are regions which remained almost absolutely closed to our knowledge till after 1860, when the temporary overthrow of the Chinese power, and the enterprise of British, Russian and other explorers, again made them known.

From Khotan the Polos passed on to the vicinity of Lop-Nor, reached for the first time since Polo's journey by Prjevalsky in 1871. Thence the desert of Gobi was crossed to Tangut, the region at the extreme north-west of China, within and without the Wall. In his account of the Gobi, or desert of Lop, as he calls it, Polo describes the waste, strikingly reproducing the description of the superstitious terrors of Suan T'sang, who crossed the desert six hundred years earlier.

Early in 1275 the Venetians were cordially received by the Great Khan at Shangtu, and Marco made rapid progress. The "young bachelor" studied the languages of the Khan's subjects and soon entered the public service. G. Pauthier found in the Chinese annals a record that in 1277 a certain Polo was nominated as a second-class commissioner or agent attached to the imperial council, a passage which we may apply to the young Venetian. On his public missions he travelled through the provinces of Shansi, Shensi, and Szechuen, and the wild country on the borders of Tibet, to the remote province of Yunnan, called by the Mongols *Karajang,* and northern Burma (Mien). Marco, during his stay at court, had observed the khan's interest in strange countries, and his disgust at the stupidity of envoys and commissioners who could tell of nothing but their official business. He made notes on facts likely to interest Kublai, which, on his return, he related. He encountered many semi-civilized and barbarous tribes, many of which interested Kublai greatly.

Marco rose rapidly in favour and was often employed on distant missions as well as in domestic administration; he held for three years the government of Yangchow; on another occasion he visited Kangchow, the capital of Tangut, just within the Great Wall, and perhaps Karakorum on the north of the Gobi, the former residence of the Great Khans: also Ciampa, or southern Cochin-China; and perhaps, once more, on a separate mission to the southern states of India. We are not informed whether his father and uncle shared in such employments, though they rendered great service to the khan, in forwarding the capture of Siang-yang (on the Han river) during the war against southern China, by the construction of powerful artillery engines—a story, however, perplexed by chronological difficulties.

The Polos had become rich, and after their exile they began to dread what might follow Kublai's death. The khan, however, was deaf to suggestions of departure and the opportunity only came by chance. Arghun, khan of Persia, a grand-nephew of Kublai, lost in 1286 his favourite wife. Her dying injunction was that her place should be filled only by a lady of her own Mongol tribe. Ambassadors were despatched to the court of Peking to obtain one. The lady Cocacin (Kukachin), a maiden of seventeen, was chosen. The overland road from Peking to Tabriz was then imperilled by war, and Arghun's envoys proposed to return by sea. Having met the Venetians, and being eager to profit by their experience, they begged the khan to send the Franks in their company. He fitted out the party nobly for the voyage, sending friendly messages to the potentates of Christendom, including the pope, and the kings of France, Spain and England. They sailed from *Zaiton* or Amoy harbour in Fukien (probably the modern Changchow), then one of the chief Chinese havens for foreign trade, in 1292. The voyage involved long detention on the coast of Sumatra, and in south India, and two years or more passed before they arrived in Persia. Two of the three envoys and most of their suite died by the way; but the three Venetians survived all perils, and so did the young lady, who had come to look on them with filial regard. Arghun Khan had died before they left China; his brother reigned in his stead; and his son Ghazan married the lady. The Polos went on by Tabriz, Trebizond, Constantinople and Negropont to Venice, arriving about the end of 1295.

The first biographer of hfarco Polo was John Baptist Ramusio, who wrote more than two centuries after the traveller's death. We need not hesitate to accept as a genuine tradition the substance of his story of the Polos' arrival at their family mansion in St. John Chrysostom parish in worn and outlandish garb, of the scornful denial of their identity, and the stratagem by which they secured acknowledgment from Venetian society.

We next hear of Marco Polo in a militant capacity. Jealousies had been growing between Venice and Genoa throughout the 13th century. In 1298 the Genoese prepared to strike at their rivals on their own ground, and a powerful fleet under Lamba Doria made for the Adriatic. Venice equipped a larger fleet under Andrea Dandolo. The crew of a Venetian galley at this time amounted to 250 men, under a *comito* or master. On one of the galleys of Dandolo's fleet Marco Polo served as *sopracomito* or gentleman commander. The hostile fleets met before Curzola Island on Sept. 6, and engaged next morning. The battle ended in victory for Genoa, and Marco Polo was taken there as a prisoner. The captivity lasted less than a year, and Marco returned to Venice in July or August 1299.

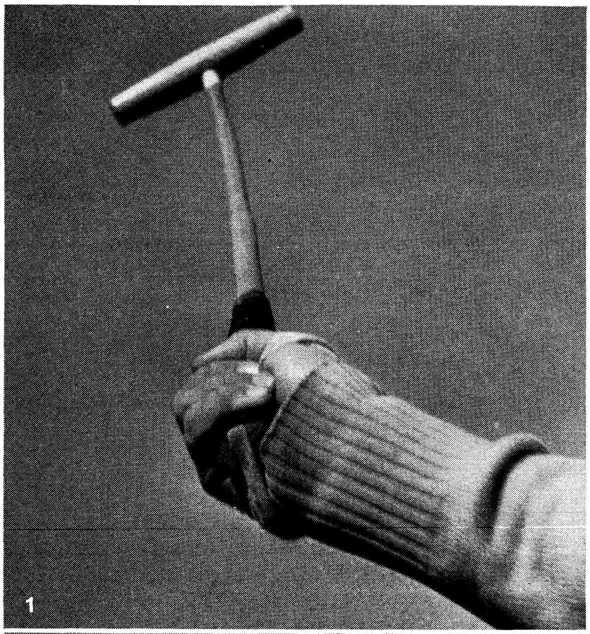
His captivity was the immediate cause of his *Book*. Up to this time he had related his experiences among his friends; and from these stories he had acquired the nickname of *Marco Millioni*. Yet he had written nothing. The narratives not only of Marco Polo but of other famous mediaeval travellers seem to have been extorted from them by pressure, and written down by other hands. In the prison of Genoa Marco Polo met Rusticiano or Rustichello of Pisa, also a captive of the Genoese, who was a respectable literary hack; he wrote down Marco's experiences at his dictation.

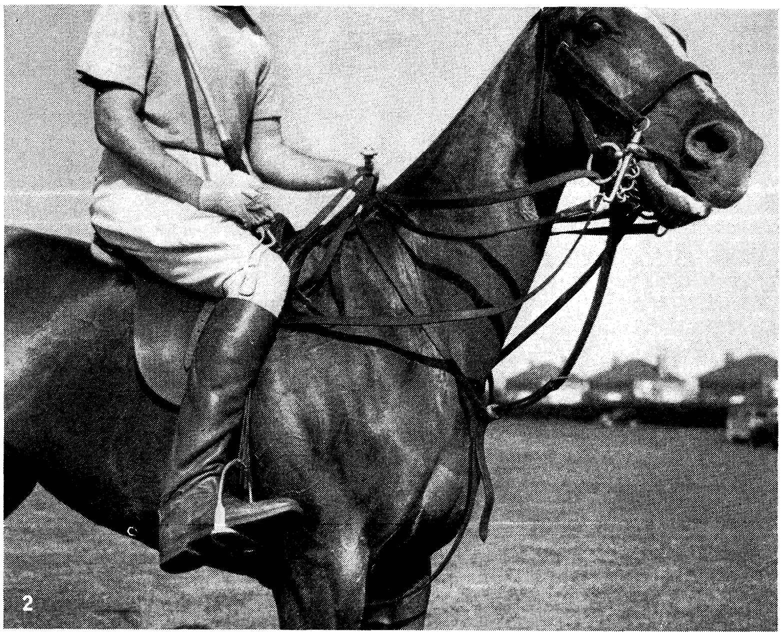
We learn little of Marco Polo's history after this captivity; at his death he left a wife, Donata, and three daughters, Eantina, Bellela and Moreta. One last glimpse of the traveller is gathered from his will. On Jan. 9, 1324, he sent for a priest and notary to make his testament, and died the same day. He was buried, according to his wish, in the Church of St. Lorenzo. The archives of Venice have yielded a few traces of our traveller. Besides his own will just alluded to, there are the wills of his uncles, Marco and Maffeo; a few legal documents connected with the house property in St. John Chrysostom, and two or three entries in the record of the Maggior Consiglio. Another document is a catalogue of curiosities and valuables in the house of Marino Faliero, which mentions several objects that Marco Polo had given to one of the Faliero family. The most tangible record of Polo's memory in Venice is a portion of the Ca' Polo—the mansion where the three travellers, after their long absence, were denied entrance. The court in which it stands was known in Ramusio's time as the *Corte del millioni*, and now is called Corte Sabbionera. That which remains of the ancient edifice is a passage with a decorated 13th century archway.

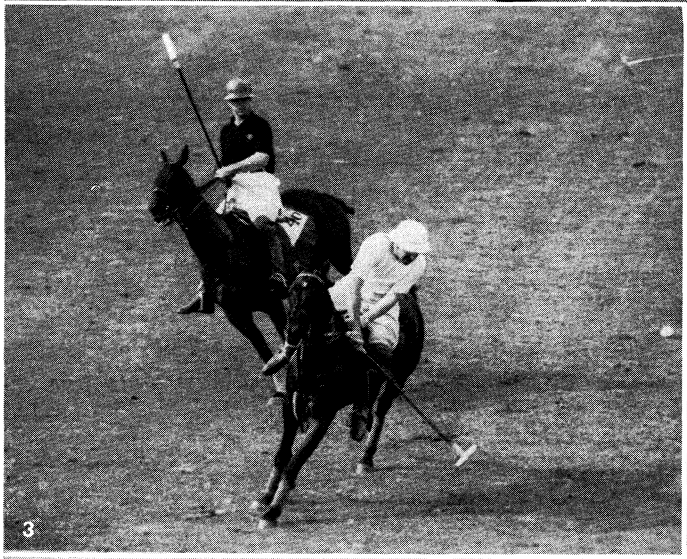
No genuine portrait of Marco Polo exists. There is a medallion portrait dated 1761 on the wall of the Sala dello Scudo in the ducal palace. The oldest professed portrait is one in the gallery of Monsignor Badia at Rome, which is inscribed *Marcus Polus venetus totius orbis et Indie peregrator primus*. It is a good picture, but of the 16th century. The Europeans at Canton have absurdly attached the name of Marco Polo to a figure in a Buddhist temple there containing a gallery of "Arhans" or Buddhist saints, and popularly known as the "temple of the five hundred gods." The Venetian municipality obtained a copy of this on the occasion of the geographical congress at Venice in 1881.

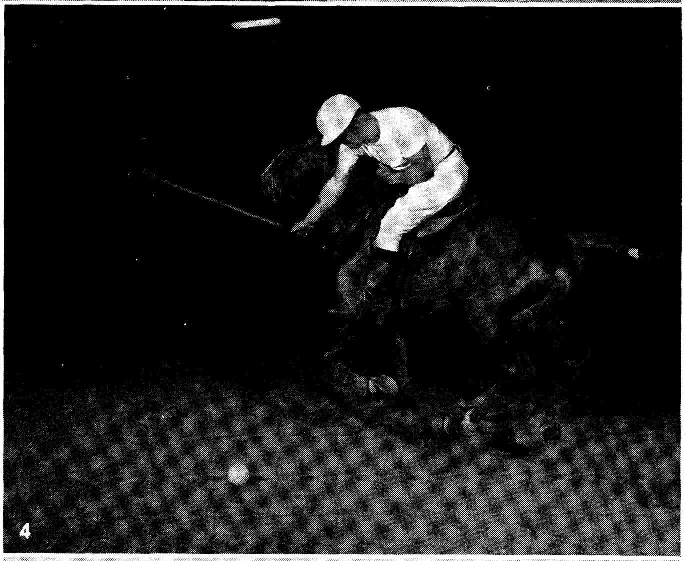
Polo was the first traveller to trace a route across the whole longitude of Asia, describing kingdoms which he had seen; the first to speak of the court at Peking; the first to reveal China in its wealth and vastness, and to tell of the nations on its borders; the first to tell more of Tibet than its name, to speak of Burma, Laos, Siam, Cochin-China, Japan, Java, Sumatra, etc.; the Nicobar and Andaman Islands, Ceylon, India, but as a country seen and partially explored; the first in mediaeval times to give any distinct account of the Empire of Abyssinia, and of the island of Sokotra, and to mention Zanzibar and Madagascar; whilst he carries us also to the remotely opposite region of Siberia and the Arctic shores, to speak of dog-sledges, white bears and reindeer-riding Tunguses.

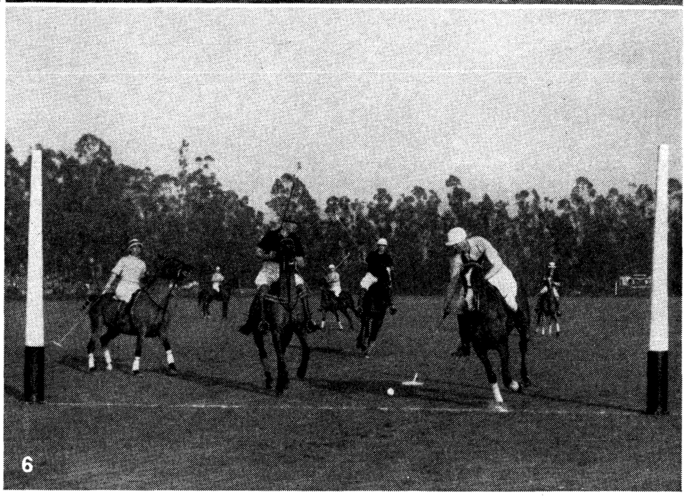
Within the traveller's own lifetime, we find the earliest examples of the practical and truly scientific coast-charts (*Portolani*), based upon the experience of pilots, mariners, merchants etc. In two of the most famous of the 14th century Portolani, we trace Marco Polo's influence—in the *Laurentian* or *Medicean Portolano* of 1351 (at Florence), and in the *Catalan Atlas* of 1375 (now at Paris). Both represent a very advanced stage of mediaeval knowledge, a careful attempt to represent the known world on the basis of collected fact, and a disregard for theological or pseudo-scientific theory; in the *Catalan Atlas*, as regards Central and Further Asia, and partially as regards India, Marco Polo's *Book* is the basis of the map. His names are often much perverted, and it is not always easy to understand the view that the compiler took of his itineraries. Still we have Cathay placed in the true position of China, as a great empire filling the south-east of Asia. The trans-Gangetic peninsula is absent, but India proper is for the first time represented with a fair approximation to correct form and position. The map of Fra Mauro (1459) gives a much less accurate idea of Asia than the *Carta catalana*. Columbus possessed a copy of the Latin version of Polo's book made by Pipino, and on many pages of this there are manuscript notes in the admiral's handwriting, testifying to the influence of the work of the Venetian merchant upon the discoverer of the new world. As to the alleged introduction of important inven-











PHOTOGRAPHS, (1-3, 5) ACME, (4) PUBLIX PICTORIAL SERVICE, (6) INTERNATIONAL

TECHNIQUE AND PLAYS IN POLO

1. A thong attached to the haft of the mallet is wound tightly around the player's wrist to insure against loss of the mallet during play. The ball is hit with the side. not the head, of the mallet

2. Proper arrangement of the bridle reins on a polo pony. A martingale passed between the pony's forelegs and fastened to the girth under the belly gives the rider added control over his mount

3. Player making a backhand save. The ball is at the far right

4. Strobo-flash photograph of beginning of the swing in a backhand save

5. The player at the left is racing forward to receive a pass from his teammate (right) who is being pressed from behind by an opponent

6. Making a goal

tions into Europe by Polo—although the striking resemblance of early European block-books to those of China seems clearly to indicate the derivation of the art from that country, there is no reason for connecting this introduction (any more than that of gunpowder or the mariner's compass) with the name of Marco. In the 14th century not only were missions of the Roman Church established in eastern China, but a regular overland trade was carried on between Italy and China. Many a traveller other than Marco Polo might have brought home the block-books, and some might have witnessed the process of making them. This is the less to be ascribed to Polo, because he so curiously omits to speak of the process of printing, when, in describing the block-printed paper money of China, his subject seems absolutely to challenge a description of the art.

The book indited by Rusticiano is in two parts. The first, or prologue, as it is termed, is unfortunately the only part which consists of actual personal narrative. It relates the circumstances which led the two elder Polos to the khan's court, together with those of their second journey (when accompanied by Marco), and of the return to the west by the Indian seas and Persia. The second part consists of a series of chapters of unequal length and unsystematic structure, descriptive of the different states and provinces of Asia (certain African islands and regions included), with occasional notices of their sights and products, of curious manners and remarkable events, and especially regarding the Emperor Kublai, his court, wars and administration, A series of chapters near the close treats of sundry wars that took place betueen various branches of the house of Jenghiz in the latter half of the 13th century. There is now no doubt that the original was written in French. A manuscript in rude and peculiar French, belonging to the National Library of Paris (Fonds Fr. 1116), which was printed by the *Société de géographie* in 1824, is evidently either the original or a close transcript. It shows characteristics of the unrevised product of dictation which would necessarily have disappeared in a translation or revised copy. Eighty-five mss. of the book are known, and their texts exhibit considerable differences. For a discussion of these *see* the authorities quoted in the bibliography.

We know from Gilles Mallet's catalogue of the books collected in the Louvre by Charles V., dating *c.* 1370–75, that five copies of Marco Polo's work were then in the collection; but on the other hand, the 202 known mss. and the numerous early printed editions of "Mandeville," with his lying wonders, indicates a much greater popularity. Dante, who lived twenty-three years after the book was dictated, never alludes to Polo; nor can any trace of Polo be discovered in the book of his contemporary, Marino Sanudo the Elder, though he is well acquainted with the work of Hayton the Armenian. "Mandeville" himself, who plundered right and left, hardly ever plunders Polo. The only literary works we know of the 14th century which show acquaintance with Polo's book or achievements are Pipino's *Chronicle,* Villani's *Florentine History,* Pietro d'Abano's *Conciliator,* the *Chronicle* of John of Ypres, and the poetical romance of *Baudouin de Sebouro.*

BIBLIOGRAPHY.—The *Recueil* of the Paris Geographical Society (1824), vol. i., giving the text of the fundamental ms. (Nat. Libr. Paris, Fr. 1116; *see* above), as well as that of the oldest Latin version; G. Pauthier's edition, *Livre . . . de Marco Polo . . .* (Paris, 1865), based mainly upon the three Paris mss. (Nat. Libr. Fr. 2810; Fr. 5631; Fr. 5649; *see* above) and accompanied by a commentary of great value; Baldelli-Boni's Italian edition, giving the oldest Italian version (Florence, 1827); Sir Henry Yule's edition, which in its final shape, as revised and augmerted by Henri Cordier (*. . . Marco Polo . . .* London, 1903), is the most complete storehouse of Polo learning in existence, embodying the labours of all the best students of the subject, and giving the essence of such works as those of Major P. Molesworth Sykes (*Ten Thousand Miles in Persia,* etc.) so far as these touch Marco Polo; the Archimandrite Palladius Katharov's "Elucidations of Marco Polo" from vol. x. of the *Journal* of the North China Branch of the Royal Asiatic Society (1876), pp. 1–54; F. von Richthofen, *Letters to Shangai Chamber of Commerce; E. C.* Baber, *Travels . . . in Western China; G.* Phillips, *Identity of . . . Zaitun with Changchau* in *T'oung Pao* (Oct. 1890), and other studies in *T'oung Pao* (Dec. 1895 and July 1896). There are in all 10 French editions of Polo as well as 4 Latin editions, 27 Italian, 9 German, 4 Spanish, 1 Portuguese, 12 English, a Russian, 1 Dutch, 1 Bohemian (Czech), 1 Danish and 1 Swedish. *See* also E. Bretschneider, *Mediaeval Researches from Eastern Asiatic Sources,* i. 239, 167; ii. 8, 71, 81–84, 184; Léon Cahun, *Introduction à l'histoire de l'Asie,* 339, 386; *C.* Raymond Beazley, *Dawn of Modern Geography,* iii. 15–160, 545–547, 554, 556–563; R. Allulli, *Marco* Polo (1923). (H. Y.; X.)

POLO, the most ancient of games with stick and ball. Its name is derived from the Tibetan *pulu,* a ball. Hockey, the Irish national game of hurling, and possibly golf and cricket, are derived from polo. The latter was called hockey or hurling on horseback in England and Ireland respectively, but historically hockey and hurling are polo on foot. The earliest records of polo are Persian. From Persia it spread to Constantinople, eastwards through Turkestan to Tibet, China and Japan. From Tibet polo travelled to Gilgit and Chitral, possibly also to Manipur. Polo also flourished in India in the 16th century. Then for 200 years its records in India cease, till in 1863 polo came into Bengal from Manipur by way of Cachar.

Chronology of Modern Polo.—Polo was first introduced to India in 1863 by Maj.-Gen. Sherar. He brought two teams of Manipuri natives from Manipur to Calcutta, where they played an exhibition match. In 1869 polo was brought to England by the 10th Hussars. In 1871 the first recorded match took place on Hounslow Heath between the 9th Lancers and the 10th Hussars with eight players on each side. An account of this match appeared in the *Morning Post* in July 1871. In 1873 the numbers on each side mere reduced to five. A match under these conditions took place at Lillie Bridge. The first code of rules was drawn up by the committee of the Hurlingham Club in 1874. In 1876 the height of ponies was fixed by Hurlingham at 14·0 hands and the Champion Cup was inaugurated at Hurlingham with five players on each side. In 1877 the first inter-regimental tournament was held in India, and in 1878 at Hurlingham. In the same year the first county cup tournament and the first Oxford *v.* Cambridge match were held at Hurlingham, and the first All-Ireland open cup at Phoenix park, Dublin. In 1882 the number of players on each side was reduced to four. In 1884 John Watson introduced the back-hand stroke to Hurlingham from India, and placed the players at No. 1, No. 2, No. 3 and No. 4 or back, thus laying the foundation of the modern combination game. In 1886 John Watson took the first team to America and won the Westchester Cup. He taught the Americans the back-hand stroke and the rudiments of the combination game. In 1888 the height of ponies in India was raised from 13·2 to 13·3. In 1895 the height of the ponies was raised by the Hurlingham committee to 14·2 and an official measurer appointed. In 1902 an American team first visited England and was defeated by England by two matches to one. In India the height of ponies was raised to 14·1. In 1909 America won the cup at I-Iurlingham. In 1910 handicapping was introduced into English polo, and offside was abolished. Both these innovations were copied from America. India adopted these alterations. In 1911 and 1913 England was defeated in America. In 1914 England beat America in America, and brought the cup back. In 1919 the height limit for ponies was abolished. In 1921 America regained the cup from England. In the same year a committee sat in London during the summer and evolved a code of universal rules. This code of rules has been adopted wherever polo is played, with local modifications as regards height of ponies and the duration of matches. In 1924, 1927 and 1930 England was defeated in America.

The Game.—A full-sized ground should not exceed 300yds. in length by 200yds. in width, if unboarded; and 300yds. in length by 160yds. in width, if boarded. The goals are not less than 250yds. apart, and each goal 8yds. wide.

Polo is played with four players on each side, on exactly the same principles as hockey or association football. A match lasts about one hour, divided into periods of play; during the intervals ponies are changed. In England seven periods of eight minutes are played for a full match; in America, eight periods of seven-and-a-half minutes. The players are placed at No. 1, No. 2, No. 3, or half-back, and No. 4 or back. So there are two forwards and two backs. But during the course of the game as the players pass the ball to one another these places are being constantly changed. The modern game is a most elastic one, but there should always be one player in each place. Two umpires are required in a first-class match to award the penalties for infringement of the rules, and in an important tournament a referee at the side of the ground decides disputes if the umpires disagree.

The Development of the Method of Play.—Previous to John Watson's teaching, the method of play was for one man on each side to be the goalkeeper, and for the others to play forward and to hit the ball when and how they could. He introduced the back-hand stroke, and placed his men at No. 1, No. 2, half-back or No. 3, and back. He also taught them to combine and hit to each other, But he taught the game on rather wooden and inelastic lines. Then the brothers Peat appeared on the scene, and soon found out and demonstrated how to play the game in a more scientific manner and with such success that they won the champion cup at Hurlingham on eight occasions. Then came the era of the Freebooters', Rugby, Old Cantab and Roehampton teams, and of the various good regimental teams, such as the 7th, 10th, 11th, 13th and 20th Hussars, the 9th and 17th Lancers and the Inniskilling Dragoons. The training both of men and ponies was rapidly improved. A very scientific game was developed, accurate combination being carefully taught; but too much importance was probably directed to defence, the principles of attack not being sufficiently developed.

While this was going on in England, polo was being rapidly improved in India, and many very fine players were produced there. The ponies were then much smaller, and consequently much more easy to train and ride. The grounds are harder and much easier to hit the ball on; also as the game is played in India all the year round far more practice is possible. Everything seemed to be in a satisfactory state as regards the game till 1909, when English polo players got a rude awakening from the American team at Hurlingham, who defeated the English representatives very easily.

The Americans had never adopted the offside rule. They consequently developed a very much faster game. They also perfected strokes that had hardly been attempted elsewhere. They met the ball on possible occasions and hit under their ponies' necks instead of hitting back-handers from the side of the ground. They played a most elastic game, hitting harder and passing more accurately. They had developed the science of the attack, galloped faster, and were much more accurate goal hitters.

In 1910 the Hurlingham Club decided to profit by the lessons learnt from the Americans in 1909, and made two most important alterations in their rules. Offside was abolished and handicapping was introduced. The abolition of offside quickened up the game to a very great extent, and the institution of handicapping resulted in much harder and more even matches. The periods of play were shortened from ten to eight minutes, seven periods being played for a match instead of six. English polo probably reached its zenith in 1914 when the English team which visited America brought the cup back.

The Effects of the World War.—Then came the World War which gave a set-back to English polo from which it has not yet recovered. The expenses of polo have vastly increased since the pre-war years. In 1919, owing to the pony wastage of the war, the troubles in Ireland, formerly the chief source of supply of high-class ponies, and the fact that the breeding of ponies in both England and Ireland had almost ceased, it was impossible to supply the demand for 14·3 ponies of the right stamp. This necessitated the abolition of the height limit. The big thoroughbred pony now in use in first-class polo is more expensive to buy, dearer to keep and much more difficult to train and to ride. Also, undoubtedly, the abolition of offside and the institution of handicapping has made the game more expensive. For the handy pony of moderate speed is now quite useless in an ordinary good game, and the handicap entails far more close matches, which means that more ponies are required. In spite of this polo is in a very flourishing condition. In Great Britain it is played at Hurlingham, Ranelagh, Roehampton, and at some 30 county clubs affiliated to the County Polo Association. It is played throughout the British empire, wherever sufficient players can collect together to make up a game. It is played all over India; many of the maharajahs and chiefs keep up teams in the native States. It is played on the Continent, and is fast becoming a national game in the U.S.A.

Polo Centres and Tournaments.—London has for a number of years attracted most of the best players of the world. During the season, May 1 to July 31, matches and tournaments for every class of player are held at Hurlingham, Ranelagh and Roehampton. These clubs maintain seven grounds, as well as three at Worcester park as an overflow. Since the war, first-class teams from America, India and the Argentine have taken part in the various tournaments, and as a rule there are two or three first-class English teams competing in all the principal events such as the Whitney Cup, the Champion Cup, the Ranelagh Open Cup and the Roehampton Open Cup. The second and third-class players are catered for equally well in a variety of lesser competitions; the soldiers have their own tournaments, *i.e.,* the inter-regimental at Hurlingham, the Subalterns' Cup at Ranelagh and the handicap military tournament at Roehampton. The whole organization is well-nigh perfect, controlled by professional polo managers. India has good tournaments at far separated places such as Calcutta, Delhi, Meerut, Amballa, Rawalpindi, etc., but there is no place in India where good polo can be concentrated for a lengthy period as in England. In England a good player can play at Minehead, Somerset, in April; he can then go to London for May, June and July; then come the county tournaments beginning at Cowdray in Goodwood week, Rugby in the first week in August, Cirencester, Cheltenham, Tidworth, and he can finish up with a month of good games at Minehead. A keen player can, weather permitting, get nearly six months on end of match play.

Organization.—The "Hurlingham Club Rules" and the "General and Field Rules of the U.S.A. Polo Association" are now practically identical, and except for minor differences, such as height of ponies and the duration of matches and periods of play, the Hurlingham rules are followed all over the world. The Hurlingham Polo Club committee consists of 38 members: 10 nominated by the Hurlingham Club; 5 by the Army Polo committee; 5 by the Indian Polo Association; 5 by the County Polo Association; 3 by the All-Ireland Polo Club; 2 by the South African Polo Association; 2 by the Egypt, Sudan and Palestine Polo Association; 2 by the New Zealand Polo Association; 2 by the Ranelagh Club; 2 by the Roehampton Club. There are two sub-committees: (1) general purposes, (2) handicapping. Five stewards are appointed annually, whose duties are similar to those of the "Stewards of the Jockey Club." The County Polo Association legislates for everything connected with county polo clubs in England, and to this body are affiliated practically every polo club in Great Britain. This organization was started in 1899.

For the purposes of organization, England and Scotland are divided into four divisions, each with an honorary divisional secretary, viz., Northern, 6 clubs; Midland, 10 clubs; South-Eastern, 7 clubs; South-Western, 7 clubs—total 30. The Army Polo Association committee, consisting of five members, is responsible as a sub-committee of the Hurlingham Club for the army organization. The Indian Polo Association, which sends five representatives to serve on the Hurlingham committee, is the governing body of Indian polo. This body organized and despatched the Indian Army teams to America in 1927.

Breeding of Polo Ponies.—The interest of the breeding of polo ponies is supervised by the National Pony Society. This society edits a stud book for all kinds of riding ponies, and holds an annual show at the Agricultural Hall, Islington. The society gives prizes and medals at many shows for polo pony classes. It has done for 35 years, and is still doing, a great work for the encouragement of the breeding of the best class of riding pony.

Up to the year 1909 nearly all the best polo ponies used in the game were bred in Ireland, England and Australia. The latter were chiefly used in India. In India, until about 1888, country-breds were relied on chiefly, very good animals, not more than 13.2 in height. Then Arabs began to be bred in greater numbers, only to be superseded in their turn by walers from Australia, which were imported in large numbers by dealers to Calcutta and Bombay. When the height was raised to 14·1 in 1902, only the very best Arabs and a few country-breds produced on the Government and regimental farms could compete with the Australian pony in high-class tournaments. Large numbers of easy, handy, rather common ponies were imported from 1892 to about 1909 from the Argentine to England. They were cheap and easy to play, but as a rule rather deficient in pace. Occasionally an absolutely first-class pony appeared, but they were few and far between. But in the last 20 years the class of pony bred in the Argentine has improved out of all recognition. Several generations of thoroughbred stallions have been used to such an extent that as good ponies as can be obtained anywhere are produced and exported. Many quite thoroughbred ponies are bred in the Argentine, and the remainder of the best animals have only a far back strain of the native pony in their pedigree on the dam's side. The best ponies are, whatever their nationality, thoroughbred or very nearly so. Probably the ideal breeding is for the sire to be thoroughbred and the dam nearly if not quite thoroughbred of the hardy old Irish stock. The National Pony Society in England, and the polo breeding societies in America and the Argentine are doing a great work in proving that polo ponies can be bred to type.

The Price of Ponies.—The increase in the price of polo ponies is illustrated by the following figures. In 1890 when the 17th Lancers left India they sold their very large stud of polo ponies by auction at an average price of about rupees 800, *i.e.*, £60. In 1891, Egyptian ponies were purchased in Cairo for an average of from £20 to £25. Some of these were sold at Tattersall's in 1893 for from 150 to 250 guineas apiece. In 1897 at a sale at Spring Hill, Rugby, by the brothers Miller, 32 ponies fetched an average of £281, the then record price being reached by Sailor—750 guineas. In 1913, in America, the duke of Westminster's best ponies were sold at from £600 to £700 apiece. In 1924 the first great rise in prices took place at an auction at Long Island when the English ponies fetched enormous prices. One pony sold for no less than $10,000, *i.e.*, £2,000. In 1925, the Argentine ponies belonging to an Argentine team which won the Champion Cup were sold on the same scale. In 1928 all records were broken when £4,400 was paid for a single first-rate pony.

BIBLIOGRAPHY.—Accounts of the oriental forms of polo will be found in the following works: Persia: Firdousi's *Shahnama;* A. Shirley, *Travels in Persia* (1569); J. Chardin, *Voyages en Perse* (1686); W. Ouseley, *Travels in various countries of the East, particularly Persia* (1810). There are many allusions to polo in the poets, notably Nizami, Jami and Omar Khayyam. Constantinople: *Cinnamus Joannes epitome rerum ab Ioanne et Alexio Comnenis gest.* (Bonn, 1836). India: *Ain-i-Akbari* (1555); G. F. Vigne, *Travels in Kashmir, Ladakh and Iskardo* (1842); A. Durand, *The Making of a Frontier* (1899). Gilgit and Chitral: "Polo in Baltistan," *The Field* (1888). Manipur: W. McCulloch, *Account of the valley of Manipore and the Hill Tribes* (Calcutta, 1859). China and Japan: H. A. Giles, *Adversaria Sinica* (Shanghai, 1905); B. H. Chamberlain, *Things Japanese* (1898); the *Ku Chin T'u Shu* (Encyclopaedia).

For the modern form of the game *see* J. Moray Brown, *Riding and Polo,* Badminton Library (revised and brought up to date by T. F. Dale, 1899), and *Polo* (1896); G. J. Younghusband, *Polo in India* (1897), *Tournament Polo* (1897), *Tournament Polo* (1904); T. F. Dale, *The Game of Polo* (1897); H. de B. de Lisle, *Hints to Polo Players in India* (1897); T. B. Drybrough, *Polo* (1898, revised 1906); E. D. Miller, *Modern Polo* (1903); H. L. Fitzpatrick, *Equestrian Polo,* in Spalding's Athletic Library (1904); W. Buckmaster, "Hints on Polo Combination," *Library of Sport* (1909); W. C. Forbes, *As to Polo* (1920); W. B. Devereux, *Position and Team Play in Polo* (1924); Hurlingham Club, *Rules of Polo; Register of Ponies; Polo and Riding Pony Society Stud Book* (12 volumes). Periodicals: *Bailey's Magazine; The Polo Monthly.* The American Polo Association and the Indian Polo Association issue annual publications.

(E. D. M.)

United States.—Attack has always been stressed in American play. The system of fractional fouls also aided speed. Instead of stopping the game on a foul, as at present, and allowing a free hit from varying distances for the goal, a fraction was deducted from the offending side's score and play continued without a break. In 1888 what has since been regarded as perhaps the most important legislative contribution to the sport came with the first handicapping of players. The game, until that time, had been pretty well monopolized by the better players and H. L. Herbert conceived the idea of the handicap to make possible a wider spread of play. The handicap, low at the start of a player's career, increases with his ability. Thus the beginners are able to play with the more experienced players on a far more even footing. Only the international matches and the open tournaments are played without handicap. In a game the handicaps of all four players are totalled and the team handicaps compared. One team (unless the totals are even) then receives the difference in total handicap. The handicapping system almost immediately resulted in new tournaments and new clubs, among them Myopia and the Dedham Polo and Country Club, two of the most famous of the Boston district.

Up to 1935 ten goals was the highest rating ever given to a player. This has been held in the American game at varying times by the following: Foxhall P. Keene, John E. Cowdin, Thomas Hitchcock, R. L. Agassiz, J. M. Waterbury, Jr., Lawrence Waterbury, Harry P. Whitney, Louis E. Stoddard, J. Watson Webb, M. Stevenson and D. Milburn; today only Thomas Hitchcock, Jr., Cecil Smith and Elmer Boeseke hold this rank.

The U.S. Polo Association had in 1928 86 members, these including the U.S. army, the Intercollegiate Association and several others which, in turn, had their member organizations. The handicap list of that year showed a total of 2,572 handicapped players in the country, 1,274 civilians, 1,152 on the army list and 146 on the Intercollegiate list.

After America, in 1909, won her first victory in the international series with England, the rules were assimilated. The Americans took over the British rule permitting the hooking of mallets, and the English abandoned their offside rules and adopted the handicap system. At the close of the World War in 1918 all effort at limiting the size of ponies was abandoned.

At first Americans played with native horses, mainly found in the South-west and descended, in part, from the Spanish barb left by those who penetrated that part of the United States in its early history, To-day, though Texas and Wyoming produce a great many polo horses, the thorough-bred is much in demand, with English and Irish blood prominent in a certain line of mounts. The ponies of Argentina have become perhaps the most popular among the higher-rated players. This is the result of visits to the United States by Argentine teams in 1922, 1926 and 1931, and of a return invasion of the Argentine in 1932. (R. F. K.)

POLONAISE, a stately ceremonious dance, usually written in $\frac{3}{4}$ time. As a form of musical composition it has been employed by such composers as Bach, Handel, Beethoven, and above all by Chopin. It is usual to date the origin of the dance from the election (1573) of Henry duke of Anjou, afterwards Henry III. of France, to the throne of Poland. The ladies of the Polish nobility passed in ceremonial procession before him at Cracow to the sound of stately music. This procession to music became the regular opening ceremony at royal functions, and developed into the dance.

The term is also given to a form of skirted bodice, which has been fashionable for ladies at different periods.

POLONIUM, a radioactive element of atomic number 84 and atomic weight (estimated) of about 210, also known as radium-F since it is one of the decomposition products of radium. (See RADIOACTIVITY.)

POLOTSK, a town of White Russia, at the confluence of the Polota and Dvina, in 55° 29' N., 28° 49' E. Pop. (1926) 21,455. It is on a railway junction and has saw-milling and timber industries and a flour-mill. Its position between central Russia and the west made it a storm centre. and little of the ancient town remains; both the upper castle, which had seven towers, and the lower one are in ruins and its 12th century cathedral fell in ruins in the 18th century.

Polotesk or Poltesk is mentioned in 862 as one of the towns given by the Scandinavian Rurik to his men. In 980 it had a prince of its own, Ragvald (Rogvolod or Rognvald), whose daughter is the subject of many legends. It remained an independent principality until the 12th century, resisting the repeated attacks of the princes of Kiev; those of Pskov, Lithuania, and the Livonian Knights, however, proved more effective, and Polotsk fell under Lithuanian rule in 1320. About 1385 its independence was destroyed by the Lithuanian prince Vitovt. It was five times besieged by Moscow in 1500–18, and was taken by Ivan the Terrible in 1563. Recaptured by Stephen Bathory, king of Poland, 16 years later, it became Polish by the treaty of 1582. It was then a large and populous city, and carried on an active commerce. Pestilences and conflagrations were its ruin; the plague of 1566 wrought great havoc among its inhabitants, and that of 1600 destroyed 15,000. The castles, the town and its walls were burned in 1607 and 1642. The Russians continued their attacks, burning and plundering the town, and twice, in 1633 and 1705, taking possession of it for a few years. It was not definitely annexed to Russia until 1772, after the first dismemberment of Poland. In 1812 its inhabitants resisted the French invasion. and the town was partially destroyed.

POLTAVA, a town in the Ukrainian S.S.R., Union of Soviet Socialist Republics, on the right bank of the Vorskla river, in 49° 36′ N., 34° 35′ E. Pop. (1939) 130,305.

It is the centre of an agricultural district in nhich grains, sugar beet, tobacco, vines and orchard fruits are grown. Leather is the chief manufacture, and there is an annual fair for the sale of skins, leather and leather goods. Other industries include smelting, stocking manufacture, distilling and brewing. The town is on the railway and is a grain collecting centre. The Russian annals mention Poltava in 1174 under the name of Ltava In 1430 it was given, together with Glinsk, to the Tatar prince Leksada by Gedimin, prince of Lithuania.

Under the Cossack chief, Bogdan Chmielnicki, it was the chief town of the Poltava "regiment"

Peter the Great defeated Charles XII of Sneden in the neighbourhood of Poltava in 1709.

POLTERGEIST: *see* PSYCHICAL RESEARCH.

POLTORATSK: *see* ASHKHABAD.

POLTROT, *JEAN* DE (*c.* 1537–1563), sieur de Méré or Mérey, a nobleman of Angoumois, who murdered Francis, duke of Guise. He had lived some time in Spain, and his knowledge of Spanish, together nith his swarthy complexion, which earned him the nickname of the "Espagnolet," procured him employment as a spy in the wars against Spain. Becoming a fanatical Huguenot, he determined to kill the duke of Guise and gained admission as a deserter to the camp of the Catholics nho were besieging Orléans. On Feb. 18, 1563, he hid by the side of a road along which he knew the duke would pass, fired a pistol at him and fled. He was captured the next day, tried, tortured and sentenced to be drann and quartered. On March 18, 1563, he underwent a frightful punishment. The horses not being able to drag off his limbs, he was hacked to pieces with cutlasses He had made several contradictory declarations regarding the complicity of Admiral Gaspard de Coligny, but his accusations seem to have had no foundation.

POLYAENUS, a Macedonian, who lived at Rome as a rhetorician and pleader in the 2nd century A.D. When the Parthian War (162–5) broke out, Polyaenus dedicated to the emperors Marcus Aurelius and Lucius Verus a work, stilt extant, called *Strategica* or *Strategemata,* a historical collection of stratagems and maxims of strategy written in Greek and strung together in the form of anecdotes. It is not strictly confined to warlike stratagems, but includes also examples of wisdom, courage and cunning drawn from civil and political life. The work is divided into eight books (parts of the sixth and seventh are lost), and originally contained 900 anecdotes, of which 833 are extant. His works on Macedonia, on Thebes, and on tactics (perhaps identical with the *Strategica)* are lost.

The best edition of the text is Wölfflin and Melber (Teubner Series, 1887, with bibliography and editio princeps of the *Strategemata* of the emperor Leo); annotated editions by Isaac Casaubon (1589) and A. Coraes (1809); I. Melber, *Ueber die Quellen und Werth der Strategemensammlung Polyäns* (1885); Knott, *De jide et fontibus Polyaeni* (1883), Eng. trans. by R. Shepherd (1793).

POLYANDRY, the system under which a woman is married to several men at the same time (Gr. πολύς, many, and ἀνήρ, man). Cases of it have been noticed among certain South American Indians, and in North America among some Eskimo, the Tlingit, the Aleut and the Kaniagmiut on the Alaskan coast. In an old description of the conquest of the Guanches in the Canary islands in 1402 it is said that in the Island of Lancerote most of the women have three husbands, "who wait upon them alternately by months." Sporadic cases of polyandry have been found in Madagascar, among a few peoples on the African continent, in some places of the Malay archipelago and among certain South Sea islanders, while in the Marshall islands and the Marquesas it has been practised on a much larger scale. In Tibet polyandry has prevailed from time immemorial, the husbands being as a rule brothers, who live together with their common wife as members of the same household Fraternal polyandry is more or less frequent in vast districts of the Himalayan region from Assam to the dependencies of Kashmir, chiefly among people of Tibetan affinities, and in South India, where its prevalence among the Todas of the Nilgiri hills has attracted special attention: and it existed throughout the interior of Ceylon until it was prohibited by the British government about the year 1860. Among the Nayars or Nairs of Cochin, Malabar and Travancore we meet nith polyandrous unions of a different, non-fraternal type, the prevalence of which has been testified by a large number of travellers from the beginning of the 15th century onward. According to Nayar usage every girl, before she attained puberty, was subjected to a certain marriage ceremony, after which the nominal husband went his way and she was allowed to cohabit nith any Brahman or Nayar she chose; usually she had several lovers, who cohabited with her by agreement among themselves but did not live with her. Strabo asserts that polyandry prevailed in Arabia Felix, and some modern scholars think that they have found confirmation of this statement in Sabian and Minaean inscriptions.

Very frequently polyandry is modified in a monogamous direction, one, usually the first, husband being the chief husband; nay, in various cases any other man with whom he shares his wife acts as husband and master of the house only during the absence of the true lord. Where fraternal polyandry prevails the eldest brother is commonly regarded as the principal husband; he chooses the wife, and the contract he makes may implicitly confer matrimonial rights on all the other brothers. Among many polyandrous peoples the various husbands live or cohabit with their common wife in turn; and if they are brothers the eldest one is sometimes expressly said to take the lead.

Among many polyandrous peoples there are said to be more men than women, and their polyandry has in several cases been directly attributed to this fact; and even if some of these statements, in the absence of statistical data, are more or less hypothetical, there are others the accuracy of nhich is past all doubt. But pclyandry has also been traced to economic motives. In Tibet it has been said to obtain as a necessary institution, serving the end of checking the increase of population in regions from which emigration is difficult and also keeping the family property together; and similar reasons have been assigned for polyandry in Ladakh, Bhutan. South India and Ceylon. The polyandry of the Tibetans, the Himalayans and some peoples in the south of India seems also to be partly due to the dangers or difficulties nhich would surround a woman left alone in her home during the prolonged absence of her husband. The peculiar polyandry of the Nayars is most probably connected nith their military organization, which prevented their living the ordinary life of a husband and father of a family.

BIBLIOGRAPHY.—*Census of India,* 1901 and 1911; W. H. R. Rivers, *The Todes* (1906); E. Thurston, *Ethnographic Notes in Southern India* (1906); H. Muller, *Untersuchungen über die Geschichte der polyandrischen Eheformen in Südindien* (1909); L. K. Anantha Krishna Iyer, *The Cochin Tribes and Castes,* vols. i. and ii. (1909–1912); E. Westermarck, *The History of Human Marriage,* vol. iii bibl. (1921); R. Briffault, *The Mothers,* vol. i. bibl. (1927). (E. W.)

POLYANTHUS, the oxlip (*Primula elatior*); also any narcissus derived from *Narcissus tazetta.*

POLYBIUS (*c.* 201–*c.* 120 B.C.), Greek historian, mas born at Megalopolis in Arcadia, being the son of Lycortas, the friend and successor of Philopoemen as leader of the Achaean League. The precise dates of his birth and death are not known. but they can be inferred approximately. We have his own statement (xxiv. 6) that in 181 B.C, when he was appointed along with Lycortas and Aratus as an ambassador to Egypt, he was still under the legal age, which appears to have been 30 (xxix. 9). According to Cicrro. *Ad Fam.* v. 12, Polybius wrote a special history of the Numantine War, uhich ended in 132 B.C. Lastly in Lucian, *Macrob.* 22 we read that he dird in consequence of a fall from his horse at the age of 82.

The more notable events of his life may be briefly stated On the death of Philopoemen in Messenia (182 B C.) he took a leading part in conveying home the urn which contained his ashes (Plutarch, *Philopoem.* 21). In 169, during the war between the Romans and Perseus of Macedonia, when it was decided to send an Achaean force to assist the consul Q. Marcius. Polybius was appointed to command the cavalry. He was among the envoys sent to consult with the consul, and, although the proffered assistance was declined, he remained for a time in the Roman camp (xxviii. 13). The turning point in his life came when Perseus was finally defeated by the Romans at Pydna in 168. Polybius was one of 1,000 leading Achaeans who were carried to Rome, at the instigation of Callicrates, on the charge of having been lukewarm in their support of the Roman cause.

While the others were distributed among the Italian towns, Polybius was allowed, through the influence of L. Aemilius Paullus, and his sons Fabius (Q. Fabius Maximus Aemilianus) and Scipio (P. Cornelius Scipio Africanus minor) to remain in Rome (xxxii. 9., Pausan. vii. 10. 2). With Scipio he formed a close friendship and to his influence with Scipio it was due that in 151 B.C., the remnant of the Achaean exiles obtained permission to return to their homes (xxxv. 6). Polybius himself, after a short stay in Achaea, joined Scipio in Africa in 147 and was present at the siege and destruction of Carthage in 146. Meanwhile the mistaken attempt of the Achaean League to assert its independence of Rome had ended in disaster and the remaining public work of Polybius was devoted to alleviating so far as possible for his countrymen the consequences of their policy, and to facilitating the establishment of order under the new régime (xl. 8–10).

The manner in which he accomplished this was such as to earn the gratitude of his compatriots, as was attested by the statues erected in his honour at Mantineia (Pausan. viii. 9. 1.), Pallantium (Pausan. viii. 44. 5), Tegea (Pausan. viii. 48. 8), Megalopolis (Pausan. viii 30. 8)—where the inscription recorded that he "had roamed over all the earth and sea, and had been the ally of the Romans and had made them cease from their anger against Greece"—Acacesium, the inscription declaring that "Hellas would never have come to grief, if she had obeyed Polybius in all things, and, having come to grief, she found succour through him alone" (Pausan. viii. 87. 2). The base of a statue erected to him by Elis was discovered at Olympia in 1877 with the inscription:

ἡ πόλις ἡ Ἠλείων Πολύβιον Λυκόρτα Μεγαλοπολίτην.

The Histories (Ἱστορίαι), on which his reputation as a historian now rests, were in 40 books. Of these the first five are extant. For the remaining books we have excerpts from a collection of passages from the Greek historians, which was made by the order of Constantine Porphyrogenitus in the 10th century; excerpts of vi.–xviii. contained in another compilation of uncertain date, first printed at Basle in 1549; and a fragment of xi., 13–16, in a Berlin papyrus (3rd century A.D.).

The original intention of Polybius was to narrate the history of the 53 years (220–168 B.C.)—from the beginning of the Hannibalic War to the defeat of Perseus at Pydna—in which Rome made herself mistress of the world. The first two books are prefatory—a "preparation" (προκατασκευή I. 3)—dealing with the earlier history of Rome, the first Punic War, and contemporary events in other parts of the world. But the opening chapter of Book III. indicates an intention to modify his original plan by adding an account of the manner in which the Romans exercised their supremacy down to the destruction of Carthage in 146 B.C. Thus the history of the period 168–146 B.C. appears to have occupied the last ten books.

Scientific Conception of History.—With regard to the function of the historian, Polybius is one of those who consider history to be—in the phrase of Dionysius—"philosophy teaching by examples." Thus he says in i. 35: "Whereas there are for all men two ways of improvement, to wit by one's own disasters or those of others, the former is the more vivid, the latter is the less harmful. Therefore, one should never willingly choose the former, since the improvement which it brings is fraught with great danger and pain, but one should always pursue the latter, since in it one can discern the better way without hurt. And it is therefore to be considered that the best education for real life is the knowledge of affairs which accrues from practical history (πραγματικὴ ἱστορία) which alone, without personal hurt, makes men on every occasion and in all circumstances, true judges of the better way."

From this conception of history, which differs little, if at all, from that of Thucydides or the modern historian of the scientific school, it follows that the chief interest lies, not in the question of origins, in the legendary or semi-legendary traditions, by which states or nations, like individuals, when they have achieved greatness, are fain to decorate their origins, but in the actual transactions of historical times, the plain matters of fact which appeal to the plain man. This seems to be undoubtedly what Polybius means by the term "pragmatic" by which he several times characterizes his History. Thus in criticizing Phylarchus he writes (ii. 56. 7. seq.): "Endeavouring to excite his readers to pity and to make them sympathetic with his narrative, he introduces embracing of wives, disordered hair, baring of breasts, tears and lamentations of men and women haled away with their children and aged parents. This he does throughout his whole history, seeking always to give a vivid picture of horrors. The ignoble femininity of this design may be left out of the question; but we must consider what is proper and profitable in history. It is the function of the historian not to astonish his readers by prodigies nor to hunt up all possible tales and recount all the concomitants of his subjects, as tragedians do, but to narrate in their verity the things actually done and said, how modest soever they may be. For the end of history is not identical with that of tragedy, but quite the contrary. In tragedy the end is by the most plausible language to astonish and move the audience temporarily. In history the end is by real facts and real speeches to instruct and persuade for all time the lovers of knowledge: since in the former the leading motive is the plausible, even if the plausible be false, for the deception of the spectators; in the latter the leading motive is truth for the benefit of the student."

What Polybius himself means by "Pragmatic history" (i. 2. πόσα καὶ πηλίκα συμβάλλεσθαι πέφυκε τοῖς φιλομαθοῦσιν ὁ τῆς πραγματικῆς ἱστορίας τρόπος) is illustrated by his remarks (iii. 47) on those who have written of Hannibal's crossing of the Alps: "Wishing to astonish their readers by their marvellous account of the localities, they fall into two faults which are most foreign to all history; for they are compelled to tell falsehoods (ψευδολογεῖν) and to contradict themselves. On the one hand they introduce Hannibal as a general of inimitable daring and prudence, while they show him admittedly the most imprudent; and on the other hand, unable to reach a dénouement or an issue from their own mendacity, they introduce into pragmatic history gods and the children of gods. . . . Ignorant of these things they say that a hero (*i.e.*, a demigod) appeared and showed the Carthaginians the roads. Hence, naturally, they find themselves in the same position as the writers of tragedies. For the dénouements of their dramas need a god and a machine, because their first premises are false and contrary to reason; and historians must be in like case and must represent gods and heroes appearing when their premises are improbable and false."

Polybius (iii. 6) insists on the distinction between the remoter causes (αἰτίαι) of events and their immediate origins (ἀρχαί) and in the same spirit he emphasizes the necessity of taking a comprehensive or synoptic view of history, regarding history as a unity in so far as the interests of different nations mutually interact: "In previous times the actions of the world were sporadic . . . now history is, as it were, an organic whole; the affairs of Italy and Africa are intertwined with those of Asia and Greece and all have reference to one end" (i. 3). It is this conception of history which leads Polybius to prefix to his more immediate subject the preparatory narrative of his first two books: "The peculiarity of our study and the marvel of our times is this. Just as Fortune (τύχη) has bent almost all the affairs of the world to one end and has inclined them to one and the same goal, so by means of history we must bring under one conspectus for our readers the agency which Fortune has employed to accomplish the whole. For this consideration it is chiefly which incited and stimulated me to undertake my history, coupled with the fact that no one in our time has attempted a general history: otherwise I had been much less eager in this direction. But when I see that many writers occupy themselves with particular wars and some of the actions connected with them, while no one, so far as I know, has even attempted to examine the general and comprehensive economy of events—when and whence they originated and how they attained fulfillment—I considered it absolutely essential not to omit or allow to pass unnoticed the most beautiful and at the same time the most beneficial exhibition of the power of Fortune. For many as are her innovations and unceasingly as she engages in the affairs of men, absolutely never has she wrought such a work or engaged in such a struggle as in our time. This cannot be seen from sectional histories—unless it be that one who visits the most eminent individual cities or sees them represented in a picture, imagines straightway that he understands the form of the whole world, and its general position and arrangement" (i. 4).

Sources of Information.—Starting with the initial advantage of being himself conversant with public affairs, Polybius seems to have taken pains unusual for his time to equip himself with the knowledge requisite to ensure accuracy. In the first place he was a careful student of the practice of war, and indeed wrote a treatise on Tactics (ix. 20. 4. cf. Arrian, Tact. i. 1., Aelian, Tact. i. 2; iii. 4; xix. 10). He had an extensive first-hand acquaintance with geography (cf. the inscription on his statue at Megalopolis as quoted above); he accompanied Scipio in many campaigns (Arrian, Tact. l.c.) and, as he tells us himself, "it was mainly for this reason that I undertook the dangers and discomforts incident to travel in Africa and Spain and also Gaul and the Outer Sea (Atlantic) adjacent to those lands, in order that I might correct the ignorance of my predecessors in those matters and make known those parts of the world to the Greeks" (iii. 59). He also tells us (iii. 48) in discussing Hannibal's passage of the Alps, that he had himself seen the region and had travelled over the Alps for the sake of information and observation. His intimate study of constitutional matters is shown by his account of the Roman constitution in Book VI. Finally he made diligent use of the documentary and monumental evidence accessible to him. Thus in iii. 33, after giving the numbers of Hannibal's forces with a detail "suggesting the plausible mendacity of a historian" he explains that he took the numbers from a record in bronze left at Lacinium (in Bruttium) by Hannibal himself. In xvi. 15 he appeals to the evidence of a despatch preserved in the *prytaneum* of Rhodes; and the manner in which he quotes the terms of the treaty which ended the first Punic War (i. 62) and of that between Hannibal and Philip (vii. 9) implies that he is either translating or quoting a translation of an original document which he possibly obtained from official sources.

His enlightened conception of the function of history, his careful preparation for his task, entitle Polybius to an honourable place among historians. The completely impartial historian is an ideal, certainly unattainable and perhaps undesirable. No very serious charge on this ground is made against Polybius, nor can such charges in any case be either confuted or confirmed authoritatively. He has himself at all events forestalled criticism: "That historians may incline the balance in favour of their own country I would allow—not that they should make statements which contradict the facts. There are enough errors of ignorance to which historians are liable and which a man may hardly avoid. But if we write falsely from intention—be it for country or for friends or for favour—what better are we than those who make their living by such means? . . . On this tendency readers should keep a watchful eye, and historians themselves should guard against it" (xvi. 14).

The main criticism directed against Polybius from Dionysius of Halicarnassus (1st century, B.C.) to the present day is made on the ground of style. Dionysius, from the standpoint of a strict Atticist, writes of the later Greek historians who have so far neglected style that they "have left behind them compositions which no one endures to read to the end—Phylarchus, Duris, Polybius" (Dionys. De *comp.* verb. iv.). The modem reader, from a more general standpoint, would be inclined to think that his defects of style have been exaggerated. But his unfamiliar vocabulary, his intentional rejection of the picturesque concomitants of historical events, his anxiety to point a moral, combine to render him less popular than his merits deserve: one more proof that something more than knowledge, more than accuracy, more than serious purpose and moral earnestness, is required in the historian to whom the world will gladly listen.

BIBLIOGRAPHY.—*Editio princeps,* Bks. I.–V., *Opsopoeus* (Koch), (Hagenau, 1530). Chief editions: Ernesti, 1763–64; Schweighauser, 1793; Bekker, 1844; Büttner-Wobst, 1889–1905; Hultsch, 1867–71. Selections from Polybius, ed. Strachan-Davidson (Oxford, 1888); W. W. Capes, The History of the Achaean League (1888). Other literature: Wunderer, *Polybios-forschungen* (1898–1909); Cuntz, Polybios *und* sein Werk (Leipzig, 1902); R. v. Scala, Die Studien des Polybios (Stuttgart, 1890); I. B. Bury, Ancient Greek Historians (1909). Translation in Loeb Series, W. R. Paton. (A. W. MA.)

POLYCARP (c. 69–*c.* 155), bishop of Smyrna and one of the Apostolic Fathers, derives much of his importance from the fact that he links together the apostolic age and that of nascent Catholicism. The sources from which we derive our knowledge of the life and activity of Polycarp are: (1) a few notices in the writings of Irenaeus, (2) the Epistle of Polycarp to the Church at Philippi, (3) the Epistle of Ignatius to Polycarp, (4) the Epistle of the Church at Smyrna to the Church at Philomelium, giving an account of the martyrdom of Polycarp. Since these authorities have all been more or less called in question and some of them entirely rejected by recent criticism, it is necessary to say a few words about each.

Sources.—I. The Statements of Irenaeus are found (a) in his *Adversus* haereses, iii. 3, 4, (*b*) in the letter to Victor, where Irenaeus gives an account of Polycarp's visit to Rome, (*c*) in the letter to Florinus—a most important document which describes the intercourse between Irenaeus and Polycarp and Polycarp's relation with St. John. The genuineness of (*c*) is not uncontested, but it is generally accepted.

2. The Epistle of *Polycarp.*—Though Irenaeus states that Polycarp wrote many "letters to the neighbouring churches or to certain of the brethren" only one has been preserved, viz., the well-known letter to the Philippians. The epistle is largely involved in the Ignatian controversy (see IGNATIUS). The rehabilitation of the Ignatian letters in modern times has, however, practically destroyed the attack on the Epistles of Polycarp. The date of the epistle depends upon the date of the Ignatian letters and is now generally fixed between 112 and 118. The language in this letter is simple but powerful.

3. The Epistle of Ignatius to *Polycarp.*—This epistle has of course been subjected to the same criticism as has been directed against the other epistles of Ignatius (see IGNATIUS); the general criticism, may now be said to have been completely answered by the investigations of Zahn, Lightfoot and Harnack. Some modern scholars feel a difficulty about the peremptory tone which Ignatius adopts towards Polycarp. There was some force in this argument when the Ignatian Epistles were dated about 140, as in that case Polycarp would have been an old and venerable man at the time. But now that the date is put back to about 112 the difficulty vanishes, since Polycarp was not much over forty when he received the letter.

4. The Letter of the Church at Smyrna to the Philomelians is a most important document, because we derive from it all our information with regard to Polycarp's martyrdom. Eusebius has preserved the greater part of this epistle (iv. 15), but we possess it entire with various concluding observations in several Greek mss., and also in a Latin translation. The epistle gives a minute description of the persecution in Smyrna, of the last days of Polycarp and of his trial and martyrdom; and as it contains many instructive details and professes to have been written not long after the events to which it refers, it has always been regarded as one of the most precious remains of the 2nd century. Certain recent critics, however, have questioned the authenticity of the narrative. The more moderate school of modern critics—*e.g.*, Lightfoot (Ignatius and Polycarp, 1589 seq.), Harnack (Gesch. d. altchrist. Lit. II. i. 341), and Krüger (Early Christian Lit., 1897)—is unanimous in regarding it as an authentic document, though it recognizes that here and there a few slight interpolations have been inserted. Besides these we have no other sources for the life of Polycarp.

Life.—Polycarp must have been born not later than the year 69, for on the day of his death (c. 155) he declared that he had served the Lord for eighty-six years (*Martyrium,* 9). Irenaeus tells us that in early life Polycarp "had been taught by apostles and lived in familiar intercourse with many that had seen Christ" (iii. 3, 4).

This testimony is expanded in the remarkable words which Irenaeus addressed to Florinus:

"I saw thee when I was still a boy (παῖς ἔτι) in Lower Asia in company with Polycarp . . . I can even now point out the place where the blessed Polycarp used to sit when he discoursed, and describe his goings out and his comings in, his manner of life and his personal appearance and the discourses which he delivered to the people, how he used to speak of his intercourse with John and with the rest of those who had seen the Lord, and how he would relate their words. And everything that he had heard from them about the Lord, about His miracles and about His teaching, Polycarp used to tell us as one who had received it from those who had seen the Word of Life with their own eyes, and all this in perfect harmony with the Scriptures. To these things I used to listen at the time, through the mercy of God vouchsafed to me, noting them down, not on paper but in my heart, and constantly by the grace of God I brood over my accurate recollections."

These words establish a chain of tradition (John-Polycarp-Irenaeus) which is without a parallel in early church history. Polycarp thus becomes the living link between the Apostolic age and the great writers who flourished at the end of the 2nd century. Recent criticism, however, has endeavoured to destroy the force of the words of Irenaeus. Harnack *(Chronologie,* i., 325–329), for instance, attacks this link at both ends. *(a)* The connection of Irenaeus and Polycarp, he argues, is very weak, because Irenaeus was only a boy (παῖς) at the time, and his recollections therefore carry very little weight. The fact, too, that he never shows any signs of having been influenced by Polycarp and never once quotes his writings is a further proof that the relation between them was slight. (b) The connection which Irenaeus tries to establish between Polycarp and John the apostle is probably due to a blunder Irenaeus has confused John the apostle and John the presbyter. Polycarp was the disciple of the latter, not the former. In this second argument Harnack has the support of a considerable number of modern scholars who deny the Ephesian residence of John the apostle. But in spite of much modern criticism there seems to be no solid reason for rejecting the statements of Irenaeus and regarding Polycarp as the link between the Apostolic age and the first of the Catholic fathers.

Though Polycarp must have been bishop of Smyrna for nearly half a century we know next to nothing about his career. We get only an occasional glimpse of his activity, and the period between 115 and 155 is practically a blank. The only points of sure information which we possess relate to (1) his relations with Ignatius, (2) his protests against heresy, (3) his visit to Rome in the time of Anicetus, (4) his martyrdom.

His Relations with **Ignatius.**—Ignatius, while on his way to Rome to suffer martyrdom, halted at Smyrna and received a warm welcome from the church and its bishop. Upon reaching Troas he despatched two letters, one to the church at Smyrna, another addressed personally to Polycarp. In these letters Ignatius charged Polycarp to write to all the churches between Smyrna and Syria (since his hurried departure from Troas made it impossible for him to do so in person) urging them to send letters and delegates to the church at Antioch to congratulate it upon the cessation of the persecution and to establish it in the faith. The letters of Ignatius illustrate the commanding position which Polycarp had already attained in Asia. It was in the discharge of the task which had been laid upon him by Ignatius that Polycarp was brought into correspondence with the Philippians. The Church at Philippi wrote to Polycarp asking him to forward their letters to Antioch. Polycarp replied, promising to carry out their request and enclosing a number of the letters of Ignatius which he had in his possession.

Polycarp's Attack on Heresy.—All through his life Polycarp appears to have been an uncompromising opponent of heresy. We find him in his epistle (ch. vii.) uttering a strong protest against certain false teachers (probably the followers of Cerinthus).

For every one who shall not confess that Jesus Christ is come in the flesh is antichrist; and whosoever shall not confess the testimony of the Cross is of the devil; and whosoever shall pervert the oracles of the Lord to his own lusts and say that there is neither resurrection nor judgment, that man is the first-born of Satan. Wherefore let us forsake their vain doing and their false teaching and turn unto the word which was delivered unto us from the beginning.

Polycarp lived to see the rise of the Marcionite and Valentinian sects and vigorously opposed them. Irenaeus tells us that on one occasion Marcion endeavoured to establish relations with him and accosted him with the words, "Recognize us." But Polycarp displayed the same uncompromising attitude which his master John had shown towards Cerinthus and answered, "I recognize you as the first-born of Satan." The steady progress of the heretical movement in spite of all opposition was a cause of deep sorrow to Polycarp, so that in the last years of his life the words were constantly on his lips, "Oh good God, to what times hast thou spared me, that I must suffer such things!"

Polycarp's Visit to Rome.—It is one of the most interesting and important events in the church history of the 2nd century that Polycarp, shortly before his death, when he was considerably over eighty years old, undertook a journey to Rome in order to visit the bishop Anicetus. Irenaeus, to whom we are indebted for this information *(Haer.* iii. 3, 4; *Epist. ad victorent, ap.* Euseb. v. 24), gives as the reason for the journey the fact that differences existed between Asia and Rome "with regard to certain things" and especially about the time of the Easter festival. Unfortunately all he says is that with regard to the certain things the two bishops speedily came to an understanding, while as to the time of Easter, each adhered to his own custom, without breaking off communion with the other. We learn further that Anicetus as a mark of special honour allowed Polycarp to celebrate the Eucharist in the church, and that many Marcionites and Valentinians were converted by him during his stay in Rome.

Polycarp's Martyrdom.— Not many months apparently after Polycarp's return from Rome a persecution broke out in Asia. A great festival was in progress at Smyrna. The proconsul Statius Quadratus was present on the occasion, and the asiarch Philip of Tralles was presiding over the games. Eleven Christians had been brought, mostly from Philadelphia, to be put to death. The appetite of the populace was inflamed by the spectacle of their martyrdom. A cry was raised, "Away with the atheists. Let search be made for Polycarp." Polycarp took refuge in a country farm. His hiding-place, however, was betrayed and he was arrested and brought back into the city. Attempts were made by the officials to induce him to recant, but without effect. When he came into the theatre, the proconsul urged him to "revile Christ," and promised, if he would consent to abjure his faith, that he would set him at liberty. To this appeal Polycarp made the memorable answer, "Eighty and six years have I served Him and He hath done me no wrong. How then can I speak evil of my King who saved me?" These words only intensified the fury of the mob. They clamoured for a lion to be let loose upon him there and then. The asiarch, however, refused, urging as an excuse that the games were over. When they next demanded that their victim should be burned, the proconsul did not interfere. Timber and faggots were hastily collected and Polycarp was placed upon the pyre. With calm dignity and unflinching courage he met his fate and crowned a noble life with an heroic death.

Eusebius in his *Chronicon* gives A.D. 166 as the date of Polycarp's death, and until the year 1867 this statement was never questioned. In that year appeared Waddington's *Mémoire sur* la *chronologie de la vie du rhéteur Aelius Aristide,* in which it was shown from a most acute combination of circumstances that the Quadratus whose name is mentioned in the *Martyrium* was proconsul of Asia in 155–156, and that consequently Polycarp was martyred on Feb. 23, 155. Waddington's conclusion has received overwhelming support amongst recent critics. His views have been accepted by (amongst many others) Renan *(Antéchrist,* 1873, p. 207), Hilgenfeld *(Zeitschr. f. wiss. Theol.,* 1874, p. 325), Gebhardt *(Zeitschr. f. hist. Theol.,* 1875, p. 356), Lipsius *(Jahrb. f. prot. Theol.,* 1883, *p.* 525), Harnack *(Chronologie,* i. 334–356), Zahn *(Zeitschr. f. wiss. Theol.,* 1882, p. 227), Lightfoot *(Ignatius and Polycarp,* i. 629–702) and Randell *(Studia biblica,* 1885, i. 175). Against this array of scholars only the following names of Importance can be quoted in support of the traditional view—Keim *(Aus dem Urchristentum, p.* go), Wieseler *(Die Christenverfolgungen der Caesaren,* 1878, p. 34) and Uhlhorn *(Studia Biblica,* 1890, ii., 105–156). The problem is too complex to admit of treatment here. There seems to be little doubt that the case for the earlier date has been proved.

The significance of Polycarp in the history of the Church is out of all proportion to our knowledge of the facts of his career. The violent attack of the Smyrnaean mob is an eloquent tribute to his influence in Asia. "This is the teacher of Asia," they shouted, "this is the father of the Christians: this is the destroyer of our gods: this is the man who has taught so many no longer to sacrifice and no longer to pray to the gods." And after the execution they refused to deliver up his bones to the Christians for burial on the ground that "the Christians would now forsake the Crucified and worship Polycarp." Polycarp was indeed, as Polycrates says, "one of the great luminaries" (μεγάλα στοιχεῖα) of the time. It was in no small degree due to his staunch and unwavering leadership that the Church was saved from the peril of being overwhelmed by the rising tide of the pagan revival which swept over Asia during the first half of the 2nd century, and it was his unfaltering allegiance to the Apostolic faith that secured the defeat of the many forms of heresy which threatened to destroy the Church from within.

Polycarp had no creative genius. He was a "transmitter, not a maker." As Irenaeus says (iii. 3, 4), "Polycarp does not appear to have possessed qualifications for successfully conducting a controversial discussion with erroneous teachers . . . but he could not help feeling how unlike their speculations were to the doctrines which he had learned from the Apostles, and so he met with indignant reprobation their attempt to supersede Christ's gospel with fictions of their own devising." It is this that constitutes Polycarp's service to the Church, and no greater service has been rendered by any of its leaders in any age.

BIBLIOGRAPHY.—J. B. Lightfoot, *Apostolic Fathers,* pt. ii. (2nd ed., 1889). Polycarp is dealt with in i. 417–459, 530–704; ii. 897-1086; G. Volkmar, *Epistula Polycarpi Smyrnaei genuina* (Zürich, 1885); T. Zahn, *Forschungen zur Geschichte des Kanons, &c.*, iv. 249, 279; J. M. Cotterill, "The Epistle of Polycarp to the Philippians," *Journ. of Philol.* (1891), xix., 241–285; Harnack, *Chronologie der altchristlichen Litteratur* (1897), and authorities quoted in the text. *See* also APOSTOLIC FATHERS. (H. T. A.; X.)

POLYCHAETA, a class of segmented worms (Annelida, *q.v.*). The name refers to the numerous bristles present along the sides of most species. The class includes the common lug worm *(Arenicola)* and the sea-mouse *(Aphrodite).*

POLYCLEITUS, the name of two Greek sculptors of the school of Argos; the first belonging to the fifth century, the second to the early part of the fourth.

1. The elder and best known Polycleitus was a contemporary of Pheidias, and in the opinion of the Greeks his equal. Whether he was actually a pupil of Ageladas is disputed; at any rate he carried on the tradition. He made a figure of an Amazon for Ephesus which was regarded as superior to the Amazon of Pheidias made at the same time; and his colossal Hera of gold and ivory which stood in the temple near Argos was considered as worthy to rank with the Zeus of Pheidias. It would be hard for a modern critic to rate Polycleitus so high: the reason is that balance, rhythm and the minute perfection of bodily form, which were the great merits of this sculptor, do not appeal to us as they did to the Greeks of the 5th century. He worked mainly in bronze.

As regards his chronology we have data in a papyrus published by Grenfell and Hunt containing lists of athletic victors. From this it appears that he made a statue of Cyniscus, a victorious athlete of 464 or 460 B.C., of Pythocles (452) and Aristion (452). He thus can scarcely have been born as late as 480 B.C. His statue of Hera is dated by Pliny to 420 B.C. His artistic activity must thus have been long and prolific. His two great statues, ideal athletic types rather than portraits, are the Diadumonos and the Doryphorus, copies of both of which are common. The Doryphorus was known as the Canon, because it embodied the correct proportions of the ideal male form. The completest copy is from Pompeii, and there is a copy of the Diadumonos from Vaison in the British Museum. Both are late Roman copies, unpleasantly heavy and square and in marble, thus giving little idea of the finish of Polycleitus' work in bronze. This has been enforced by the discovery at Delos, by the French excavators, of a diadumenus of far more pleasing type and greater finish, which also goes back to Polycleitus. The excavations at Olympia have widened our knowledge of his early work. Among the bases of statues found on that site were three signed by Polycleitus, still bearing on their surface the marks of attachment of the feet of the statues. This at once gives us their pose; and following up the clue, A. Furtwängler has identified several extant statues as copies of figures of boy athletes victorious at Olympia set up by Polycleitus. Among these the Westmacott athlete in the British Museum is conspicuous.

The Amazon of Polycleitus survives in several copies, among the best of which is one in the British Museum. The masterpiece of Polycleitus, his Hera of gold and ivory, has of course totally disappeared. The coins of Argos give us only the general type. Waldstein has identified the head of a girl in the British Museum as belonging to this type.

The want of variety in the works of Polycleitus was brought as a reproach against him by ancient critics. Varro says that his statues were square and almost of one pattern. Except for the statue of Hera, which was the work of his old age, he produced scarcely any notable statue of a deity. His field was narrowly limited; but in that field he was unsurpassed.

2. The younger Polycleitus was of the same family as the elder, and the works of the two are not easily to be distinguished. Some existing bases, however, bearing the name are inscribed in characters of the 4th century, at which time the elder sculptor cannot have been alive.

See A. Furtwangler, *Masterpieces of Greek Sculpture* (Eng. trans. 1895); P. Paris, Polyclète (Paris, 1895); Mahler, *Polyklit und seine Schule* (Athens, 1902).

POLYCRATES, tyrant of Samos (c. 535–515 B.C.). Having won popularity by donations to poorer citizens, he took advantage of a festival of Hera, which was being celebrated outside the walls, to make himself master of the city (about 535 B.C.). After getting rid of his brothers Pantagnotus and Syloson, who had at first shared his power, he established a despotism which is of great importance in the history of the island. He equipped a fleet of 100 ships and so became master of the Aegean basin. This ascendancy he abused by numerous acts of piracy which made him notorious throughout Greece; but his real aim was the control of the archipelago and the mainland towns of Ionia. He maintained an alliance with Lygdamis of Naxos, and dedicated to Delos the island of Rheneia. He also defeated a coalition of two great naval powers of the Asiatic coast, Miletus and Lesbos. He made an alliance, probably commercial in object, with Amasis of Egypt. But the squadron he sent to Amasis' support against Cambyses of Persia, being composed of pclitical opponents of Polycrates, suspected treachery and returned and attacked Polycrates. After a defeat by sea, Polycrates repelled an assault upon the walls, and subsequently withstood a siege by a joint armament of Spartans and Corinthians assembled to aid the rebels. He maintained his ascendancy until about 515, when Oroetes, the Persian governor of Lydia, who had been reproached for his failure to reduce Samos by force, lured him to the mainland and put him to death by crucifixion.

Beside the political and commercial pre-eminence which he conferred upon Samos, Polycrates adorned the city with public works on a large scale. He was also a patron of letters; he collected a library, and Anacreon lived at his court.

POLYGALACEAE, a family of dicotyledonous herbs, shrubs and small trees, comprising ten genera and about 700 species, not represented in New Zealand, Polynesia and the Arctic zone, but otherwise cosmopolitan. Polygala *vulgaris* is the British milkwort (*q.v.*), and P. *Senega,* the Senega snake-root, a North American medicinal plant. In North America some 50 species are found, chiefly in the southern and western United States.

POLYGLOTT or **POLYGLOT,** a book which contains side by side versions of the same text in several languages (Gr. **πολύς,** many, and γλῶττα, tongue). The most important polyglotts are editions of the Bible, or its parts, in which the Hebrew and Greek originals are exhibited along with the great historical versions. The famous *Hexapla* of Origen, in which the Old Testament Scriptures were written in parallel columns, probably suggested the later polyglotts, but though it gives six texts it is itself only in two languages. In the 16th and 17th centuries polyglotts became a favourite means of advancing the knowledge of Eastern languages as well as the study of Scripture. The series began with the *Complutensian* printed by Arnaldus Guilielmus de Brocario at the expense of Cardinal Jimenez (*q.v.*) at the university at Alcalá de Henares (Complutum). This contained for the Old Testament the Hebrew text, Latin Vulgate and the Septuagint and Chaldee versions with Latin renderings; for the New Testament, the Greek and Vulgate Latin. The six volumes bear dates ranging from Jan. 10, 1514, to July 10, 1517, but the work did not receive the papal sanction till March 1520, and was apparently not issued till 1522, probably because of the Imperial privilege obtained by Erasmus for his Greek Testament in 1516. The *Antwerp* Polyglott, printed by Christopher Plantin (1569–72, in 8 vols. folio), under the patronage of Philip II. of Spain, added a new language to those of the *Complutensian* by including the Syriac New Testament. Next came Le Jay's Paris Polyglott (1645), which embraces the first printed texts of the Syriac Old Testament and of the Samaritan Pentateuch. It has also a series of various Arabic versions. The last great polyglott was that edited by Brian Walton, published in London in 1657. This is much less beautiful than Le Jay's, but includes the Syriac of Esther and of several apocryphal books, Persian versions of the Pentateuch and Gospels, and the Psalms and New Testament in Ethiopic. It was in connection with this polyglott that E. Castell produced his famous Heptaglott Lexicon (2 vols. folio, London, 1669). Of the numerous polyglott editions of parts of the Bible it may suffice to mention the Genoa psalter of 1j16, edited by Giustiniani, bishop of Nebbio. This is in Hebrew, Latin, Greek, Chaldee and Arabic, and is interesting from the character of the Chaldee text, being the first specimen of Western printing in the Arabic character. (A. W. P.)

POLYGNOTUS, famous Greek painter, *c.* 470–440 B.C., son of Aglaophon, was a native of Thasos, but was adopted by the Athenians, and admitted to their citizenship. He painted for them, in the time of Cimon, a picture of the taking of Ilium on the walls of the Stoa Poecile, and another of the marriage of the daughters of Leucippus in the Anaceum. In the hall at the entrance to the Acropolis other works of his were preserved; and he collaborated with Mikon in paintings of Greeks and Amazons in the Theseum. The most important, however, of his products were his frescoes in the Lesche erected at Delphi by the people of Cnidus. The subjects of these were the visit to Hades by Odysseus, and the taking of Ilium. Fortunately the traveller Pausanias has left us a careful description of these paintings, figure by figure (Paus. x. 25–31); and we may form some idea of their style from contemporary vase decorations. The foundations of the building have been recovered in the course of the French excavations at Delphi. From this evidence some modern archaeologists have tried to reconstruct the composition of the paintings. The figures were detached and seldom overlapping, ranged in two or three rows one above another; and the farther were not smaller nor dimmer than the nearer. We learn also that Polygnotus employed but few colours. His excellence lay in the beauty of his drawing of individual figures; but especially in the "ethical" and ideal character of his art. His work must have had the same grandeur as the contemporary sculptures of Olympia, combined apparently with a new delicacy; for he is praised for his transparent garments, his head-dresses of variegated colours, and his speaking expressions. He was the great representative of Greek painting of the fifth century B.C., as Pheidias was of sculpture.

POLYGONACEAE, in botany, a family of dicotyledons, containing 40 genera with about 750–800 species, chiefly in the north temperate zone, and represented in Great Britain by three genera, Polygonum, *Rumex* (dock, *q.v.*) and Oxyria. They are mostly herbs characterized by the union of the stipules into a sheath or ocrea, which protects the younger leaves in the bud stage. Some are climbers, as, for instance, the British *Polygonum convolvulus* (black bindweed). In *Muehlenbeckia platyclada,* a native of the Solomon islands, the stem and branches are flattened, forming ribbon-like cladodes jointed at the nodes. The leaves are alternate, simple and generally entire; the edges are rolled back in the bud. They are generally smooth, but sometimes, especially in mountain species, woolly. The small regular, generally hermaphrodite flowers are borne in large numbers in compound inflorescences, the branches of which are cymose. The parts of the flower are whorled (cyclic) or acyclic. The former arrangement may be derived from a regular trimerous flower with two whorls of perianth leaves, two staminal whorls and a three-sided ovary—this type of flower occurs in the Californian genus Pterostegia. The flower of rhubarb (Rhsum) is derived from this by doubling in the outer staminal whorl and that of the dock (*Rumex*) by doubling in the outer staminal whorl and suppression of the inner whorl. Dimerous whorled flowers occur in Oxyria (mountain sorrel), another arctic and alpine genus, the flowers of which otherwise resemble those of *Rumex.* In the acyclic flowers a pentamerous perianth is followed by five to eight stamens as in Polygonum. The perianth leaves are generally uniform and green, white or red in colour. They are free or more or less united, and persist till the fruit is ripe, often playing a part in its distribution, and affording useful characters for distinguishing genera or species. Thus in the docks the three inner leaves enlarge and envelop the fruit as three membranous wings one or more of which bear on the back large fleshy warts. The number of the carpels is indicated by the three-sided (in dimerous flowers two-sided) ovary, and the number of the styles; the ovary is unilocular and contains a single erect ovule springing from the top of the floral axis. The fruit is a dry one-seeded nut, two-sided in bicarpellary flowers, as in Oxyria. The straight or curved embryo is embedded in a mealy endosperm. The flowers are wind-pollinated, as in the docks (*Rumex*), where they are pendulous on long slender stalks and have large hairy stigmas; or insect-pollinated, as in Polygonum or rhubarb (Rheum), where the stigmas are capitate and honey is secreted by glands near the base of the stamens. Insect-pollinated flowers are rendered conspicuous chiefly by their aggregation in large numbers, as for instance in bistort (Polygonum bistortu), where the perianth is red and the flowers are crowded in a spike. In buckwheat (*q.v.,* P. *fagopyrum*) the numerous flowers have a white or red perianth and are perfumed; they are dimorphic, *i.e.,* there are two forms of flowers, one with long styles and short stamens, the other with short styles and long stamens. In other cases self-pollination is the rule, as in knotgrass (P. *aviculare*), where the very small, solitary odourless flowers are very rarely visited by insects and pollinate themselves by the incurving of the three inner stamens on to the styles.

Polygonaceae is mainly a north temperate order. A few genera are tropical, *e.g.,* Coccoloba, which has 125 species restricted to tropical and sub-tropical America. *Polygonum* has a very wide distribution spreading from the limits of vegetation in the north ern hemisphere to the mountains of tropical Africa and South Africa, through the highlands of tropical Asia to Australia, and in America as far south as Chile. Most of the genera have, however, a limited distribution. In the British Isles, Polygonum has 14 species; *Rumex* (12 species) includes the various species of dock (*q.v.*) and sorrel (R. Acetosa); and *Oxyria* digyna, an alpine plant (mountain sorrel), takes its generic name (Gr. ὀξύς, sharp) from the acidity of its leaves. Rheum (rhubarb, *q.v.*) is central Asiatic.

In the United States the largest genus is Eriogonum, containing about 200 species, all natives of America, and most of them in the western United States. The other prominent genera occurring in America are *Rumex* (docks), and *Polygonum* (knotweeds). *Fagopyrum* (buckwheat) and *Rheum* (rhubarb or pie-plant) also are abundant but they are natives of the old aorld. The Mexican genus *Antigonon* is cultivated in the scuth as an ornamental.

POLYGONAL AND POLYHEDRAL NUMBERS: see FIGURATE NUMBERS.

POLYGONS. A polygonal *line,* also called a broken line, joining the point A_1 to the point An is any finite set of points A_1, A_2, . . . , A, and the segments A_1A_2, A_2A_3, . . . , $A_{n-1}A_n$. In this and the following definition of a polygon the phrase "a point A_i" means a point associated with the symbol A_i and the phrase "a segment A_iA_j" means the segment, whose ends are the points which are the associates of the symbols A, and A_j respectively, associated with the symbol A_iA_j. A segment is the set of all points of any (straight) line which are between any two points of that line. Each of the latter points is called an *end* of the segment. A polygon is any finite set of points A_1A_2, . . . , A, and the segments A_1A_2, A_2A_3 . . . , A_{n-1} A_n, A_nA_1. The points A_i and segments A_iA_{i+1}, A_nA_1, $i=1, 2, \ldots,$ n, are called respectively the vertices and sides of the polygon; similarly for a polygonal line.

The terms polygonal line and polygon are used also with meanings which are different from, although closely related to, those given above. A polygon as defined may have one of two senses assigned to it so that the first end and the second end of each side is specified in such a way that the vertex A_i is either the first end of the side A_iA_{i-1} and the last end of the side $A_{i-1}A_i$ if $i=1$, and A_nA_1 if $i=1$, or vice versa. A polygon with such an assignment of a sense is called an oriented or a sensed polygon. In an obvious way an oriented polygonal line is defined. Thus two sensed polygons or polygonal lines are associated with each polygon or polygonal line. In the sequel the phrase the oriented (or sensed) side AB of a sensed polygon indicates that A is the first end of the oriented side AB of that oriented polygon, and B the second. Polygonal lines and polygons according to the first definition are referred to as unoriented or *unsensed* polygonal lines and polygons respectively. In formulating a third meaning of the terms polygonal line and polygon it should be emphasized that the elements involved in the above definition are points and segments associated with symbols so that an unoriented or oriented polygon is neither a set of points and segments nor a set of points. The word polygon also is used to signify either certain sets of points and segments or certain set of points. The distinctions just pointed out although delicate are logically essential and even practically important. For the purpose of this article the single word "polygon" denotes any set of points which consists of the points which are the associates of the symbols $A_1, A_2, \ldots, A_n$ and the points which belong to the segments which are the associates of the symbols A_iA_{i+1}, $i=1, 2, \ldots, n$ and A_nA_1 of the first definition; *i.e.,* the definition of an unsensed polygon. Similarly in the case of a polygonal line.

The above definitions are of broad scope and define abstractions which are based on the phenomenon of the motion of a particle from point to point along intermediate rectilinear stretches. Important specializations of these ideas are the so-called simple polygons or polygonal lines according to any of the definitions given. A simple unoriented polygon is any unoriented polygon which is such that none of its vertices is an end of more than two of its sides and no side of the unoriented polygon contains a vertex or a point which belongs to another side of the unoriented polygon. The definitions of simple unoriented polygonal lines, simple oriented polygonal lines and polygons as well as those of simple polygons and polygonal lines in conformity with the third definition are apparent and consequently are not stated formally. Alternative definitions for the several concepts defined or indicated above may be given; for example a simple polygon may be defined as a finite set of points and segments such that (a) every point of the set is the end of two and only two segments of the set, (b) each end of every segment of the set is a point of the set, (c) no segment of the set contains a point of the set or a point of another segment of the set and (d) no (proper) subset of the given set satisfies (a), (b) and (c). It is easy to show that this definition is equivalent to the one indicated in introducing the third formulation of the idea of a polygon and it is valuable in that it admits of immediate generalization to the idea of a polyhedron in space.

Place of Polygons in Mathematics. — The theory of polygons as a special chapter in mathematics is chiefly concerned with the classification of unoriented and oriented polygons all of whose elements, — that is, vertices and sides, — are in the same plane. The corresponding question for space concerns polyhedrons and is taken up in the article on **SOLIDS, GEOMETRIC.** Polygons whose elements are not in one plane have not as yet formed the subject of any interesting theory. Such polygons, as well as plane polygons, however, serve as important aids, as in the study of continuous curves in general. This is largely because of the fact that any continuous arc contains the vertices of a polygonal line, the length of whose sides are all less than any preassigned positive number, and which is simple if the arc is simple. In particular, the length of an arc of a curve is defined by means of the lengths of the inscribed polygonal lines, — that is, polygonal lines which join the ends of the arc and whose vertices are on the arc and have an order which conforms to one of the two senses along the arc. In the geometry of the Euclidean plane, plane polygons, — that is, those having all of their points in one plane, — take on an added significance because of the fact that the Euclidean plane is separated into two regions by any simple polygon that is contained in it. This is a consequence of the basic fact that a line separates the Euclidean plane. Unless it is stated otherwise it is understood that in the following all configurations are in the Euclidean plane. A region is a set of points such that any point of the set is the centre of a circle which has only points of the set in its interior and such that the set is not composed of two sets having the latter property and also having no points in common. It follows easily that any two points of a region are joined by a simple polygonal line which is contained in the region. A precise statement of the important fact mentioned above is that if P is any simple plane polygon, then the plane is composed of P and two regions which have no points in common with each other or with P. One of these regions is of infinite extent and the other is not. A region such as the latter is referred to as a polygonal region and also as the interior of the polygon concerned and the latter is called the boundary of the polygonal region. Every circle which has a point of the boundary of the polygonal region as centre contains points of the region and any point which is such that any circle having it as centre contains points which belong to the region and also points which do not is a point of the boundary of the region. This property of the boundary of any polygonal region is used as the defining property of the boundary of a region in general. As a further consequence should be mentioned the fact that any polygonal region plus its boundary is composed of a finite number of triangles and their interiors, which have no points in common, and the vertices of the triangles are vertices of the bounding polygon. A region which is not a polygonal region is, however, approximated to by polygonal regions according to the following theorem: If Σ is any region, then there exists a sequence of polygonal regions $\Sigma_1, \Sigma_2, \Sigma_3, \cdots, \Sigma_n, \cdots$ such that (a) Σ_n and its boundary is contained in Σ and also in Σ_{n+1} for all (positive integral) values of n and (b) each point of Σ is contained in all but a finite number of the polygonal regions Σ_n. This theorem is easily proved by using as the polygonal regions regions which are composed of congruent squares which are formed by two sets of parallel lines, the lines of each set being equally spaced and intersecting orthogonally those of the other set. These acts indicate the importance of polygonal lines and polygons in the study of more general configurations.

THE THEORY OF PLANE POLYGONS

The Interior, Exterior and Peripheral Angles of a Plane Polygon. — We now proceed to the special theory of plane polygons. As remarked above, this theory concerns itself largely with unoriented and oriented polygons. In the case of a simple polygon the meaning of "an interior angle of a polygon" is immediate in virtue of the theorem concerning the separation of the plane by the polygon. This meaning leads to an interesting generalization in the case of an oriented polygon. In proceeding to this generalization and to related ideas it should be stated that all of the terms used are not defined with the mathematical completeness that would be possible with a greater allowance of space, but it has been aimed at least to indicate clearly the way to that completeness. Now it can be proved that if P is a simple oriented polygon and A any vertex of P then for the positive (counterclockwise) rotation of any side AB of P about its first end A, in accordance with the sense of P, which transforms the side AB into the other side of P having A as an end and which has a magnitude not exceeding 2π radians, then the points on the intermediate positions of AB which are within a certain distance of A are all in the interior of the polygon determined by P if the sense of P is the same as that of the rotation and all in the exterior in the contrary case. (Note that senses of oriented polygons are compared only in the case of simple oriented polygons.) Accordingly the interior angle at any vertex A_i of any oriented polygon P is defined as the positive angle (rotation) which has A_i as its vertex and whose initial side contains the side of P which has A_i

as its first end, say the side A_iA_{i+1}, whose terminal side contains the side with the ends A_i and A_{i-1}, if $i \neq 1$, and A_n if $i=1$, and whose magnitude does not exceed 2π. (See fig. 1.)

Further if A_i is any vertex of an oriented polygon P and the first end of the oriented side A_iA_{i+1} of P then there is a rotation about A_i of the half-line having A_i as its initial point and having the same direction as the oriented side $A_{i-1}A_i$ $(i-1 \equiv n$ if $i=1)$, that is the half-line of the line through A_{i-1} and Ai, which has A_i as its initial point and which does not contain A_{i-1}, into the half-line which contains the side A_iA_{i+1} which has a magnitude greater than $-\pi$ and less than or equal to π and there is another such rotation which is positive and has a magnitude not exceeding 2π. The former angle (rotation) is called the exterior angle and the latter the peripheral *angle* of the oriented polygon P at the vertex A_i. If α_i, β_i, γ_i are respectively the magnitudes of the interior, exterior and peripheral angles of the oriented polygon P at the vertex A_i then $\alpha_i+\beta_i=\pi$ and $\alpha_i+\gamma_i=\pi$ or 3π according as α_i is or is not less than π. If α_i is less than π then γ_i is and conversely. If the sum of all the β_i is set equal to $2a\pi$ and the sum of all the γ_i to $2a'\pi$ then a and a' are integers or zero as a simple consideration shows and $a'-a$ is the number of interior angles of P whose magnitudes are greater than or equal to π. If P' and P'' are two oriented polygons which differ only in orientation and if α_i', β_i', γ_i' and α_i'', β_i'', γ_i'' are respectively the magnitudes of the interior, exterior and peripheral angles of P' and P'' at the vertex A_i then $\alpha_i'+\alpha_i''=2\pi$, $\beta_i'+\beta_i''=0$ and $\gamma_i'+\gamma_i''=2\pi$. Hence the value of a for P'' is the negative of its value for P' while the value of a' for P'' is the number of vertices of P' (or P'') minus the value of a' for P'.

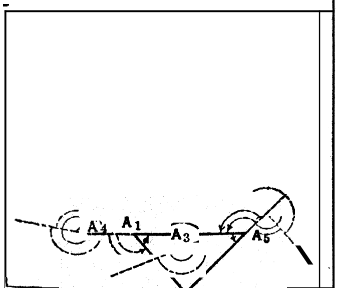


FIG. 1.—CONTINUOUS DEFORMATION OF AN ORIENTED POLYGON. WITH FIVE VERTICES

Classification of Plane Polygons.—In the classification of oriented polygons the numbers a and a' have been used to define the so-called types of such polygons. It is obvious how they may be used in the classification of unoriented polygons. There exist oriented polygons of any number n of vertices for which the value of a is any number whose absolute value does not exceed $\frac{1}{2}(n-1)$ except that for a triangle a cannot be zero. A more detailed scheme of classification is according to the values of a and $q=a'-a$. If all of the interior angles of an oriented polygon have magnitudes which do not exceed π then the polygon is called a convex oriented polygon. The unoriented polygon P is convex if and only if P with a sense assigned to it is convex. Both of these definitions are in conformity with the important notions of a convex simple polygon and a convex *polygonal* region. A convex region is a region such that all of the points of any segment whose ends belong to the region belong to the region also. A simple polygon is said to be convex if it is the boundary of a convex region, which is then a convex polygonal region. As theorems we have: A line which does not contain a side of a convex simple polygon contains not more than two points of the polygon and conversely. Also, no point of a convex simple polygon is on a particular one of the two sides of the line which contains any side of the polygon and conversely.

Another method of classification of unoriented and oriented polygons uses the notion of the continuous deformation of such polygons. Any one of two unoriented polygons with the vertices $A_1, A_2, \ldots, A_n$ and $B_1, B_2, \ldots, B_n$ respectively is deformable continuously into the other so that the vertex A_i corresponds to the vertex B_i and the side A_iA_{i+1} to the side B_iB_{i+1}. To obtain subclasses of unoriented polygons continuous deformations of such polygons, which satisfy any or all of the following conditions, are used: (1) no intermediate polygon of the deformation has two consecutive sides which lie in the same line and which have no points in common; (2) neither of two consecutive sides of any intermediate polygon of the deformation is contained in the other; and (3) no point is common to more than two sides of any intermediate polygon of the deformation. In the case of oriented polygons it is also required that sense be preserved by the deformation. Two oriented polygons that are transformable one into the other by a continuous deformation satisfying the first condition have the same value for a. If instead of the first condition the second is satisfied the oriented polygons have the same value for a'. If the deformation satisfies both the first and second conditions then the two oriented polygons are related so that if the magnitudes of one of two corresponding interior angles is less than π then the same is true of the other. Corresponding results for unoriented polygons follow easily. An interesting classification of unoriented polygons which satisfy the conditions on the intermediate polygons of the deformations satisfying all three conditions and which, in addition, have no vertex as the end of more than two sides and no side containing a vertex or a point belonging to more than two sides is that in which any unoriented polygon in one class is deformable into any other or into the symmetric image of any other in that class by a continuous deformation satisfying all three of the above conditions. For unoriented polygons of 4, 5 and 6 vertices there are respectively 3, 11 and 70 classes under this classification.

Non-metrical and Metrical Theories. Regular Polygons. Area of Polygons.—It should be pointed out that the above theory of the classification of unoriented and oriented polygons holds without essential modification in a more general plane than the Euclidean for only the order relations of the Euclidean plane are essential. Between this theory and the corresponding theory in the projective plane there are, because of the different kinds of linear order, some essential differences, but both theories are non-metrical. By making use of the metric properties of the Euclidean plane the consideration of regular polygons, oriented or not, becomes possible; also the question of the area of polygonal regions arises. An unoriented polygon is regular if any side is congruent to any other side and any angle of the polygon, *i.e.*, the figure consisting of a vertex and the two consecutive sides having that vertex as an end, congruent to any other "angle" of the polygon. The regular polygons are convex and there exists a circle circumscribed about and another inscribed in every regular polygon. Those regular polygons that are not simple also are called star polygons. If n points which are equally spaced on the circumference of a circle and numbered in order along that circumference are joined by segments so that the i-th point is joined to the $(i+d)$-th point, where d is a fixed positive integer, then the polygon resulting is a regular polygon for which the value of a, defined above, is d. Thus the number of "types" of regular polygons of n vertices is half of the number of positive integers which are less than and prime to n. Other kinds of regular polygons have been studied with particular reference to their classification along the lines explained above. For instance, there are the polygons which have the property that the figure composed of any vertex and the two sides of the polygon which have that vertex as an end is congruent to any other such figure and also the polygons which are such that the figure consisting of any side and two adjacent angles of the polygon is congruent to any other such figure. These polygons have an even number of vertices and a circle is circumscribable about any of those of the former kind and inscribable in any of those of the latter.

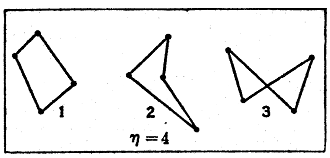


FIG. 2.— DEFORMATION OF A POLYGON OF FOUR VERTICES INTO THREE TYPES

Assuming the fact that the area of any plane simple polygon or rather polygonal region is the sum of the areas of the triangles of any finite set of triangles which have no interior points in common and which are such that every point of the polygonal region belongs to a triangle of the set or to the interior of one and every point of any triangle of the set or of the interior of any belongs to the polygonal region or its boundary the notion of the area of any plane unoriented or oriented polygon is approached. In the case of an unoriented or oriented polygon in general there is no region uniquely determined as in the case of simple polygons. In the following only the case of oriented polygons is considered for that essentially covers the case of unoriented polygons. If the area of a triangle according to the usual meaning is a then the area of that triangle with a sense assigned to it is defined as a or $-a$ according as that sense is positive or negative, *i.e.*, the same or not the same as the counterclockwise sense along the circumference of a circle. Using the symbol $A_1A_2 \dots A_n$ to denote

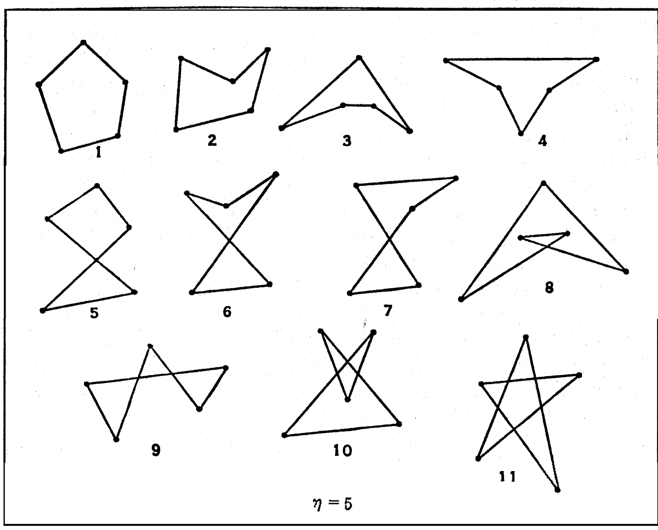


FIG 3 — DEFORMATION OF A POLYGON OF FIVE VERTICES INTO ELEVEN DIFFERENT TYPES

the oriented polygon with the vertices $A_1, A_2, \dots, A_n$ and the sensed sides A_iA_{i+1}, the area of the oriented polygon $A_1A_2 \dots A_n$ is defined as the sum of the areas of the oriented triangles $OA_1A_2, OA_2A_3, \dots, OA_nA_1$ where O is any point of the plane. It is, of course, proved that the value of the area thus defined does not depend on the position of O and that if $A_1A_2 \dots A_n$ is simple, this definition agrees with the area of a simple polygon according to the fundamental definition. An oriented polygon P determines a finite number of polygonal regions in its plane which have no points in common and whose boundaries are composed of points belonging to P. One and only one of these regions is of infinite extent. Now the following interesting facts pertain: Let the regions, or cells, of finite extent be denoted respectively by $S_1, S_2, \dots, S_k$, and let the area of the cell S_i according to the fundamental definition of the area of a polygonal region be σ_i so that σ_i is a positive number; then there exists a set of numbers $c_1, c_2, \dots, c_k$ which are either integers or zero such that the area of the oriented polygon P is $c_1\sigma_1+c_2\sigma_2+ \dots +c_k\sigma_k$. Further, c_i is the number of complete positive revolutions minus the number of complete negative revolutions made by the radius vector, having any point O of S_i as its initial point, as its terminal point describes once the oriented polygon P in the assigned sense. c_i is called the coefficient of the cell S_i.

BIBLIOGRAPHY.—M. Brückner, Vielecke und *Vielflache* (Leipzig, 1900); H. G. Forder, The Foundations of Euclidean Geometry, ch. 10, 11 (London, 1927); E. Steinitz, Encyklopaedie der *mathematische Wissenschaften*, Bd. iii., heft 9 (Leipzig, 1922); O. Veblen and J. W. Young, Projective Geometry, vol. ii., ch. ix. (New York, 1918); C. Wiener, *Über* Vielecke und *Vielflache* (Leipzig, 1864). (G. A. P.)

POLYGYNY, the system under which a man is married to several women at the same time (Gr. πολύς, many, and γυνή, woman), popularly called polygamy (γάμος, marriage), which derivatively also includes the practice of polyandry. Polygyny is nowhere the exclusive form of marriage, and among most peoples who practise it the large majority of men live in monogamy. It may be modified in a monogamous direction both from the social and the sexual point of view. Very frequently one of the wives, generally the one first married, holds a higher position than the rest or is regarded as the principal wife. In some cases this position implies certain sexual privileges; but more often we are told that it is the custom for the husband to cohabit with wives in turn, or that this is actually required of him. Another matter is how far theory and practice coincide. We have reason to suspect that one of the wives is for a time the favourite.

Lower Culture Groups.—Among the uncivilised races polygyny does not seem to be practised on a large scale by any of the lower hunters and food-collectors, except some Australian and Bushman tribes, nor by any incipient agriculturists, at least among those of the lower type. On the other hand, a considerable number of these low hunting and slightly agricultural tribes—such as some of the South American Indians, the aboriginal tribes of the Malay Peninsula, most of the Andaman islanders, the Veddas of Ceylon, certain tribes in the Malay archipelago, most of the Negritos of the Philippine islands, and some at least of the Central African Pygmies—are represented as strictly monogamous. Among the higher hunters polygyny is more frequent, although in the majority of their tribes it is practised only occasionally; and exclusive monogamy is very rare, though perhaps not unknown. Among pastoral peoples there seems to be no one who can be regarded as strictly monogamous; and both among them and the higher agriculturists polygyny is undoubtedly more frequent than among the hunters and incipient agriculturists, although cases of regular monogamy are more frequent among the higher agriculturists than among the higher hunters. The cases in which polygyny is represented as "general" are comparatively much more numerous among African than among non-African pastoral peoples and higher agriculturists. Polygyny is at its height in Africa, both in point of frequency and in number of wives. King Mtēssa of Uganda and the king of Loango are said to have had 7,000 wives. This is apparently the high-water mark of polygyny anywhere.

Archaic Civilizations.— Polygyny, or a sort of concubinage hardly distinguishable from genuine polygyny, is found among most peoples of archaic civilization. In China there are, or have been, besides the legal principal wife, so-called wives "by courtesy" or lawful concubines. In Japan concubinage of the Chinese type existed as a legal institution until 1880. In ancient Egypt polygyny seems to have been permitted but to have been unusual, except in the case of kings. The Babylonian Code of Ḫammurabi assumes that marriage shall be monogamous; yet "if a man has married a wife and a sickness has seized her," he may take a second wife; and if she remained childless he might take a concubine. Among the Hebrews a man could in any circumstances have a plurality of wives, and there was no difference in the legal status of different wives, nor was there any limit to the number of wives a man might take. In Arabia Mohammed ordained that a man's legal wives should be not more than four. Polygyny has been permitted among many of the Indo-European peoples—among ancient Slavs and Teutons, the ancient Irish and the Vedic Indians—though it seems to have been as a rule confined to kings or chiefs or nobles. None of the Hindu law-books restricts the number of wives a man is allowed to marry; yet some preference is often shown for monogamy, and at the present day most castes object to their members having more than one wife, except for some cogent reason. On the other hand, there can be little doubt that monogamy was the only recognized form of marriage in Greece; concubinage existed in Athens, but it was well distinguished from marriage, conferring no rights on the concubine. Roman marriage was strictly monogamous; liaisons between married men and mistresses were not uncommon by the close of the Republic, but such a relation was not considered lawful concubinage in after-time.

Christian and Modern Times.—Polygyny has been found even in Christian Europe. No obstacle was put in the way of its practice by kings in countries where it had occurred in the times of paganism. In the middle of the 6th century Diarmait, king of Ireland, had two queens and two concubines. Polygyny was frequently practised by the Merovingian kings. Charlemagne had two wives and many concubines; and one of his laws seems to imply that polygyny was not unknown even among priests. In later times Philip of Hesse and Frederick William II. of Prussia contracted bigamous marriages with the sanction of the Lutheran clergy. In 1650, soon after the Peace of Westphalia, when the population had been greatly reduced by the Thirty Years' War, the Frankish *Kreistag* at Nuremberg passed the resolution that thenceforth every man should be allowed to marry two women. The Anabaptists and the Mormons have advocated polygyny with much religious fervour.

Causes.—One cause of polygyny is an excess of marriageable women; we may safely say that whenever there is a marked and more or less permanent majority of women in a savage tribe polygyny is allowed But while the existence of available women makes polygyny possible, the direct cause of it is generally the man's desire to have more than one wife. There are various reasons for this desire. Among many of the simpler peoples the husband has to abstain from his wife not only for a certain time every month, but during her pregnancy, or at least during the latter stage of it, and after child-birth until the child is weaned, which often means an abstinence lasting for a couple of years or more. Other causes of polygyny are the attraction which female youth and beauty exercise upon the men, the latter's taste for variety, their desire for offspring—which is one of the principal causes of polygyny in the East—and the fact that polygyny contributes to a man's material comfort or increases his wealth, and thereby also his social importance and authority, through the labour of his wives. The usefulness of wives as labourers partly accounts for the increasing practice of polygyny at the higher grades of economic culture. But it should also be noticed that economic progress leads to a more unequal distribution of wealth, and this, combined with the necessity of paying a bride price the amount of which is more or less influenced by the economic conditions, makes it possible for certain men to acquire several wives while others can acquire none at all.

BIBLIOGRAPHY—L. T. Hobhouse, G. C. Wheeler, and M. Ginsberg, The Material Culture and Social Institutions of the *Simpler* Peoples (1915); Nobushige Hozumi, Ancestor-Worshtp and Japanese Law (1913); K. v. Amira, "Recht," in H. Paul's Grundriss der germanisclzen *Philologie,* vol. iii. (1900); P. W. Joyce, *A Social* Hzstory of Ireland, vol. ii. (1903); J. Jolly, *Recht* und Sitte (1896); L. Beauchet, *Histoire* du droit *privé* de *la République Athénienne,* vol. i. (1897); Th. Mommsen, *Römisches* Strafrecht (1899); E. Westermarck, The History of Human Marriage, vol. iii. (1921); R. Briffault, The Mothers, vol. ii. (1927). (E. W.)

POLYHEDRON: see SOLIDS, GEOMETRIC.

POLYMERIZATION, in chemistry, is the process whereby two or more atoms or molecules of the same substance unite to give a more complex molecule; the resulting "polymeride" therefore has the same percentage composition as the original substance, but a molecular weight which is 2, 3 or 4, etc., times as great. This is the sense in which the term was originally used (see the articles ISOMERISM and ASSOCIATION). But there is a tendency to restrict its use to cases in which the chemical and physical properties of the substance are altered in the process, the term association being conveniently applied to cases in which it has not hitherto been possible to distinguish clearly between the properties of the simple and the more complex substance. Moreover, once a substance has polymerized it is not readily reconverted to the simpler compound, whereas in association the two are in a constant state of change into one another, *i.e.,* they are in equilibrium. Water (*q.v.*) is undoubtedly a mixture of (probably) H_2O, $(H_2O)_2$, and $(H_2O)_3$ molecules which have not yet been obtained as separate liquids; it is therefore said to be associated. On the other hand when acetylene gas, C_2H_2, is passed through a red-hot tube, some of it is polymerized into liquid benzene, C_6H_6; or when the volatile, mobile liquid isoprene, C_5H_8, is warmed, or even kept for a short time, it polymerizes first to dipentene, $C_{10}H_{16}$, and then to a rubber-like substance, $(C_5H_8)_n$, of very high molecular weight (see TERPENES). In these two cases the properties of the polymerides are very different from those of the original substances, and separation of the two is easy. It should be emphasized, however, that there is no very clear line of demarcation between association and polymerization, and the distinction is chiefly one of convenience.

Cases of polymerization among inorganic substances are dealt with under the heading of ASSOCIATION, since it is only in a few cases, such as sulphur and phosphorus, that different polymerides, *e.g.,* S_4, S_6 and S_8, can be identified and shown to have different properties (*see* ALLOTROPY). The following examples are therefore restricted to organic compounds.

Formaldehyde (*q.v.*), CH_2O, a gas which is usually sold as a 40% aqueous solution ("formalin"), polymerizes to paraformaldehyde, probably $(CH_2O)_2$, when the solution is concentrated. When this is carefully heated it gives rise to trioxymethylene, $(CH_2O)_3$, a white crystalline solid which is also formed spontaneously and rapidly by anhydrous liquid formaldehyde when kept below its boiling point ($-21°$ C). Further, when formalin is kept with milk of lime at the ordinary temperature, it gradually changes to "formose," "methylenitan," or "a-acrose," a complex mixture of sugars of the formula $C_6H_{12}O_6$ or $(CH_2O)_6$. Acetaldehyde (*q.v.*), $CH_3{\cdot}CHO$, also gives rise to a number of polymerides, *e.g.,* (1) aldol, $CH_3{\cdot}CH(OH){\cdot}CH_2{\cdot}CHO$, which is produced by the action of dilute hydrochloric acid or of zinc chloride at the ordinary temperature, (2) paraldehyde, $(C_2H_4O)_3$, formed by the addition of one drop of concentrated sulphuric acid; it has a much higher boiling point than acetaldehyde (124° C as compared with 21° C), and is used as a soporific, (3) metaldehyde, also $(C_2H_4O)_3$, produced by the action of acids at low temperature, a crystalline solid which sublimes unchanged but is reconverted to acetaldehyde on long heating. *Acrolein,*

$$CH_2{:}CH{\cdot}CHO,$$

a volatile liquid, polymerizes slowly to disacryl, a white amorphous mass; or when warmed with alkalis it gives metacrolein, $(C_3H_4O)_3$, a solid melting at 45° C which is of use in the manufacture of synthetic resins (*q.v.*).

Cyanic acid, cyanamide and their derivatives furnish examples of ready and complex polymerization. The acid is $N{\vdots}C{\cdot}OH$ (or $HN{:}CO$), isomeric with fulminic acid ($C{:}N{\cdot}OH$); at ordinary temperatures its aqueous solutions rapidly give cyamelide, a white, porcelain-like insoluble mass. The esters of cyanic acid are unknown, but the isomeric isocyanic esters, *e.g.,* $CH_3{\cdot}N{:}C{:}O$, rapidly polymerize to isocyanuric esters

$$CO\left\langle\begin{matrix}N(CH_3)\cdot CO\\ N(CH_3)\cdot CO\end{matrix}\right\rangle N\cdot CH_3.$$

Cyanuric acid on distillation gives cyanic acid,

$$\begin{matrix} & N{=}C{\cdot}OH & \\ HO{\cdot}C & & N \\ & N{-}C{\cdot}OH & \end{matrix} \rightarrow 3N{\vdots}C{\cdot}OH,$$

and was the first polymeride to be investigated (Wohler). Cyanuric chloride is formed when cyanogen chloride is kept in a sealed tube: $3ClCN \rightarrow \begin{matrix}CCl{=}N{-}CCl\\ | \qquad\quad \|\\ N{=}CCl{-}N\end{matrix}$. Cyanamide, $CN{\cdot}NH_2$ or $NH{:}C{:}NH$, is converted into dicyandiamide, $HN{:}C\left\langle\begin{matrix}NH_2\\ NH{\cdot}CN\end{matrix}\right.$ on standing or on evaporation of its aqueous solution; either of these gives tricyantriamide, or melamine, $\begin{matrix} & N{=}C{\cdot}NH_2 & \\ NH_2{\cdot}C & & N \\ & N{-}C{\cdot}NH_2 & \end{matrix}$, on heating at 150° C. Further, just as acetylene gives benzene, so bromoacetylene, $CH{\vdots}CBr$, gives tribromobenzene, $C_6H_3Br_3$, but even more readily, since the change in this case occurs at the ordinary temperature. Many of the higher olefines (see CHEMISTRY, ORGANIC: Aliphatic *Division*) polymerize readily under the influence of dilute acids; thus *iso*amylene, C_5H_{10}, gives di- and tri-isoamylenes, $C_{10}H_{20}$ and $C_{15}H_{30}$. Esters of cinnamic acid slowly polymerize on keeping, but more rapidly in sunlight, to truxillic and truxinic esters:

$$2C_6H_5{\cdot}CH{:}CH{\cdot}CO_2Et \rightarrow \begin{matrix}C_6H_5{\cdot}CH{-}CH{\cdot}CO_2Et\\ | \qquad |\\ EtO_2C{\cdot}CH{-}CH{\cdot}C_6H_5\end{matrix} \text{ or } \begin{matrix}C_6H_5{\cdot}C{-}CH{\cdot}CO_2Et\\ | \qquad |\\ C_6H_5{\cdot}C{-}CH{\cdot}CO_2Et\end{matrix}$$

The foregoing examples illustrate the great variety of possibilities in polymerization. Many synthetic resins which are finding increasing industrial application, owe their characteristic properties to the fact that their high molecular weight is the result of polymerization. (A. D. M.)

POLYMETRYLENES: *see* CHEMISTRY: *Organic: Homocyclic Division.*

POLYNESIA, the easternmost of the three main divisions of the island groups of the South Pacific, the others being Melanesia and Micronesia (*qq.v.*). It includes the numerous groups and small islands situated south of the Equator and falling roughly between 170° E. and 110° W. longitude. The two islands of New Zealand are the largest and most important homelands of the Polynesians, other groups being the Hawaiian (U. S. A.), Society and Marquesas (French), Tonga, or Friendly islands (British), and Samoa (British and U. S. A.). For an account of the structure, geology, climate, flora and fauna and economic conditions of Polynesia, see the treatment of the various island groups under PACIFIC ISLANDS.

Ethnology. — The Polynesians are a Caucasian people, in contrast to the Negroid Melanesians, their island neighbours to the west, with whom they have intermingled to some extent. They are scattered over the widest expanse of free ocean in the globe; there are so few bits of land between Hawaii and New Zealand, between Easter island and Tonga, that navigators have crossed this wide body of water without seeing a trace of land. Brown in colour, with black hair, tall in stature, governed by chiefs in hereditary line through the father (in contrast to the matriarchal Melanesians), the Polynesians have been warlike and adventurous in their history, while at the same time responsive to foreign influence.

The origin of this Pacific island race has fascinated and perplexed students of ethnology, anthropology and archaeology. Only a people with considerable skill in navigation could have reached these islands; yet they have maintained through centuries a very primitive form of economy, without a trace of commercial intercourse or money.

The preponderance of scientific opinion is that the Polynesians migrated from Asia, not from the American continent. The absence of any trace, among the Polynesians, of the religions of the east indicates that the migration took place at a very early period. It seems probable that at some dim pre-historic time they practised a primitive form of "island hopping," moving from one new place of settlement to another in the large canoes which they are traditionally expert in operating until they found their present home in the eastern part of Oceania. There seems to be some reason to believe that Java was the home of these migrants for a time and that they were forced by Malayan invaders to seek a refuge farther east.

Traditions are still retained of a mythical land of the Polynesian forefathers, called Hawaiki (which can be linguistically connected with the word Java as we know it to-day), to which the souls of the dead return. Moreover, the peoples of all the important islands place to the west the locality whence the departed souls commence their journey. Research among the Nagas of Assam, and archaeological research by the French Colonial authorities in Cambodia indicated that there is a linking up with the immigrants, particularly with the Nagas, who apart from their stoneworking, practise many Polynesian customs. The massive stone ruins at Ponape in the Carolines (see MICRONESIA), which are a mystery in their own right, may indicate a stage in the long journey of the Polynesians over thousands of miles of ocean to their present homelands.

Physical Characteristics. — The Polynesians, with their simple outdoor life, often develop fine bodies and are almost always expert swimmers. They are taller than the Melanesians (except for the natives of Fiji, where there is some intermixture of the two races), with long, black hair and black, expressive eyes. Tattooing is much in vogue. The Polynesians attach great importance to the shape of the head, and the head of every baby is moulded into the desired form, flat-backed, dome-topped, sloping-browed and round, by means of a process of massaging. The nostrils are deliberately flattened, which is a tribute to the Negroid Melanesians and is a result of the frequent bringing back of Melanesian wives for the harems of the chiefs after raids on Melanesian islands. The Polynesians, especially the women, tend to become stout as they grow older; this is considered a desirable sign of beauty in a woman.

Religion. — The Polynesian religion, like the Melanesian, is simple and animistic, but is enriched with a larger number of imaginative myths. Survivals of sun worship are found in some of the islands, and this is considered an indication of the Indonesian origin of the natives. A fine wooden reproduction of Tangaroa, god of the sea, is preserved in the British museum, and the Polynesians also adored Ra, the sun god, and Io, the supreme being. However, these supreme deities are far away from the consciousness of the average Polynesian, who is more inclined to worship the spirits of departed chiefs and ancestors and natural objects in which supernatural power is supposed to reside.

Throughout the Pacific islands there is a general fear of the ***aitu,*** or supernatural beings, who are conceived as possessing some of the qualities both of gods and of ghosts. Every house has its ghost, and Polynesian folklore contains legends of mysterious lights at sea and of sirens who lure unwary youths to destruction. The souls of great men who have died are invoked by the living, and stones and trees are sometimes regarded as sacred and propitiated with offerings of fruit and pigs. In the past, human sacrifices were sometimes offered; but this practice disappeared as the Polynesians came under the rule of foreign powers.

Social Structure. — The Polynesians, in contrast to the Melanesians, displayed a considerable aptitude for social organization. The power of the chief, who is supposed to be in contact with the gods, is very great; in some of the larger islands the landowners constitute a kind of native nobility, while the practice of organizing castes or classes of hereditary carpenters, fishermen and persons engaged in other occupations is quite familiar. Foreign visitors to Polynesian islands are often impressed by the dignity and decorum with which general tribal assemblies are conducted. The liquid Polynesian language, with its many vowels, lends itself to oratory. This language is widely understood throughout Polynesia, while in Melanesia there is a babel of local dialects, people of one island often being unable to understand their neighbours on another.

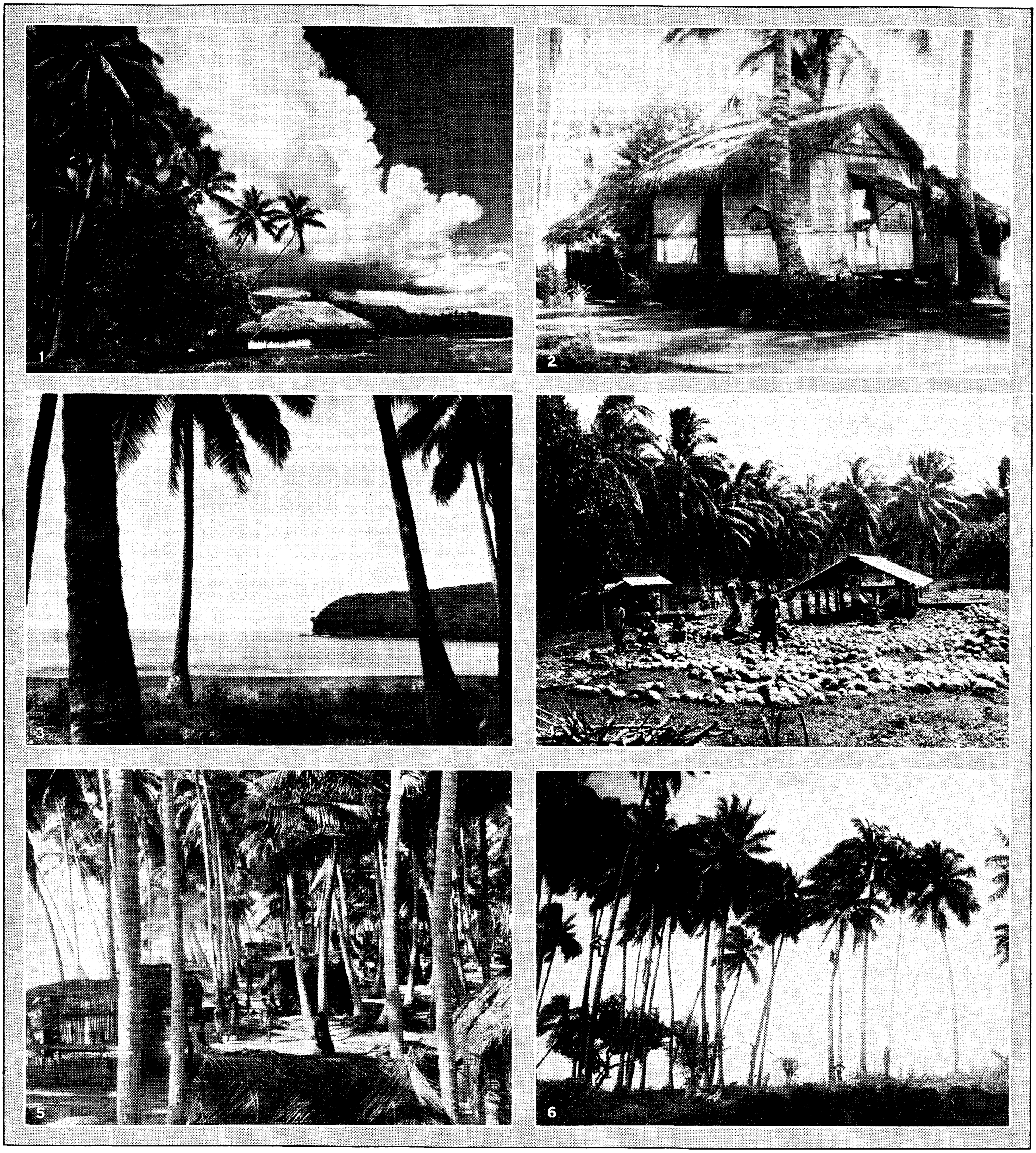
The Polynesians were less addicted to cannibalism than the Melanesians, although this practice prevailed in the Marquesas islands and in New Zealand. The art of the New Zealand Maori wood carvers is the finest in the South Pacific. In the figure-heads and stern-pieces of the larger Maori canoes and sometimes in the lintels of the doors, one often finds delicate and refined open-work carving, consisting sometimes of tree-fern spirals, sometimes of interlacing human figures.

There are some remarkable stone ruins throughout Polynesia, and an elaborate system of drains was discovered in a swampy region of northern New Zealand. The Polynesians have long been acquainted with the art of working stones; the remains of huge sanctuaries and stone platforms have been found in Hawaii, the Society islands, Rarotonga and even on tiny Easter island. It is possible that the latter represents the remnant of a larger body of land that has been submerged in the ocean, since it is difficult to conceive how the necessarily small population of the present tiny island could have carried out such elaborate construction work. All these stone ruins convey the impression that Polynesia may have possessed a more numerous population and a more developed political and social organization in the past.

Polynesian daily life is strongly affected by the widespread practice of tabu (*q.v.*) which is so prevalent among primitive peoples all over the world. It is in the hands of the kings and priests. For instance, when Captain Cook wanted to set up an observatory on one of the islands, the priests made the proposed site tabu by waving wands over it.

Some chiefs in New Zealand are considered tabu, with the consequence that they must be fed, instead of feeding themselves, and in some Polynesian communities men are given this semi-sacred status. In Rapa, in the southern part of French Oceania, women are supposed to pop morsels of food into the mouths of the men, but are not permitted to eat with them, as this would be considered a profanation. Before 1819 it was an offense punishable with death for a woman in the Hawaiian group to join in the meal of male relatives.

Tongan Group. — This western outpost of Polynesia is one of the healthiest and most prosperous of the island groups. Elementary education was widely developed, and the people are noted for their comparatively high standard of intelligence. The Tongans are among the most daring navigators of Polynesia and have sent out migrants to



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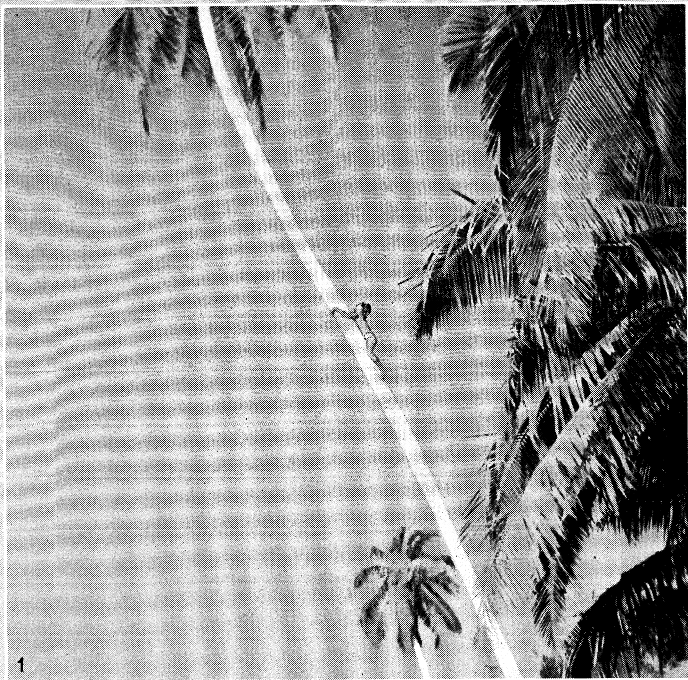
HOUSES AND PALM GROVES OF THE POLYNESIAN ISLANDS

1. A native hut with thatched roof is shown near a grove of coco-nut palms
2. A characteristic native house, built of hardwood posts, bamboos and plaited palm leaves with a reed thatched roof
3. View of a Polynesian harbour bordered with palm trees
4. Harvesting coco-nuts in a palm grove, Tahiti
5. A native village sheltered by palm trees. The houses are built with hardwood posts and bamboos and are roofed with palm or other leaves
6. Natives climbing coco-nut trees in Tahiti. The native loops himself to the tree with rope to prevent falling and climbs by gripping the trunk with his toes



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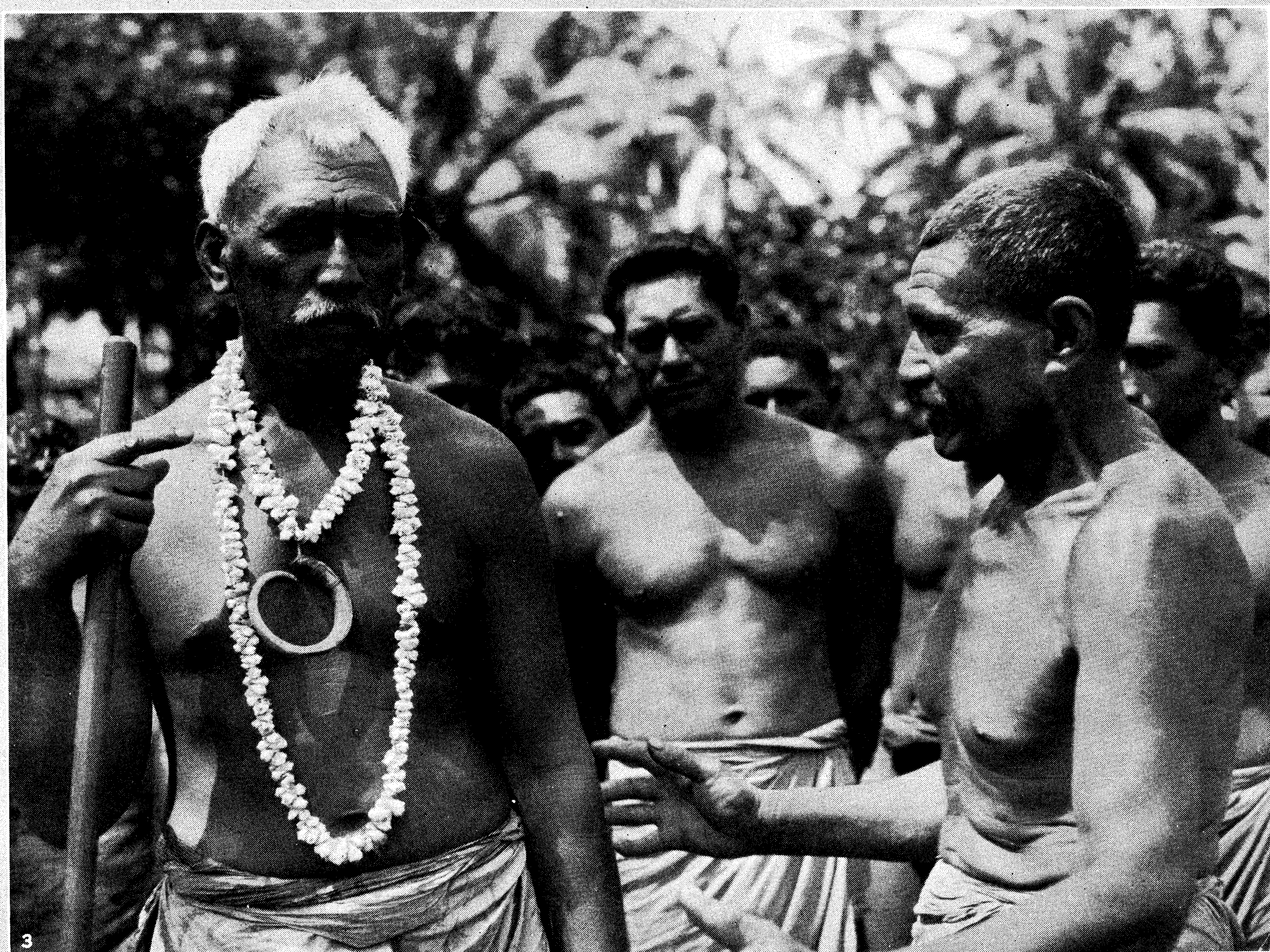

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NATIVES OF THE MARQUESAS ISLANDS, POLYNESIA

1. Boy of the Marquesas climbing a coco-nut palm
2. Native orchestra playing, with dishpan and drum
3. Group of Marquesans with their tribal chief (left)

distant islands, such as Rotumah and Ellice, while storm-tossed Tongan canoes landed settlers and raiding parties in the outlying Solomons and New Hebrides. Tongan expeditions to Fiji for the purpose of obtaining wood foı war canoes were frequent in the years when there was no foreign authority to enforce law and order in the islands.

Declining Islands of Polynesia. — In some of the islands of French Oceania, especially in Tahiti and in the Marquesas group, one finds the spectacle, at once melancholy and curious, of a formerly virile and physically fit people wasting away and tending toward extinction. The native population of Tahiti, according to the census of 1911, was less than the number of warriors who turned out from two small districts at the time of Cook's second visit to that island. The physical deterioration after that time was also very marked.

There are two main causes for this decline in population (still more striking in the Marquesas islands than in Tahiti) and for the deterioration in health. Foreigners brought with them into these islands infectious diseases for which the natives possessed no immunity and to which they proved very susceptible. Measles, smallpox and phthisis carried out ravages.

Moreover, the deterioration had set in even before the coming of the foreigners brought the scourge of epidemics for which medical science provided remedies only slowly. The second important cause of the decline of some of the Polynesian islands was the indolence of the natives and the gradual evaporation of their vital energies. This indolence was promoted, because life on these islands, with their luxuriant tropical vegetation, could be maintained with extremely little physical effort. The breadfruit tree, which grows abundantly without artificial cultivation, provides the native with almost everything he needs for his simple food and clothing.

Tribal war was a former stimulus to action among the islanders of the South Seas. When war was repressed by the French authorities, the natives in the islands with the most abundant free food supply lost the last antidote to the life of complete sloth that atrophied all their vital faculties and led naturally to overwhelming decline of population through the double effect of a high death-rate and a low birth-rate. It is interesting to note that in the southern islands of French Oceania, where climatic and physical conditions make it necessary for the natives to work for a living, the symptoms of depopulation are absent.

Megalithic Remains. — There is a fascinating reflection of vanished empires, races and civilizations, in the great stone remains found sporadically all the way across the Pacific, from the islands near Japan to tiny Easter island, in eastern Polynesia. There is the deserted Venice of Ponape, there are the stepped pyramids of Samoa, Tonga and Tahiti, the *maraes*, or great stone temples of Rarotonga, the Marquesas and Pitcairn island, refuge of the mutineers against Captain Bligh of the "Bounty." The process reaches a climax in Easter island, which has been described as "the most astonishing collection of mortuary monuments in the world."

BIBLIOGRAPHY.—Brigham, *Index to the Islands of the Pacific* (Honolulu, 1900); J. Cook, *Narrative of Voyages* (1773–84); W. Ellis, *Polynesian Researches*, 2 vols. (1830): A. Fornander, *The Polynesian Race* (1878–85); B. Thornson, *The Diversions of a Prime Minister* (1894); J. Macmillan Brown, *Peoples and Problems of the Pacific* (1927).

POLYNESIAN LANGUAGES, a general term for one branch of the great Oceanic family of speech, the other branches being Melanesian, Micronesian and Indonesian. These four divisions are so clearly marked off from each other and so definitely spring from one common parent that it is customary to refer to the individual languages of each group as mere dialects. The existing differences between the languages as we know them, however, are such as to justify the use of the term languages.

The principal members of the Polynesian group are (a) Samoan (probably the oldest form of Polynesian speech extant), (b) Maori, (c) Tahitian, (d) Hawaiian, (e) Tongan, (f) Mangarevan, (g) Nukuhivan (of the Marquesas Islands) and (h) the dialects of the Paumotu archipelago. From these main tongues dialects and sub-dialects have developed until Polynesia has almost a hundred variants of the original tongue.

Phonetics. — The Polynesian languages are amazingly rich in vowels with striking consonantal poverty. Although possessing only the five vowels *a, e, i,* o, *u,* in a short and long form the musical register of the Polynesian voice is so wide as to produce the illusion of numberless variants of these vowels. The *i* in particular is occasionally so shrill that no European can satisfactorily reproduce it.

The consonants are *k, t, p, s, (h), l, (v), ṅ, n, m,* f, *(v), (w).* No single Polynesian tongue contains all these consonants, those in parentheses being alternatives in some languages for the letter immediately preceding. Fakaafo is one of the richest of these tongues having *k, t, p, s, f,* v, *l, ṅ, n, m;* most of the others lack two or three of this number. Maori has, in addition, a compound or aspirated consonant *wh* which sounds very like an aspirated *v*, as in *whaka-*, the prefix of causative verbs. A tabular view of the phonetics of the chief Polynesian languages follows.

A. Vowels

Hawaiian	Fakaafo	Samoan	Tongan	Maori	Rarotongan	Mangareva	Paumotu	Tahiti	Nukuhiva
a, o	*a*	*a*	*a, e*	*(l, e*	*a*	*a*	*a*	*a*	*a, e*
e	*e*	*e*	*e*	*e*	*e*	*e*	*e*	*e*	*e*
i	*i*	*i*	*i*	*i*	*i*	*i*	*i*	*i*	*i*
o	*o*	*o*	*o*	*o*	*o*	*o*	*o*	*o*	*o*
u	*u*	*u*	*u*	*u, i*	*u*	*u*	*u*	*u, i, o*	*u, o*

Thus, *e, i,* and *o* are constant; *a* and *u* variable. But so jealously are vowel-values guarded by Polynesian speakers that these changes are constant within the bounds set by any particular language and it is possible for the speaker of one idiom to say definitely what form a word will take in another whose phonetic system he knows.

B. Consonants

Hawaiian	Fakaafo	Samoan	Tongan	Maori	Rarotongan	Mangareva	Paumotu	Tahiti	Nukuhiva
. .	*k*	. .	*k*	*k*	*k*	*k*	*k*	. .	*k*
k	*t*	*t*	*t*	*t*	*t*	*t*	*t*	*t*	*t*
p	*p*	*p*	*p*	*p*	*p*	*p*	*p*	*p*	*p*
h	*s*	*s*	*h*	*h*	. .	. .	*h*	*h*	*h*
h	*f*	*f*	*f*	*w, h*	. .	. .	*f, w*	*f, h*	*f, h*
w	*v*	*v*	*v*	*W*	*v*	*v*	*v, w*	*v*	*v*
l	*l*	*l*	*l*	*r*	7	7	*r*	*r*	7
ṅ	*ṅ*	*ṅ*	*ṅ*	*ṅ*	*ṅ*	*ṅ*	*ṅ*	. .	*ṅ, k, n*
n	*n*	*n*	*n*	*n*	*n*	*n*	*n*	*n*	*n*
m	*m*	*m*	*m*	*m*	*m*	*m*	*m*	*m*	*m*

Variability is much more frequent among the consonants than with the vowels, which are the backbone of Polynesian speech. *k* is constant except in Hawaiian, Samoan and Tahiti speech where it is replaced by a glottal check; *t* is constant except in Hawaiian where it becomes *k, e.g.,* Maori *taṅata,* a man, Hawaiian *kanaka,* Nukuhiva *kenata, enata.* P, *n* and *m* do not change at all and *l* and *r* appear alternately. The Samoan and Fakaafo *s* for *h* in the other languages, betrays the sibilant sound of h before a weak vowel (an analogy is found in Luchuan and Japanese *hito, fito,* pronounced *shto).* All the changes illustrated in the table are regular and very few exceptions are found.

Morphology. — Syllables in Polynesian tongues may begin with a consonant or a vowel but must always end in a vowel. From this it results that many vowels come together in words of several syllables; extreme cases are *hooiaioia, mou'a, kauikeaouli.* Here, however, each successive vowel is a syllable, there being no true diphthongs in these languages. There is no vowel elision, and the accent (penultimate), is very light, so that each syllable is clearly enunciated. But owing to the Polynesian distaste for consonants many homophones are created, mostly consisting of two vowels, *e.g.,* Nukuhivan *ua* means "rain," "two," "to heat," "lobster," etc., from elision, the original words being *uka* or *usa, rua, ura,* and *uka.* The genius of the language can be clearly seen from the borrowings from foreign languages, chiefly from English, *e.g.,* the word "quarter" appears as *tuafa,* "governor" as *tavana* or *kavana,* "doctor" as *taote,* etc.

In normal words, when compounds are made the accent shifts so as to fall still on the penultimate syllable, *e.g.,* Samoan, *áve* to give, *aveṅía* to be given; Hawaiian, *ldhe* to hear, *lohéa* to be heard. But there are exceptions to the rule of penultimate accent, which must be learnt by practice only; most of these, which are not numerous, arise from the difficulty of distinguishing between homophones or from the need of distinguishing a common word from one which has become *tapu* as the name of a chief or other prominent person.

One phenomenon of Polynesian speech deserves attention, viz., reduplication, complete or partial. Many new words are built up in this way and delicate nuances are conveyed by the doubling of a single syllable. In Maori *haere* conveys the idea "going," haerehaere means "roaming about, take a walk"; Samoan tufa, "divide," yields, *tufatufa,* "to split up into many pieces," etc.; Maori *inu,* "to drink" gives *iinu,* "to tipple, soak"; Tahiti parau, "to speak" gives *paraparau,* "to chatter"; from Tonga *nofo,* "to live" comes nonofu, "to live with someone." Adjectives are treated in the same way: Rarotongan nui, "big" gives *nunui,* "very big"; Hawaiian lii, "small," gives *liilii,* "very small."

Word-building is simple. From tama, "a child" and arzki, "a chief" is made *tamariki,* "a son" (lit. a princeling. noble child); from tanta, "a child" and *wahine,* "a woman," comes tantahine, "a daughter, a girl"; *uritaata,* "an ape" is made up of *uri,* "a dog," and taata, "a man."

The article differs from language to language; the indefinite article is usually identical with the numeral one, (sa, se). This is not used, however, unless absolutely necessary, although the definite article (Samoan, *o* le or *le;* Hawaiian, he; Maori, te; Tahiti, Rarotongan, Mangarevan, Nukuhiva e), usually appears before a noun. Maori has a plural article *ṅa* (nga), and the other languages have prefixes which mark the noun as plural although nouns undergo no change in form from singular to plural.

There are cases in the language marked by prefixes. The noun as agent is preceded by ko (*'o*), the genitive is occasionally still shown by position (as was the original method), although the prefixes *na, a, no, o* are now usually employed. The dative case is shown by a prefixed particle *ki* (before proper names and pronouns *kia*) and the accusative (when it is marked at all) is preceded by *i* or *ia.* The particle preceding the noun in the ablative case is e and in one or two languages there are other prefixes, but these do not actually form part of a genuine declension. The vocative case is marked by the syllable e preceding the name or noun.

The adjective suffers no change in any of the languages and it follows its noun except when it is used as a predicate when it precedes it; Samoan *laau* tele, "a big tree" When the adjective follows its substantive as attribute, the plural of the whole phrase is accomplished by the reduplication of the adjective: Maori, ika *pai,* "a good fish," ika *papai,* "good fish"; Hawaiian, hale *nui,* "a big house," *hale nunui,* "big houses."

The pronouns are complex in Polynesian speech, there being singular, dual and plural forms with inclusive and exclusive varieties. The normal forms are:—

	1st person	2nd person	3rd person
Dual (inclusive)	*ta-rua*	*ko-rua*	*ra-rua*
Dual (exclusive)	*ma-rua*	*mo-rua*	*ra-rua*
Plural (inclusive)	*ta-toru*	*ko-toru*	*ra-toru*
Plural (exclusive)	*ma-toru*	*mo-toru*	*na-toru*

These forms vary according to the dialect and the consonant-changes tolerated therein There are full and contracted forms for the possessive and demonstrative pronouns which are also complicated The interrogative pronoun serving many purposes is wai (Maori and Hawaiian); *vai* (Tahiti); *hai* (Tongan); and *ai* for the other dialects, used only for living things and for inanimate objects, aha (Maori, Hawaiian, Nukuhiva); *ha* (Tongan); aa (Rarotongan), and *ā* in the other tongues. There is no relative pronoun in any of the languages—either it remains unexpressed or a circumlocution is employed with the personal or demonstrative pronoun.

The Polynesian verb, like the noun and adjective, undergoes no change in form, and all moods and tenses are indicated by participles prefixed to the root form of the verb. The verb has no special form to distinguish it from other parts of speech and, indeed, many adjectives are used as verbs without change.

The passive voice is constructed from the active by the use of the participle prefix *ia* (hia, *lia, kia,* kina, *mia,* etc); the causative is similarly produced by the prefix fa'a (*whaka, ha'a,* aka, etc.). A desiderative is formed by the prefix *fia* (fie, *hia*), and one verbal suffix exists whereby a reciprocal form is made (-aki, *-faki, -laki, -taki, -raki*).

The present indicative is shown by the participle e or te, the future by a, and the preterite by *na.* The moods are few and vary greatly between the languages, the most common being ia (kia, ke) for the conjunctive: a, ka, kite, pea, poo, *ahiri, ina,* etc., for the conditional and *fau* (Tonga only) for the potential. The particle *ana,* a'a makes the participle.

Numerals

	Hawaiian	Fakaafo	Samoan	Tongan	Maori	Rarotonga	Tahiti	Nukuhiva
1	*kahi*	*tasi*	*tasi*	*tahu*	*tahi*	*tai*	*tahi*	*tahi*
2	*lua*	*lua*	*lua*	*ua*	*rua*	*rua*	*rua*	*ua*
3	*kolu*	*tolu*	*tolu*	*tolu*	*toru*	*toru*	*toru*	*tou*
4	*ha*	*fa*	*fa*	*fa*	*wa*	*a*	*ha*	*fa, ha*
5	*lima*	*lima*	*lima*	*nima*	*rima*	*rima*	*rima*	*ima*
6	*ono*	*ono*	*ono*		*ono*	*ono*	*ono*	*ono*
7	*hiku*	*fitu*	*fitu*		*witu*	*itu*	*hitu*	*fitu, hitu*
8	*walu*	*valu*	*valu*	*valu*	*waru*	*varu*	*varu*	*vau*
9	*iwa*	*ioa*	*iva*	*hiva*	*iwa*	*ioa*	*iva*	*iva*
10	*'umi*	*fulu*	*sefulu*	*hoṅofulu*	*ṅahuru*	*ṅauru*	*ahuru*	*onohuu*

The word for "five" (lima), is the general word for "hand" in Polynesia, the word for "ten" is borrowed from Malay *puloh* The identity between the words of the languages is rarely so close as it is with the numerals and a few terms of relationship The ordinal numbers are formed by placing the definite article before the cardinals, *e.g.,* Tahiti, *o te rima* (lit. "the five") "fifth"; Samoan, *o le lua,* "the second," etc.

Vocabulary.—The Polynesian tongues are rich in terms of relationship, in names of natural objects, fish, birds, plants, flowers and phenomena of nature, all the winds and zephyrs, all kinds of clouds, waves, streams, hills, shores and so on having special names. There is a shortage of abstract terms, metaphor is common, a concrete noun doing double duty. Maori and Samoan, however, in the philosophical chants (*see* POLYNESIAN LITERATURE) have developed a definitely abstract vocabulary There is a decided lack of direct, forceful words and in translation from European languages it is difficult to turn decisive phrases into Polynesian equivalents. The vocabularies suffice for all ordinary purposes and a little ingenuity often turns an English phrase into a telling South Seas equivalent.

BIBLIOGRAPHY.—The *Journal of the Polynesian Society* (Wellington, N.Z.), a quarterly publication in which many excellent sketches of the [illegible] Polynesian languages [illegible] Humboldt. *Über dze Kawi-Sprache* etc (1836–39); Lorrin Andrews, *A Grammar of the Hawaiian Language* (Honolulu, 1854); Friedrich Muller, *Grundriss der Sprachwissenschaft,* ii., part 2 (1882). The dictionary *par excellence* is Edward Tregear's *Maori-Polynesian Comparative Dictionary* (Wellington, *N.Z.* rodak) wherein is to be found the most complete bibliography of Polynesian linguistic works See also Meillet and Cohen, *Les Langues du Monde* (1924), pp. 450–455.

(A N. J W.)

POLYNESIAN LITERATURE. A few decades ago this title would have been deemed an anachronism, or worse, but since the publication of the Sacred Songs of the Hula by Dr. N. B Emerson under the title Unwritten Literature of Hawaii (1909), it has been generally conceded that the Polynesians, like other illiterate races, may have a literature in the truest sense of that term. The old Polynesian priests with their extraordinary memories held every word of the old traditions as flawlessly as papyrus or paper could have done; the proof of this lies in the presence, in texts taken down from native lips, of words so archaic that even the hierarchs have forgotten their meanings. It soon came to be realized that this wealth of literature was rapidly dying with the chiefs who were its last repositories, and numerous legends and collections of songs were taken down from the lips of the *kahuna* or sorcerers.

The literature of the Samoan islands is probably older than that of any other part of Polynesia and is wonderfully akin to the old Maori philosophical chants. *The* Creation Song in Samoan is not only interesting as folk-lore; it is a marvellously dignified piece of poetic literature. Long genealogies interspersed with legends of philosophic and historic import are now available in Roman script, providing much material for the study of the history and language-development of the Pacific islanders. Many migration songs and legends are known and there is still time to collect others. The whole text of the *'ava* ceremonial and similar ritual texts are now in our hands and there is reason to believe that a close study of others in process of being collected will prove of the greatest possible value in the solution of problems of migration and tribal mixing.

Maori literature is of two kinds, philosophic and traditional-historical. The Maori Chant of Eternity is, in places, identical with the Samoan Creation Song but has a definite individuality. Speculation on life and its problems appears in many of the legends centred round Maui, the great common Polynesian Ancestor, the Divine Angler, whose hook caught on the islands of New Zealand and brought them to the surface as an abode for his children. Hawaiki, that mysterious, far land, renowned in Polynesian song, is vaguely glimpsed, now as a paradise to which men's souls shall go, now as the Eden from which the ancestors of the singers emerged countless centuries before. The stories of the creation of the cosmos and its peopling are all before us in Maori speech, put together with a reverence and delicacy of phrase worthy of any literature.

Hawaiian literature is essentially romantic. The hula, a religious performance, was in its essence an ebullition of joyous animal-spirits, outflowing toward Nature. The "abandonment" seen by some in the dance and in the words of the songs is largely imaginary although it is undeniable that much of the *hula* and mele literature of Hawaii is made up of protracted double-entendres. In the Hawaiian one can observe a close love of nature through understanding; the trees wave in a warm breeze and the sunlight glints on azure waves because the singer is happy and because the gods are weaving anew their ancient spell of poetic song. Even the dread voice and searing tongue of Pele, the awful volcano-goddess, can be wooed by song and dance, to rest. The allusions in the songs and prose of Hawaii point to a long cultural experience and deep reverence for tradition. The lyrics of Hawaii rank high among the pure rhapsodies of the world.

The literature of other Polynesian islands is largely a repetition of that outlined above. The traditions of Tonga supply lacunae in the stories of Samoa and New Zealand and those of Tahiti supplement those of Hawaii and the Gambier islands. In all, however, they are distinctive songs and chants, as full of beauty as they are of scientific interest.

BIBLIOGRAPHY.—Sir George Grey, *Polynesian Mythology and Ancient Traditional Mythology of the New Zealand Race,* Maori text (1855); W. W. Gill, *Myths and Songs from the South Pacific* (1876); A. Bastian, *Die heilige sage der Polynesier* (1881); A. Kramer, *Die Samoa Inseln,* texts in Samoan and German (1902); N. B. Emerson, *Unwritten Literature of Hawaii* (Washington, 1909); M. W. Beckwith, *The Hawaiian Romance of Laieikawai,* Hawaiian text and translation (1912); N. B. Emerson, *Pele and Hiiaka* (1915); *Fornander Collection of Hawaiian Antiquities and Folk Lore,* memoirs of the Bernice Pauahi museum (Honolulu, 1916). (A. N. J. W.)

POLYNOMIAL, in elementary algebra, an expression composed of two or more terms combined by operations of addition or subtraction. Thus $\frac{1}{2}a+7b+c$ and $2+a-\sqrt{(\frac{1}{2}xy)}+z^2$ are polynomials. A polynomial of two terms is called a binomial, and one of three terms is called a trinomial. An expression consisting of a single term is called a monomial.

The word polynomial is often used with a more technical meaning, particularly in higher mathematics, to characterize the manner of dependence of an expression on one or more quantities regarded for the time being as independent variables. Importance attaches then to the nature of the operations performed on the variables, rather than to the number of terms, and monomial expressions of suitable form are admitted as special cases. Under this interpretation, which will be adopted throughout the rest of the article, a polynomial in one variable is a sum of terms, each consisting of a power of the variable multiplied by a coefficient independent of the variable, or, as an extreme case, a single such term; in a polynomial in several variables, each term contains a power of one of the variables or a product of powers of two or more of them. By a power in this connection is meant a power with exponent equal to a positive whole number or zero. The highest exponent that occurs, or, in the case of more than one variable, the highest value attained by the sum of the exponents in a single term, is the degree of the polynomial. Thus ax^2+bx+c is a polynomial of the second degree in x (if $a\neq 0$), and $x^5+3xy^2-8x^3y^4$ is a polynomial of the seventh degree in x and y. The latter is also said to be of the fifth degree in x, and of the fourth degree in y.

Having fundamentally a relative sense, the definition is applicable to characterize the manner of dependence on quantities which may themselves be more or less complicated expressions of any form. Thus ax^2+bx+c, $a(1+\sqrt{x})^2+b(1+\sqrt{x})+c$, $a/x^2+b/x+c$, $a(\log x)^2+b\log x+c$ are polynomials with respect to x, $1+\sqrt{x}$, $1/x$, and $\log x$ respectively, though the last three are not polynomials with respect to x; and ax^4+bx^2+c, a polynomial in x, can also be regarded as a polynomial in x^2. The sum, difference, or product of two *polynomials* is a polynomial; their quotient in general is not. Polynomials and quotients of polynomials are known collectively as rational *functions.*

In elementary algebra, expressions coming under the more technical definition of polynomials are studied largely in connection with the equations formed by setting them equal to zero. If $f(x)$ denotes the polynomial

$$a_0x^n+a_1x^{n-1}+a_2x^{n-2}+\dots+a_{n-1}x+a_n,$$

where $a_0\neq 0$, the equation $f(x)=0$ has n roots, $r_1, r_2, \dots, r_n$ (which may or may not be all different from each other); and then $f(x)$ can be factorized in the form

$$f(x)\equiv a_0(x-r_1)\ (x-r_2)\ \dots\ (x-r_n).$$

Thus every polynomial of the nth degree in a single variable can be resolved into n factors of the first degree. A corresponding resolution into factors of the first degree is not possible in general for polynomials in more than one variable. A polynomial (such as x^2+y) which cannot be expressed as a product of polynomials of lower degree is said to be irreducible. Every polynomial which is not itself irreducible can be resolved into irreducible factors, and apart from the order of the factors, and from factors which are merely constant, can be so resolved in only one way.

It is an important fact in trigonometry that the cosine of n times an angle, when n is a whole number, can be expressed as a polynomial of the nth degree in terms of the cosine of the angle itself; *e.g.,*

$$\cos 2x=2\cos^2 x-1,\ \cos 3x=4\cos^3 x-3\cos x,$$
$$\cos 4x=8\cos^4 x-8\cos^2 x+1.$$

The sine of nx can be expressed as the product of $\sin x$ by a polynomial of degree $n-1$ in $\cos x$; when n is odd, but not when n is even, it can also be expressed as a polynomial of the nth degree in $\sin x$; *e.g.,*

$$\sin 2x=2\sin x\cos x,\ \sin 3x=\sin x\,(4\cos^2 x-1)=3\sin x-4\sin^3 x.$$

The relation between algebra and trigonometry was emphasized by Vieta (1540–1603), who contributed largely to the advancement of both branches.

Analytic geometry is largely concerned with the geometric interpretation of the equations obtained by setting polynomials in the co-ordinates equal to zero. In the plane, an equation of the first degree, of the typical form $Ax+By+C=0$, represents a straight line; *i.e.,* if (x, y) are the rectangular co-ordinates of a point, all points whose co-ordinates satisfy the equation lie on a straight line, and all points of the line have co-ordinates satisfying the equation. The conic sections (*q.v.*),—ellipse, circle (which may be regarded as a special case of the ellipse), parabola, hyperbola (*qq.v.*), and certain "degenerate" forms (pairs of straight lines)—are represented by equations of the second degree, of the form

$$Ax^2+Bxy+Cy^2+Dx+Ey+F=0,$$

where in particular cases one or more of the coefficients may be equal to zero. Descartes (*Géométrie,* 1637) and his contemporary, Fermat, are regarded as the founders of analytic geometry (*q.v.*). The curves represented by equations of the third degree were systematically studied by Newton (1704). In three dimensions, an equation of the first degree, $Ax+By+Cz+D=0$, represents a plane, and one of the second degree a *quadric surface*—ellipsoid, sphere (a special case of the ellipsoid), hyperboloid (of one sheet or of two sheets), paraboloid (elliptic or hyperbolic), cone, cylinder (*qq.v.*), or, as a degenerate form, a pair of planes.

The theory of the transformation of homogeneous polynomials, or *forms* (see ALGEBRAIC FORMS) by linear substitutions in the variables, and of the invariants and covariants associated with such transformation, is an important branch of modern algebra with numerous applications. For example, if x, y in the polynomial $ax^2+bxy+cy^2$ are expressed, in terms of a new pair of variables u, v, by the relations

$$x=\alpha u+\beta v, \qquad y=\gamma u+\delta v,$$

where $\alpha\delta-\beta\gamma=1$, it is found that $ax^2+bxy+cy^2$ is identically equal to an expression of the form $Au^2+Buv+Cv^2$, in which $B^2-4AC=b^2-4ac$, a fact which is of fundamental significance in analytic geometry. More generally, for any values of a, β, γ, 6,

$$B^2-4AC=(\alpha\delta-\beta\gamma)^2\,(b^2-4ac).$$

The expression b^2-4ac, itself a polynomial in terms of the coefficients a, b, c, is called an *invariant.*

Polynomials in one variable are the simplest class of functions from the point of view of the calculus, because the rules for their differentiation and integration are particularly simple, and are obtained immediately from the definitions of these processes. The result of differentiating or integrating a polynomial with respect to its independent variable is always a polynomial.

In the modern theory of functions (see FUNCTION), any polynomial is a continuous and analytic function of its variables. If a function of a single complex variable z is analytic for every finite value of z, and becomes infinite when z, represented by a point in a plane, goes to infinity in an arbitrary manner, the function is necessarily a polynomial.

One of the chief investigators of the properties of polynomials during the 19th century was the Russian mathematician Chebichev (Tschebyschef) (1821–94). Among theorems discovered only recently may be mentioned (a) the one which states that, if a polynomial of the nth degree in x does not exceed a number L in absolute value for values of x in the interval from -1 to $+1$, the absolute value of its derivative can not exceed $nL/\sqrt{1-x^2}$ in the same interval (S. Bernstein, 1912), and (b) some results on the relation between the roots of a polynomial and those of its derivative in the complex plane (J. L. Walsh, Annals of Mathematics, 1920, and subsequent papers in the Bulletin and Transactions of the American *Mathematical Society*).

Applications.—Apart from their specific properties, polynomials are of fundamental importance from their use in the approximate representation of other functions. The standard functions of elementary analysis can be represented by power series (see SERIES), of the form

$$c_0+c_1x+c_2x^2+c_3x^3+\ldots \text{ (Maclaurin's series)},$$

or, more generally,

$$c_0+c_1(x-a)+c_2(x-a)^2+c_3(x-a)^3+\ldots \text{ (Taylor's series)},$$

which reduces to the preceding when $a=0$; the sum of an infinite series is by definition the limit approached by the sum of a finite number of its terms, as the number of terms is taken larger and larger, and the sum of a finite number of terms of a power series is a polynomial. Representation by power series can be made the basis for a systematic treatment of analytic functions of a complex variable. Another important form of development in series, theoretically applicable with greater generality, proceeds in terms of the polynomials of Legendre (1752–1833) or Legendre's coefficients. These may be defined as the coefficients of successive powers of r in the power series for $(1-2xr+r^2)^{-\frac{1}{2}}$. One of their most striking properties is that the product of any two of them, integrated over the interval from -1 to $+1$, gives zero. The theory of Legendre series is still under investigation. Approximations in terms of the polynomials of Hermite (1822–1901) are of importance in the theory of probability. Weierstrass (1885) proved that an arbitrary continuous function can be uniformly approximated by a polynomial with any assigned degree of accuracy.

The ordinary process of simple interpolation (*q.v.*), is equivalent to the replacement of the tabulated function by a polynomial of the first degree, over the interval in which the interpolation is performed. Formulae for interpolation by means of higher differences depend for their derivation on the fitting of polynomials of higher degree to the tabulated values. Formulae of numerical integration or *mechanical* quadrature likewise depend on the fitting of polynomial approximations. In connection with the use of polynomials for interpolation, it is an important fact that, if the values of a polynomial of the nth degree are tabulated for equally spaced values of the variable, the nth differences are constant. Consider for example the following table of values of the polynomial $y=x^2+7x+3$:

x = 0	y = 3		
		$\Delta y=8$	
1	11		$\Delta^2 y=2$
		10	
2	21		2
		12	
3	33		2
		14	
4	47		2
		16	
5	63		

The first column contains values of x, and the second, the corresponding values of y. The entries in the third column, obtained by subtracting each y from the following, are the first differences. The last column is made up of the differences of the first differences, which are called second differences, and in the present instance are all equal. It is clear that by means of this property the table could be continued further, without direct substitution in the original formula. (*See* CALCULUS OF DIFFERENCES.)

BIBLIOGRAPHY.—H. Weber, Lehrbuch der Algebra (1895); A. A. Markoff, *Differenzenrechnung* (Leipzig, 1896); G. Chrystal, Algebra (1898, 1901); M. Bôcher, Introduction to Higher Algebra (1907); D. E. Smith, History of Mathematics (Boston, 1923); W. Le R. Hart, College Algebra (1926); L. E. Dickson, Modern *Algebraic* Theories (1926). (D. JA.)

POLYP, the name applied technically to an individual animal of given form, which is of frequent occurrence among those creatures known as the Coelenterata (*e.g.,* sea anemone, coral polyp, Hydra). The form of a polyp is outlined in the article COELENTERATA. (*See* also HYDROZOA; SCYPHOZOA; ANTHOZOA.)

POLYPHEMUS, the most famous of the Cyclops, son of Poseidon and the nymph Thoosa. Odysseus, having been cast ashore on the coast of Sicily, fell into the hands of Polyphemus, who shut him up with twelve of his companions in his cave and blocked the entrance with an enormous rock. Odysseus at length succeeded in making the giant drunk, blinded him by plunging a burning stake into his eye while he lay asleep, and with six of his friends (the others having been devoured by Polyphemus) made his escape by clinging to the bellies of the sheep let out to pasture. *See* CYCLOPES; ACIS; ODYSSEUS.

POLYPODIUM, an inclusive genus of ferns containing about 600 species, widely distributed throughout the world, but specially developed in the tropics. Sometimes it is divided into ten or more "natural" genera. The name is derived from Gr. πολύς, many, and πόδιον, a little foot, on account of the foot-like appearance of the rhizome and its branches. The species differ greatly in size and general appearance and in the character of the frond; the sori or groups of spore-cases (sporangia) are borne on the back of the leaf, are globose and naked, that is, are not covered with a membrane (*indusium*). The common polypody (P. *vulgare*), of Europe, Asia and western North America, is widely diffused in the British Isles, where it is found on walls, banks, trees, etc.; the creeping, densely-scaly rootstock bears deeply pinnately cut fronds, the fertile ones bearing on the back the bright yellow naked groups of sporangia. It is also known as adder's foot, golden maidenhair and wood-fern. There are a large number of varieties, differing chiefly in the form and division of the pinnae; var. *cambricum* (originally found in Wales) has the pinnae themselves deeply cut into narrow segments; var. serratunz has the pinnae serrate. Besides the well-known polypody of eastern North America (P. virginianum), very similar to the foregoing, several other species occur in the southern and western states.

POLYPUS, a term signifying a tumour which is attached by a narrow neck to the walls of a cavity lined with mucous membrane. (See TUMOUR.)

POLYTECHNICS. Polytechnic is a term used in modern phraseology to describe an educational institution equipped to teach many scientific and technological processes (Gr. πολυς, many, and τέχνη, an art). The word, however, has no common meaning either in Great Britain or in other countries. In France, the name *école polytechnique* was applied in 1795 to the École des Travaux publics, which had been founded by the National Convention a year earlier as a protest against the almost exclusive devotion to literary and abstract studies in places of higher education. The école polytechnique was devoted largely to the instruction of recruits for civil and military engineering, In Germany also, numerous technical colleges were founded for a like purpose. In Switzerland, the Zurich Polytechnikum has been provided by the Federal Government as an institution of university rank teaching commercial and industrial processes.

In London, the word polytechnic connotes an institution providing not only technological instruction in many forms, but also one which has definite social and civic ideals. In the report to the special committee on technical education of the London County Council in 1892 Llewellyn Smith (now Sir Hubert Llewellyn Smith, G.C.B.) defined a polytechnic institute in London as an "institute carrying out the double purpose of providing evening recreation and education for persons of both sexes engaged in industry in the day. Such of these institutes as already exist and others for which funds are now being collected are governed by, or for the most part conform to, certain schemes of the charity commissioners framed under the City Parochial Charities Act, and most of them are endowed to some extent out of the funds of the city parochial charities applicable under that act to the benefit of the 'poorer classes' of London." In other parts of England the term "polytechnic" is frequently used as an alternative title for a technical school; in Glasgow it is the name appropriated by a large and popular store or shop. In America the word is seldom used; for a discussion of American technical education see ENGINEERING EDUCATION and TECHNICAL EDUCATION.

The London Polytechnics. — The London polytechnics, with their distinctive purpose and organization, spring from the social ideals of Quintin Hogg, an old Etonian, who, in 1865, began classes for street urchins under the Adelphi arches by the side of the Thames. Later, in 1882, he purchased a disused building in Regent street which had been called the Polytechnic, and had enjoyed an ephemeral popularity as an institution for the exposition of Pepper's Ghost and other scientific novelties. This enterprise rapidly developed from an evangelistic effort into an educational institution which provided instruction in many subjects and promoted spiritual, intellectual, athletic and social ideals. In 1927 the Regent street polytechnic was attended by over 13,000 day and evening students, taught by 350 full-time or part-time lecturers and instructors, while its social activities covered athletics and social organizations of all kinds.

The success achieved by the Regent street polytechnic led to the formation of other institutions, which were also called "polytechnics." In 1878 a royal commission was appointed to report on the parochial charities of the City of London, as it appeared that by reason of the increase in the funds and the diminution or extinction of the objects of these charities the income was far more than sufficient to provide for all the proper objects of such charities. The outcome of the report was the City of London Parochial Charities Act, 1883. Among other things, the act provided that the charities in 107 parishes of the City of London should, after seven years, be administered by a corporate body (the trustees) of the London Parochial Charities. Schemes were drawn up for the utilization of the secular part of the income derived from the consolidation of the charities towards the establishment and maintenance of polytechnics and kindred institutions. Before handing over the funds to the trustees, the charity commissioners made certain capital grants out of the corpus of the charities. They also made offers of annual endowments for the establishment of institutions in a number of districts generally on condition that an amount representing approximately the capitalized value of the endowment offered was subscribed for capital purposes. Local committees were set up to secure the foundation of institutes in the various parts of London. Valuable sites were given by private benefactors and subscriptions were received from city companies, charities and other voluntary sources towards the cost of building. Altogether, including grants made by the charity commissioners and the trustees of the London Parochial Charities, over £500,000 was secured for capital expenditure while from 1900 to the present time the trustees of the London Parochial Charities have contributed over £1,000,000 towards the maintenance of the polytechnics.

The general aim of the polytechnic institutions may be stated briefly to be the promotion of industrial skill, general knowledge, health and well-being of young men and women belonging to the poorer classes by (1) instruction in the general rules and principles of the arts and sciences and the practical application of such rules and principles in any handicraft, trade or business; (2) instruction in such other branches and subjects of art, science, language, literature, general knowledge, as may be approved by the governing body; (3) instruction and practice in gymnastics, drill, swimming and other bodily exercises; (4) facilities for the formation and meeting of clubs and societies; (5) provision of library, museum and reading rooms.

The London County Council was empowered under the Technical Instruction Act, 1889, to give grants-in-aid to the polytechnics, and since then an increasing percentage of their revenue has been derived from public moneys. The passing of the Education Act, 1902, as applied to London by the act of 1903, has tended to diminish the distinction between the polytechnics, which are "aided" or partly supported by the London County Council, and other technical institutes which are "maintained" or entirely supported by the London County Council. The Education (Consolidation) Act, 1921, empowers the London County Council, in common with other local education authorities, to promote social and physical well-being and to co-ordinate all forms of education within its area. The social and recreative activities, a characteristic feature of the organization of the polytechnics, created by reason of the funds granted by the trustees of the London Parochial Charities, are likely, therefore, to be developed in other institutions. The distinction between a polytechnic and a technical institute is slowly becoming managerial rather than educational. The greater part of the expenditure of polytechnics is now met by a grant from the London County Council, towards which the Board of Education contributes 50%. Towards building and equipment the London County Council has, in the past, contributed over £600,000, while its maintenance grants to these institutions amount to nearly £350,000 a year.

The table on next page shows the chief polytechnic institutions in London and the number of students and gross expenditure of each polytechnic.

The expenditure is met by students' fees to the extent of 19%, by grants from the London County Council and Board of Education to the extent of 70%, and by income from other sources (including the City Parochial Foundation) to the extent of 11%.

Battersea, Chelsea, Northampton, Northern and Woolwich polytechnics, together with the City of London college and Sir

	No. of students, 1927	Gross expenditure, 1927
		£
Rattersea polytechnic . . .	2,940	54,451
Borough polytechnic . . .	4,069	57,140
Chelsea polytechnic . . .	2,627	39,874
City of London college. . .	2,450	24,845
Northampton polytechnic . .	2,546	41,620
Northern polytechnic . . .	3,380	50,667
Regent street polytechnic . .	13,328	133,855
Sir John Cass technical institute	1,246	15,996
Woolwich polytechnic . . .	2,440	44,880

John Cass Technical institute, present students for the internal degree examinations of the University of London, certain members of the teaching staff ranking as recognized teachers of the university. The subjects taught embrace the chief technological and commercial processes required for industrial and scientific processes in the London trades, varied according to local requirements. Careful attention has been given by the London County Council to secure that in the larger polytechnics and technical institutes there should be an organized concentration of effort; that an institution whose circumstances were such that it could with advantage, for regional or other reasons, specialize in branches of instruction affecting one trade or group of trades should seek development in the direction suitable to it, rather than indulge in competition in other directions in which adequate provision is made by another institution. In accordance with these principles the governing bodies have accepted suggestions from the London County Council involving important revisions in the educational programmes of the different institutions. Evening classes for commercial instruction have, in many cases been transferred to the council's evening institutes. Various branches of technology and art have been concentrated at certain institutions, and secondary schools previously housed in certain polytechnics have, with one exception, been removed.

Most of the polytechnics have now developed characteristic features. Battersea polytechnic has important departments of engineering and chemistry and also a training college for domestic science teachers. The Borough polytechnic has achieved notable success in the training of the artisan; it also conducts an important school of bakery and confectionery in co-operation with the National Association of Master Bakers and Confectioners. At the Chelsea polytechnic there is a natural science department and a chemistry department (including a school of pharmacy); there is also a training college for physical education. The City of London college deals exclusively with commercial studies and the marketing of commodities. Engineering, telegraphy and telephony, aeronautics and technical optics are taught at Northampton polytechnic. The Northern polytechnic has an important architectural and building department and also gives instruction in the rubber and musical instrument trades.

The programme at Regent street polytechnic embraces a wide field of activity and includes important departments of architecture, art, chemistry, commerce, engineering, modern languages, photography, carriage and motor-body building, hairdressing and tailoring; a large secondary school for boys is also conducted at the polytechnic. There is an important chemistry department at the Sir John Cass Technical institute and among the special features are classes in petroleum technology and the fermentation industries. Engineering is the foremost subject of instruction at the Woolwich polytechnic, and special courses are held for apprentices at the Royal Arsenal. Provision was made under the original schemes of the Charity Commission for the erection of the North-Western polytechnic in Kentish Town. Owing to the delay in securing the site and later owing to war difficulties, building operations for the erection of this polytechnic were only commenced in 1927. The building is now nearing completion and the polytechnic will be opened in 1929. Birkbeck college was connected with the polytechnic movement, but this connection ceased in 1920, when the college became a School of the University of London, in the Faculties of Arts and Science, for evening and part-time students. (G. H. GA.)

POLYTONALITY, a comparatively recent addition to musical terminology, signifying the simultaneous employment of conflicting keys. (See HARMONY; KEY.)

POLYXENA, daughter of Priam and Hecuba. The shade of Achilles appeared to the returning Greeks in the Thracian Chersonese and demanded Polyxena, who was put to death on his tomb. As a prominent leader he claimed a prominent female prisoner for his share of the booty, as Agamemnon did Cassandra (*q.v.*). Hence, in Philostratus, Dictys and other late authors, the story of a romantic affection between Achilles and Polyxena.

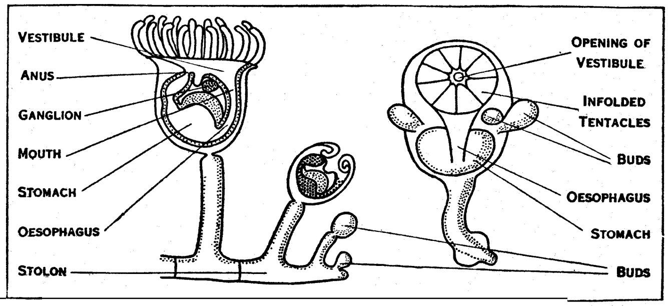
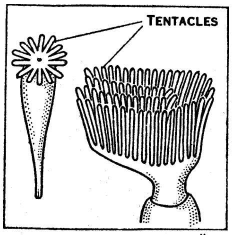


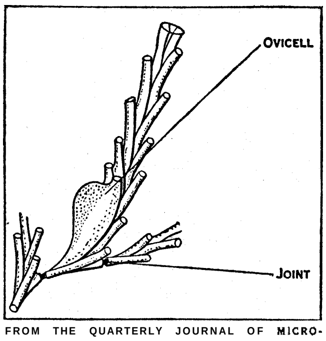
FIG. 1.—ENTOPROCTA; SHOWING PEDICELLINA ON LEFT, AND LOXOSOMA ON RIGHT

POLYZOA. A group of animals so called from the fact that numerous individuals, formed by budding, remain united in a colony. They were mostly included in the Zoophyta of the older naturalists, in consequence of their plant-like appearance, a feature which is emphasized in their alternative name, Bryozoa, or moss-like animals. They are here regarded as a primary group of invertebrates, although they have been placed with the Brachiopoda in a larger group, hfolluscoidea—an association which rests on insufficient evidence. Certain characters of their larvae suggest that they may be distantly related to the Mollusca and Rotifera. They are pre-eminently marine, but a small proportion are confined to fresh water. A colony may have a diameter of a foot, but this size is exceptional in recent forms; and in many cases the longest measurement does not exceed an inch, the individuals ("zooecia") being commonly less than a millimetre long. The walls are generally stiffened with calcareous matter, and the Polyzoa are accordingly represented by numerous fossil species. It is probable that as their study advances they will take an increasingly important part in the determination of the geological age of strata. They may be defined as aquatic animals, forming colonies by budding, with ciliated tentacles which can be infolded or retracted into a depression of the body-wall, with a U-shaped alimentary canal and a ganglion lying between the mouth and anus. Specific excretory organs are found in the Entoprocta alone.



FROM KRAEPELIN, "DIE SÜSSWASSER BRYOZOEN IN ABHANDLUNGEN AUS DEM GEBIETE DER NATURWISSENSCHAFTEN" (FRIEDERICHSEN, DE GRUYTER)

FIG. 2.—ECTOPROCTA Left, Gymnolaemata (*Paludicella*), right, Phylactolaemata (*Lophopus*)



FROM THE QUARTERLY JOURNAL OF MICROSCOPICAL SCIENCE

FIG. 3.—CYCLOSTOMATA (CRISIA), AFTER HARMER

Classification.—Sub-class I. Entoprocta.—Lophophore (the part bearing the tentacles) circular, including both mouth and anus. Tentacles infolded, during retraction, into a "vestibule," which can be closed by a circular muscle. Body-wall not calcified, body-cavity absent. Definite excretory organs present. Reproductive organs continuous with ducts, which open into the vestibule.

Loxosoma (fig. 1), marine, is unique among the Polyzoa in the fact that the colony consists merely of a single individual, with its system of buds, which are produced in two series, each bud breaking off on reaching maturity. It is of minute size, and nearly always occurs on other animals, Sponges, Polychaet and Sipunculid worms, Ascidians or even Polyzoa. As in other Entoprocta, the individual consists of a muscular stalk bearing a "calyx" or body, which contains the viscera and bears the tentacles. *Pedicellina* (fig. 1), marine, has the individuals arranged in a linear series on an attached, narrow "stolon." The calyces are deciduous and can be regenerated, a process analogous to the formation of "brown bodies" in the Ectoprocta. *Urnatella,* a fresh water species.

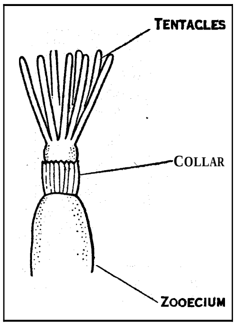


FIG. 4.—CTENOSTOMATA, (BOWERBANKIA)

Sub-class II. Ectoprocta.—Lophophore circular or shaped like a horseshoe (fig. 2), including the mouth but not the anus. Tentacles retractile into a delicate, flexible "introvert" ("tentacle-sheath") of the body-wall (fig. 6). Remainders of the body-wall membranous or calcified, the body-cavity spacious, containing the reproductive organs, which are not continuous with ducts. Specific excretory organs absent. Zooecia usually closely apposed to their neighbours, with which they are in organic connection by means of threads of living tissue, traversing "communication-pores" in the separating walls. There is naturally no evidence as to the anatomy of the two exclusively fossil Orders.

Tribe I. Gymnolaemata. Lophophore circular (fig. z), without an "epistome" or lip. Body-cavities not continuous with one another, body-wall not muscular.

Order 1. Trepostomata. Fossil, Palaeozoic. Zooecia long, coherent, their cavity traversed by many transverse partitions, which become more numerous near the terminal orifice. Surface of colony with regularly distributed elevations or "monticules." The reference of these organisms, which include the Rfonticuliporidae, to the Polyzoa has been disputed, but the characters of the primary individual of the colony are in favour of this association.

Order 2. Cryptostomata. Fossil, Palaeozoic. Zooecia usually shorter than in the Trepostomata, sometimes with transverse partitions. Orifice at the bottom of a vestibular shaft, which may be traversed by diaphragms. This order, which includes the net-like Fenestellidae, has been regarded by palaeontologists as ancestral to the Cheilostomata.

Order 3. Cyclostomata. Zooecia elongated, prismatic or cylindrical (fig. 3), with terminal, typically circular orifice, of the full width of the tubular part. The ovicells are modified, greatly enlarged zooecia, and, in the recent species investigated, contain numerous embryos, produced by the division of a single, primary embryo. The polypide is protruded with the aid of a "membranous sac," which surrounds it. The Cyclostomata are known from early Palaeozoic strata (Ordovician) onwards and are represented in the Cretaceous by specially numerous species; their highly calcareous zooecia being well preserved as fossils. They form a comparatively small proportion of the recent marine fauna, in which *Crisia, Tubulipora, Idmonea, Entalophora, Hornera* and *Lichenopora* are represented by many species.

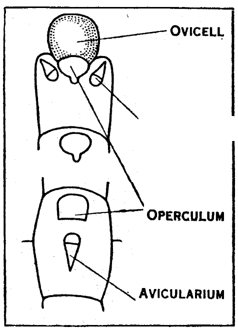


FIG. 5.—AVICULARIA AND OVICELL OF ENCRUSTING CHEILOSTOMATA

Order 4. Ctenostomata. Walls soft and uncalcified, the orifice being closed by a membranous "collar" (fig. 4), with folded walls, which surrounds it. Encrusting or erect and broadly lobed, the zooecia connected with one another (*Alcyonidium, Flustrella*); or erect and delicate, the zooecia arising separately from a connecting stem (*Amathia, Bowerbankia*). The preceding are marine, but *Victorella* and Paludicella, belonging to the second group, occur in fresh water. Certain Palaeozoic fossils (*Rhopalonaria, Vinella*) have been referred to this order.

Order 5. Cheilostomata. Much or little calcified, the orifice closed by a chitinous operculum (fig. 5). Polymorphism usually occurs, certain individuals being modified as "avicularia" or "vibracula." A prominent, globular "ovicell" is commonly found at the distal ("upper") end of the fertile zooecium, serving as an external brood-cavity in which an egg develops. This order is first known in the Mesozoic period (Jurassic), but its species become extremely numerous in the Cretaceous. In the Tertiary period, as at present, it is the dominant group of Polyzoa, chiefly marine but occasionally found in brackish water. Representative genera are: *Membranipora, Flustra, Onychocella, Cellaria, Scrupocellaria, Bugula, Schizoporella, Retepora, Cellepora.*

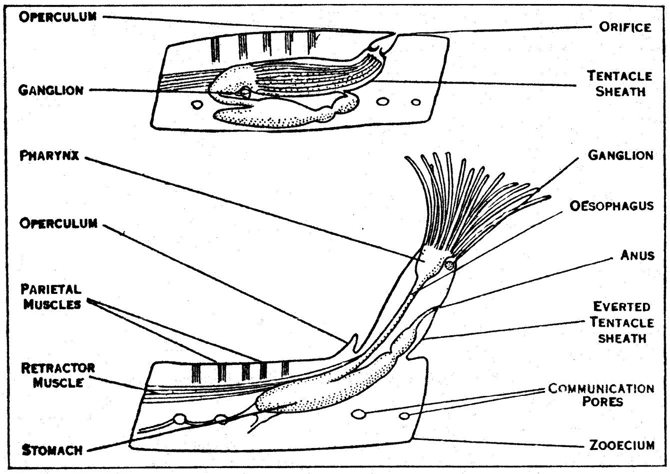


FIG. 6.—CHEILOSTOMATA ANASCA (ELECTRA), SHOWING ABOVE, POLYPIDE RETRACTED; BELOW, POLYPIDE EXPANDED

Tribe II. Phylactolaemata. Lophophore horseshoe-shaped (fig. 2), except in *Fredericella,* the mouth guarded by a lip or "epistome." Body-wall muscular, uncalcified, the body-cavities continuous with one another. Reproduction sexual and by means of "statoblasts" (fig. 12), internal buds protected by a chitinous shell. Fredericella, *Plumatella, Lophopus, Cristatella.* The colony can move slowly from place to place in the last two.

Structure of Ectoprocta.—The colony may assume several distinct forms: (*a*) Encrusting, the zooecia in close contact with one another, usually in a single layer, attached to a stone or seaweed by the basal surface, the orifices on the exposed or "frontal" surface, sometimes becoming multilaminar by the addition of new layers, each of which completely covers its predecessor, sealing the orifices; (b) erect, with broad lobes or branches, unilaminar or bilaminar, the zooecia correspondingly opening on one or both surfaces. Both these conditions are found in *Flustra* and its allies, in which there is little calcification and the branches are flexible. Retepora is a highly calcified unilaminar type, the branches of which form an elegant network. In other genera the branches are cylindrical, the orifices arranged all round the curved surfaces; (c) erect and more slender, resembling Hydroids, mostly unilaminar or with cylindrical branches, often with flexible joints; (d)

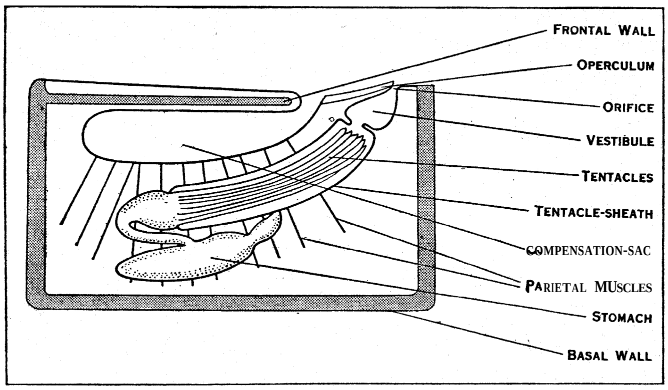
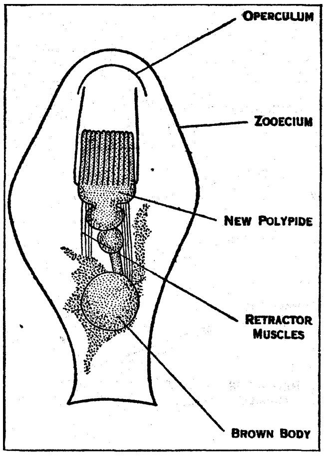


FIG. 7.— CHEILOSTOMATA ASCOPHORA, ILLUSTRATING THE METHOD OF PROTRUSION OF THE POLYPIDE

not rigidly attached, unilaminar, discoidal or conical.

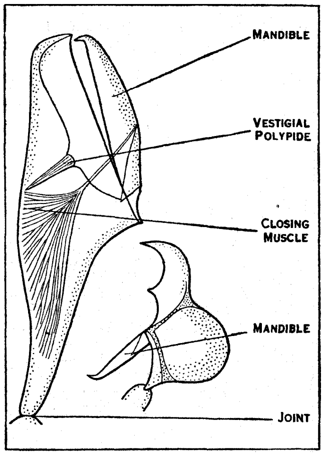
The zooecium of the Cheilostomata (fig. 6) resembles a shallow box, having the "orifice" near the distal end, the one further from the base or commencement of the colony. The orifice is the external opening of a thin-walled "tentacle-sheath," really a flexible, uncalcified part of the body-wall, pushed into the body-cavity. The tentacles arise from the blind end of the retracted sheath; and these parts, with the U-shaped alimentary canal and the nerve-ganglion which lies between the mouth and anus, constitute the "polypide." Retraction of the tentacles takes place rapidly by means of retractor muscles, but protrusion is a more gradual process and is effected by "parietal muscles," the contraction of which increases the fluid pressure in the body-cavity and forces out the tentacles. Some part of the body-wall must accordingly be flexible, and in the division Anasca (fig. 6) this is the whole or part of the frontal surface. In the Ascophora (fig. 7) most of the frontal wall is calcified and rigid, but the part which lies on the proximal side of the operculum has been pushed in as a very delicate "compensation-sac," into the basal wall of which the parietal muscles are inserted. The contraction of these muscles dilates the sac, into which water enters from the outside, and the mechanism of protrusion is thus the same as in the Anasca In the erect Ctenostomata the whole body-wall is flexible, and the parietal muscles produce their effect by passing from one part of it to another, across the body-cavity. In the Phylactolaemata the flexible body-wall is itself muscular. The calcareous Cyclostomata have a special, rather complicated arrangement for protrusion (see Borg, 1926).



FROM THE "QUARTERLY JOURNAL OF MICROSCOPIC SCIENCE"

FIG 8.—CHEILOSTOMATA; REGENERATION OF THE POLYPIDE (CARBASEA), AFTER HARMER

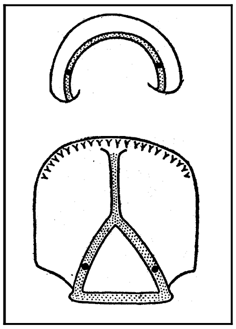
Regeneration of the **Polypide.**—The duration of life of the polypide does not correspond with that of the zooecium, which has a succession of polypides. This curious fact is probably the result of the absence of definite excretory organs, the function of which seems to be performed largely by the stomach. The wall of this organ becomes charged with brown granules (probably excretory), and after a time the entire polypide degenerates, decreasing in size and ultimately becoming a small, rounded "brown body" (fig. 8). which owes its colour to these granules The substances of nutritive value have probably been absorbed, for future use, by the cells which surround the degenerating polypide. An internal polypide-bud is simultaneously developed, and in some species its stomach envelopes the brown body, which passes into its cavity and is rejected with the faeces. In other cases the brown body remains as an inert mass in the zooecium, and the occurrence of several brown bodies indicates a corresponding number of degenerated polypides.



AFTER HARMER

FIG. 9.—CHEILOSTOMATA; LEFT, STALKED AVICULARIA OF CORNICOPINA, RIGHT, OF BUGULA

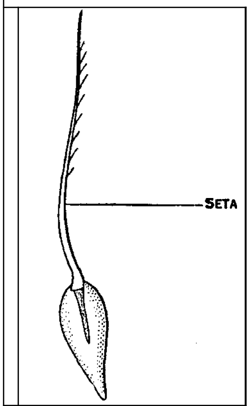
Polymorphism. — In the majority of Cheilostomata, certain zooecia have merely a vestige of a polypide, and the operculum, now known as the "mandible," and its muscles become modified for prehension. These units are known as "avicularia," from their resemblance to the head of a bird, in *Bugula* (fig. g) and other genera in which they attain their highest development. The avicularia may be "vicarious," in series with the zooecia, which they may surpass in size, the mandibles being often much larger than the opercula (fig. 10); or they are "adventitious" (fig. j), when they occur as appendages of ordinary zooecia. They are either "sessile," closely attached to the zooecia (fig. 5) or stalked (fig. g), and they show a wide range of form, in different species The "vibracula" (fig. 11), which are found in a small number of Cheilostomata, have the operculum transformed into a long "seta," which sweeps through the water. In Caberea the vibracula of a branch have been observed to move in unison, but this is exceptional. The avicularia and vibracula appear to be defensive organs, and they doubtless ward off the attacks of some predacious animals. They probably prevent the overgrowth of the colony by encrusting organisms, by discouraging the attachment of larvae, and they may also serve to keep the colony clean, by dislodging foreign particles which might otherwise settle on it.



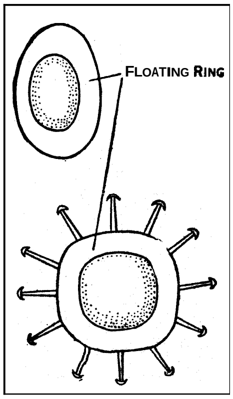
AFTER HARMER

FIG. 10.—CHEILOSTOMATA (STEGANOPRELLA) Above, operculum, below, mandible of avicularium

Reproduction. — The reproductive organs occur in the body-cavity in Ectoprocta; and organs of both sexes may be produced by a single zooecium, simultaneously or successively. The colony seems to be generally bisexual, even when testes and ovaries are found in different zooecia. The ciliated larvae, in this group, rarely possess an alimentary canal. If this is present they are known as *Cyphonautes,* a common constituent of the floating fauna, especially of coastal waters. If it is absent the tissues are charged with nutritive yolk. In either case, the larva attaches itself, loses its larval organs and becomes the "ancestrula" or first zooecium of the colony, developing a polypide as an internal bud. The ancestrula buds off other zooecia, which repeat the process, thus building up the colony; and the zooecia develop their polypides in the same way as the ancestrula. In species with a *Cyphonautes* the egg develops in the water, but in most cases it develops in the parent colony. The characteristic "ovicells" of Cheilostomata (fig. 5) are external brood-spaces into which the egg passes when it is laid, and are formed in part by the distal end of the fertile zooecium, but principally by the frontal surface of the succeeding zooecium The egg passes from the body-cavity to the exterior (in the few cases where the process has been observed) through the "intertentacular organ," a ciliated tube between the bases of the two tentacles nearest the anus, or through a pore found in the same position. The Cheilostome ovicell nearly always contains a single egg, but in the Cyclostomata the ovicell (fig. 3) contains very numerous embryos, which have been produced by the fission of a primary embryo, developed from an egg In Phylactolaemata the polypide is produced by the larva while it is still free, several polypides occurring in *Cristatella* before the larva attaches itself. Another form of reproduction is found in this group, where the zooecium produces internal buds from the "funiculus," a cord connecting the blind end of the stomach with the body-wall These special buds are known as "statoblasts" (fig 12), and each is protected by a strong chitinous shell, the outer part ("annulus") of which is modified as a ring containing air-



. 11.—CHEILOSTOMATA, VIBRACULUM OF CABEREA



AFTER KRAEPELIN

FIG 12 —STATOBLASTS OF PHYLACTOLAEMATA Above, *Plumatella;* below, *Pectinatella* cells which enable the statoblast to float on the surface of the water when it becomes free. In temperate latitudes this happens in the late summer or autumn, and the statoblast develops into a new colony in the ensuing spring.

BIBLIOGRAPHY.—G. Busk, *Catalogue of Marine Polyzoa in the British Museum* pts. i-iii (1852, 1854, 1875) and "Report on the Polyzoa," pts. i, ii, *Challenger Reps.*, pts. xxx 1/50 (1884, 1886); G. J. Allman, *Monograph of the Fresh-wafer Polyzoa,* Roy. Soc. (1856); T. Hincks, *A History of the British Marine Polyzoa* (2 vols., 1880); K. Kraepelin, "Die deutschen Siisswasser-Bryozoen," i, ii, *Abhandl. Naturw. Ver. Hamburg,* Festschrift and Bd. xii (1887, 1892); E. C. Jelly, *Synonymic Catalogue of the Recent Marine Bryozoa* (1889); S. F. Harmer, "Polyzoa," *Cambridge Nat. Hist.*, ii, 463 (1896), general account, and "The Polyzoa of the Sibega Expedition," pts. i, ii, *Siboga Reps.*, Monogr. xxviii a,b (Leyden 1915, 1926); J. M. Nickles and R. S. Bassler, "Synopsis of American Fossil Bryozoa, including Bibliography and Synonymy," *Bull. U.S. Geol. Surv.*, No. 173 (1900); K. A. von Zittel, *Text-book of Palaeontology,* i, 314 (1913); F. Borg, "Studies on Recent Cyclostomatous Bryozoa," *Zool. Bidrag från Uppsala,* x (Uppsala, 1926).
(S. F. H.)

POMBAL, SEBASTIÃO JOSE DE CARVALHO E MELLO, MARQUESS OF (1699–1782), Portuguese statesman, was born at Soure near Pomba, on May 13, 1699. In 1739 he was sent as Portuguese ambassador to London, where he remained until 1745. He was then transferred to Vienna. In 1749 he took up the post of secretary of state for foreign affairs and war. Though he came into power only in his 51st year, without previous administrative experience, he was able to reorganize Portuguese education, finance, the army and the navy. He also built up new industries, promoted the development of Brazil and Macao. and expelled the Jesuits. His complete ascendancy over the mind of King Joseph dates from the time of the great Lisbon earthquake (Nov. 1, 17jj). In Sept. 1770 he was made marquess of Pombal.

Soon after the death of King Joseph, in 1777, Pombal was dismissed from office; and he was only saved from impeachment by the death of his bitterest opponent, the queen-mother, Mariana Victoria, in Jan. 1781. On Aug. 16, a royal decree forbade him to reside within 20 leagues of the court. He died at Pombal on May 8, 1782.

See in addition to the works dealing with the period 1750–77 and quoted under PORTUGAL: *History;* S.J.C.M. (Pombal), *Relação abreviada,* etc. (Paris, 1758); *Memoirs of the Court of Portugal,* etc. (1765); *Anecdotes du ministère de Pombal* (Warsaw, 1781); *Administration du marquis de Ponzbal (4* vols., Amsterdam, 1787); *Cartas . . . do marques de Pombal* (3 vols., Lisbon, 1820–24); J. Smith, Count of Carnota, *Menzoirs of the Marquess of Pombal,* etc. (1843); F. L. Gomes, *Le Marquis de Pombal,* etc. (1869); B. Duhr (S.J.), *Pombal,* etc. (Freiburg im Breisgau, 1891); C. J. de Menezes, *Os Jesuitas* e o *marques* de *Pombal* (Oporto, 1893).

POMEGRANATE. Throughout the orient this fruit has since earliest times occupied a position of importance alongside the grape and the fig. It is produced by a bush or small tree, *Punica granatum,* only member of the family Punicaceae.

King Solomon possessed an orchard of pomegranates; and when the children of Israel, wandering in the wilderness, sighed for the abandoned comforts of Egypt, the cooling pomegranates were remembered longingly. Centuries later, the prophet Mohammed remarked sententiously: "Eat the pomegranate, for it purges the system of envy and hatred." It will thus be seen that this fruit is of exceptional interest because of its historic background.

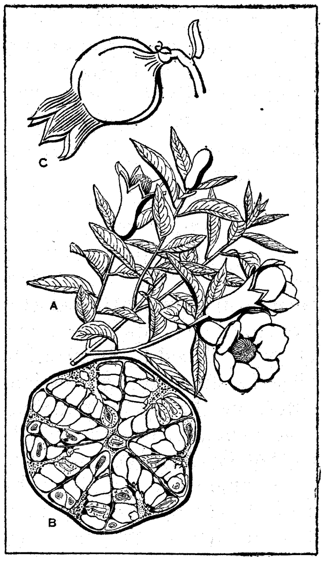
While the pomegranate is considered to be indigenous in Persia and perhaps neighbouring countries, its cultivation long ago encircled the Mediterranean and extended through Arabia, Afghanistan and India.

There is something in the character of the juicy subacid pomegranate which makes it particularly agreeable to inhabitants of hot arid regions — which are precisely those in which it attains its greatest perfection.

The ancient Semitic name rimmon was adopted by the Arabs as *rumman,* from which the Portuguese in turn formed *romão* or roman. From the early Roman names *malum punicum* (apple of Carthage) and *granatum* have come the modern botanical binomial and the common name *granada,* used in Spanish-speaking countries.

The plant, which may attain 15 or 20 ft. in height, has elliptic to lanceolate bright green leaves about 3 in. long, and handsome axillary orange-red flowers borne toward the ends of the branchlets. The calyx is tubular, persistent, 5- to 7-lobed; the petals lanceolate, inserted between the calyx-lobes. The ovary is embedded in the calyx-tube and contains several locules in two series, one above the other.

The fruit is the size of an orange and often larger, obscurely six-sided, with a smooth leathery skin which ranges from brownish yellow to red in colour. Within it is divided into several cells, containing many thin transparent vesicles of reddish juicy pulp, each surrounding an angular elongated seed. A ripe pomegranate has a delightful subacid flavour.



POMEGRANATE (PUNICA GRANATUM), A. BRANCH WITH FLOWERS. B. TRANSVERSE SECTION THROUGH FRUIT SHOWING SEEDS, C. YOUNG FRUIT

Presumably the plant was introduced into the new world by the early Spanish colonists. It is commonly cultivated in gardens from the warmer parts of the United States to Chile. Small commercial plantings have been made in California. Though it will grow in a wide range of climates, good fruit is produced only where high temperatures and dry atmosphere accompany the ripening period. Deep, rather heavy loams are probably the best soils. Propagation is effected by seeds, cuttings and layers: the first-named can readily be grown, but choice varieties cannot be reproduced in this manner. Commercial propagation is by hardwood cuttings 10 to 12 in. long, which can be rooted in the open ground.

The varieties of the pomegranate are numerous. Ibn-al-Awam, a Moor who wrote in the 13th century, described some ten which were grown in southern Spain at that time. The three leading ones which have been cultivated commercially in the United States are Wonderful, Paper-Shell and Spanish Ruby. There are also dwarf forms which produce fruit of no value but are grown for their handsome scarlet flowers. (W. Po.)

POMERANIA (German, Pommern), a territory of Germany and a maritime province of Prussia, bounded on the north by the Baltic, on the west by Mecklenburg, on the south by Brandenburg, and on the east by Poland. Its area, with the border province (Grenzmark Posen-Westpreussen), is 14,870 sq.mi. and the population in 1939 was 2,405,048, showing a density of 162 inhabitants to the square mile. Pomerania is one of the flattest parts of Germany, although east of the Oder it is traversed by a range of low hills, and there are also a few isolated eminences to the west. Off the west coast, which is very irregular, lie the islands of Rügen, Usedom and Wollin; the coast of Farther Pomerania is smooth in outline and is bordered with dunes, or sandbanks. Besides the Oder and its affluents, the chief of which are the Peene, the Ücker and the Ihna, there are several smaller rivers flowing into the Baltic; a few of these rivers are navigable for ships, but the greater number only carry rafts.

The soil of Pomerania is for the most part thin and sandy, but patches of good land are found here and there. The principal crops are potatoes, rye and oats, but wheat and barley are grown in the more fertile districts; tobacco, flax, hops and beetroot are also cultivated. Horses for farmwork, sheep for both wool and mutton, cattle, pigs, geese (for flesh and feathers) are features of local agriculture. Owing to the long line of coast and the numerous lakes, fishing forms an important industry. Linen weaving is practised as a domestic industry. Shipbuilding is carried on at Stettin and at several places along the coast. The chief commercial ports of Pomerania are Stettin, Stralsund and Swinemünde. Education is provided for by a university at Greifswald and by numerous schools.

History.— In prehistoric times the southern coast of the Baltic seems to have been occupied by Celts, who afterwards made way for tribes of Teutonic stock. These in their turn were replaced, about the end of the 5th century A.D. by Slavonic tribes, the Wilzi and the Pomerani. The name of Pomore, or Pommern, meaning "on the sea," was given to the district by the latter of the tribes about the time of Charlemagne. Originally it seems to have denoted the coast district between the Oder and the Vistula. Afterwards Pomerania extended much farther to the west, while being correspondingly curtailed on the east, and a distinction was made between Slavinia, or modern Pomerania, and Pomerellen. The latter, corresponding substantially to the so-called Polish corridor, remained subject to Poland until 1309, when it was divided between Brandenburg and the Teutonic Order.

The history of Pomerania, as distinct from that of Pomerellen, consists mainly in a succession of partitions and in constant hostilities with the elector of Brandenburg, who claimed to be its immediate feudal superior. During the Thirty Years' War Pomerania was devastated and by the peace of Westphalia the elector of Brandenburg acquired eastern Pomerania (Hinterpommern), and the western part (Vorpommern) was awarded to Sweden. In 1720 Swedish Pomerania was curtailed by extensive concessions to Prussia, but the district to the west of the Peene remained in the possession of Sweden until the general European settlement of 1815. Then Sweden assigned her German possessions to Denmark in exchange for Norway, whereupon Prussia, partly by purchase and partly by the cession of the duchy of Lauenburg, finally succeeded in uniting the whole of Pomerania under her rule.

See F. W. Barthold, *Geschichte von Rügen und Pommern* (Hamburg, 1839–45); the *Codex Pomeraniae diplomaticus,* edited *by* K. F. W. Hasselbach and J. G. L. Kosegarten (Greifswald, 1862); H. Berghaus, *Landbuch des Herzogtums Pommern* (1865–76); K. Mass, *Pommersche Geschichte* (Stettin, 1899); J. Bugenhagen, *Pomerania,* edited by O. Heinemann (Stettin, 1900); M. Wehrmann, *Geschichte von Pommern* (Gotha 1904–6).

POMFRET, JOHN (1667–1702), English poet, born at Luton, became rector of Maulden, Bedfordshire, in 1695, and of Milibrook in the same county in 1702. His poems were printed in Johnson's *English Poets* (1779, vol. xxi.).

POMMER or **BOMBARD,** the alto, tenor and basses of the shawm or schalmey family, and the forerunners respectively of the cor-anglais, bassoon or fagotto, and double bassoon or contrafagotto. (See Bassoon and Oboe.)

POMO. This group of American Indians, speaking seven dialects of Hokan (*q.v.*) lineage, on Russian river and Clear lake, California, is noted for its basketry, which is perhaps the finest and most varied made on the continent. The general culture was central Californian as typified by the Maidu (*q.v.*). The Pomo have decreased from about 8,000 to 800. *See* S. A. Barrett, *Univ. Calif. Publ. Am. Arch. Ethn.*, vols. vi., vii. (1908); E. W. Gifford, *ibid.*, vol. xviii. (1926); E. M. Loeb, *ibid.*, xix. (1926).

POMONA, an old Italian goddess of fruit and gardens. Pomona had a special priest at Rome, the *flamen Pomonalis,* and a sacred grove near Ostia, called the Pomonal.

POMONA, a city of Los Angeles county, California. U.S.A., 30 mi. E. of Los Angeles, at an altitude of 850 feet. It is served by the Santa Fe, the Southern Pacific, and Union Pacific and electric railways, and by motor coach lines. Pop. 13,505 in 1920 (88% native white); in 1940 it was 23,539 by the federal census. It is one of the principal shipping points in the state for citrus fruits and walnuts. At Claremont, 4 mi. N., is Pomona college, incorporated under the auspices of the Congregational churches of Southern California in 1887. Pomona was founded by fruit-growers in 1875 and was chartered as a city in 1875.

POMONA or **MAINLAND,** central and largest island of the Orkneys. Scotland. Pop. (1931) 13,352. It is 25 in. long from N.W. to S.E. and 15 m. broad from E. to W.; area, 190 sq.m.; hut where the coast is cut into, on the N. by Kirkwall Bay and on the S. by Scapa Flow, the land is less than 2 in. across. The west coast is almost unbroken, the bays of Birsay and Skaill being the only bays of any importance, but the east and south shores are much indented. The highest points of the watershed from Costa Head to the Scapa shore are Milldoe to the north-east of Isbister and Wideford Hill to the west of Kirkwall. There are also a few eminences towards the south-west, Ward Hill (880 ft.) in the parish of Orphir being the highest peak in the island. There are numerous lakes, some of considerable size and most of them abounding with trout. Kirkwall, the capital of the Orkneys, and Stromness are the only towns.

In Harray, the only parish in the Orkneys not trenched at some point by the sea, Norse customs have survived longer than elsewhere in the group save in North Ronaldshay.

The antiquities of Pomona are of great interest. The examples of Pictish remains include *brochs,* chambered mounds and weems, or underground dwellings afterwards roofed in. North-east of Stromness, and within a mile of the stone circles of Stenness, stands the great barrow or chambered mound of Maeshowe. The tumulus has the form of a blunted cone, 300 ft. in circumference, and at a distance of 90 ft. from its base is encircled by a moat. The ground-plan shows that it was entered from the west by a passage, which led to a central apartment, the walls of which ended in a beehive roof. The barrow is variously ascribed to the Stone Age and to 10th century Norsemen.

The stone circles forming the Ring of Brogar and the Ring of Stenness lie $4\frac{1}{2}$ m. N.E. of Stromness. The Ring of Brogar, once known as the Temple of the Sun, stands on a raised circular platform of turf, surrounded by a moat and a grassy rampart. The ring originally comprised 60 stones, varying from 9 to 14 ft. in height, set up at intervals of 17 ft. Only 13 are now erect. The Ring of Stenness—the Temple of the Moon of local tradition—is of similar construction. The Stone of Odin, the great monolith, pierced by a hole at a height of 5 ft. from the ground, which figures so prominently in Scott's *Pirate,* stood 150 yd. to the north of the Ring of Stenness.

POMORZE or **POMERANIA** (*i.e.,* "along the sea"), a province of Poland, bounded on the N. by the Baltic, on the E. by East Prussia, on the S. by the provinces of Warsaw and Poznan, on the W. by Germany. Area, 9,917 sq.mi.; pop. (1931), 1,086,000. Germany seized the province in 1939.

Pomorze, which has been, in modern times, very incorrectly called West Prussia and the "Polish corridor," consists of two quite distinct units. West of the Vistula is eastern Pomerania, which was colonized by Poland when West Pomerania became a German colony, was seized by the Teutonic Order in 1309, recovered by Poland in 1466 and held till 1773, when it was seized by Prussia. East of the Vistula is the territory of Chelmno or Kulm, a Polish border province ceded to the Teutonic Order in the 13th century and recovered in 1466. Both these territories remained mainly Polish despite the colonizing efforts of the Prussian government in the 19th century. Danzig, which had a German majority, was made into a Free State by the treaty of Versailles; mixed areas decided their future by a plebiscite, and the remaining territory was reunited to the other parts of Poland, to which it was essential as the only outlet of Poland on the sea. The Prussian rule of over 140 years left a German minority, forming 11% of the population; the Poles formed 89% (1935).

Pomorze is mainly an agricultural country, its industries depending on agriculture. Together nith Poznan, it was formerly one of the chief sources of foodstuffs for Germany. The peasant is highly educated and well organized, the agricultural co-operative societies having been a great economic and national asset. Forestry is well organized in the great Tuchola forest. Distilling, brewing and sugar refining are important industries. The province is famous for stockbreeding, having a greater number of sheep per acre than any other part of Poland. The fisheries are extensive, but not well organized. The province is well served by railways. A constantly growing traffic by rail and river descends to Danzig and the new port of Gdynia. The chief towns are Gdynia (pop. 120,000 in 1939), Torun (pop. 54,000 in 1939), Grudziadz (pop. 54,000) in the east; Chojnice, Puck, Tuchola, Starograd and Swiecie in the west. Pomorze, tactically difficult to defend, was rapidly conquered by Germany in World War II.

POMPADOUR, JEANNE ANTOINETTE POISSON LE NORMANT D'ÉTIOLES, MARQUISE DE (1721–1764), mistress of Louis XV., was horn in Paris on Dec. 29, 1721, and baptized as the legitimate daughter of François Poisson, an officer in the household of the duke of Orleans, and his wife, Madeleine de la Motte, in the church of St. Eustache; but she was educated at the charge of a wealthy financier and farmer-general of the revenues, Le Normant de Tournehem. He declared her "un morceau de roi," and specially educated her to be a king's mistress. This idea was confirmed in her childish mind by the prophecy of an old woman, whom in after days she pensioned for the correctness of her prediction In 1741 she was married to a nephew of her protector and guardian, Le Normant d'Étioles, who was passionately in love with her, and she soon became a queen of fashion. The king met her at a ball given by the city to the dauphin in 1744, and he was immediately subjugated. She at once gave up her husband, and in 1745 was established at T'ersailles as "maîtresse en titre." Louis XV. bought her the estate of Pompadour, from which she took her title of marquise (raised in 1752 to that of duchess).

She was hardly established firmly in power before she began to mix in politics. Knowing that the French people of that time were ruled by the literary kings of the time, she paid court to them, and tried to play the part of a Maecenas. T'oltaire was her poet in chief, and the founder of the physiocrats, Quesnay, was her physician. The command of the political situation passed entirely into her hands; she it was who brought Belle-Isle into office with his vigorous policy; she corresponded regularly with the generals of the armies in the field, as her letters to the Comte de Clermont prove; and she introduced the Abbé de Bernis into the ministry in order to effect a very great alteration of French politics in ijj6. The continuous policy of France since the days of Richelieu had been to weaken the house of Austria by alliances in Germany; but Mme. de Pompadour changed this hereditary policy for the alliance with Austria which brought on the Seven Years' War, with all its disasters.

But it was to internal politics that this remarkable woman paid most attention. She made herself indispensable to Louis. She died on April ij, 1764, at the age of forty-two

See Capefigue, *Madame la marquise de Pompadour* (1858); *E.* and J. de Goncourt, *Les Mattresses de Louis XV.*, vol. ii. (1860); and Campardon, *Madame de Pompadour et la cour de Louis XV. au milieu du dix-huitidnze siècle* (1867). Far more valuable are Malassis's two volumes of correspondence, *Correspondance de Madame de Pompadour avec son père M. Poisson, et son frère M. de Vanditres,* etc. (1878), and Bonhomme, *Madame de Pompadour, général d'armée* (1880), containing her letters to the Comte de Clermont. *See* also P. de Nolhac, *La Marquise de Pompadour* (1903).

POMPEII, an ancient town of Campania, Italy, near the river Sarnus, almost at the foot of Mt. Vesuvius. Its foundation was ascribed by Greek tradition to Heracles, in common with the neighbouring city of Herculaneum, but it was not a Greek colony. Strabo, in whose time it was a populous and flourishing place, tells us that it was first occupied by the Oscans, afterwards by the Tyrrhenians (*i.e.,* Etruscans), to whom it probably owes its rectangular ground plan, and Pelasgians, and lastly, by the Samnites. (See CAMPANIA.) No doubt, Pompeii shared the fate of the neighbouring cities, and afterwards passed in common with them under the yoke of Rome. But its name is only mentioned incidentally during the wars of the Romans with the Samnites and Campanians only when a Roman fleet landed near Pompeii in 309 B.C. and made an unsuccessful marauding expedition up the river valley as far as Nuceria. At a later period, however, it took a prominent part in the Social War (91–89 B.C.), when it withstood a long siege by Sulla, and was one of the last cities of Campania that were reduced by the Roman arms. The inhabitants were admitted to the Roman franchise, but a military colony was settled in their territory in 80 B.C. by Sulla (Colonia Cornelia Veneria *Pompeianorum*), and the whole population was rapidly Romanized. Before the close of the republic many Roman nobles acquired villas in the neighbourhood, among them Cicero, whose letters abound with allusions to his Pompeian villa. The same fashion continued under the empire, and during the first century of the Christian era, Pompeii had become a flourishing place with a considerable population. In AD. 59 a tumult took place in the amphitheatre between the citizens and visitors from Nuceria. Many were killed and wounded on both sides. The Poinpeians were punished for this violent outbreak by the prohibition of all theatrical exhibitions for ten years. A painting on the walls of one of the houses represents this event.

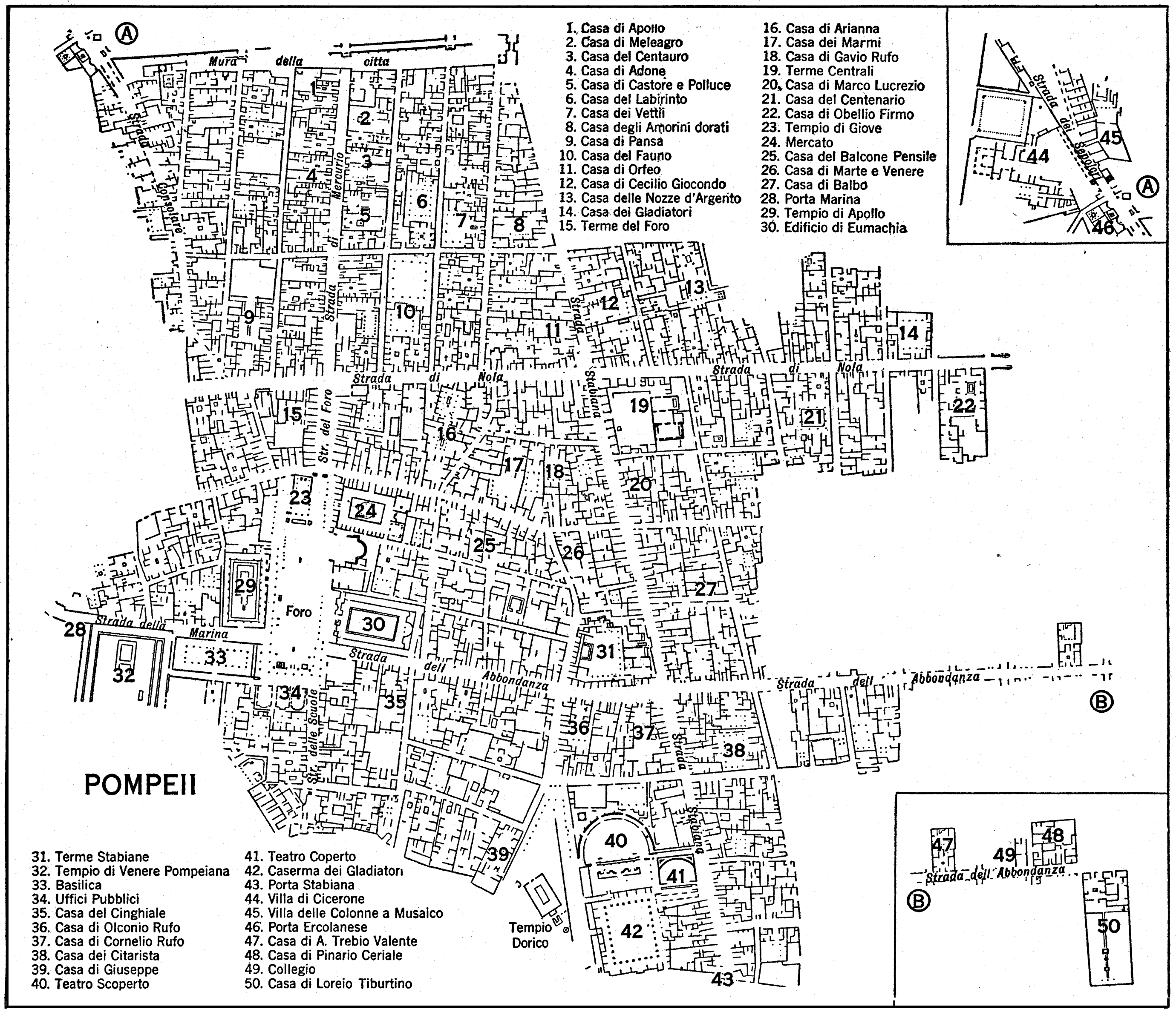
Four years afterwards (A.D. 63) an earthquake vented its force especially upon Pompeii, a large part of which, including most of the public buildings, was either destroyed or so seriously damaged as to require to be rebuilt. The inhabitants were still actively engaged in repairing and restoring it, when the whole city was overwhelmed by the great eruption of Vesuvius (*q.v.*), A D 79. Pompeii was merely covered with a bed of lighter substances, cinders, small stones and ashes, which fell in a dry state, while at Herculaneum the same substances, being drenched with water, hardened into a sort of tufa, which in places is 65 ft. deep. The whole of this superincumbent mass. attaining to an average thickness of from 18 to 20 ft., was the product of one eruption, though the materials may be divided generally into two distinct strata, the one consisting principally of cinders and small volcanic stones (called in Italian *lapilli*), and the other and uppermost layer of fine white ash, often consolidated by the action of water from above so as to take the moulds of objects contained in it (such as dead bodies, woodwork, etc.), like clay or plaster of Paris. It was found impossible to rebuild the town, and its territory was joined to that of Nola. But the survivors returned to the spot, and by digging down and tunnelling were able to remove all the objects of value, even the marble facing slabs of the large buildings.

In the middle ages, however, the very site was forgotten. Ruins and inscriptions were found by the architect Domenico Fontana in making an underground aqueduct across the site in 1594–1600, but only in 1748 a more careful inspection of this channel revealed the fact that beneath there lay entombed ruins far more accessible than those of Herculaneum. Only in 1763 systematic excavations were begun; the work, which had received a vigorous stimulus during the period of the French government (1806–14), was prosecuted under the Bourbon kings (1815–61). Since 1861 it has been carried on under the Italian government on a system devised by G. Fiorelli, according to which the town is for convenience divided into 6 or g regions, which are subdivided into *insulae* (blocks), the gates, streets and houses being also named for convenience, though often incorrectly.

The town was situated on rising ground less than a mile from the foot of Vesuvius. This eminence is itself due to an outflow of lava from that mountain, during an eruption in prehistoric times, for we know that Vesuvius had been quiescent ever since the Greek settlements in this part of Italy.

The area occupied by the ancient city was of an irregular oval form, and about 2 m. in circumference. It was surrounded by a wall, which is still preserved for more than two-thirds of its extent, but no traces of this are found on the side towards the sea, and there is no doubt that on this side it had been already demolished in ancient times, so as to give room for the free extension of houses and other buildings in that direction. It consisted of two parallel stone walls with buttresses, about 15 ft. apart and 28 in. thick, the intervening space being filled with earth, and there being an embankment on the inner side. These walls are strengthened at intervals by numerous towers, occupying the full width of the wall. They appear to have been added at a later period, probably that of the Social War. Similar evidences of the addition of subsequent defences are to be traced also in the case of the gates, of which five have been cleared, while at least one (and perhaps three) more are unexcavated

The general plan of the town is very regular, the streets being generally straight, and crossing one another at right angles or nearly so. But exceptions are found in the south-west corner, where a small irregular group of streets represents the original Oscan settlement, and on the north-west in the street



FROM "GUIDA D'ITALIA DEL TOURING CLUB ITALIANO"

leading from the Porta Ercolanese (gate of Herculaneum) to the forum, which, though it must have been one of the principal thoroughfares in the city, was crooked and irregular, as well as very narrow, in places not exceeding 12 to 14 ft. in width. Another exception is to be found in the Strada Stabiana (Stabian Street) or Cardo, which, owing to the existence of a natural depression which affects also the line of the street just east of it, is not parallel to the other north and south streets. The other main streets are in some cases broader, but rarely exceed 20 ft. in width, and the broadest is about 32 ft., while the back streets running parallel to the main lines are only about 14 ft. (the standard width of a Roman highroad). They are uniformly paved with large polygonal blocks of hard basaltic lava, fitted very closely together, though now in many cases marked with deep ruts from the passage of vehicles in ancient times. They are also in all cases bordered by raised footways on both sides, paved in a similar manner; and for the convenience of foot-passengers, these are connected from place to place by stepping-stones raised above the level of the carriage-way. The careful investigation in recent years of the buildings in the eastern portion of the Strada dell' Abbondanza has shown that previous conceptions of the appearance of the exterior of the houses were entirely erroneous. The upper stories were diversified by balconies, open loggias, colonnades, etc., while the lower portions of the façades were painted, often with scenes of considerable interest. The streets were also diversified by fountains, small water-towers and shrines.

The first-mentioned of the two principal streets was crossed, a little before it reached the forum, by the street which led directly to the gate of Nola (Strada delle Terme, della Fortuna, and di Nola). Parallel to this last to the south is a street which runs from the Porta Marina through the forum, and then, with a slight turn, to the Sarno gate, thus traversing the whole area of the city from east to west (Via Marina, Strada dell' Abbondanza, Strada dei Diadumeni). These two east and west streets are the two *decumani.*

The population of Pompeii was mixed; both Oscan and Greek inscriptions are still found up to the last, and evidences of the presence of Jews are not lacking—such are a wall-painting, probably representing the Judgment of Solomon, and a scratched inscription on a wall, "Sodoma, Gomora." From the number of skeletons discovered, about 2,000 persons may have perished in the city itself in the eruption of A.D. 79.

The whole portion of the city which lies to the west of the Strada Stabiana, towards the forum and the sea, has been completely excavated. It is over one-half of the whole extent, and that the most important portion, inasmuch as it includes the forum, with the temples and public buildings adjacent to it, the thermae, theatres, etc. The greater part of that on the other side of the Strada Stabiana remains still unexplored, with the exception of the amphitheatre, a small space in its immediate neighbourhood and the buildings on each side of the Strada dell' Abbondanza and the Strada di Nola.

The forum at Pompeii was the centre of the life and movement of the city. Hence it was surrounded on all sides by public buildings or edifices of a commanding character. It was not, however, of large size, only 467 ft. in length by 126 in breadth (excluding the colonnades). The nature of its pavement, composed of broad flags of travertine, into which was let an inscription in large bronze letters, shows that it was only intended for foot-passengers. It was adorned with numerous statues. It was surrounded on three sides by a series of porticos supported on columns; and these porticos were originally surmounted by an upper storey, traces of the staircases leading to which still remain. Both this portico and the adjacent buildings were undergoing a process of restoration after the earthquake of 63, involving material changes in the original arrangements, which was still incomplete at the time of their final destruction. The north end of the forum, where alone the portico is wanting, is occupied in great part by the imposing temple of Jupiter, Juno and Minerva, or Capitolium. It was raised on a podium 10 ft. high, and had a portico with six Corinthian columns in front. This magnificent edifice had, however, been evidently overthrown by the earthquake of 63, and is in its present condition a mere ruin, the rebuilding of which had not been begun at the time of the eruption. On each side of it were two arches, affording an entrance into the forum, but capable of being closed by gates. On the east side of the forum were four public edifices. The first (from the north), is a *macellum* or meat-market, consisting of a rectangular court surrounded by a colonnade, with a twelve-sided roofed building (*tholus*) in the centre. On the south side were shops, and in the centre of the east side a chapel for the worship of the imperial house. Next to this comes the sanctuary of the Lares of the city, a square room with a large apse; and beyond this a small temple. Beyond this again, bounded on the south by the Strada dell' Abbondanza, is a large and spacious cloth-exchange, erected by a priestess named Eumachia. It is an open court, oblong, surrounded on all four sides by a colonnade; in front is a portico facing the forum, and on the other three sides there is a corridor behind the colonnade with windows opening on it. On the south side of the Strada dell' Abbondanza was the Comitium. At the south end of the forum are three halls side by side, similar in plan with a common façade —the central one, the curia or council chamber, the others the offices respectively of the duumvirs and aediles, the principal officials of the city; while the greater part of the west side is occupied by two large buildings—a basilica, which is the largest edifice in Pompeii, and the temple of Apollo, which presents its side to the forum. The former, a building of the 2nd cent. B.C., was an oblong edifice divided by columns into a central hall and a corridor running round all the four sides with a tribunal opposite the main entrance; and, unlike the usual basilicae, it had, instead of a clerestory, openings in the walls of the corridor through which light was admitted, it being almost as lofty as the nave. The temple was an extensive edifice, having a comparatively small *cella*, raised upon a *podium*, and standing in the midst of a wide space surrounded by a portico of columns, outside which again is a wall, bounding the sacred enclosure. Between this temple and the basilica the Via Marina leads off direct to the Porta Marina.

The remains of five other temples have been discovered. The most interesting, though the least perfect, is not only by far the most ancient edifice in Pompeii, but a true Greek temple (6th century B.C.). Unfortunately only the foundation and a few Doric capitals and other architectural fragments remain; they were coated with brightly painted stucco. The reverence attached to it in later periods is shown by its being left standing in the midst of a triangular space adjoining the great theatre, which is surrounded by a portico, so as to constitute a kind of forum (the so-called Foro Triangolare). Not far off, and to the north of the great theatre, stood a small temple, dedicated to Isis, rebuilt after the ruinous earthquake of 63. It is interesting as the only temple of Isis that has come down to us in a good state of preservation. The decorations were of somewhat gaudy stucco. The plan is curious, the internal arrangements being adapted for the performance of the peculiar rites of this deity. Close to this was the small temple of Zeus Milichius. The temple of the Fortune of Augustus (Fortuna Augusta), which stood north of the Forum, suffered very severely from the earthquake, but we learn from existing remains that its walls were covered with slabs of marble, and that the columns of the portico were of the same material. The fifth temple, that of Venus Pompeiana, to the west of the basilica, was in process of rebuilding at the time of the eruption. Before the earthquake of 63 it must have been the largest temple of the whole city. It was surrounded by a large colonnade, and the number of marble columns in the whole block has been reckoned at 296. Venus was the protectress of the young men of Pompeii, who had formed a society for gymnastics and other sports. They met in a hall (the Schola Iuventutis Pompeianae) in the Strada dell' Abbondanza.

All the temples above described, except that ascribed to Hercules, which was approached by steps on all four sides, agree in being raised on an elevated *podium* or basement—an arrangement usual with all similar buildings of Roman date. Among the other public buildings, the most conspicuous are the theatres, of which there were two, placed, as was usual in Greek towns, in close juxtaposition with one another. The largest of these, which was partly excavated in the side of the hill, was in great part cased with marble, with seats of the same material for about 5,000 spectators. It was erected in Roman times by two members of the same family, M. Holconius Rufus and M. Holconius Celer, both of whom held important municipal offices at Pompeii during the reign of Augustus. Their work was only a reconstruction of a more ancient edifice (probably 5th cent. B.C.), while its first alteration belongs to the "tufa" period, and three other periods in its history can be traced. The smaller theatre (for 1,500 spectators) was erected by two magistrates specially appointed for the purpose by the decuriones of the city, soon after the establishment of the Roman colony under Sulla. It was permanently covered.

Adjoining the theatres is a large rectangular enclosure, surrounded by a portico, at first the colonnade connected with the theatres, and converted, about the time of Nero, into the barracks of the gladiators. Remains of armour and weapons were found in some of the rooms, and in one, traces of the stocks used to confine insubordinate gladiators with three skeletons in them (63 were found in the whole building). The amphitheatre was erected by the same two magistrates who built the smaller theatre, C. Quinctius Valgus and M. Porcius when no permanent edifice of a similar kind had yet been erected in Rome itself, and is indeed the oldest structure of the kind known to us. It is in great part excavated in the surface of the hill, instead of the seats being raised on arches. Nor are its dimensions (460 by 34; ft.) such as to place it in the first rank, nor are there any underground chambers below the arena. The seating capacity was about 20,000 (for illustration see AMPHITHEATRE).

Among the more important public buildings of Pompeii were the public baths (*thermae*). Three different establishments of this character have been discovered, the first, the baths near the forum, though the smallest of the three. is in some respects the most complete and so well preserved that we trace without difficulty all the separate apartments described to us by Roman authors—the apodyterium, *frigidarium, tepidarium*, caldarium, and so on. (See BATHS.) The greater thermae (the so-called "Stabian" baths), which were originally built in the 2nd century B.C., and repaired about 80 B.C., are more extensive and combine a palaestra in the centre and other apartments for exercise or recreation. An inscription records the repair and restoration of the edifice after the earthquake of 63. These two establishments were inadequate to supply the wants of the inhabitants, and a third edifice, the so-called central baths, at the corner of the Strada Stabiana and the Strada di Nola, but on a still more extensive scale, intended for men only, was in course of construction in A.D. 79.

Far more interesting is the insight afforded us by the numerous private houses and shops into the ordinary life and habits of the population of an ancient town. The houses at Pompeii are generally low, rarely exceeding two storeys in height; the upper storey is generally of a slight construction, and occupied by small rooms, serving as garrets, or sleeping places for slaves. From the mode of destruction of the city these upper floors were in most cases crushed in and destroyed. The principal living rooms, as well as those intended for the reception of guests or clients, were all on the ground floor, the centre being formed by the atrium, or hall, which had an opening in the centre—the *compluvium*, so-called because the rain from the roofs was collected by it and fell into a basin (the *impluvium*). In the larger houses it was often surrounded with columns. Into this opened other rooms, the entrances to which, rarely protected by doors, were only closed by curtains. At the back was a garden. Later, under Greek influences, a peristyle with rooms took the place of the garden.

All the apartments and arrangements described by Vitruvius and other ancient writers may be readily traced in the houses of Pompeii, and in many instances these have for the first time enabled us to understand the technical terms and details transmitted to us by Latin authors. We must not, however, hastily assume that the examples thus preserved to us by a singular accident are to be taken as representing the style of building in all the Roman and Italian towns—in fact, the excavations at Ostia (*q.v.*) have shown us the contrary. We know from Cicero that Capua was remarkable for its broad streets and widespread buildings, and it is probable that the Campanian towns in general partook of the same character. At Pompeii indeed the streets were not wide, but they were straight and regular, and the houses of the better class occupied considerable spaces, presenting in this respect no doubt a striking contrast, not only with those of Rome itself, but with those of many other Italian towns, where the buildings would necessarily be huddled together from the circumstances of their position. Even at Pompeii itself, on the south side of the city, where the ground slopes somewhat steeply towards the sea, houses are found which consisted of three storeys or more, and with the inner walls painted black (with white designs on them) owing to the brilliancy of the light.

The excavations have provided examples of houses of every description, from the humble dwelling-place of the artisan or proletarian, with only three or four small rooms, to the stately mansions of Sallust, of the Faun, of the Golden Cupids, of the Silver Wedding, of the Vettii, of Pansa, etc.—the last of which is among the most regular in plan. But the general similarity in their plan and arrangement is very striking, and in all those that rise above a very humble class the leading divisions of the interior, the *atrium, tablinum,* peristyle, etc., may be traced with unfailing regularity. In all the more considerable houses in Pompeii the front, where it faces one of the principal streets, is occupied with shops, usually of small size, and without any communication with the interior of the mansion. In general the shop had a very small apartment behind it, and probably in most cases a sleeping chamber above it, reached by a staircase. The front of the shop was open to the street, but was capable of being closed with wooden shutters. Not only have the shops of silversmiths been recognized by the precious objects of that metal found in them, but large quantities of fruits of various kinds preserved in glass vessels, various descriptions of corn and pulse, loaves of bread, moulds for pastry, fishing-nets and many other objects too numerous to mention, have been found in such a condition as to be identified without difficulty. Inns and wine-shops appear to have been numerous; one of the latter we can see to have been a *thermopolium,* where hot drinks were sold. Bakers' shops are also frequent, though arrangements for grinding and baking appear to have formed part of every large family establishment. In other cases, however, these were on a larger scale, provided with numerous querns or hand-mills of the well-known form, evidently intended for public supply. Other establishments on a large scale were *fullonicae* (fullers' shops), where all the details of the business were illustrated by paintings still visible on the walls. Dyers' shops, a tannery and a shop where colours were ground and manufactured are of special interest, as is also the house of a surgeon, where numerous surgical instruments were found, some of them of a very ingenious and elaborate description, but all made of bronze. A blacksmith's shop was also found, with many tools that had been brought in for repair: here were discovered the remains of a groma, the instrument used by Roman land-surveyors, which has been successfully reconstructed (Dells Corte in *Monumenti* dei *Lincei*, 1922). Another curious discovery was that of the abode of a sculptor, containing his tools, as well as blocks of marble and half-finished statues.

Of the numerous works of art discovered in the course of the excavations the statues and large works of sculpture, whether in marble or bronze, are inferior to those found at Herculaneum, but some of the bronze statuettes are of exquisite workmanship, while the profusion of ornamental works and objects in bronze and the elegance of their design, as well as the finished beauty of their execution, are such as to excite the utmost admiration—more especially when it is considered that these are the casual results of the examination of a second-rate provincial town, which had, further, been ransacked for valuables (as Herculaneum had not) after the eruption of 79. The same impression is produced in a still higher degree by the paintings with which the walls of the private houses, as well as those of the temples and other public buildings, are adorned, and which are not merely of a decorative character, but in many instances present us with elaborate compositions of figures, historical and mythological scenes, as well as representations of the ordinary life and manners of the people, which are full of interest to us, though often of inferior artistic execution. It has until lately been the practice to remove these to the museum at Naples; but the present tendency is to leave them (and even the movable objects found in the houses) in *situ* with all due precautions as to their preservation, which adds immensely to the interest of the houses; indeed, with the help of careful restoration, their original condition is in large measure reproduced. In some cases it has even been possible to recover the original arrangement of the garden beds, and to replant them accordingly, thus giving an appropriate framework to the statues, etc., with which the gardens were decorated, and which have been found in situ. The same character of elaborate decoration, guided almost uniformly by good taste and artistic feeling, is displayed in the mosaic pavements, which in all but the humbler class of houses frequently form the ornament of their floors. One of these, in the House of the Faun, well known as the battle of Alexander, presents us with the most striking specimen of artistic composition that has been preserved to us from antiquity.

The architecture of Pompeii presents in general a transitional character from the pure Greek style to that of the Roman Empire. The temples (as already observed) have always the Roman peculiarity of being raised on a podium of considerable elevation; and the same characteristic is found in most of the other public buildings. All the three orders of Greek architecture—the Doric, Ionic and Corinthian—are found freely employed in the various edifices of the city, but rarely in strict accordance with the rules of art in their proportions and details; while the private houses naturally exhibit still more deviation and irregularity. In many of these indeed we find varieties in the ornamentation, and even in such leading features as the capitals of the columns, which remind one rather of the vagaries of mediaeval architecture than of the strict rules of Vitruvius or the regularity of Greek edifices. One practice which is especially prevalent, so as to strike every casual visitor, and dates from the early years of the empire, is that of filling up the flutings of the columns for about one-third of their height with a thick coat of stucco, so as to give them the appearance of being smooth columns without flutings below. The architecture of Pompeii suffers from the inferior quality of the materials generally employed. No good building stone was at hand; and the public as well as private edifices were constructed either of volcanic tufa, or lava, or Sarno limestone, or brick (the latter only used for the corners of walls). In the private houses even the columns are mostly of brick, covered merely with a coat of stucco. Marble was sparingly employed.

These materials are used in several different styles of construction belonging to the six different periods which Mau traces in the architectural history of Pompeii.

1. That of the Doric temple in the Foro Triangolare (6th cen-

tury B.c.) and an old column built into a house in Region vi., Insula 5; also of the older parts of the city walls—date uncertain (Sarno limestone and grey tufa).

2. That of the limestone atriums (outer walls of the houses of ashlar-work of Sarno limestone, inner walls with frame ork of limestone blocks, filled in with small pieces of limestone). Date before zoo B.C.

3. Grey tufa period; ashlar masonry of tufa, coated with fine white stucco; rubble work of lava. The artistic character is still Greek, and the period coincides with the first (incrustation) style of mural decoration, which (coming from Asia Minor or Greece perhaps by way of Sicily) aimed at the imitation in stucco of the appearance of a wall veneered with coloured marbles. No wall paintings exist, but there are often fine floor mosaics. To this belong a number of private houses (*e.g.*, the House of the Faun), and the colonnade round the forum, the basilica, the temples of Apollo and Jupiter, the large theatre with the colonnades of the Foro Triangolare, and the barracks of the gladiators, the Stabian baths, the Palaestra, the exterior of the Porta Marina, and the interior of the other gates—all the public buildings indeed (except the Doric temple mentioned under [:], which do not belong to the time of the Roman colony). Date, end of 2nd century B.C.

4. The "quasi-reticulate" period—walling faced with masonry not yet quite so regular as opus reticulatum, and with brick quoins, coinciding with the second period of decoration (the architectural, partly imitating marble like the first style, but without relief, and by colour only, and partly making use of architectural designs framing pictorial scenes, which are conceived as seen through openings). It is represented by the small theatre and the amphitheatre, the baths near the forum, the temple of Zeus Milichius, the Comitium and the original temple of Isis, but only a few private houses. This style probably owes much to Hellenistic theatrical decoration. Date, from 80 B.C. until nearly the end of the Republic.

5. The period from the last decades of the Republic to the earthquake of A.D. 63. No homogeneous series of buildings—we find various styles of construction (quasi-reticulate, *opus reticulatum* of tufa with stone quoins, of the time of Augustus, opus *reticulatum* with brick quoins or with mingled stone and brick quoins, a little later); and three styles of wall decoration fall within its limits: the later stage of the second, already mentioned, the third or ornate, with its freer use of ornament and its introduction of designs which suggest an Egyptian origin (originating in the time of Augustus), and the fourth or intricate, with a return to architectural forms, dating from about A.D. 50. Marble first appears as a building material in the temple of Fortuna Augusta (c. 3 B.C.).

6. The period from the earthquake of A.D. 63 to the final destruction of the city, the buildings of which can easily be recognized. The only wholly new edifice of any importance is the central baths.

Outside the Porta Ercolanese, or gate leading to Herculaneum, is found a house of a different character from all the others, undoubtedly a large villa; its remains are of interest as aiding us in understanding the description of ancient authors, such as Vitruvius and Pliny, of the numerous appurtenances frequently annexed to houses of this description.

In the cellar of this villa were discovered no less than twenty skeletons, and fourteen in other parts of the house. Almost all the skeletons and remains of bodies found in the city were discovered in similar situations, in cellars or underground apartments—those who had sought refuge in flight having apparently for the most part escaped from destruction, or having perished under circumstances where their bodies were easily recovered by the survivors. It has been found possible in many cases to take casts of the bodies found.

An interesting farm-house (few examples have been so far discovered in Italy) is that at Boscoreale excavated in 1893–94, which contained the treasure of one hundred and three silver vases now in the Louvre. The villa of P. Fannius Synhistor, not far off, was excavated in 1900; it had fine wall paintings, which were exported, and sold by auction in Paris (some now in the Louvre, while others are in New York). (See F. Barnabei, La Villa *pompeiana* di P. *Fannio Sinistore;* Rome, 1901.) Another, closer to Pompeii, in the so-called Villa Item, contains remarkable life size frescoes representing scenes of initiation into the mysteries of Dionysus or of Orpheus.

The road leading towards Herculaneum is bordered on both sides for a considerable extent by tombs, in many instances monuments of considerable pretension, and of a highly ornamental character, which present in the highest degree the advantage common to all that remains of Pompeii, their perfect preservation.

There appears to have been in the same quarter a considerable suburb, outside the gate, extending on each side of the road towards Herculaneum, apparently much resembling those which are now found from thence to Naples. Other suburbs were situated at the harbour and at the saltworks (salinae).

No manuscripts have been discovered in Pompeii. Inscriptions have been found in considerable numbers, and give much information concerning the municipal arrangements of the town, as well as the construction of various edifices and other public works. The most interesting of these are such as are written in the Oscan dialect, which appears to have continued in official use down to the time when the Roman colony was introduced by Sulla. From that time the Latin language was the only one officially employed. Still more curious are the numerous writings painted upon the walls, which have generally a semi-public character, such as recommendations of candidates for municipal offices, advertisements, etc., and the scratched inscriptions (*graffiti*), which are generally the mere expression of individual impulse and feeling, frequently amatory, and not uncommonly conveyed in rude and imperfect verses. In one house also a whole box was found filled with written tablets—diptychs and triptychs—containing the record of the accounts of a banker named L. Caecilius Iucundus.

See A. Mau, *Pompeii: its Life and Art* (trans. by F. W. Kelsey, 2nd ed., New York and London, 1902; 2nd revised edition of the German original, *Pompeii in Leben und Kunst,* Leipzig, 1908) with *Anhang* (1913), with full references; and, for later excavations, *Notizie degli Scavi* and *Romische Mitteilungen, passim. A.W.* Van Buren in *Classical Journal* xv. (1919–20) 404–416, and *Companion to Pompeian Studies* (American Academy in Rome, 1927); W. Enpelmann, *New Guide to Pompeii* (Leipzig, 1925); *A.* Ippel, *Pompeii,* ib. id.; *T.* Warscher, *Pompeii, ein Führer durch die Ruinen.* For the inscriptions on the tablets and on the walls, *Corpus inscriptionum latinarum,* vol iv. For the paintings, *see* E. Pfuhl, *Masterpieces of Greek Drawing and Painting* (tr. J. D. Beasley, London 1926); M. Della Corte, *Case ed abitanti a Pompeii (Pompeii,* 1926). (E. H. B.; T. A.)

POMPEIUS, GNAEUS, surnamed STRABO (squint-eyed), Roman statesman, father of the triumvir. He was successively quaestor in Sardinia (103 B.C.), praetor (94), propraetor in Sicily (93) and consul (89). He fought with success in the Social War, and was awarded a triumph for his services. Probably towards the end of the same year he brought forward the law (lex *Pompeia* de Gallia *transpadana*), which conferred upon the inhabitants of that region the privileges granted to the Latin colonies. During the civil war between Marius and Sulla he seems to have shown no desire to attach himself definitely to either side. He set out for Rome; the engagement which he fought before the Colline gate, although hotly contested, was indecisive. Soon afterwards he was killed by lightning (87).

See Plutarch, *Pompey,* 1; Appian, *Bell. civ.* i. 50, 52, 66–68, 80; Vell. Pat. ii. 21; Livy, *Epit.* 74–79; Florus iii. 18.

POMPEIUS, GNAEUS, surnamed MAGNUS (c. 75–45 B.C.), the elder son of the triumvir. In 48 B.C. during the civil war he commanded his father's fleet in the Adriatic. After the battle of Pharsalus he set out for Africa with the remainder of the Pompeian party, but, meeting with little success, crossed over to Spain. Having been joined by his brother Sextus, he collected a considerable army, the numbers of which were increased by the Pompeians who fled from Africa after the battle of Thapsus (46). Caesar, who regarded him as a formidable opponent, set out against him in person. A battle took place at Munda on March 17, 45, in which the brothers were defeated. Gnaeus managed to escape, but was soon (April 12) captured and put to death

See Pseudo-Oppius, *Bellum hispaniense,* 1–39; Lucan, *Pharsalia,* ix. 120; Dio Cassius, xliii. 28–40.

POMPEIUS, SEXTUS, surnamed MAGNUS (75–35 B.C.), the younger son of the triumvir. After his father's death he continued the struggle against the new rulers of the Roman empire. From Cyprus, where he had taken refuge, he made his way to Africa, and after the defeat of the Pompeians at Thapsus (46) crossed over to Spain. After Caesar's victory at Munda (45), he abandoned Corduba (Cordova), though for a time he held his ground in the south, and defeated Asinius Pollio, the governor of the province. In 43 he was proscribed by the triumvirate and put himself at the head of a fleet manned chiefly by slaves or proscribed persons, with which he made himself master of Sicily, and from thence ravaged the coasts of Italy. Rome was threatened with a famine, as the corn supplies from Egypt and Africa were cut off by his ships, and it was thought prudent to negotiate a peace with him at Misenum (39), which was to leave him in possession of Sicily, Sardinia and Achaea, provided he would allow Italy to be freely supplied with corn. But the arrangement could not be carried into effect, as Sextus renewed the war and gained some considerable successes at sea. However, in 36 his fleet was defeated and destroyed by Agrippa at Naulochus off the north coast of Sicily. After his defeat he fled to Mytilene, and from there to Asia Minor. In the attempt to make his way to Armenia he was taken prisoner by Antony's troops, and put to death at Miletus.

See Dio Cassius, xlvi.–xlix.; Appian, Bell. civ. iv. 84–117, v. 2–143; Vell. Pat. ii. 73–87; Plutarch, Antony; Livy, Epit. 123, 128, 129, 131; Cicero, Philippica, xiii., and many references in Letters to *Atticus*.

POMPEY, the common English form of Pompeius, the name of a Roman plebeian family.

POMPEIUS, GNAEUS (106–48 B.C.), the triumvir, the first of his family to assume the surname MAGNUS, was born on Sept. 30, in the same year as Cicero. When only 17 he fought together with his father in the Social War. He took the side of Sulla against Marius and Cinna, but for a time, in consequence of the success of the Marians, he kept in the background. On the return of Sulla from the Mithridatic War Pompey joined him with an army of three legions, which he had raised in Picenum. Thus early in life he connected himself with the cause of the aristocracy, and a decisive victory which he won in 83 over the Marian armies gained for him from Sulla the title of imperator. He followed up his successes in Italy by defeating the Marians in Sicily and Africa, and on his return to Rome in 81, though he was still merely an eques and not legally qualified to celebrate a triumph, he was allowed by general consent to enjoy this distinction, while Sulla greeted him with the surname of *magnus,* a title he always retained and handed down to his sons. Latterly, his relations with Sulla were somewhat strained; after Sulla's death he resisted the attempt of the consul M. Aemilius Lepidus to repeal the constitution. In conjunction with A. Lutatius Catulus, the other consul, he defeated Lepidus when he tried to march upon Rome, and drove him out of Italy (77). He retained his army, and jockeyed the senate into sending him to Spain pro *consule* (though he had as yet held no magistracy) to deal with Sertorius. Pompey was fighting in Spain from 76 to 71. After Sertorius had fallen a victim to assassination, Pompey easily defeated his successor Perperna and put an end to the war. On his way back he met and cut up a body of slaves, part of Spartacus' defeated forces, in flight northwards. He demanded a triumph, and permission to stand for the consulate.

The Consul. — The senate was inclined to grudge it, so he entered into a coalition with Crassus, and as both had armies at the gates, there was no more to be said. Pompey and Crassus were consuls together in 70, and that year saw the work of Sulla undone; the tribunate and censorship were restored, and the administration of justice was shared between the Senate, the equites, and the *tribuni aerarii.*

Pompey rose still higher in popularity, and on the motion of the tribune Aulus Gabinius in 67 he was entrusted with an extraordinary command over the greater part of the empire, specially for the extermination of piracy in the Mediterranean, by which the corn supplies of Rome were seriously endangered, while the high prices of provisions caused great distress. He was completely successful; the price of corn fell immediately on his appointment, and in 40 days the Mediterranean was cleared of the pirates. Next year, on the proposal of the tribune Manilius, his powers were still further extended, the care of all the provinces in the East being put under his control for three years together with the conduct of the war against Mithridates VI., who had recovered from the defeats he had sustained from Lucullus and regained his dominions. Both Caesar and Cicero supported the tribune's proposal, which was easily carried in spite of some opposition in the senate. Pompey was entirely successful. Mithridates was beaten and driven into the Crimea, and there was a general settlement of affairs in the East. Syria and Palestine were annexed in 64 and 63. Tigranes of Armenia submitted and was confirmed as a vassal king, and an agreement was reached with Phraates of Syria whereby the Euphrates marked the boundary between them.

Pompey, now in his 45th year, returned to Italy in 61 to celebrate the most magnificent triumph which Rome had ever witnessed, as the conqueror of Spain, Africa and Asia.

Politics. — This triumph marked the turning-point in his career. As a soldier everything had gone well with him; as a politician he was a failure. He found a great change in public opinion, and the people indifferent to his achievements abroad. The senate had a unique chance to secure his support, but refused to ratify the arrangements he made in Asia or to provide money and lands for distribution amongst his veterans. In these circumstances he drew closer to Caesar on his return from Spain, and became reconciled to Crassus. The result was the first triumvirate. He was married to Caesar's daughter Iulia, and as yet the relations between the two had been friendly. Pompey was now in fact ruler of the greater part of the empire, while Caesar had only the two provinces of Gaul. But being no political tactician, Pompey made no use of this advantage, and all this time the balance of power was steadily turning in Ceasar's direction. The senate and the aristocracy disliked and distrusted Pompey, but they felt that, should things come to the worst, they might still find in him a champion of their cause. Hence the joint rule of Pompey and Caesar was not unwillingly accepted, and anything like a rupture between the two was greatly dreaded as the sure beginning of anarchy throughout the Roman world. In 55 Pompey was consul again, in accordance with the arrangement with Caesar when the triumvirate was renewed at Luca in 56. As proconsul he should have left for his province, but he remained in charge of the corn-supply, virtually master of Rome, and governed Spain by his legati. With the death of Pompey's wife Iulia (54) and of Crassus (53) the relations between him and Caesar became strained, and soon afterwards he drew closer to the conservative party and married into the house of Scipio. In 52, in the utter disorder that followed the death of Clodius, he was elected sole consul, carried through the trial of Milo, and started a programme of administrative and provincial legislation threatening Caesar's position.

Civil War. — The crisis arrived with the approaching end of Caesar's command at the end of 50. Pompey nearly compromised by accepting the Parthian command and leaving Rome, but Marcellus forced his hand, and civil war began. Pompey, wisely or unwisely, abandoned Italy. His cause, with that of the senate and aristocracy, was finally ruined by his defeat by Julius Caesar in 48 in the neighbourhood of Pharsalus. That same year he fled with the hope of finding a safe refuge in Egypt, but was treacherously murdered by one of his old centurions as he was landing. He was five times married, and three of his children survived him — Gnaeus, Sextus, and a daughter Pompeia.

BIBLIOGRAPHY.—*Ancient:* Plutarch, Pompey; Dio Cassius; Appian; Velleius Paterculus; Caesar, De *bello civili;* Strabo xii., 555–560; Cicero, passim; Lucan, Pharsalia.

Modern: Histories of Rome in general (see ROME: Ancient History ad fin.); works quoted under CAESAR and CICERO. Also G. Boissier, Cicero and His Friends (Eng. trans., A. D. Jones, 1897); J. L. Strachan-Davidson's Cicero (1894); Warde Fowler's Julius Caesar (1892); C. W. Oman, Seven Roman Statesmen of the Later Republic (1902); notes in Tyrrell and Purser's Correspondence of Cicero.

POMPONAZZI, PIETRO (PETRUS POMPONATIUS) (1462–1525), Italian philosopher, was born at Mantua on Sept. 16, 1462, and died at Bologna on May 18, 1525. He took his M.D.

at Padua in 1487 and was elected extraordinary professor of philosophy. From about 1495 to 1509 he occupied the chair of natural philosophy and when the schools of Padua closed, he took a professorship at Ferrara where he lectured on the *De anima.* From 1512 to his death he was at Bologna where he produced all his important works. In 1516 appeared his *De immortalitate animi,* which gave rise to a storm of controversy between the orthodox Thomists, the Averroists headed by Agostino Nifo, and the so-called Alexandrist School. The treatise was burned at Venice, and Pomponazzi himself ran serious risk of death. Two pamphlets followed, the *Apologia* and the *Defensorium,* wherein he explained his paradoxical position as Catholic and philosophic materialist. His last two treatises, the *De incantationibus* and the *De fafo,* were posthumously published in an edition of his works printed at Basel.

See A. H. Douglas, *Philosophy and Psychology of Pietro Pomponazzi* (1910) ; J. A. Symonds, *The Renaissance in Italy;* L. Ferri, *La Psicologia di P. Pomponazzi* (1877) ; Überweg, *Grundriss der Gesck. der Philosophie* p. 1–3.

POMPOSA, an abbey of Emilia, Italy, in the province of Ferrara, 2 m. from Codigoro, which is 30 m. E. of Ferrara in the delta of the Po. The fine church, a work of the 6th century, rebuilt in the 11th, with interesting sculptures and terra cotta decorations on the façade and a splendid Romanesque campanile 163 ft. high (1063) contains a good mosaic pavement (1036) and interesting frescoes of the 14th century—a "Last Judgment" of the school of Giotto and others; and there are also paintings in the refectory. It was abandoned in 1650 on account of malaria.

See G. Agnelli, *Ferrara e Pomposa* (Bergamo, 1902), and F. R. Hiorns in *Journal of the Royal Institute of British Architects* xxxiv. (1927) 355 *sqq.*

POMPTINE MARSHES, a low tract of land in the province of Rome, Italy, varying in breadth between the Volscian mountains and the sea from 10 to 16 m , and extending north-west to south-east from Velletri to Terracina (40 miles). In ancient days this tract was fertile and contained prosperous cities (Suessa Pometia, Ulubrae—perhaps the mod. Cisterna—etc.), but it had already become unhealthy at the end of the Republican period. Attempts to drain the marshes were made by Appius Claudius in 312 B.C., when he constructed the Via Appia through them and at various times during the Roman period. A canal ran through them parallel to the road and was used in preference to the road during the Augustan period. Trajan repaired the road, and Theodoric did the same some 400 years later. But in the middle ages it had fallen into disrepair. Popes Boniface VIII., Martin V., Sixtus V., and Pius VI. all attempted to solve the problem, the last-named reconstructing the road admirably. By a law passed in 1919 the special provisions for the obligatory improvement of the Roman Campagna had been extended to the Pomptine territory.

See T. Berti, *Paludi pontine* (Rome, 1884) ; R. de la Blanchère, *Un Chapitre d'histoire pontine* (Paris, 1889).

PONCA CITY, a city of Bay county, Oklahoma, U.S.A., on the Arkansas river, at an altitude of 1,000 ft., 90 mi. N. by E. of Oklahoma City. It is on federal highways 60 and 77; has a municipal airport and is an air-mail station on the Chicago-Dallas route; and is served by the Rock Island and Santa Fe railways. The population in 1940 was 16,794. It is the second largest city in the historic Cherokee strip; the trading point for six Indian tribes; and the centre of one of the greatest light oil-producing districts in the country. The two large refineries located there, the Continental Oil company and the Cities Service Oil company, are connected by pipe lines to fields producing under proration more than 200.000 bbl. of oil per day. but potentially capable of yielding much in excess of that amount. The two refineries have a combined capacity of 40.000 bbl. per day. Both are connected with the Great Lakes Pipe line. the first major pipe line in the country, which transports the refined products to the principal cities in the midwest and Great Lakes region. The city is the home of the famous Pioneer Woman statue, donated to the state by former Governor E. W. Marland, founder of the old Marland Oil company, and resident of the city. Nine miles south of the city is the old Miller Brothers 101 Ranch, now being broken up into small farming tracts by the Farm Security administration (1941). The site of Ponca City was visited by one of General Pike's lieutenants in 1806. The city was founded on Sept. 16,1893, when the Cherokee strip was opened to white settlement, and was incorporated in 1899. Oil was discovered in 1911. In 1940 the city had an assessed valuation of $6,000,000, and the school district, $14,000,000. The city owns its electric light and water plants, the profits from which meet all the expenses of the municipal government, and no city tax of any kind has been levied since 1931.

PONCE, the largest and most important city on the southern coast of Puerto Rico and the second city in size and importance on the island. The population in 1940 was 65,182. The population of the municipal district in 1940 was 105,116.

Although the name of the city appears in public documents since early in the history of Spanish colonization, it was not until 1836 that it became an independent municipality. After that its growth increased and its importance was greatly magnified. Ponce was one of the first places at which the American forces landed in Puerto Rico during the Spanish-American War. They were most cordially and enthusiastically welcomed by the citizens. They took possession of the city, after having entered into an agreement with the Spanish forces who withdrew into the interior of the island.

Ponce has an agreeable climate, the temperature being moderated by the constant breezes prevailing during the greater part of the year. Industrially and commercially it is one of the foremost cities of the island. It is the principal shipping port on the Caribbean sea, and has an increasing commerce with the southern islands and the northern countries of South America. This importance has been recognized by the Government at Washington, and extensive improvements of the harbour are now under way under the direction of the U.S. service.

Ponce is a well managed city and its streets, plazas, parks and recreation grounds are well kept and attractive. Its public buildings and private residences are well built, and the beautiful setting among the tropical foliage and blossoms excite admiration.

The city is on the line of the American railroad, and is the terminus of important highways, north, east and west. There are several banks and some important commercial and industrial firms, producing cigars and cigarettes, bay rum, mineral waters, hats, shoes, clothing, laces, embroidery, cut diamonds, foundry and iron products, ice, brick, chocolate, soap and candy. The city has water-works, electric light and power, telegraph, telephone and cable service. It has two daily newspapers and several weekly publications. (H. M. T.; X.)

PONCE DE LEON, JUAN (c. 1460–1521), discoverer of Florida, was born in Servas, Spain, about 1460. He took part in the Moorish wars and then sailed for America with Columbus on his second voyage (1493). In 1509 he conquered Porto Rico and was appointed governor. As soon as the island was under control and pacified he set out with three ships to search for the land of "Bimini," wherein, as the Indian legend told him, there was a fountain with waters of marvellous curative power. On Mar. 27, 1513, he discovered the mainland which he named Florida because the day was Easter Sunday (*Pascua Florida*). He landed north of the present site of St. Augustine on April 2, and on April 8 took possession in the name of the Spanish king. He afterwards explored the coast southward to the cape and up the west shore of the peninsula to at least 27° 30′, and perhaps to where the coast trended westward. He returned to Spain in 1514, and received an appointment from Ferdinand V. as governor of "The Island of Florida." In 1521 he set out to conquer and colonize his possession but the fierceness of the natives prevented his success. In a sharp engagement Ponce de León was mortally wounded and his force driven to the ships. He died in Cuba in June 1521.

See F. A. Ober, *Ponce de Ledn* (1908) ; Justin Windsor, *Narrative and Critical History of America,* vol. ii. chap. iv. (1886) ; "The Track of Ponce de León," *Amer. Geog. Soc. Bulletin, xlv.,* pp. 721–735 (1913) ; *Boletin histórico de Puerto Rico, Año I;* pp. 118–161 (1914).

PONCELET, JEAN VICTOR (1788–1867), French mathematician and engineer, was born at Metz on July 1, 1788. From 1808 to 1810 he attended the *École polytechnique,* and afterwards, till 1812, the *École d'application* at Metz. He then became lieutenant of engineers, and took part in the Russian campaign, during which he was taken prisoner arid was confined at Saratov on the Volga until 1814, when he returned to France. During his imprisonment he began his researches on projective geometry which led to his great treatise on that subject. This work, the *Traité des propriétés projectives des figures,* which was published in 1822 (2d ed., 2 vols. 1865–66), is occupied with the investigation of the projective properties of figures *(see* GEOMETRY), and entitles Poncelet to rank as one of the greatest of those who took part in the development of the new geometry of which G. Monge was the founder. Poncelet developed the principle of Duality, and discovered the circular points at infinity, so causing the principle of continuity to be recognized. From 1815 to 1825 he was occupied with military engineering at Metz; and from 1825 to 1835 he was professor of mechanics at the *Bcole d'application* there. In 1834 he became a member of the *Acade'mie;* from 1838 to 1848 he was professor to the faculty of sciences at Paris, and from 1848 to 1850 commandant of the *École polytechnique.* He died at Paris on Dec. 22, 1867.

Poncelet's works include *Cours de méchanique, applique'e aux Machines* (1826) ; and *Mémoire sur les roues hydrauliques à aubes courbes* (1826). *See* J. Bertrand, *Éloge historique de Poncelet* (1875).

PONCHIELLI, AMILCARE (1834–1886), Italian musical composer, was born near Cremona on Sept. 1, 1834, and studied at the Milan Conservatoire. He attained his fame with *La Gioconda* (1876), written to a libretto founded by Arrigo Boito upon Victor Hugo's tragedy, *Angelo, Tyran de Padoue. La Gioconda* was followed by *Il Figliuol prodigo* (1880) and *Marion Delorme* (1885). In 1881 Ponchielli was made maestro di cappella of Piacenza cathedral. He died at Milan on Jan. 17, 1886.

POND, JOHN (*c.* 1767–1836), English astronomer-royal, was born about 1767 in London. After leaving Trinity college, Cambridge, he settled at Westbury near Bristol, and began to determine star-places with a fine altitude and azimuth circle of 23 ft. diameter by E. Troughton. His demonstration in 1806 *(Phil. Trans.* xcvi. 420) of a change of form in the Greenwich mural quadrant led to the introduction of astronomical circles at the Royal Observatory, and to his own appointment as its head. He was elected a fellow of the Royal Society on Feb. 26, 1807; he married and went to live in London in the same year, and in 1811 succeeded Maskelyne as astronomer-royal.

Under Pond the instrumental equipment at Greenwich was completely changed, and the number of assistants increased from one to six. The superior accuracy of his determinations was attested by S. C. Chandler's discussion of them in 1894, in the course of his researches into the variation of latitude (*Astron. Journ.* Nos. 313, 315). Pond received many academic honours. He published eight folio volumes of *Greenwich Observations,* translated Laplace's *Système du monde* (in 2 vols. 8vo., 1809), and contributed thirty-one papers to scientific collections. His catalogue of 1.112 stars (1833) was of great value. He retired in 1835 and died at Blackheath on Sept. 7, 1836, and was buried beside Halley in the churchyard at Lee.

See *Mem. Roy. Astron. Soc.* x. 357; *Proc. Roy. Soc.* iii. 434; *Penny Cyclopaedia* (De Morgan) ; F. W. Bessel, *Pop. Vorlesungen,* p. 543; *Report Brit. Assoc.* i. 128, 136 (Airy); Sir G. Airy's *Autobiography,* p. 127; *Observatory,* xiii. 204, xxii. 357; *Annual Biography and Obituary* (1837); *R.* Grant, *Hist. of Phys. Astron.* p. 491; Royal Society's *Cat. Scient. Papers;* Maunder, *The Royal Observatory Greenwich.*

POND, a small pool of standing water; the name is usually applied to one for which the bed has been artificially constructed. The term is a variant of "pound" (*q.v.*), an enclosure.

PONDICHERRY, the capital of the French possessions in India, situated on the Coromandel or western coast, 122 m. by rail S. of Madras. The territory, which is entirely surrounded by the British district of South Arcot, has an area of 113 sq.m. with a population (1936) of 179,890. It is ruled by a governor, with a Privy Council, and a General Council, and is represented in the French senate and chamber. The chief crops are dry grains, rice, earth-nuts and a little indigo. The territory is traversed by a branch of the South Indian railway from Villapuram. The town (pop. [1936] 48,896) is well laid out with fine public buildings, and lit by electricity; the water-supply is derived from artesian wells. There is a college, and a fine Court of Appeal building was begun in 1927.

Pondicherry was founded in 1683 by François Martin, on the site of a village given him by the governor of Gingee. In 1693 the Dutch took Pondicherry, but restored it, with the fortifications greatly improved, in 1697, at the peace of Ryswick. In 1748 Admiral Boscawen laid siege to it without success, but in 1761 it was taken by Colonel Coote from Lally. In 1763 it was restored to the French. In 1778 it was again taken by Sir Hector Munro, and its fortifications destroyed. In 1783 it was retransferred to the French, and in 1793 recaptured by the English. The treaty of Amiens in 1802 restored it to the French, but it was retaken in 1803. In 1816 it was restored to the French.

PONDO, a Kafir people who have given their name to Pondoland, the country comprising much of the seaboard of Kaffraria, Cape province, immediately to the south-west of Natal.

PONDWEED, a popular name for *Potamogeton natans,* a cosmopolitan aquatic plant found in ponds, lakes and ditches, with broad, more or less oblong-ovate, olive-green, floating leaves. The name is also applied to other species of *Potamogeton,* one of the characteristic genera of lakes, ponds and streams all over the world, but more abundant in temperate regions, embracing about 90 species. It is the principal genus of the family Potamogetonaceae, and contains plants with slender branched stems, and submerged and translucent, or floating and opaque, alternate or opposite leaves, often with membranous united stipules. The small flowers are borne above the water in axillary or terminal spikes; they have four stamens, which bear at the back four small herbaceous petal-like structures, and four free carpels, which ripen to form four small green fleshy fruits, each containing one seed within a hard inner coat; the seed contains a large hooked embryo. An allied genus *Zannichellia,* occurring in fresh and brackish ditches and pools in Great Britain and nearly throughout North America, and also widely elsewhere in temperate and tropical regions, is known as horned pondweed, from the curved fruit.

FROM STRASSBURGER, "LEHRBUCH DER BOTANIK FUR HOCHSCHULEN" (GUSTAV FISCHER)

PONDWEED (POTAMOGETON NATANS) SHOWING FLOWERING STEM AND LEAVES

See P. Ascherson and P. Graebuer, "Potamogetonaceae," *Pflanzenreich* 31 (iv, ii): 1–184, fig. 1–36 (1907).

PONGEE, a plain-weave fabric made of *tussah* or wild silk, originated with the Chinese in ancient times. Its sphere of usefulness has been broadened due chiefly to the increase in standard width from 18 to 36 or more inches, and the variety of colours extended. The Japanese buy from the Chinese the wild silk and work it up in their own plants. *Shantung,* a variety of pongee, derives its name from the province which is the centre of the wild silk industry. It differs from true pongee in that the former must be a plain weave, while Shantung may include many types, even adding coloured threads for decoration. Because of the ease with which they can be laundered and their durability pongees are among the most practical of silks.

PONIARD, a dagger, particularly one of small size, used for stabbing at close quarters. The French word *poignard,* from which the English is a 16th century adaptation, is formed from *poing,* fist, in which the weapon is grasped. *(See* DAGGER.)

PONIATOWSKI, the name of a Polish princely family of Italian origin, tracing descent from Giuseppe Torelli, who married about 16jo an heiress of the Lithuanian family of Poniatov, whose name he assumed.

STANISLAUS PONIATOWSKI (1677–1762), only belonged to the family by adoption, being the reputed son of Prince Sapieha and a Jewess. He was born at Dereczyn in Lithuania, and was adopted by Sapieha's intendant, Poniatowski. Attaching himself to the party of Stanislaus Leszczynski, he became major-general in the army of Charles XII. of Sweden, who also employed him as diplomatic intermediary to the Sultan. He next became governor of the duchy of Zweibriicken, Bavaria. After the death of Charles XII. in 1718 he visited Sweden; and was subsequently reconciled with Leszczynski's rival on the throne of Poland, Augustus II., who made him grand treasurer of Lithuania in 1724. On the death of Augustus II. he tried to secure the reinstatement of Leszczynski, but presently gave his allegiance to Augustus III., by whom he was made governor of Cracow. He died at Kyki on Aug. 3, 1762.

His second son Stanislaus Augustus became king of Poland. *(See* STANISLAUS II.) Of the other sons, Casimir (1721–1780) was his brother's chancellor; Andrew (1735–1773) became feldzeugmeister in the Austrian service; and Michael (1736–1794) became archbishop of Gnesen and primate of Poland. Joseph Anthony (*q.v.*), son of Andrew, became one of Napoleon's marshals.

STANISLAUS PONIATOWSKI (1757–1833), son of Casimir, was grand treasurer of Lithuania, starost of Podolia and lieutenant-general of the royal army In 1793 he settled in Vienna, and subsequently in Rome, where he made a magnificent collection of antique gems, subsequently sold. He died in Florence, Feb. 13, 1833, and the Polish and Austrian honours became extinct.

His natural, but recognized, son, JOSEPH MICHAEL XAVIER FRANCIS JOHN PONIATOWSKI (1816–1873), was born at Rome and in 1847 was naturalized as a Tuscan subject. He received the title of prince in Tuscany (1847) and in Austria (1850). He represented the court of Tuscany in Paris from 1848, and he was made a senator by Napoleon III., whom he followed to England in 1871. He also wrote numerous operas. He died on July 3, 1873. His son, Prince Stanislaus Augustus, married and settled in Paris. He was equerry to Napoleon III., and died in Jan. 1908.

PONIATOWSKI, JOSEPH ANTHONY (1763–1813), Polish prince and marshal of France, son of Andrew Poniatowski and the countess Theresa Kinsky, was born at Warsaw in 1763. He served with distinction in the imperial forces against the Turks in 1788, then becoming major-general and subsequently lieutenant general in the Polish army under his uncle, King Stanislaus. In 1789 he commanded the Ukrainian division; and after the proclamation of the constitution of May 3, 1791, was made commander-in-chief. Aided by Kosciuszko, he conducted the operations against Russia with much skill, but when the king acceded to the confederation of Targowica *(see* POLAND: *History),* at the same time guaranteeing the adhesion of the army, Poniatowski, and most of the other generals threw up their commissions and emigrated. During the Kosciuszko rising he again fought gallantly for his country under his former subordinate, and after the fall of the republic lived in retirement. After the evacuation of the Polish provinces by Prussia, Poniatowski became commander of the National Guard, and on the creation of the grand duchy of Warsaw he was nominated war minister.

During the war of 1809, he operated successfully against the Austrians. In Napoleon's campaign against Russia in 1812 Poniatowski commanded the fifth army corps; and after the disastrous retreat of the grand army remained faithful and formed a new Polish army of 13,000 men, with which he joined the emperor at Liitzen. In 1813 he guarded the passes of the Bohemian mountains and defended the left bank of the Elbe. As a reward for his brilliant services at Leipzig he was made a marshal of France and entrusted with the duty of covering the retreat of the army, in the course of which he perished, fighting heroically against overwhelming odds. His relics were conveyed to Poland and buried in Cracow Cathedral, where he lies by the side of Tadeusz Kosciuszko and Jan Sobieski. Poniatowski's *Mes souvenirs sur la campagne de 1792* (Leinberg, 1863) is of historical value.

See *Correspondence* , *Poniatowski* (ed. E. Raczynski, Posen, 1843); Bronislaw Dembinski, *Stanislaus Augustus and Prince Joseph Poniatowski in the light of their Correspondence* (Fr.; Lemberg, 1904); Szymon Askenazy, *Prince Joseph Poniatowski* (Pol.; Warsaw, 1905).

PONS, JEAN LOUIS (1761–1831), French astronomer, was born at Peyres (Hautes Alpes) on Dec. 24, 1761. He entered the Marseilles observatory in 1789, and in 1819 became the director of the new observatory at Marlia near Lucca, which he left in 1825 for the observatory of the museum at Florence. Here he died on Oct. 14, 1831. I-Ie spent his time searching for comets, of which he discovered a record number; some bear his name, *e.g.*, Pons-Winnecke's comet.

See M. *R. A.* Henrion, *Annuaire biographique*, i. 288 (1834): *Memoirs Roy. Astron. Soc.* v. 410; *R.* Wolf, *Geschichte der Astronomie*, p. 709; *J.* C. Poggendorff, *Biog. lit. Handworterbuch.*

PONSARD, FRANÇOIS (1814–1867), French dramatist, was born at Vienne, Isère, on June 1, 1814, and studied law. His translation of *Manfred* was published in 1837. His play *Lucrdce* was represented at the Théâtre Français on April 1, 1843. This date marks a reaction against the romantic style of Dumas and Hugo. He received, in 1845, the Academy's prize for a tragedy "to oppose a dike to the waves of romanticism." Ponsard combined the liberty of the romantics with the sober style of earlier French drama. The success of his plays was aided by the impersonation of many of the principal rôles in them by Rachel. He followed up *Lucrèce* with *Agnès de Méranie* (1846), *Charlotte Corday* (1850), and others. *L'Honneur et l'argent,* one of his most successful plays, was acted in 1853, and he became an academician in 1855. In 1866 he obtained great success with *Le Lion Amoureux,* another play dealing with the revolutionary epoch. His *Galilée,* which excited great opposition in the clerical camp, was produced in 1867. He died in Paris on July 7, 1867.

His *Oeuvres complètes* were published in Paris (3 vols., 1865-76). *See* C. Latreille, *La Fin du théâtre romantique et François Ponsard d'après des documents inédits* (1899).

BONSONBY OF SHULBREDE, ARTHUR AUGUSTUS WILLIAM HARRY PONSONBY, 1ST BARON (1871–), British author and politician, was born on Feb. 16, 1871, and educated at Eton and at Balliol college, Oxford. In 1894 he entered the diplomatic service, and after holding posts in Constantinople and Copenhagen, returned in 1902 to join the staff of the Foreign Office. In 1906 he became principal private secretary to Sir Henry Campbell-Bannerman, and two years later was elected Liberal M.P. for Stirling. He represented this constituency until 1918, and in 1922 was elected Labour member for the Brightside division of Sheffield, and held various minor posts in the Labour Governments of 1924 and 1929–31. He was raised to the peerage in 1930, and was leader of the opposition in the House of Lords from 1931 to 1935.

His works include *The Decline of Aristocracy* (1912); *Democracy and Diplomacy* (1915); *Wars and Treaties (1815–1914)* (1917); *Religion in Politics* (1921); *Now is the Time* (1925).

PONSONBY, English family. PONSONBY, JOHN (1713–1789), Irish politician, was born on March 29, 1713. In 1739 he entered the Irish parliament, where he became first commissioner of the revenue (1744), a privy councillor (1746), and in 1756 Speaker. Belonging to one of the great families which at this time monopolized the government of Ireland, Ponsonby was one of the principal "undertakers," men who controlled the whole of the king's business in Ireland, and he retained the chief authority until the marquess Townshend became lord-lieutenant in 1767. A struggle for supremacy between the Ponsonby faction and the party dependent on Townshend followed, which caused Ponsonby to resign the speakership in 1771. He died on Dec. 12, 1789. His wife was Elizabeth, daughter of William Cavendish, 3rd duke of Devonshire, a connection of advantage to the Ponsonbys.

Ponsonby's third son, GEORGE PONSONBY (1755–1817), lord chancellor of Ireland, was born on March 5, 1755, and educated at Trinity College, Cambridge. A barrister, he became a member of the Irish parliament in 1776 and was chancellor of the Irish exchequer in 1782, afterwards taking part in the debates on the question of Roman Catholic relief, and leading the opposition to the union of the parliaments. Ponsonby represented Wicklow and then Tavistock in the united parliament; in 1806 he was lord chancellor of Ireland, and from 1808 to 1817 he was the official leader of the opposition in the House of Commons

He left an only daughter when he died in London on July 8, 1817.

George Ponsonby's elder brother, WILLIAM BRABAZON PONSONBY, 1st Baron Ponsonby (1744–1806), was also a leading Whig politician, being a member of the Irish, and after 1800, of the British parliament. In 1806 shortly before his death he was created Baron Ponsonby of Imokilly. On the death of his grandson, WILLIAM BRABAZON PONSONBY (1807–1866), the barony became extinct.

PONTA DELGADA, the capital of an administrative district, comprising the islands of St. Michael's and St. Mary in the Portuguese archipelago of the Azores. Pop. (1930), 18,022. Ponta Delgada is built on the south coast of St. Michael's, in 37° 40' N. and 25° 36' W. Its mild climate, and the fine scenery of its mountain background, render it very attractive to visitors; it is the commercial centre, and the most populous city of the archipelago. Great improvements in the harbour were effected after 1860 by the construction of a breakwater 2,800 ft. long.

PONT-À-MOUSSON, a town of northern France in the department of Meurthe-et-Moselle, 17 mi. N.N.W. of Nancy by rail. Pop. (1936) 11,036. Dating from the 9th or 10th century, Pont-à-Mousson constituted a lordship, which was made a marquisate in 1354. It mas from 1572 to 1763 the seat of a well-known university. The Moselle divides the town into two quarters, united by a 16th century bridge. The church of St. Martin dates from the 13th, 14th and 15th centuries. The lower ecclesiastical seminary occupies the building of an old Premonstratensian convent. The town has engineering workshops, blast furnaces, and manufactures of lacquered ware, paper, cardboard, cables and tin- and iron-\\are. It is an agricultural centre.

PONTANUS, JOVIANUS (1426–1503), Italian humanist and poet, was born in 1426 at Cerreto, in the duchy of Spoleto, and educated, after the death of his father in a civil disturbance, at Perugia. At the age of 22 he went to Naples, where he remained for the rest of his life. He became a friend of the famous scholar Beccadolli, and was introduced by him to Alphonso the Magnanimous, who made him tutor to his sons. Thereafter he was political adviser, military secretary and chancellor to the Aragonese dynasty. He illustrates very clearly the importance of men of letters in Italy. He arrived in Naples a penniless scholar, and became almost immediately one of the most important men in the kingdom. He founded an academy for the meetings of scholars in Naples, which lasted long after his death. In 1461 he married Adriana Sassone, who bore him one son and three daughters and died in 1491. Soon after this he married a girl from Ferrara, only known to us as Stella. He was passionately fond of wife and children, and much of his verse, especially *Eridanus,* written after his second marriage, tells of his love for them. He outlived Stella also, and died in 1503 at Naples, where a group of life-size terra-cotta figures is still to be seen on his tomb at Monte Oliveto church. Pontanus had a good Latin style and the faculty, rare among his contemporaries, of expressing the facts of modern life, the actualities of personal emotion, in language sufficiently classical yet always characteristic of the man. His ambitious *Urania* embodies the astronomy of the day. His most original compositions in verse, however, are elegiac and hendecasyllabic pieces on personal topics—the *De conjugali amore, Eridanus, Tumuli, Naeniae, Baiae, etc.*—in which erotic freedom is condoned by a passionate sincerity. Pontanus' prose and poems were printed by the Aldi at Venice. For his life *see* Ardito, *Giovanni Pontano e i suoi tempi* (Naples, 1871) ; for his place in the history of literature, Symonds, *Renaissance* in *Italy* (1875, etc.).

PONTARLIER, capital of an arrondissement in the department of Doubs, eastern France, 36 mi. S.E. of Besançon. Pop. (1936), 12,639. It is 2,750 ft. above sea-level on the Doubs, about 4 mi. from the Swiss frontier, and forms an important strategic point at the mouth of the defile of La Cluse, one of the principal passes across the Jura. Pontarlier is the seat of a subprefect. It is the junction of railway lines to Neuchâtel, Lausanne, Lons-le-Saunier, Dole and Besançon, and has an airfield. At Pontarlier the French army of the East made its last stand against the Prussians in 1871 before crossing the Swiss frontier. The distillation of herbs, largely grown for kirsch and other liqueurs, is the chief industry. Clocks and watches are manufactured.

PONT AUDEMER, a town of northwestern France, in the department of Eure, 39 mi. N.W. of Evreux, on the railway to Honfleur. Pop. (1936) 6,279. The town owes its name to Audomar, a Frank lord, who in the 7th or 8th century bridged the Risle there. The church of St. Ouen, which has fine stained glass of the 16th century, combines the late Gothic and Renaissance styles; its choir is Romanesque. Manufacturing includes the founding of malleable metal; also glue and paper, cotton-spinning and leather goods. There is trade in flax, wool, grain, cattle, cider, paper, iron, wood and coal. The port has a length of over half a mile on the Risle, which is navigable for small vessels from this point to the Seine (10 mi.).

PONTECORVO, a city of Lazio, Italy, in the province of Frosinone, on the Garigliano, about 48 mi. from Caserta and 3 mi. from Aquino on the railway from Rome to Naples. Pop. (1936), 14,437 (town and the commune). The principality of Pontecorvo (about 40 sq.mi. in extent), once an independent state, belonged alternately to the Tomacelli and the abbots of Monte Cassino. Napoleon bestowed it on Bernadotte in 1806, and in 1810 it was incorporated with the French empire.

PONTECOULANT, LOUIS GUSTAVE LE DOULCET, COMTE DE (1764–1853), French politician, was born at Caen on Nov. 17, 1764. He entered the army in 1778. A moderate supporter of the revolution, he was returned to the convention for the department of Calvados in 1792, and became commissary with the army of the North. He attached himself to the party of the Gironde, and in Aug. 1793 was outlawed. He refused to defend his compatriot Charlotte Corday, who wrote him a letter of reproach on her way to the scaffold. He returned to the convention on March 8, 1795, and became its president in July; he was for some months a member of the council of public safety. He was elected to the council of five hundred, but was suspected of royalist leanings, and spent some time in retirement before the consulate. Becoming senator in 1805, and count of the empire in 1808, he organized the national guard in Franche Comté in 1811, and the defense of the northeastern frontier in 1813. He sat in the upper house under the Restoration. He died in Paris on April 3, 1853. *See* his *Souvenirs historiques et parlementaires 1764–1848* (4 vols., 1861–65).

PONTEFRACT (pronounced and sometimes written "Pomfret"), market town, municipal borough, in the West Riding of Yorkshire, England, 21 mi. S.W. from York, served by the L.M.S. and L.N.E. railways. Pop. (1938) 21,340. Area, 7.6 sq.mi. It is well situated, on an eminence, near the junction of the Aire and the Calder. The most important remains are those of the famous castle situated on a rocky height, and containing eight round towers. The remains are principally of Norman date, and an unusual feature is the existence of various subterranean chambers in the rock. Below the castle is All Saints church, which suffered severely during the siege of the castle, but still retains some work of the 12th century. In 1837 the tower and transepts were fitted for divine service. In Southgate is an ancient hermitage and oratory cut out of the solid rock, which dates from 1396. At Monkhill there are the remains of a Tudor building called the Old Hall. A grammar school of ancient foundation, renewed by Elizabeth and George III, occupies modern buildings. The town hall (18th century) occupies the site of one erected in 1656, which succeeded the old moot-hall dating from Saxon times. Among other buildings are the court house, the market hall, the assembly rooms, and large barracks. The foundation of the principal almshouse, that of St. Nicholas, dates from before the Conquest. Trinity Hospital was founded by Sir Robert Knolles (d. 1407). At Ackworth is a Society of Friends' school (1778), in the foundation of which Dr. John Fothergill (1712–1780) was a prime mover. There are extensive gardens and nurseries in the neighbourhood of Pontefract, and liquorice is grown for the manufacture of the celebrated Pomfret cakes. The town possesses iron-foundries, sack and matting manufactories, tanneries, breweries, corn mills and brick and terra-cotta works.

The remains of a Roman camp have been discovered near Pontefract. At the time of the Domesday Survey Tateshall (now Tanshelf, a suburb of the town) was the chief manor while Kirkby, afterwards the borough of Pontefract, was one of its members. The change of status was probably owing to the founding by Ilbert de Lacy, of a castle at Kirkby. The town was known as Pontefract in 1140 when Archbishop Thurstan died there. The manor remained in the Lacy family until it passed by marriage to Thomas, duke of Lancaster, who was beheaded after the battle of Boroughbridge. His estates were restored to his brother Henry, earl of Lancaster, on the accession of Edward III., and the manor thereafter formed part of the duchy of Lancaster. The town took part in most of the rebellions in the north of England, and in 1399 Richard II. was imprisoned and secretly murdered in the castle. During the Wars of the Roses the town was loyal to Henry VI., and several of the Yorkist leaders were executed here after the battle of Wakefield. It was taken by Robert Aske, leader of the Pilgrimage of Grace, in 1536. In 1642 the castle was garrisoned for Charles I. and sustained four sieges, the second in 1644, being successful, but two years later it was retaken by the royalists, who held it until after the execution of the king, when they surrendered to General Lambert and the castle was destroyed.

Roger de Lacy in 1194 granted a charter and in 1484 Richard III. incorporated the town. The market rights are still held under his charter. The privilege of returning two members to parliament which had belonged to Pontefract at the end of the 13th century was revived in 1620–21. Between 1885 and 1918 it returned one member, when its representation was merged in that of the county, its name being given to the division.

PONTEVEDRA, a maritime province of north-western Spain, before 1833 a part of Galicia. Pop. (1939), 599,149; area, 1,695 sq.mi., with a density of population, 353.4 inhabitants per square mile. The surface is mountainous. The coast line is deeply indented; navigation is rendered difficult by fogs in summer and storms in winter. Large agricultural fairs are held in the chief towns, and there is export of cattle, hams, salt meat and fish, eggs, breadstuffs, leather and wine. Vigo is the chief port and there are harbours at Bayona, Carril, Marin, Viliagarcia and elsewhere among the deep estuaries of the coast. At Tuy the Spanish and Portuguese railways meet.

PONTEVEDRA, the capital of the Spanish province of Pontevedra; on the Tuy-Corunna railway, and on the river Lerez, which here enters the Ria de Pontevedra, an inlet of the Atlantic. Pop. (1940) 32,120. The name of the town is derived from the ancient Roman bridge (pons *vetus*) of twelve arches, which spans the Lerez near its mouth. Pontevedra is mainly built of granite, and still partly enclosed by mediaeval fortifications. There is an active trade in grain, wine and fruit: cloth, hats, leather and pottery are manufactured.

PONTIAC (c. 1720–1769), famous chief of the Ottawa Indians and leader in the "Conspiracy of Pontiac" in 1763–64, was born about 1720, probably on the Maumee river, in what is now northwestern Ohio. His father was an Ottawa, and his mother an Ojibwa. By 1755 he had become a chief of the Ottawa and a leader of the loose confederacy of the Ottawa, Potawatomi and Ojibwa. As an ally of France, he possibly commanded the Ottawa in the defeat (1755) of Gen. Braddock. In 1760 he met Maj. Robert Rogers, then on his way to occupy Michilimackinac and other forts surrendered by the French, and agreed to let the English troops pass unmolested on condition that he should be treated with respect by the British. Like other Indians he soon realized the difference between French and English rule—that the Indians were no longer welcomed at the forts and that they would ultimately be deprived of their hunting grounds by encroaching English settlements. French hunters and traders encouraged Indian disaffection with vague promises of help from France; and in 1762 Pontiac enlisted the support of practically all the Indian tribes from Lake Superior to the lower Mississippi for a joint move to expel the British. He arranged for each tribe to attack the fort nearest to it in May 1763, and then to combine to wipe out the undefended settlements. Pontiac himself decided to capture Detroit, but his carefully laid plans for a surprise attack on May 9 were betrayed to the commanding officer, Maj. Gladwin, and he was forced to lay siege to the fort. The siege coneinued for five months, marked by desultory attacks and sorties. Schooners sent through Lake Erie with supplies and provisions were captured by the Indians, but Pontiac could not prevent reinforcements from Fort Niagara under Capt. Dalzell from reaching Detroit. However, when the besieged made a night attack on the Indian encampment, Pontiac, apprised of their coming, inflicted heavy losses on them at Bloody Run, July 31. The Indians were unused to making long sieges and, after a few months, several of the associated tribes made peace. With his own Ottawa, Pontiac continued to camp around Detroit until Oct. 30 when, hearing that no aid from the French could be expected owing to the signing of the peace treaty with the English, he withdrew to the Maumee river.

Pontiac's larger plan was more successful. Of the 12 fortified posts attacked by the Indians, all but four were captured; most of the garrisons were massacred; several relief expeditions were nearly annihilated, and the frontiers were desolated and plundered. Col. Bouquet, however, succeeded in defeating the Indians at Bushy Run, when on his way to relieve Forts Pitt and Ligonier, and in 1764, he led a second expedition into Ohio from Pennsylvania, and forced the Indian tribes to sue for peace and release their prisoners. Pontiac still hoped to arouse other tribes to continue the fight, but after another year he saw that the English were the real masters of the situation and, on behalf of the tribes lately banded in his league, he concluded a treaty of peace and amity with Sir William Johnson at Oswego, N.Y., July 25, 1766. Pontiac, laden with gifts from the enemy, returned to his home on the Maumee. He met his death in 1769 at the hands of an Illinois Indian bribed by an English trader to murder him at Cahokia (nearly opposite St. Louis). His death occasioned a bitter war among the Indians, and the Illinois group was all but annihilated by his avengers. Pontiac was one of the most remarkable men of the Indian race in American history, possessing a commanding energy and force of mind combined with subtlety and craft, and a power of organization.

BIBLIOGRAPHY.—*See* Francis Parkman, The *Conspiracy* of *Pontiac* (Boston, 1851; 10th ed., 1905); *Handbook of American Indians* (Bureau of American Ethnology, vol. ii., 1910).

PONTIAC, a city of Illinois, U.S.A., on the Vermilion river, 92 mi. S.W. of Chicago; the county seat of Livingston county. It is on highways 66, 116 and 23, and is served by the Chicago and Alton. the Illinois Central and the Wabash railways. Pop. 8,272 in 1930 (87% native white); 1940 population 9,585 by the federal census. It is the trading and shipping point for a rich agricultural region. Creameries, hatcheries, shoe factories, corn grinders and printing are its chief industries. It is the seat of a state penitentiary. The city was founded in 1837 and incorporated in 1872.

PONTIAC (pŏn′tĭ-ăc), a city of Michigan, U.S.A., 26 mi. N.W. of Detroit, on federal highways 10, 24 and state highway 59; the county seat of Oakland county. It is served by the Grand Trunk Western railroad and by intercity motor coach and truck lines. The population in 1940 was 66,626 by federal census. Pontiac is an important automobile manufacturing centre in the midst of a picturesque summer resort region. There are 11 state parks and one county park in the county which contains over 400 lakes. At Orchard lake (5 mi. S.E.) is Apple island, formerly the home of the famous Chief Pontiac, and on its shores are ancient burial grounds of the Sac, Huron and Wyandot Indians. The city's industries include automobiles, motor trucks, motor coaches, automobile engines, bodies, parts and accessories, drop forgings, tools and dies, paints and varnishes. The city has a land area of 19.8 sq.mi. and had an assessed property valuation in 1940 of $72,535,000.

There are more than 800 retail establishments. The city operates a municipal airport, six parks, one golf course, 26 schools with an enrolment of 14,837 and a public library. The Eastern state hospital for the insane is there. Pontiac was first settled in 1818, became the county seat in 1820, and was chartered as a city in 1861.

PONTIANUS, pope from 230 to 235. He was exiled by the emperor Maximinus to Sardinia. and in consequence of this sentence resigned (Sept. 28, 235). He was succeeded by Anteros.

PONTIFEX. The collegium of the pontifices was the most important priesthood of ancient Rome, being specially charged with the administration of the jus *divinum;* i e., that part of the civil law which regulated the relations of the community with the deities recognized by the State officially, together with a general superintendence of the worship of gens and family. The name is clearly derived from pons and *facere,* but whether this indicates any special connexion with the sacred bridge over the Tiber (*Pons* Sublicius) cannot now be determined. The college existed under the monarchy, when its members were probably three in number; they may be considered as legal advisers of the rex in all matters of religion. Under the republic they emerge into prominence under a pontifex *maximus,* who took over the king's duties as chief administrator of religious law, just as his chief sacrificial duties were taken by the rex *sacrorum;* his dwelling was the regia, "the house of the king." During the republican period the number of pontifices increased, probably by multiples of three, until after Sulla (82 B.C.) we find them 15; for the year 57 B.C. we have a complete list of them in Cicero (Harusp. *resp.* 6, 12). Included in the collegium were also the rex sacrorum, the *flamines,* three assistant pontifices (minores), and the vestal virgins, who were all chosen by the pontifex *maximus.* Vacancies in the body of *pontifices* were originally filled by co-optation; but from the second Punic war onwards the *pontifex maximus* was chosen by a peculiar form of popular election, and in the last age of the republic this held good for all the members. They all held office for life.

The immense authority of the college centred in the *pontifex maximus,* the other pontifices forming his *consilium* or advising body. His functions were partly sacrificial or ritualistic, but these were the least important; the real power lay in the administration of the *jus divinum,* the chief departments of which may briefly be described as follows: (1) the regulation of all expiatory ceremonials needed as the result of pestilence, lightning, etc.; (2) the consecration of all temples and other sacred places and objects dedicated to the gods by the State through its magistrates; (3) the regulation of the calendar both astronomically and in detailed application to the public life of the State; (4) the administration of the law relating to burials and burying-places, and the worship of the Manes, or dead ancestors; (5) the superintendence of all marriages by *confarreatio; i.e.,* originally of all legal patrician marriages; (6) the administration of the law of adoption and of testamentary succession. They had also the care of the State archives, of the lists of magistrates, and kept records of their own decisions (*commentarii*) and of the chief events (*annales*).

It is obvious that a priesthood with such functions and holding office for life, must have been a great power in the State, and for the first three centuries of the republic it is probable that the pontifex *maximus* was in fact its most powerful member. The office might be combined with a magistracy, and, though its powers were declaratory rather than executive, it may be described as quasi-magisterial. Under the later republic it was coveted chiefly for the great dignity of the position; Julius Caesar held it for the last 20 years of his life, and Augustus took it after the death of Lepidus in 12 B C, after which it became inseparable from the office of the reigning emperor.

See Marquardt, *Staatsverwaltung,* iii. 235 et seq.; Wissowa, Religion *u. Kultus* der *Römer,* 501 seq.; Bouché-Leclercq, Les *Pontifes,* passim.

PONTIVY, a town of W. France, capital of an arrondissement in the department of Morbihan. Pop. (1936) 7,109 A monastery was founded there in the 7th century by St. Ivy of Lindisfarne. The town, at the confluence of the Blavet with the Nantes-Brest canal, has distinct parts—the old town and that to the south known as Napoléonville and built by Napoleon I as military headquarters for Brittany The ancient castle (1385) of the dukes of Rohan, whose capital the town was, is a museum. The chief industry is the manufacture of agricultural implements.

PONT-L'ABBÉ, a tonn of western France in the department of Finistère, 13 mi. S.W. of Quimper by rail. Pop (1936) 5.578. The town stands on the right bank of the estuary of Pont-l'Abbé, 2 mi. from the sea Its port carries on fishing, imports timber. coal, etc., and exports mine-props and the cereals and vegetables of the neighbourhood. There is a church of the 14th, 15th and 16th centuries, once attached to a Carmelite convent; an old castle is occupied by the *hôtel* de *ville.* The local costumes, trimmed with the bright-coloured embroideries for which the town is noted, are among the most striking in Brittany; the *bigouden* or headdress of the women has given its name to the female inhabitants.

PONTOISE, a town of northern France, capital of an arrondissement of the department of Seine-et-Oise, 18 mi N.W. of Paris on the railway to Dieppe. Pop. (1936) 11,959. Pontoise existed in the time of the Gauls as *Briva* Zsarae (Bridge of the Oise). It was destroyed by the Normans in the 9th century, united with Normandy in 1032, and acquired by Philip I. in 1064. Capital of the French Vexin, it played a conspicuous part in the wars between the French and the dukes of Normandy and in the Hundred Years' War. The English took it in 1419, and again in 1437. In 1441 Charles VII. took it by storm after a three months' siege. After belonging to the count of Charolais down to the Treaty of Conflans, it was given as a dowry to Jeanne of France when she was divorced by Louis XII. The parlement of Paris several times met in the town; and in 1561 the states-general convoked at Orléans removed thither after the death of Francis II. During the Fronde it offered a refuge to Louis XIV. and Mazarin. Henry III. made it an apanage for his brother the duke of Anjou. Later it passed to the duke of Conti. Down to the Revolution it remained a monastic town.

Two churches alone remain: St. Maclou, a 12th century church, restored in the 1 jth and 16th centuries, and containing a fine holy sepulchre of the 16th century; and Notre-Dame, of the close of the 16th century, with the tomb of St. Gautier, abbot of Meulan in the 12th century. Trade is in grain and in flour ground by numerous water-mills on the Viosne; a well-known fair is held in November. At Mériel, near Pontoise, there are remains of the 12th century Cistercian abbey of Le Val.

PONTOPPIDAN, ERIK (1698–1764), Danish author, was born at Aarhus on Aug. 24, 1698. He studied divinity at the University of Copenhagen, and for some time acted as a travelling tutor. In 1735 he became one of the chaplains of the king. In 1738 he was made professor extraordinary of theology at Copenhagen, and in 1745 bishop of Bergen. He died on Dec. 20, 1764.

His principal works are: *Theatrum* Daniae *veteris* et modernae (4to, 1730), a description of the geography, natural history, antiquities, etc, of Denmark; Gesta et *vestigia danorum* extra Daniam (3 vols. 8vo, 1740), a laborious but uncritical work; Annales *ecclesiae danicae* (3 vols., 1741–1747); *Marmora danica* selectiora (2 vols. fol, 1739–41); *Glossarium* norvegicum (1749); Det forste *forsög Norges* naturlige *historie* (4to, 1752–54); Eng. trans., Natural History *of* Norway (2 vols., 17jg), containing curious accounts, often referred to, of the Kraaken, sea-serpent, and the like; Origines *hafnienses* (1760); *Menoza* (3 vols., 1742–43), a religious novel. His Danske Atlas (7 vols. 4to), is an historical and topographical account of Denmark.

See S. M. Gjellerup in Dansk *Biografisk* Lexikon (vol. xiii., 1899).

PONTOPPIDAN, HENRIK (1857–1943), Danish author, was born at Fredericia on July 24, 1857. He studied at the university of Copenhagen, and when he was 18 travelled on foot through Germany and Switzerland. His novels show an intimate acquaintance with peasant life and character, the earlier ones showing clear evidence of the influence of Kjelland. An excellent example of his work is the trilogy dealing with the history of Emanuel Ransted, a theorizing radical parson who marries a peasant wife These three stories, *Muld* ("Soil," 1891), Det *Forjaettede Land* ("The Promised Land," 1892) and *Dommens Dag* (1895) are marked by fine discrimination and great narrative power. Among his other works are Fra Hytterne (1887), *Folkelivsskildringer* (2 parts, 1888–90) and Skyer (1890). He began in 1898 a new series in Lykke Per, the story of a typical Jutlander, completed in 1904. In 1912–16 appeared his trilogy, *De Dodes Rige,* dealing with the first decade of the 20th century. In 1917 he shared with Gjellerup the Nobel prize for literature. He died Aug. 21, 1943, in Charlottenlund, Denmark.

See an article of Niels Möller in Dansk *Biografisk* Lenikon (vol. xiii., 1899); also V. Andersen, *Henrik* Pontoppidan (Copenhagen, 1917).

PONTORMO, JACOPO DA (1494–1556), was one of the leading representatives of the late Florentine school of painting, which, though nearing exhaustion. still reflected the traditions of the great age. He was born at Pontormo, near Empoli, on May 24, 1494, and was the son of Bartolommeo Carucci, a painter. He was apprenticed to Leonardo da Vinci, and afterwards to Albertinelli and Piero di Cosimo. At the age of 18 he entered the workshop of Andrea del Sarto and was remarked as a young man of exceptional promise. One of his earliest works extant, painted in 1516, is the fresco in the vestibule of S. Annunziata, Florence, representing the "Visitation." Two years later he completed the altarpiece in the church of S. Michele Visdomini. From this early period of the master date three small pictures painted for the mansion of Piero Franceschi Borgherini of Florence. One of these, representing "Joseph and his Kindred in Egypt," is now in the National Gallery, London. It was regarded by Vasari as Pontormo's best picture. The other two panels, also of the story of Joseph, are with Lady Desborough at Panshanger. In 1521 he was employed on decorative work in the Medicean villa at Poggio a Caiano. He was then at the height of his powers, and a fresco painted in a large lunette with mythological figures may be regarded as one of his most successful achievements. He then took to imitating Durer, whose engravings and woodcuts were circulating in Italy. In 1522 he executed at the Certosa di Val d'Erna a series of frescoes founded on the Passion subjects of the German master. Pontormo's last works were a series of frescoes for the church of S. Lorenzo, Florence. He had then fallen under the dangerous influence of Michelangelo's style. After working on these for 11 years he left them incomplete. He died in Florence on Jan. 2, 1556.

See Vasari, Vite, edit. Milanesi.

PONTREMOLI, a town and bishop's see in Tuscany, Italy, in the upper valley of the Magra, 843 ft. above sea-level. Pop. (1936), 3,801 (town); 14,537 (commune). The town has a castle and walls, with the church of the Annunziata and its Augustinian monastery.

PONTRESINA (5,915 ft.), a village of the upper Engadine in the canton of Graubunden (Grisons), Switzerland, a station on the Rhaetic railway which goes over the Bernina pass. It is an important health resort and winter sport centre at the foot of the Bernina alps. Its 984 inhabitants are German-speaking.

PONTUS, a district in the north-east of Asia Minor bordering on the Euxine (Black Sea). About 301 B.C. Mithradates I., Ktistes, founded a kingdom beyond the Halys ruled by a succession of kings, mostly bearing the same name, till 64 B.C. As the greater part of this kingdom lay within Cappadocia, which extended from the borders of Cilicia to the Euxine, the kingdom was at first called "Cappadocia towards the Pontos" (πρὸς τῷ Πόντῳ), but afterwards simply "Pontus." Under the last king, Mithradates the Great, the realm of Pontus included not only Pontic Cappadocia but also the seaboard from the Bithynian frontier to Colchis, part of inland Paphlagonia, and Lesser Armenia (see MITHRADATES). After Pompey's conquest part of the kingdom was annexed to the Roman empire, being united with Bithynia in a double province called "Pontus and Bithynia"; this part included the seaboard between Heracleia (Eregli) and Amisus (Samsun), the Ora pontica. Hereafter the simple name Pontus was employed to denote the half of this dual province.

Its native population was of the same stock as that of Cappadocia, an oriental race called by the Greeks Leucosyri or White Syrians, but their precise ethnological relations are uncertain. It is a table-land, forming the north-east corner of the great plateau of Asia Minor, edged on the north by a lofty mountain rim, along the foot of which runs a fringe of coast-land. The table-land consists of a series of fertile plains, drained almost entirely by the river Iris (*Yeshil Irmak*) and its tributaries. Between the Halys and the Iris the mountain rim is comparatively low and broken, but east of the Iris it is a continuous lofty ridge, the rugged northern slopes of which are furrowed by torrent beds. These inaccessible slopes were inhabited in Strabo's time by wild, half-barbarous tribes, of whose ethnical relations we are ignorant — the Chalybes, Tibareni. Mosynoeci, 'and Macrones, on whose manners and condition some light is thrown by Xenophon (*Anab.* V.). But the fringe of coast-land from Trebizond westward is one of the most beautiful parts of Asia Minor.

The seacoast was studded with Greek colonies founded from the 6th century onwards: Amisus, a colony of Miletus, Cotyora, Cerasus, and Trapezus (Trebizond), a famous city from Xenophon's time until the end of the middle ages. The last three were colonies of Sinope, itself a Milesian colony. The chief towns in the interior were Amasia, on the Iris, the birthplace of Strabo, the capital of Mithradates the Great, and the burial place of the earlier kings, whose tombs still exist; Comana, higher up the river, a famous centre of the worship of the goddess Ma (Cybele, *q.v.*); and Zela, a religious centre, refounded by Pompey, now Zileh.

Christianity was introduced into the province Pontus (the Ora pontica) by way of the sea in the 1st century after Christ and was deeply rooted when Pliny governed the province (A.D. 111–113). But the Christianization of the inland Pontic districts began only about the middle of the 3rd century and was largely due to the zeal of Gregory Thaumaturgus, bishop of Neocaesarea.

See Ramsay, *Histor.* Geogr. of Asia *Minor* (1890); Anderson and Cumont, Studia pontica (1903 et seq.); Babelon and Reinach, Recueil des *monnaies d'Asie min.,* t.i. (1904); Cambridge Ancient History, vol. iii. ch. xxv. (bibliography).

PONTUS DE TYARD (1521?–1605), French poet and member of the Pléiade (see DAURAT), was seigneur of Bissy in Burgundy, where he was born in or about 1521. He belonged to the Lyons group of poets and was a friend of Antoine Héroet (*q.v.*) and Maurice Scève. His *Erreurs amoureuses,* originally published in 1549, was augmented with other poems in successive editions till 1573. He translated (1551) the *Dialoghi d'amore* of Léon Hébrieu, the breviary of philosophic lovers of that day. Two of his *Discours philosophiques* (1552) have what may fairly be called parallel statements of the *Défense* et illustration *de* la *langue française* of Du Bellay. Pontus was one of the first to write sonnets in French (the actual priority belongs to Melin de St. Gelais). It is also said that he introduced the sestine into France, or rather re-introduced it, for it was originally a Provencal invention. In 1578 he became bishop of Châlons-sur-Saône. He resigned in 1594, and died Sept. 23, 1605.

See the *Pléiade française* (1875) of M. Ch. Marty-Laveaux.

PONTYPOOL, an urban district of Monmouthshire, England, $9\frac{1}{4}$ mi. N. of Newport, served by the G.W.R. and L.M.S.R. Pop. (est. 1938) 40,200. Area, 24 9 sq.mi. It is at the base of Mynydd Maen on the right bank of the Avon Lewyd, a tributary of the Usk. Its growth is due to its situation on the eastern edge of the great south Wales coalfield. The earliest record of trade in iron is in 1588, but it was developed chiefly in the beginning of the 18th century by the Hanbury family. Tin plate was first made there by Andrew Yarranton in 1670. There are tin and iron works in the neighbourhood. Water communication is with Newport by the Monmouthshire canal. The urban district included after 193j the former urban districts of Abersychan and Panteg. The rapid growth of the Abersychan population caused the town to expand along the main valley and its tributaries. At Panteg are large steel and galvanized iron works. This whole district suffered greatly in the depression of the 1930s.

PONTYPRIDD, an urban district of Glamorganshire, Wales, situated on the Taff at its junction with the Rhondda, on the G.W.R. and on the Glamorganshire canal, 12 mi. N.W. from Cardiff. Pop. (est. 1938) 38.610. Area, 12.7 sq.mi. It receives its name from a remarkable one-arch bridge spanning the Taff, erected in 1755. It was an insignificant village till the opening of the Taff Vale railway into the town in 1840, and it owes its progress chiefly to the development of the coal areas of the Taff-Rhondda valleys. It also possesses chain and cable works, chemical works, and iron and brass foundries. It became a sort of gathering focus for the coal before being sent to Cardiff and Barry for export. Depression following World War I seriously affected this area, 60 8% of insured men being unemployed in May 1934. A trading estate in the district afforded some relief.

PONY, a horse of a small breed (see HORSE).

PONY EXPRESS, THE, an establishment **of** the United States government to carry mail on horseback from St. Joseph, Mo. to the Pacific before railways or telegraph It was started in 1860, when an impending crisis made the rapid communication of news between the older States and far-distant California a national necessity, and it had a brief existence of but 16 months before it was supplanted by a telegraph line. The animals used were, of course, not ponies but fleet American horses. They were stationed at "stages" from 10 to 15 miles apart and each rider rode three animals successively, covering not less than 33 miles before he passed the pouch to his successor. The fastest trip made was in 7 days and 17 hours when Lincoln's first inaugural address was carried, but the schedule was 10 days, about 24 days faster than the schedule of Butterfield's Overland Stage line travelling on the southern route. The maintenance of this schedule in all kinds of weather and in the face of Indian dangers and other hazards won for the service a fame which time has not diminished.

PONZA (anc. *Pontia)*, the principal of a small group of islands belonging to Italy. Pop. (1936), 2,787 (town), 6,457 (commune). The group is of volcanic origin, and includes Palmarola (anc. Palmaria), Zannone (Sinonia), Ventotene (Pandateria) and Santo Stefano. It is about 20 mi. S. of Monte Circeo and 70 mi. W. of Naples. There is regular communication with Naples by steamer, and in summer with Gaeta. The islands rise to a height of about 70 ft. above sea-level. Ventotene has a convict prison, and the islands were a place of banishment in ancient times. Under fascism, Ponza became again a place of banishment for Italians opposed to Mussolini, like Gen. Bencivenga and others.

POOD, a Russian weight, equivalent to 40 lb. Russian and about 36 lb. avoirdupois. A little more than 62 poods go to the ton. The word is an adaptation of the Norse *pund*, pound.

POOLE, REGINALD STUART (1832–1895), English archaeologist and orientalist, was born in London on Jan. 27, 1832, the son of Edward Poole and his wife *née* Sophia Lane. Poole acquired his taste for antiquities during a stay (1842–49) with his uncle, R. S. Poole, in Cairo. In 1852 he became an assistant in the British Museum, and was assigned to the department of coins and medals. of which in 1870 he became keeper. In 1882 he helped to found the Egypt Exploration Fund, and in 1884 the Society of English Medallists. He retired in 1893, and died on Feb. 8, 1895.

His elder brother, EDWARD STANLEY POOLE (1830–1867), who was chief clerk in the science and art department at South Kensington, was an Arabic scholar, whose early death cut short a promising career. His two sons, Stanley Lane-Poole (*q.v.*) and Reginald Lane-Poole (b. 1857), keeper of the archives at Oxford (1909–27), lecturer in diplomatic, and author of various historical works, carried on the family tradition of scholarship.

POOLE, WILLIAM FREDERICK (1821–1894), American bibliographer and historian, was born in Salem, Mass., on Dec. 24, 1821. He graduated at Yale college in 1849 and in the previous year had already compiled an *Index* to *Periodicals,* which was published anew in 1853 and 1882. Later editions were prepared in collaboration and rendered great service to scholars. He was one of the founders of the American Library Association.

His writings include: *The Battle of the Dictionaries* (1856); *Websterian Orthography* (1857); *Cotton Mather and Salem Witchcraft* (1869); *The Popham Colony* (1886); *Anti-Slavery Before 1800* (1887); and *Columbus and the Finding of the New World* (1892).

POOLE, a municipal borough and county, market town and seaport in Dorsetshire, England, 113½ mi. S.W. by W. from London by the S.R. Pop. (est. 1938) 68,860. Area 24.4 sq.mi. Poole is not mentioned till after the Domesday survey. The manor, part of that of Canford, belonged in 1086 to Edward of Salisbury, and passed to William Longespée, earl of Salisbury, thence to Edmund de Lacy, earl of Lincoln, and with his heiress to Thomas, earl of Lancaster, and so to the crown. It is uncertain when the burgesses obtained their town at the fee-farm rent of £8 13*s.* 4*d.* mentioned in 1312. In 1372 they obtained assize of bread and ale. and right to hold the courts of the lord of the manor. Elizabeth incorporated Poole in 1569 and made it a separate county. Poole, as headquarters of the Parliamentary forces in Dorset during the Civil War, escaped the siege that crippled so many of its neighbours. It is on a peninsula between Holes Bay and the shallow irregular inlet of Poole Harbour, one of the best on the south coast, extending inland 6 mi., with a general breadth of 4 mi. The harbour has a narrow entrance, and is studded with low islands, on the largest of which, Brownsea or Branksea, is a castle originally erected as a defense of the harbour in Tudor times, and strengthened by Charles I. A bridge across the harbour entrance, forming a link for road transport to Bournemouth, was opened in 1927. Clay is exported and shipbuilding and the making of ship fittings are carried on.

POOLS, IN INDUSTRY. Rival manufacturers or traders who, while still ostensibly in competition with each other, either allocate among themselves by agreement the amount or proportion of business each shall do, or agree as to who shall put in the lowest tender for a contract, frequently set up, as a part of their agreement machinery, a pooling system. One type is that adopted by those associations of manufacturers in the same industry which allot to each member a percentage of the output of the whole group, and require that each member who exceeds his "quota" shall pay an appropriate sum into a pool and that each member who does not reach his quota shall receive an appropriate sum from it. In associations concerned with work for which tenders are asked, three kinds of pooling are known. In one the tenders prepared by members of the group are confidentially examined by the secretary of the association and a percentage added to each, to be subsequently paid by the successful tenderer into a pool and divided among the rest. In another a uniform tender price is decided upon which all shall quote on the understanding that the firm receiving the contract shall pay an agreed percentage into the pool. In another the tenderers are informed of the order in which the sums quoted run, from highest to lowest, in order that the lowest tenderer may hold out for his price: in which case also the successful tenderer pays an agreed percentage of his contract into a pool. Another arrangement is the profit pooling agreement in which the future profits of two or more businesses are for a specified period paid into a common fund and divided out in agreed proportions. *See* ASSOCIATIONS, INDUSTRIAL; COMPETITION and TRUSTS. (J. H.)

Finance and Commerce — A pool on the stock exchange would work in some such way as follows, although the actual details naturally vary: —

(1.) Its members would consist of the holders of a certain share, and while the pool organizers would not attempt to bring in every shareholder, the members of the pool would between them have to hold a substantial block of the total shares issued for the formation of the pool to be worth while.

(2.) The pool members would authorize the pool organizers to sell their shares on their behalf, and would agree not to sell them themselves.

(3.) The pool organizers would agree not to sell these shares at less than a certain price. Thus the first third of the shares in the pool might be sold at a minimum of 21s., the next third at 22s., and the remainder at 23s. 6d. The proceeds of the sale as effected, less the charge for the pool's expenses, would be paid over to the pool members in proportion to the shares each held.

(4.) After six months from its date of formation, the pool would break up, and any shares still unsold would be re-transferred to the members, to deal with as best they could.

The whole object of a pool is to control and regulate the supply of a certain share to the market. For a pool to be effective, it must have a big holding of the share, or it will be faced with competitive selling from outsiders, and will be unable to obtain its minimum price.

If a new issue meets with an immediately unfavourable reception so that the bulk of it has to be taken up by the underwriters, it often happens that the underwriters form a pool.

A commercial pool in a commodity would work in very much the same way; it might be a buyer's pool—as the American rubber pool—or a seller's pool, such as the Canadian wheat pool, a great non-profit, co-operative marketing association in Canada. In either case, the buying and selling is done by the pool for its members, who agree to operate only through the pool. The object is to obtain by combined effort a reasonable price. (N. E. C.)

United States. — Pools among railway companies became widely prevalent throughout the United States between 1870 and 1887 and aroused so much opposition on the part of the public that the Interstate Commerce Act was passed in 1887 making them illegal as regards interstate traffic. The act was not altogether successful for division of traffic, especially in the shipping of cotton, fruit and grain, persisted without the usual pooling machinery being in evidence. Such agreements, however, being non-enforceable, were seldom of long duration. The wisdom of the Interstate Commerce Act has been often called into question, and recommendations favouring legalization under government supervision have been made both in presidential messages and in the reports of the interstate commerce commission itself. A decision of the Supreme Court in 1911 making contracts not illegal unless in "unreasonable restraint of trade" eased the situation somewhat, while the modern tendency toward combination also tends to eliminate the conditions which cause pooling arrangements to be made.

POONA, a city and district of British India, in the Central division of Bombay. The city is at the confluence of the Mutha and Mula rivers, 1,850 ft. above sea-level and 119 m. S.E. from Bombay on the Great Indian Peninsula railway. Pop. (1931), 214,380 (including Kirkee). It is pleasantly situated amid extensive gardens, with a large number of modern public buildings, and also temples and palaces dating from the 16th to the 19th century. The palace of the peshwas is a ruin, having been destroyed by fire in 1827. From its healthy situation Poona has been chosen not only as the headquarters of the Southern Command, but also as the residence of the governor of Bombay during the rainy season, from June to September. The cantonment is at Kirkee, 4 m. N.W. (pop. 16,302), where there is also a large ammunition factory. The waterworks were constructed mainly by the munificence of Sir Jamsetjee Jeejeebhoy. There are cotton, paper, rice and sugar mills, ice, and iron works, distilleries and a tannery. It was proposed in 1927 to bring electric power to the city from the Tata power company's installation at Nila-Mula. Educational institutions include the government Deccan college; Fergusson college; the government colleges of science, engineering and agriculture; training schools for masters and mistresses; medical school; and municipal technical school.

The DISTRICT OF POONA has an area of 5,332 sq.m. Population (1931), 1,169,798. Towards the west the country is undulating, and numerous spurs from the Western Ghats enter the district; to the east it opens out into plains. The district is liable to drought. The two most important irrigation works are the Mutha canal, with which the Poona waterworks are connected, and the Nira canal. The district is traversed by the Great Indian Peninsula railway, and also by the Madras and Southern Mahratta line, which starts from Poona city towards Satara.

In the 17th century the district formed part of the Mohammedan kingdom of Ahmadnagar, and was the early centre of the Mahratta power and the seat of government.

POORE (or POOR), **RICHARD** (d. 1237), English bishop, was a son of Richard of Ilchester, bishop of Winchester. About 1197 he was chosen dean of Sarum and, after being an unsuccessful candidate for the bishoprics of Winchester and of Durham, he became bishop of Chichester in 1214. In 1217 he was translated to Salisbury, where he succeeded his elder brother, Herbert Poore, and in 1228 to Durham. He died at Tarrant Monkton, Dorset, said by some to be his birthplace, on April 15, 1237. Poore took some part in public affairs, under Henry III., but the great work of his life was done at Salisbury. Having in 1219 removed his see from Old to New Sarum, or Salisbury, he began the building of the magnificent cathedral there. He laid the foundation stone in April 1220, and during his episcopate he found money and forwarded the work in other ways. For the city the bishop secured a charter from Henry III. and he was responsible for the plan on which it was built.

POOR LAW. The term "poor law" in British usage denotes a peculiar system of giving public relief to the destitute. (See PAUPER.) The principles are laid down in statutes and worked out in detail in "orders" and "circulars" of a central department of State, the Ministry of Health or the Scottish Board of Health. The administration is in the hands of a special local authority, known as the board of guardians in England and Wales, and the parish council in Scotland. The modern system began in 1834, when the "New Poor Law" replaced the "Old Poor Law" which after nearly two and a half centuries of existence had become an intolerable scandal. The machinery set up then has not undergone much change, nor, in theory at least, have the methods of relief, though there have been considerable modifications in practice, which will be referred to presently. The whole of the Statute law was consolidated in the Poor Law Act, 1927, which together with the Poor Law Institutions Order, 1913, and the Relief Regulation Order, 1911, contains a full outline of the system.

Central Authority.—The Ministry of Health took over the functions of the Local Government Board in 1919. (The first central authority was the Poor Law Commissioners of 1834. These were replaced in 1847 by the Poor Law Board, which in turn was abolished on the creation of the Local Government Board in 1871.) The Ministry of Health exercises a close control over the local authorities, through its poor law "orders," which they must obey, its inspectors, its systematic audit of local accounts, and its power of sanctioning loans. And, by the Boards of Guardians (Default) Act, 1926, the minister has power to supersede any board of guardians, which he considers unable to discharge its functions properly, by persons appointed by himself.

Local Authorities.—The board of guardians is a popularly elected body in each of the 600 odd Poor Law Unions in England and Wales, whose members hold office for three years. It has a limited power of co-opting. The board acts, like other local authorities, through committees dealing with separate departments of its work, and through its permanent officials. The most important of these are the clerk, the master and the matron of the workhouse, the relieving officer and the medical officers. In addition there are officials in charge of various institutions, such as children's homes and schools and casual wards, as well as teachers, infirmary nurses, etc. The guardians' expenses are met mainly out of the local rates, by precepting on the rating authority, the town or district council. But they also receive considerable grants-in-aid from the national exchequer. In London the expenditure of the boards of guardians is largely equalized through a pool system known as the Metropolitan Common Poor Fund, into which the richer Unions pay, and out of which the poorer Unions receive, large sums. Thus in 1925–6 Bermondsey drew £248,469 from the fund, Stepney £308,386, and Poplar £520,095.

Powers **and** Duties.—The principal duty of the board of guardians is the relief of destitution. It has besides one or two minor functions; *e.g.,* it enforces the vaccination acts and appoints registrars of births and deaths. The relief to the destitute may be either "indoor" or "outdoor." Indoor relief is closely regulated by the Poor Law Institutions Order, 1913, and is given in workhouses, infirmaries and other institutions such as casual wards, district sick asylums, poor law schools, training-ships, "cottage" and other homes for children, homes for the aged, county and county borough asylums, licensed houses for lunatics, schools for the blind, deaf and dumb. Outdoor relief includes allowances in money or kind, medical attendance and drugs, the payment of funeral expenses, and the provision of work for able-bodied men. Outdoor relief is not normally given to the able-bodied; but the Relief Regulation Order, 1911, permits the guardians to depart from the rule when they consider that special circumstances warrant it, and report to, and get the sanction of, the Ministry. For the administration of medical out-relief the whole country is divided into districts more or less equal in area and population, for each of which a medical officer is appointed. Relief may, if the guardians choose, be given on loan, and the cost is then recoverable in a county court. The guardians also have power to recover the cost of relief either wholly or in part from certain persons who are legally liable for the maintenance of relatives. Thus a husband is bound to maintain his wife. Parents are bound to maintain their children under 16 (or over 16 if unable to support themselves), and grandparents their grand-children under 16. Legitimate children are bound to maintain parents who are unable to support themselves. A married womak having a separate estate is bound to maintain her husband, her children under 16 and her parents. A single woman is bound to maintain her illegitimate children under 16.

Except in the case of vagrants, relief is normally given to a person only in his own parish, *i.e.*, the parish in which he is legally "settled." Settlement is acquired by birth, marriage, ownership or occupation of property, apprenticeship, or residence. Residence for three years constitutes a full settlement; but one year's residence gives a status of "irremovability." The harsh settlement laws that caused so much mischief in the old days have been very greatly modified; but paupers can be, and still are, removed from one Union to another. Removal orders must be signed by two justices of the peace. Of course relief is not withheld because of a doubt or dispute about a person's settlement. It is given, and the questions of chargeability and removal are decided subsequently between the Unions concerned.

Vagrancy.—The treatment of vagrancy has certain peculiarities. The casual ward is subject to the strict regulations of the central authority in respect of tasks, dietary, sleeping accommodation, bathing and conditions of admission and discharge. Normally the casual cannot leave before the morning of the second day following his admission, nor till he has finished the task which is the price of his food and lodging. But if he satisfies the superintendent that he is definitely seeking work, he may be discharged after one night. The casual's task may be stone-breaking, digging, pumping, wood-cutting or grinding, and for women, washing, scrubbing, or cleaning. Oakum-picking was abolished in 1925. Since the report of the royal commission in 1909, some reforms have been introduced in the administration. In the provinces there are county vagrancy committees, representing the boards of guardians within the county, or sometimes a larger area. Through these committees a more or less uniform treatment is secured, the cost of relief of the casual paupers is pooled, and arrangements are made for mid-day meals and other forms of assistance to men on the tramp for work. Boards of guardians are not compelled to come into these combinations, and many refuse to. Some of the independent casual wards are very unsatisfactory. The majority of the boards, however, have come in, and in 1927 the vagrancy committees represented 480 Unions. In London all the' casual wards have been managed since 1912 by one central body, the Metropolitan Asylums Board. The majority of the members of the M.A.B. are representatives of the 25 London boards of guardians, the rest are nominated by the Ministry of Health. Besides the management of the casual wards it has a number of other duties; *e.g.*, it maintains isolation hospitals (for non-pauper as well as pauper cases), asylums for the mentally defective, a colony for sane epileptics, and the *Exmouth* training-ship for poor-law boys.

Scotland.—The Scottish system closely resembles the English. It begins with an Act of 1579, entitled "For Punishment of the Strong and Idle Beggars, and Relief of the Poor and Impotent," which corresponds to the English act of 1601. The Poor Law Amendment (Scotland) Act, 1845, corresponding to the English act of 1834, established poorhouses and local authorities known as parochial boards. These were replaced in 1894 by parish councils, whose duties in regard to the relief of destitution are very much the same as those of the boards of guardians, and which are under the supervision of the Scottish Board of Health. One peculiar feature of the Scottish poor law may be noted, however; an able-bodied person, until 1921, had no legal right to relief of any kind. An act of that year, the Poor Law Emergency Provisions (Scotland) Act, supplemented by another in 1927, gave the right, but only for a limited period (till the end of 1928).

The Old Poor Law.—The Old Poor Law was the creation of Tudor statesmen, and was forced upon them by the necessities of their age. After the Reformation the Church was no longer equal to the task of relieving the needs of the poor, and the social and economic changes of the 15th and 16th centuries had multiplied the numbers of the vagrants and the "idle and disorderly." Various measures were passed for dealing with the mischief, and these were eventually codified in the famous statute of the 43rd year of Elizabeth (1601). Every parish was required to appoint overseers, whose duty it was to levy rates for the relief of the poor. The rates were to be expended for the apprenticeship of children whose parents could not maintain them; for providing work for the able-bodied unemployed; and for assisting those who were unable to work owing to sickness, age or other infirmity. The Elizabethan system was fairly successful for a generation or so, but with the Civil War decay set in. After 1662 the difficulties were aggravated by the law of settlement (under which any person who came to live in a parish not his own might, if he seemed likely to become a charge on the rates, be turned out, and sent back to the place where he "belonged") and abuses rapidly increased. Experiments in reform were tried at intervals throughout the 18th century—workhouses, the farming-out of the poor to contractors, and various forms of outdoor relief, ranging from the payment of unconditional doles to the hiring of paupers to farmers at nominal wages which were supplemented out of the rates. Finally the "Speenhamland system" spread far and wide. This developed out of a rule made in 1795 by the Berkshire magistrates, meeting at the Pelican inn, Speenhamland, that allowances of money should be given on a sliding scale regulated by the price of bread. In the early part of the 19th century pauperism was a canker in the body politic, and its cost a crippling burden. In 1818 poor law expenditure reached the figure of nearly £8,000,000, or 13/3d. per head of the population, and though it fell a little in the following years, it stood at £7,000,000, or 10/– per head of the population, in 1832 In that year a royal commission was appointed to enquire into the whole system, and its recommendations were the basis of the reforms which were embodied in the Poor Law Amendment Act of 1834.

The New Poor Law.—The New Poor Law made a clean sweep of the old practice of unrestricted out-relief. It grouped hitherto independent parishes into Unions, each under an elected board of guardians, with a strong central authority to enforce a uniform policy. And it laid down the cardinal principle that relief should only be given to the able-bodied poor and their dependants in a well-regulated workhouse under conditions inferior to those of the humblest labourer outside. This drastic measure of deterrence naturally provoked widespread popular discontent, and was indeed one of the grievances which played a part in the Chartist agitation. But it went far to reduce the volume and the cost of pauperism As time wore on, however, its strict application became more and more difficult. The developnient of democracy, the growth of humanitarian feeling, and the discovery of more scientific methods of dealing with destitution, all helped to mitigate the harshness of poor law administration. There were improvements in the treatment of different classes of paupers, and many boards of guardians adopted a more generous—or, as their critics said, a more lax—policy both in the granting of outdoor relief and in the management of the workhouse. But no one who looked below the surface could be satisfied with the poor law at the beginning of this century. Its abuses were not those of a hundred years earlier, but they were serious enough to call for public investigation. A royal commission "on the poor laws and the relief of distress" was appointed in 1905, and its reports, issued in 1909, exposed the whole system to a searching criticism, The failure of the poor law was seen in almost every department. "Well-regulated workhouses" were the exception rather than the rule. Here and there the deterrent principle was maintained, and "able-bodied tests" were applied in the shape of stone-breaking or other tasks set to the unemployed workman, which were not only brutal but uneconomic. More often, however, the workhouse had an able-bodied ward, in which all and sundry were left to twiddle their thumbs in a demoralizing idleness. For the tramps there were casual wards run on methods that were cruel to the honest work-seeker, and utterly useless from the point of view of reforming the "work-shy." Nor was the condition of the non-able-bodied less deplorable. The general workhouses contained a great host of children, in constant contact with the adult paupers, often ill-tended and improperly educated. The treatment of the patients in many of the infirmaries and sick-wards, and of the idiots, imbeciles and lunatics, was a scandal. In the granting of outdoor relief there was no uniformity at all In some Unions the allowances were fairly generous, in others they were utterly inadequate. There were boards of guardians which gave a widow 1s. or 1/6d. a week for her child, with nothing for herself. And despite the strenuous efforts of many of the guardians to humanize the administration and of others to keep down the cost of pauperism, the poor law was detested by the poor and a growing burden on the rates.

Reports of Royal Commission, 1909.—The royal commission demanded drastic reforms. The majority recommended that the boards of guardians should be replaced by statutory committees of the county and county borough councils, to be known as "public assistance authorities," with a number of minor bodies (public assistance committees) working under them in sub-areas. The general workhouses should be abolished, and different classes of the destitute relieved in properly specialized institutions. The able-bodied should as far as possible be provided for by other methods. Outdoor relief, or "home assistance," should be adequate, but should be given only after strict inquiry, under supervision, and on a uniform basis. The minority were not content with this; they proposed the complete abolition of the poor law—the thing as well as the name. They argued that the system was fundamentally bad. It was the business of the community to try to prevent destitution, and not merely to palliate it when it occurred. This had long been recognized in the case of other public authorities which had to deal with different classes of the poor—the aged, the children, the sick and the feeble-minded. And these authorities, it was pointed out, were not only working on the right principle; they were better equipped than were the guardians for giving the appropriate treatment in each case, they were free of the "stigma of the poor law," and parliament was steadily extending their functions. But, while this was satisfactory in itself, it involved in practically every department a deplorable amount of administrative disorder, overlapping, duplication of machinery and waste. In the case of each class of the poor, infants, children of school age, the sick, the feeble-minded, the aged, the able-bodied, there was at least one, and often more than one, other authority set up as a rival to the board of guardians. On administrative as well as humanitarian grounds, therefore, the minority report recommended the break-up of the poor law, and the distribution of the functions of the guardians (or the parish councils in Scotland) among the appropriate local authorities, save in the case of the able-bodied, who it was proposed should be made the charge of a national unemployment authority.

This policy received strong support throughout the country and there was an active agitation for poor law reform during the next two or three years. The Government, however, was not disposed to introduce the necessary legislation, and John Burns, the president of the Local Government Board. undertook what he called "revolution by administration." All that he did in fact, was to abate certain of the most crying scandals; in essentials the poor law was left intact. When the war broke out in 1914, the problem was naturally shelved; the volume of pauperism rapidly diminished, and in any case no large reform was possible under war-time conditions. In 1917, however, the whole question was re-examined by a committee appointed by the Ministry of Reconstruction, and presided over by Sir Donald Maclean, M.P.

The Maclean Report.—The Maclean committee was important, because it included representatives of both the majority and the minority of the old royal commission, and it produced a unanimous report which reconciled their differences. The report in fact confirmed the sentence of death passed on the guardians eight years before, and made detailed recommendations for the break-up of the poor law. Its main proposals were:—

1. The transfer of all the functions of the boards of guardians to the councils of counties, county boroughs, and boroughs or urban districts with populations exceeding 50,000.

2. Provision for all the sick and infirm (including the aged requiring institutional care, and maternity cases and infants) should be made by these authorities under the Public Health Acts, suitably extended.

3. The Ministry of Health should have power to put any borough with a population over 10,000, or any urban district with over 20,000, in the position of an autonomous health authority, with such reservations as might be desirable.

4. The children should be dealt with by the local education authorities, the mentally deficient by the local lunacy authorities.

5. Every county or county borough (or borough or urban district council with a population over 50,000) should set up: (1) a prevention of unemployment and training committee (on the lines of the education committee, and including representatives of employers and trade unions); (2) a home assistance committee (on the lines of the education committee) to enquire into the economic circumstances of all applicants for public assistance, to supervise them, to administer all relief given in the home, to recover expenses of maintenance, treatment, etc., and to keep a private register of all such applicants and their families and of the assistance given.

6. County councils should appoint committees for districts or combinations of districts, to which various functions of the home assistance committee and the prevention of unemployment committee would be delegated. Such district committees would consist of: (a) members of the county council; (b) borough or district councillors; (c) persons experienced in the work to be done.

7. London should have a special scheme, in which the functions would be divided between the L.C.C. and the metropolitan borough councils. The borough councils would appoint home assistance committees, and would also be responsible for vaccination and registration of births and deaths. The L.C.C. would, through its appropriate committees, exercise the rest of the functions transferred. It would also appoint a central assistance committee, which would lay down a policy and rules of local administration for the home assistance committees in the metropolitan boroughs.

8. Poor law officials should be transferred to the local authorities (provided both they and the local authorities agreed), and compensated for any pecuniary loss incurred by the change.

9. The cost of all functions transferred should fall on the new authority (the county, county borough, borough or urban district, and in London mainly on the county, but partly on the metropolitan borough).

Scotland was outside the committee's terms of reference. But the matter was referred for consideration to the Scottish consultative council on local health administration. The council issued majority and minority reports, the majority declaring in favour of a Scottish scheme on the general lines of the Maclean report. This scheme was approved by the government of the day, and pledges were given that a bill to reform the poor law would be introduced as soon as opportunity offered. Nothing was done, however, either by that government or by its successors, until Neville Chamberlain, the Conservative minister of health, began to move in the matter in 1925.

In the meantime the poor law entered on a new and alarming phase. The industrial depression, which began in 1920, resulted in a rapid and unprecedented increase of unemployment. Trade union funds and such private savings as the workpeople had were soon exhausted, and the Unemployment Insurance Act and relief works were inadequate to meet the widespread distress. Unless the government was prepared with some heroic policy, it was evident that nothing remained save the poor law. The government refused to be heroic; it actually encouraged recourse to the poor law, in order, as its critics said, to shift as much of the cost as possible from the taxes to the rates. Before long the boards of guardians in all the most heavily stricken areas were flooded with applicants. At the end of 1920 there were just over half a million persons in receipt of poor relief in England and Wales. By the following October the figure was nearly a million and a half, and in the middle of June, 1922, it reached the record of 1,837,980, or 1 in 21 of the whole population. In certain districts the position was even worse than this. No less than thirty Unions had 1 in 10, and several had 1 in 5, of their inhabitants registered as paupers. There was presently a gradual decrease, but the total in June, 1923, was still 1,270,000. In Dec., 1925, it rose again to 1,324,000, and in Aug., 1926, as a result of the great coal dispute, to over 2,250,000. In this month there were eight Unions with a third, and fourteen others with a quarter of their population in receipt of relief. In two Unions in particular weeks more than 50% of the population were paupers. The vast majority of those relieved in the mining areas were the wives and children of the miners, since the "Merthyr judgment" forbade relief to the men themselves. (In the case of Attorney-General v. Merthyr *Tydfil Union* [1900, 1 Ch. 516], the court of Appeal decided that poor relief may not legally be given to an able-bodied person who, by reason of a strike or otherwise, refuses work which is available for him, unless he is so reduced by privation as to be physically incapable of work; but that it may be given to his dependants.) In 78 Unions (covering 85% of the mining population of the country) there were approximately 1,507,600 persons receiving out-relief on Oct. 30, 1926—or about three-fifths of the whole number of miners' dependants in those areas. And for the period of the general strike and the coal dispute, *i.e.*, from May 1 to Nov. 27, these 78 boards of guardians spent spme £63 million more than they would have done if the April rate of expenditure had continued. Scotland had much the same experience. The total number of poor of all classes relieved by the Scottish parish councils was 138,071 on September 15, 1921, and 261,408 a year later. The peak figure of 382,970 was reached on Sept. 15, 1926.

All this, of course, meant an appalling rise of the rates in the crowded industrial districts, which were hit by the trade slump in the earlier part of the period, and hit again by the general strike and the coal stoppage. On Tyneside in 1926–27 the rates were 17/5 in the £ in Wallsend, 17/6 in Tynemouth, 19/11 in Jarrow, 23/9 in Gateshead, 24/8 in Felling, 27/8 in Blaydon. The poor rate formed a large proportion of all these: in Gateshead it was 11/–, which represented an increase of over 600% over the poor rate of 1913–14. Among the metropolitan boroughs Bermondsey had a rate of 18/7, Stepney 19/–, Bethnal Green 22/–, and Poplar 25/–. Other highly rated places were Sheffield (18/2), Middlesbrough (19/8), West Ham (24/6), Pontypridd (20/8), Merthyr Tydfil (24/4). In some cases the ratepayers were unable to meet the strain. The guardians were compelled to borrow and thus saddle the' rates with a heavy burden for the future. In 1923 the actual total indebtedness of the Unions that had raised loans was about £5¼ millions. By March, 1926, it stood at over £7 millions, and in March, 1927, at nearly £12¾ millions. The bulk of the new borrowing in this last year was in the mining districts.

Breakdown of "Principles of 1834."—The task thus thrust an the poor law was clearly one for which it was neither intended nor equipped. And the inevitable result was confusion worse confounded, and a widespread abandonment of what was left of the principles of 1834. The prohibition of outdoor relief to the able-bodied unemployed, save with the express sanction of the Minister of Health in particular cases, still remained on paper. But it became virtually a dead letter in Unions where there was serious unemployment. Outdoor relief was given wholesale, and as a matter of course, to able-bodied men simply because they were out of work, and often not even the names of the recipients, but only the number of cases, were reported to the Ministry for its formal approval. The guardians of course could not fairly be blamed for this; in the circumstances there was nothing else they could do. And the central authority was equally helpless; it could not adhere to the letter of the law without provoking a general upheaval. It could, and indeed did, grumble and remonstrate, but in the last resort it was bound to sanction departure from the regulations. And it could not prevent the use of "scales" of relief adopted by boards of guardians and applied mechanically or in a slipshod fashion. It strove to keep the amount given in outdoor relief below the level of the wage earned by regular full-time employment, but even in this it was only partially successful. In the annual report of the Ministry of Health for 1923–24, the complaint is made that "it is still the fact that the scale on which relief is given is such as, in a number of Unions, to make the income of the person relieved compare very favourably with the wages of an employed person." And again in the 1926 report the warning is repeated that a scale of relief "should not be such as to challenge comparison with the earnings of the workers who are called upon, directly or indirectly, to contribute to the relief so granted." A common scale at this period was 36/– a week for a man, wife and four children. There were maximum scales in 1924–25 of 44/– in Cardiff, 45/6 in Burnley, 46/– in Leeds, 51/– in Poplar, 55/– in West Ham. In Scotland the Board of Health was a little more successful in its attempts to keep down the relief to the unemployed. In view of the critical financial position in 1926 it recommended a maximum scale (23/– a week for man and wife; 2/– for a child under 16; 7/6d. for an adult son or daughter living in the family; 15/– for a single man or woman; and all household income to be deducted), and it refused to sanction loans or overdrafts to parish councils which did not keep within the scale. This had the effect generally of stopping poor law relief in supplement of unemployment benefit, which had become a common practice. Nevertheless the burden was immense. In two big parishes, Glasgow and Govan, the 1926 expenditure was double that of the previous year, and in some smaller parishes it rose by over 300%.

"Poplarism."—To return to England, however—what appeared serious in this development was that it was not merely the result of carelessness or fluster in the guardians. On the contrary, certain boards quite deliberately adopted the policy of giving out-relief on such a generous scale that there could be no pretence of making the lot of the pauper less desirable than that of the independent labourer. This policy was not entirely new; the Poplar board, dominated by a Socialist majority, had long favoured the giving of what it regarded as adequate, and its critics as extravagant, relief. But with the increase of distress that was now facing many of the poor law authorities the burden on the ratepayers became formidable, and a struggle presently began over what was known as "Poplarism." Efforts were at first made to get the Ministry of Health to devise means for alleviating this burden in the poorer districts, but in vain. The Poplar borough council (which also had a Socialist majority) then took the desperate course of refusing to collect the rates for the London county council and certain other central bodies. Legal proceedings were taken, and the high court ordered the collection of the rates. The borough council ignored the order and 29 of its members were imprisoned for contempt of court. Their imprisonment put the Government in an uncomfortable position, and forced it to concede the legislation which Poplar had been demanding. The Local Authorities (Financial Provisions) Act, 1921, provided for a large measure of equalisation of poor rates in London; in particular it laid down that the cost of outdoor relief should be borne by the Metropolitan common poor fund within the limits of a scale to be fixed by the minister of health.

The minister, Sir Alfred Mond, issued his scale in Jan. 1922. It did not satisfy the Poplar guardians, who now pressed for a loan to tide them over their immediate difficulties. A special inquiry was then instituted by the minister into the circumstances of Poplar. The report was unfavourable to the guardians, and declared that by more economical methods they could save £100,000 a year. This they hotly denied; they still demanded their loan, and insisted on their right to administer relief at their discretion. The minister thereupon played his trump card. He issued a "peremptory order," applicable to the Poplar Union alone, providing that no relief in excess of the "Mond scale" to an able. bodied person or any member of his family should be legal, unless specially sanctioned by the minister. The guardians, however, persisted in defying this order, and so laid themselves open to surcharge. After a few months a curious complication was introduced by the Local Authorities (Emergency Provisions) Act, 1923, which apparently revoked automatically the "Mond scale," but left the Poplar order intact, though the two had been closely bound up together. This anomaly lasted till Feb. 1924. The guardians meanwhile were regularly surcharged by the auditor, but successive ministers of health shut their eyes to the matter, until at length John Wheatley in 1924 rescinded the order, and announced that no action would be taken to enforce surcharges in respect of the "illegal relief" given before its rescission. That was the end of this particular battle, though it was not the end of high relief scales. Other boards of guardians continued to favour "Poplarism" and pursued a guerrilla warfare with the Ministry of Health.

There was, of course, a division of opinion over "Poplarism." The one side insisted that it was not only the right, but the duty of the guardians to give adequate relief; the other retorted that the Poplar conception of adequacy was preposterous. But the division was not, as is sometimes supposed, simply one between Socialists and anti-Socialists. The critics included many supporters of the Labour party who not only looked askance at law-breaking tactics, but foresaw disastrous results if the policy of lavish and unconditional relief were to become general. At the same time they appreciated the difficulties of Poplar and similarly placed unions, and argued that the mischief could only be remedied by the reform or the abolition of the poor law. In this view the "Poplarists" themselves concurred, and, indeed, it was realised on all sides that the poor law guardians were not and could never be a satisfactory unemployment authority. But nothing was done to relieve them of their burden, and fresh trouble soon developed.

The Battle of West Ham.—The West Ham board of guardians had for some time been paying out in poor relief a sum far exceeding what could normally be raised by way of rates, and were in fact financed by loans advanced by the Ministry of Health on the recommendation of a Treasury committee. By the autumn of 1925 the outstanding balance of these loans had reached nearly £2,000,000, or 57% of the rateable value of the Union, and the guardians were asking for another £350,000 in respect of current expenditure. The Treasury and the Ministry of Health made a stand at this point and insisted on certain restrictions of expenditure as a condition of the loan. The guardians refused to accept the conditions, and so found themselves with no funds out of which to pay their outdoor relief, their officers' salaries or the other expenses of the Union. The minister thereupon took the unprecedented step of guaranteeing payment of tradesmen's bills for outdoor relief supplied in kind on orders made by the guardians and marked with a special stamp. The amount of the relief was not, however, to exceed three-quarters of the amount which would have been granted under the guardians' scale. This plan worked for four weeks, and then, as the guardians were still obstinate, the minister threatened that he himself would take over the whole business of administration in the West Ham Union. He had (at that date) no legal power to do this, but he would, of course, have got an indemnity from parliament. The threat brought the guardians to heel; they accepted the conditions and got their loan. But this was only the first round. In the summer of 1926 there was a renewal of the contest. At the beginning of May some 70,000 persons in the Union were in receipt of relief; by the middle of the month the general strike had brought the number up to 165,000, or 21% of the population. The board of guardians now applied for another loan of £425,000. The minister pointed out that the district auditor had held their expenditure to be in many cases entirely unjustifiable, and certain members of the board agreed with this view. Their scale of weekly relief was 24/– for a man and wife, and 4/– for each child, up to a maximum of 49/–, plus 1/6d. for coal. He once more insisted upon drastic economies, as a condition of the loan; but the guardians refused to amend their scale, and he administered a knockout blow. Under the bill that was passed into law as the Boards of Guardians (Default) Act, 1926, he superseded the West Ham guardians and handed over their functions on July 20 to three paid administrators, two civil servants and one ex-civil servant, nominated by himself. Under the new régime the number of outdoor paupers rapidly fell (it was 60,000 on July 17, 1926, and 41,000 on March 26, 1927), and the expenditure was substantially reduced.

The Guardians (Default) Act.—But West Ham was not the only Union in which the act was applied. In August the Chester-le-Street, and in the following February the Bedwellty, guardians were removed. In both cases an acute crisis had developed during the coal stoppage. Liberal relief was being given, and it was being given to unmarried miners, which was contrary to the law as laid down by the judges in the Merthyr Tydfil case. In Chester-le-Street the total of outdoor paupers rose from 10,547 on March 27, 1926, to 37,643 on August 28, and in Bedwellty from 15,293 on March 27 to 59,565 on July 17. The minister admitted that the guardians were in an exceedingly difficult position; but he declined to sanction further loans, and put in his appointed guardians. They at once revolutionised the administration by cutting down the relief scales, by refusing to supplement unemployment benefit except by medical extras, and by discontinuing all subsidies to wage-earners, and so effected a reduction of rates, if not of distress.

The passage and the application of the Default Act naturally caused much heartburning. Nor did the criticism come only from whole-hearted champions of "Poplarism." Many who deprecated the policy pursued in these three Unions held that the act was a dangerous infringement of the principles of local government. It put excessive power in the hands of a central department, which might be used quite arbitrarily to undermine democracy up and down the land. Even if Neville Chamberlain could be acquitted of any such intention, there was no guarantee that others would not cherish it, and there were actually, it was pointed out, influential persons in his party who were clamorous for tightening the grip of parliament and Whitehall on the local authorities throughout the country. On the other hand it was contended that the true interests of democracy were not served by letting it run into excesses; the example of West Ham and Chester-le-Street and Bedwellty, if it were generally imitated, would mean an immense demoralisation and in the end violent reaction. Both sides undoubtedly had a case in this controversy. though it was often exaggerated or obscured by party bias. But the real moral of the whole episode was not the danger of "Socialism" or of "Fascism." It was the folly of putting new wine into old bottles.

The Guardians **and Unemployment.**—Neither the Elizabethan nor the 19th century poor law was framed to deal with unemployment in its modern form. It is true that the duty of "setting to work all such persons having no means to maintain them" was laid upon the overseers in 1601, and the duty of "offering the workhouse" upon the guardians in 1834. But the prime objects of both the Old and the New poor law were the repression of the idle who could work and the succouring of the sick and the aged and the young, who could not work. Relief to an able-bodied adult was to be regarded as exceptional (in Scotland it was not allowed at all until 1921), and under the New poor law, at least, was given on repellent terms. How could the ancient machinery of the poor law be expected to adapt itself to the very different conditions and mind of the 20th century? Boards of guardians cannot set to work a million men of all sorts, nor can they "test" them, even if they wished to. Some, perhaps most, do not wish to "test" the unemployed workman who has lost his job through no fault of his own and is unable, either privately or through the employment exchange, to find another. That feeling of compunction, as has already been mentioned, was growing fast in the early years of this century. It was expressed in legislation for making provision for the unemployed otherwise than through the poor law; it was expressed by poor law administrators themselves in the relaxing of restrictions on relief to the able-bodied. After the war the idea of the "test" became still more unpopular, and finally the flood of unemployment made the "offer of the house" an impossibility in the most seriously affected areas. And thus it was that the poor law reverted to a condition very like that of a hundred years earlier, save that then the bulk of the pauperism had been rural, and now it was urban. The minister of health in his 1927 report mentions one remarkable similarity. "During the past six years," he says, "numbers of young men, without employment and maintained on poor law relief, have married, securing thereby an increase in their income from relief, and have had families, each addition to the family bringing its addition to the family income. In this respect it may be doubted whether the present position can be paralleled since 1834." It was inevitable that such abuses should occur. The guardians were compelled to be a dole disbursing agency, filling the "gaps" of the Unemployment Insurance Act, supplementing its benefits, or feeding those who fell outside its provisions. They had not then, and never had, the power to deal with unemployment as a whole, or to organise any proper palliative, let alone preventive, measures. In all the circumstances it is not surprising that there were muddles, fraud and extravagance, involuntary or deliberate, or that when a whole population was workless and political passions were running high, the law was defied. There might easily have been a hundred West Hams and Chester-le-Streets. As it was, there were only three; and the guardians and their officials, as a whole, might fairly claim to have struggled honestly and courageously with their herculean task.

But if the poor law managed somehow to weather the worst of the storm, that does not prove that the ship was, or can ever be made, seaworthy. What was done in the years of distress from 1921 onwards was done at a fearful cost, financial and moral. The burden of the rates lay heaviest where it could least be borne—on struggling industries and small householders and shopkeepers, in districts whose rateable value was low and in which public expenditure was bound to be high. The guardians could only ease its present weight by borrowings which spread it over the future. And the distribution of these vast sums was, and could only be, for the most part a dangerous form of charitable relief. Such a system might be justified as a temporary necessity in an emergency like that of the mining dispute of 1926. But as a settled policy it must lead to a pauperisation which would be none the less deplorable because the old "pauper stigma" was not attached to it. The experience of these "seven lean years," in short, confirmed only too plainly the conclusions of those who had insisted, before the war and after it, that local boards of guardians could not do the work of a national unemployment authority. And the vast majority of the guardians themselves, however much they might object to other proposed reforms of the poor law, were converted at least to this.

The Poor Law in 1927–28.—The following figures give some indication of the effect of the "seven lean years" on the extent and the cost of pauperism.

(A) Total number of persons in receipt of poor relief in England and Wales on January 1, and in Scotland on January 15, 1928, 1920 and 1914.

	England & Wales	Scotland
1928	1,236,000	240,580
1920	576,418	85,678
1914	761,578	105,245

(B) Total numbers in receipt of indoor and outdoor relief in 31 chief urban areas of Great Britain in Jan., 1928. (From Ministry of Labour Gazette.)

Area	No. in receipt of relief: Indoor	Outdoor	Total	Rate per 10,000 of estimated population
England and Wales:				
Metropolis:—				
West District	9,498	7,317	16,815	202
North District	10,873	18,580	29,453	286
Central District	2,399	2,578	4,977	371
East District	10,097	59,834	69,931	1,072
South District	19,647	71,936	91,583	466
Total Metropolis	52,514	160,245	212,759	461
West Ham	4,603	27,559	32,162	425
Other Districts:—				
Newcastle District	2,898	27,415	30,313	597
Stockton-on-Tees District	1,432	14,656	16,088	583
Bolton, Oldham, etc.	4,319	8,207	12,526	160
Wigan District	1,883	14,850	16,733	368
Manchester District	9,892	34,336	44,228	422
Liverpool District	10,159	65,088	75,247	593
Bradford District	1,826	6,913	8,739	237
Halifax and Huddersfield	1,562	3,349	4,911	131
Leeds	2,907	10,888	13,795	289
Barnsley District	1,007	10,509	11,516	343
Sheffield	2,655	23,694	26,349	512
Hull District	1,876	16,061	17,937	560
North Staffordshire	2,524	8,951	11,475	276
Other *Districts:—Cont.*				
Nottingham District	2,315	12,669	14,984	319
Leicester	1,208	4,147	5,355	222
Wolverhampton District	3,642	15,939	19,581	260
Birmingham	7,676	18,584	26,260	281
Bristol District	2,628	14,732	17,360	420
Cardiff and Swansea	2,645	20,039	22,684	469
Total, "Other Districts"	65,054	331,027	396,081	379
Total, Districts in England and Wales	122,171	518,831	641,002	405
Scotland:				
Glasgow District	6,121	78,963	85,084	885
Paisley and Greenock District	903	13,336	14,239	737
Edinburgh	1,794	18,742	20,536	484
Dundee and Dunfermline	877	4,802	5,679	263
Aberdeen	538	4,809	5,347	339
Coatbridge and Airdrie	380	5,529	5,909	581
Total for the above Scottish Districts	10,613	126,181	136,794	666
Total for above 31 Districts in Jan., 1928	132,784	645,012	777,796	435

(C) Unemployed persons (excluding the sick) who were in receipt of outdoor relief in England and Wales, June, 1927. (These figures are based on a return of the Ministry of Health [Cmd. 3006].)

	Men having no wife or child dependent	Men having wife or child dependent	Women	Total
Number of persons in each class who had been in receipt of poor-law relief in the same union continuously for—				
Less than one year	12,069	43,051	1,962	57,082
One year, but less than three years	9,900	27,356	1,712	38,968
Three years, but less than four years	1,934	6,795	536	9,265
Four years or more	1,963	8,528	536	11,027
Total number of persons in each class included in the returns	25,866	85,730	4,746	116,342

Of the total 82% were in 50 large unions, which contain 35% of the population of England and Wales. Over 44% of the men, and over 32% of the women were aged between 30 and 50. $2\frac{1}{2}$% of the men and $15\frac{1}{2}$% of the women were under 21. About 5% of both sexes were over 65.

(D) This table shows the total number of vagrants who were relieved in the casual wards (average on Friday nights throughout the year).

1910–11	11,801	1923–24	8,505
1913–14	7,794	1924–25	7,915
1919–20	1,870	1925–26	8,475

(E) Numbers on outdoor relief in certain London Unions in September, 1927.

Poplar	22,906	Greenwich	11,147
Bermondsey	13,206	Bethnal Green	10,851
Stepney	13,769		

(F) Proportionate increase of outdoor relief in certain London Unions (March 26, 1927, compared with December 25, 1920).

Union	*Increase* per cent.
Paddington, Hammersmith, St. Pancras, Hackney, Southwark, Lewisham	over 200
Poplar	,, 300
Greenwich	,, 500
St. Marylebone	,, 600
Stepney, Bermondsey, Woolwich	,, 700
Bethnal Green	,, 4,000

(G) Total poor law expenditure* (in round figures).

Year	England & Wales	Scotland
1926–27	£49,500,000	£5,171,000
1925–26	40,000,000	4,400,000
1919–20	23,500,000	2,100,000
1913–14	15,000,000	1,600,000

(H) Total cost of outdoor relief* (in round figures).

Year	England & Wales	Scotland
1926–27	£23,600,000	£3,947,000
1925–26	15,300,000	2,800,000
1919–20	4,109,000	963,000
1913–14	2,215,000	594,000

(*N.B. In making comparisons between the figures for different years, regard should be had to changes in the value of money. £1 in 1913–14 was equal roughly to 9/- in 1919–20, and 11/8 in 1926–27.)

(I) Cost of outdoor relief, per head of "ordinary outdoor poor," in 1926–27.

	Per week
England & Wales (average)	$6/7\frac{3}{4}$d.
Bishopsthorpe	9/-
Berwick-on-Tweed	9/9d.
London (average)	7/4d.
Bethnal Green	8/3d.
Poplar	9/6d.
Scotland (average) (1925–26):	
Other than able-bodied	$6/10\frac{3}{4}$d.
Able-bodied unemployed	$4/6\frac{1}{2}$d.

(J) Cost of indoor relief per head in 1925–26.

England & Wales (average).

(a) Provinces:

	Per week
In workhouse	from $8/11\frac{3}{4}$d. to $10/11\frac{3}{4}$d.
,, hospitals and asylums	,, $9/11\frac{1}{4}$d. to $16/8\frac{1}{2}$d.
,, separate institutions for children	,, $7/10\frac{3}{4}$d. to $9/0\frac{1}{4}$d.

(b) London:

	Per week
In workhouse	9/4d.
,, hospitals and asylums	$15/4\frac{3}{4}$d.
,, separate institutions for children	$9/7\frac{3}{4}$d.

Scotland.

"Sane indoor poor"	$19/2\frac{1}{4}$d.

Neville Chamberlain began to move in the matter of poor law reform soon after he took office as minister of health in 192; . He carried through a measure which, though its prime object was to amend the rating system, was an important preliminary step towards the abolition of the guardians. Under the Rating and Valuation Act, 1925, the parish disappears as the valuation area, the board of guardians no longer appoints the assessment committee, and all the rating functions of the overseers of the poor are transferred to the town and district councils. The Rating (Scotland) Act, 1926, was framed on similar lines; the parish councils are replaced as rating authorities by the town and county councils, and the poor rates are raised by requisition on these. This legislation was followed towards the end of 1925 by detailed plans for the break up of the poor law. The main points were:—

(1) Boards of guardians to be abolished.

(2) Registration of births, deaths and marriages to be transferred to electoral registration officers acting for counties and county boroughs.

(3) The rest of their functions, and their property (including institutions), liabilities and staffs to be transferred to the county and county borough councils.

(4) County borough councils to provide at their own discretion for the carrying out of the transferred duties.

(5) The county council to be the supervising and controlling authority for all health purposes and to have complete responsibility for "home assistance" throughout the administrative county. The transferred duties to be carried out "through existing or new committees of the council, assisted where necessary by local sub-committees consisting of county councillors, or partly of county councillors and partly of representatives of the borough and district councils of the localities" (or of the metropolitan borough councils in London). But delegation to be allowed to borough and district councils (or metropolitan borough councils in London) of "any transferred service identical in kind with a service already administered by the borough or district council" (*e.g.*, care of infancy and expectant or nursing mothers).

(6) Relief to able-bodied persons to be limited and correlated with unemployment insurance.

(7) The assigned revenue system to he abolished. Block grants, fixed for a term of years, to be paid in aid of transferred and existing health services and distributed to county borough councils on a basis of population qualified by a factor representing low ability to pay. The cost of delegated services to be borne by the borough or district councils to which they are delegated.

This scheme, it will be seen, was based in principle on the Maclean report. But it had certain differences of detail, some of them important. In particular, it gave greater power to the counties, allowing no such autonomy as the Maclean report recommended to the larger non-county boroughs and urban districts. It also contemplated some special system of dealing with the able-bodied unemployed, though what that system was could not be discovered from the brief and obscure statement *(see* point [6] above) in which it was adumbrated. The whole scheme, however, was, Chamberlain said, provisional; it was issued primarily for consideration and criticism by the local authorities and others concerned. It had a mixed reception. Root and branch reformers welcomed it, though they were critical of certain details. The county and borough and district councils raised various technical objections. The guardians, who did not want to be done away with, and their friends, who carried weight with the Conservative Government, denounced it. In these circumstances it was evident that the proposals would have to be considerably modified before they could be made the basis of a Government bill. A new scheme emerged from the melting pot in the summer of 1927. It was largely an attempt to meet the criticisms of the Conservatives in the rural areas, and it represented a dubious compromise between the demand for reform and the claims of vested interests. Its principal features are:—

(1) The administration of the poor law is to be transferred from the existing boards of guardians to (a) the councils of the county boroughs, and (b) the councils of the non-county boroughs and the districts.

(2) The area of each county borough will be a single Union and the council will exercise all the poor law functions within its area.

(3) Elsewhere there is to be a division of powers. The town or district council will become the board of guardians for its area and will have the same powers and duties as the former guardians in regard to domiciliary relief.

(4) The provision of institutional relief will be the business of the county council, and all poor law institutions — workhouses, hospitals, casual wards, etc.—will be transferred to it. The new boards of guardians (save, as stated above, in the county boroughs) will not be allowed to own or lease any institution or building, except their own offices.

(5) Schemes for the reorganisation and administration of the institutions are to be prepared by the counties and county boroughs for the approval of the Ministry of Health. And these schemes are to include proposals not merely for the institutional treatment of paupers, but for the co-ordination of the public health service generally.

(6) The expenses of running the institutions will fall on the county or county borough, but the county council may recover from each board of guardians the cost of maintenance of its cases in an institution (except vagrants, who will be wholly a county charge).

There was little public discussion of the scheme, however, and in 1928 the Government abandoned it and reverted to the original plan.

BIBLIOGRAPHY.—(A) *Official publications* (H.M. Stationery Office, London). *Reports of the Royal Commission on the Poor Laws and the Relief of Distress, 1909. Transfer of Functions of Poor Law Authorzties in England and Wales, Report of Local Government Committee of the Ministry of Reconstruction, 1918* (Maclean report). *Memorandum on the Rescission of the Poplar Order* (Cmd. 2052, 1924). *Provisional Proposals for Poor Law Reform, prepared in the Ministry of Health for circulation to the London County Council, Associations of Local Authorities*, etc. (1925). *Annual Reports* of Local Government Board, and of Local Government Board for Scotland, down to 1919. *Annual Reports* of Ministry of Health, and of Scottish Board of Health, from 1920 onwards. *Annual Local Taxation Returns*. The "Orders" of the Ministry of Health are printed in the annual volumes of *Statutory Rules and Ouders*. Some current statistics of pauperism are given each month in the *Ministuy of Labour Gazette*. (*B*) *Unofficial*. The most comprehensive and up-to-date account of the poor law, from the earliest times down to 1927, is Sidney and Beatrice Webb, *English Poor Law History* (2 vols., 1927 & 1928). Other books on the early poor law are: F. R. Salter, *Some Early Tracts on Poor Relief* (1926); *E*. M. Leonard, *The Early History of English Poor Relief* (1900); Dorothy Marshall, *The English Poor in the XVIII. Century* (1926). Of older books the two most important are *The State of the Poor*, by Sir *F*. M. Eden (1797), and *A History of the English Poor Law*, vols. *1* and *2*, by Sir Geo. Nicholls (1854), vol. 3 by T. Mackay (1899). (C. M. L.)

The Local Government Act, 1929.—The whole machinery of Poor Law administration was changed by this Act which replaced the Boards of Guardians by Public Assistance Committees acting under the Ministry of Health. Two-thirds of the members of these Committees are required to be members of a County or County Borough Council. This law, together with previous legislation, was consolidated in the Poor Law Act, 1930.

UNITED STATES

Any discussion of the laws which relate to the relief of the poor in the United States is much complicated by the wide variety of law and practice among the 48 States, the many laws within States covering the different types of public assistance, and the present involvement of the three levels of government—Federal, State, and local. Prior to 1933, there was no Federal agency where comprehensive data could be secured covering State relief laws, their administration, or relief expenditures and the number of persons assisted. Since 1933, progress has been made in the collection of data covering the country generally on various types of outdoor relief. In addition, there have been many important special studies on phases of public welfare made by various Federal agencies.

I. HISTORY PRIOR TO 1930

State Laws.—Few States had a "Poor Law" in the sense of a comprehensive statute regulating relief to the poor and its administration. In many States the subject was dealt with briefly and fragmentarily in sections scattered through the general statutes. In some States, local provisions so modified State law that it was difficult to know what the law really was.

State laws were based largely on the early English Poor Law. They had been only slightly altered since enactment, with no reflection of changing social conditions and increasing understanding of social problems. The most important changes had been effected by taking away certain functions from poor relief officials, and not by reorganizing and improving the poor relief system. Under laws largely concerned with the control of vagrancy and able-bodied pauperism, officials attempted to care for the sick, aged, infirm, dependent children, destitute families, and in some cases the insane and mental defectives.

Responsibility for Care of the Poor.—The principle of responsibility for the care of the poor by some governmental unit was found in the laws of all States. The legislation tended to be permissive, leaving to the responsible authorities the decision as to whether almshouses should be erected and whether outdoor relief should be granted.

Administrative Systems.—In the New England States the townships, through their selectmen, cared for the poor. Later, when the duties became heavier, a special poor relief official, the overseer of the poor, was substituted for the selectman. Cities usually had the same responsibilities as the towns. In Southern States, the county was the governmental unit and poor relief was on a county basis, with the governing board of the county as the administrative authority. These two systems, or some combination of them, formed the basis for the administrative systems of all the States, the governmental form adopted in the States depending largely on the system in vogue in the State from which most of the settlers came. In about half of the States all poor relief was administered on a county basis. In States having a mixed administrative system, the relation of the city and town to the county was complicated and varied greatly from State to State. City charters usually placed the responsibility for the care of the poor on a special official or board, either elected or appointed.

Authorized Relief.—The laws of every State except New Mexico authorized the establishment of almshouses by some governmental unit, either the town, city, or county. The law, with the exception of two States, was permissive. Outdoor relief was authorized at the discretion of the poor law authorities, either by specific statement or by implication. As a rule, the laws dealt briefly with outdoor relief, regarding it as a temporary expedient, and tended to place greater emphasis on almshouse care. Medical care was authorized at the discretion of the poor law officials as a form of poor relief.

Eligibility for Relief.—Practically all laws had some definition of what sort of persons were to be cared for by public relief In about three-quarters of the States, care was to be given to "persons unable to support themselves" or "all poor, indigent, and incapacitated persons." The laws of most of the States established the liability of the community for support of a needy person on the basis of "settlement,"—a required length of residence in the community. As a rule, legal settlement was acquired by a residence for a stated time in the particular governmental unit without receipt of relief. The usual requirement was for residence of one year, though some States required as much as five or seven years. Settlement was generally considered to have been lost in a State by absence for one year from that State.

Liability of Relatives.—The laws of most of the States were based on the principle that relief should be given only when there were no close relatives liable and able to support their dependents. Occasionally the grandparents and grandchildren were made liable, but usually only parents and children.

State Supervision.—While 43 States had some central board or department with some degree of administrative or supervisory responsibility relating to some phases of the care of the dependent classes, comparatively few such State bodies had definite responsibilities in regard to the supervision of poor relief. In about one-quarter of the States, State authorities inspected almshouses, received financial reports, and made recommendations to local authorities. The recommendations, however, could seldom be enforced. There was even less supervision of outdoor relief, and comparatively few States had accurate figures as to the amount expended for this purpose by local authorities.

Development of Poor Relief.—At first, the poor were cared for by outdoor relief, by indenture of adults or children, or by boarding out. As the number of poor increased, the practice grew of auctioning the care of the poor as individuals or as a group. The first almshouse was established in Massachusetts in 1660, but it was not until after 1700 that any great number were established. During the 18th century and the first half of the 19th century the almshouse came to be looked upon as the best method of correcting the abuses inherent in the earlier systems of aiding the poor at home. It soon became a catch-all for all types of people for whom no other care was available, such as the sick, the aged, infirm, children, insane, feeble-minded, vagrants, etc. The period from 1870 was characterized by a growing realization of the failure of the almshouse to care adequately for its varied type of inmates. By steady effort, specialized care was secured for many of these cases. In particular, laws were enacted forbidding the care of children in almshouses and requiring the removal of the insane and feeble-minded.

A report of the United States census on Jan. 1, 1923, showed that there were 78,090 inmates in almshouses, showing a decrease since 1910 when there had been 84,198 inmates. In 1923, 47 States had 2,183 publicly owned almshouses, representing an investment of $150,485,230. The annual maintenance cost of the publicly owned institutions was $28,740,523. About 88% of the publicly owned almshouses were directly operated by public officials. The other 12% operated under a contract system whereby the public institution and care of the inmates was given to a private individual on various terms. As to public outdoor relief, very little was known prior to 1930, since no general study had ever been made and few States had even accurate information as to the amount expended by local officials for this purpose. From figures available from a few States, it was evident that many more people were being aided by outdoor relief than through almshouse care The administration of outdoor relief was subject to great criticism which certain special studies justified.

Children. — Poor relief officials were originally responsible for all public care given to dependent children, but this function was taken away from them in all but a few States, chiefly during the years following 1900. The inefficiency of almshouse care and the inadequate care given by poor law officials to children, resulted in the establishment of new agencies for the care of dependent children, such as county boards of child welfare, boards of children's guardians, county children's courts, county children's homes, or a State institution. In all except a few States, the poor relief officials came to have practically no responsibility for children cared for away from their families.

Special Types of Assistance. — The inadequacies of the poor relief system also gave rise to statutory provision for special types of assistance, now commonly called categorical assistance, usually administered by other than poor law officials. These types included assistance to veterans, widows' pensions or mother's aid, and assistance to the blind and the aged. Relief to war veterans was the earliest type of special assistance. The first State statute providing mother's aid, now known as aid to dependent children, was passed in 1911. Major development in the field of assistance to the blind began in 1910. A law providing for old age assistance was passed in 1914, but was declared unconstitutional; the next such statute was enacted in 1923. By 1930, there had been substantial growth in all of the special types of assistance.

Poor Law Administration. — Faulty administration was undoubtedly the chief weakness of the poor relief system in every State. In only a few States was there any evidence of public interest in poor law reform. Instead, the tendency had been to transfer poor relief functions to agencies caring for special groups of dependents. Some changes made in State laws were in the direction of establishing the county as the unit of administration, as for example, the new poor law passed in Pennsylvania in 1925 and the public welfare law passed in New York State in 1929. The New York public welfare law, replacing a statute which had not been significantly changed for a hundred years, embodied the modern philosophy which was to mark later legislation in the relief field.

II. HISTORY SINCE 1930

Great changes in the relief structure of the United States occurred in the decade following 1930. The depression beginning in 1929, and the ensuing unemployment, brought on a volume of relief need with which existing poor law systems were utterly unable to cope. Not only was this magnitude of need entirely beyond the possibility of local units of Government to finance, the nature of the problem itself had significantly changed. Previously the group aided by poor officials comprised mainly the unemployable; the new group, on the other hand, was constituted principally of people out of work who were able and wanted to work. New administrative systems and procedures had to be established, and the deterrent philosophy underlying the poor law had to give way to a more constructive method of public assistance. This is strikingly apparent in the relief field, but other forms of care such as almshouse care and care of children away from their own homes have continued with relatively little change during this period.

Emergency Unemployment Relief and Federal Participation in Relief. — Beginning in 1931, States enacted emergency unemployment relief laws usually with the purpose of providing State funds for relief. In general, these laws supplemented and broadened poor laws, or temporarily superseded them. In some States, the emergency unemployment relief program was separate from the established outdoor relief system; in other States, the two programs were integrated from the outset. By 1933, legislation had been enacted in nearly three-quarters of the States which provided some system for emergency unemployment relief. In many States the systems included a program of work relief whereby needy persons were provided for by wages earned on relief projects.

A major step in the public welfare history of the country was taken with the entrance of the Federal Government as a participant in the relief problem. This occurred first in 1932, when funds were loaned to States and local governmental units for the relief of the unemployed. It continued, more significantly and on a wider scale, with the establishment of the Federal Emergency Relief Administration in 1933, authorized to make outright grants to States for relief purposes. Work programs financed by Federal, State, and local funds came to play a large part in the general relief program, and it was roughly calculated that about 50% of persons in need were cared for through work relief. Relief standards were quite generally raised through financial participation of the Federal Government and some degree of Federal supervision or control.

The FERA was discontinued in 1935, with the Federal Government then embarking on what it regarded as a sounder method of assisting in the emergency relief problem. It established a federally administered and financed work program, the Works Progress Administration. At the same time, under the Social Security Act, it provided grants in aid to States for the care of the aged, blind, and children at home. The cessation of Federal grants to States for direct unemployment relief had an adverse effect particularly serious in poorer States. In some States, though some meagre provision for assistance was available, no relief was provided to employahles for whom there was no place on WPA.

Special Types of Assistance. — The Social Security Act established the principle of Federal assistance to States in special forms of relief. It provides grants-in-aid to States for old age assistance, aid to the blind and aid to dependent children, with requirements for State financial participation and certain standards in State plans as a condition for receiving Federal grants. Prior to the Social Security Act, there had been considerable development of these special forms of relief. In 1934, all except three States had mother's aid laws; 28 States had laws providing assistance for the aged; ahd in 1935, 26 States had laws providing assistance to the blind. The Federal act stimulated greatly the enactment of more such lams, and revision of existing laws. In 1939 all but a very few States had legislative provision for all of these types of assistance.

Provisions for Care and Eligibility. — Persons in need are cared for chiefly in three ways: general home relief, special types of assistance, work relief. General home relief cares for those not eligible for the special types of assistance or for WPA, and for those eligible for but not receiving these forms of aid. Established need and settlement are the usual prerequisites for receiving general home relief. Certain additional qualifications are necessary for the special types of assistance. WPA takes care of the major number of employable unemployed who are certified as to need by relief agencies in the majority of States, but occasionally by WPA itself. In addition, hospital care, institutional care and care of children away from their own homes are provided, though these types of care are overshadowed by the magnitude of the outdoor relief programs.

Administration of Outdoor Relief. — The Federal Government directly administers WPA and establishes the standards for the special types of assistance which States must meet to receive Federal aid. The State governments either administer or supervise the local administration of the special types of assistance. About two-thirds of the States also have either administrative or supervisory responsibility for general home relief. The local governments in many States directly administer the special types of assistance, and in all except ten States are administratively responsible for general home relief. There has been a trend toward integration of State supervisory or administrative departments to cover the different types of assistance. In 1939, 45 States had State agencies administering or supervising at least three types of assistance, 22 of them administering or supervising five types of assistance. Several State agencies administered or supervised a completely integrated program. It may be said in general that the administration of special types of assistance is more controlled and on a more permanent basis than the administration of general home relief which remains quite largely the responsibility of local governmental units. Extremely significant changes, however, have occurred or are occurring, as follows: (1) a decided increase in the strengthening of State supervision of local administration; (2) an assumption by the State of direct administrative responsibility; and (3) a tendency toward integration in one central State body of supervisory or administrative responsibility. The degree to which these changes have occurred vary, of course, from State to State.

Financing of Relief.—Prior to 1930, the cost of relief with minor exceptions was borne by local units of government. This applied in the majority of instances to the special types of assistance as well as to general home relief. Beginning in 1931, there was an increase in State financial participation in general home relief; and after 1935, a similar increase for the special types of assistance. In 1939, some State funds for general home relief were provided in two-thirds of the States; all States provided funds for old age assistance; all but two States provided funds for blind assistance; and all but four States provided funds for aid to dependent children. Usually when financial responsibility is divided between States and local units, the amounts to be contributed by each are determined by a fixed percentage of the total. Some States allow administrative discretion for the distribution of State funds, with various criteria used for such distribution. The trend in the financing of relief generally parallels the trends in relief administration and supervision, with more and more responsibilities assumed by the States. For general home relief, the major financial responsibility, if not the exclusive responsibility, remains with the local units of government in most States.

Statistics on Expenditures and Caseloads.—Before 1933 there were no figures on relief expenditures for recipients even approximately complete, though special studies had shown a slight but steady trend upward before 1929, and a sharp upward trend after that year. The Social Security board has collected figures on outdoor relief with relative completeness covering the period from 1933, though the general relief figures rely partially on estimates. These figures show an increase in expenditures for all forms of outdoor relief from $1,358,159,000 in 1933 to $3,485,757,000 in 1938. Monthly expenditures in the early months of 1939 amounted to more than $300,000,000. As of 1938, WPA accounted for about 50% of the expenditures, the special types of assistance about 15%, general relief about 14%, and miscellaneous programs about 21%. It was estimated that in December of 1938, 6,500,000 households representing 20,900,000 persons, or between one-sixth and one-seventh of the total population, received some sort of assistance during the month.

Status of Relief Legislation.—Legislation in the relief field is in a transitional stage. Beginning with the enactment of emergency unemployment relief laws and later with the increase in laws covering special types of assistance, the past decade has been particularly marked by the diminishing importance of the old "poor laws" which now play a relatively small part in the total public welfare structure. The status of relief legislation varies greatly from State to State. Some States have passed unified statutes covering all types of relief; other States still operate under a combination of poor laws, laws covering special types of assistance, and emergency unemployment relief laws. The trend is toward unification, with the elimination of the poor laws and emergency laws and the enactment of comprehensive public welfare laws covering all forms of public assistance. In States where this has occurred, the new laws show marked improvement both in substance and spirit over the old laws, even though they embody some of the characteristics of the poor laws, particularly the requirements of settlement and responsibility of legally liable relatives to support dependents. In general, there has been astonishing progress made in the decade since 1930, and the coming years should show further progress toward a sound public welfare structure.

BIBLIOGRAPHY.—J. L. Gillin, *Poverty and Dependency* (1921, 1926): "Some American Almshouses," *Report* of the Woman's Dept., National Civic Federation (1927); R. W. Kelso, *The Science of Public Welfare* (1928); J. L. Gillin, C. G. Dittmer, R. J. Colbert, *Social Problems* (1928); A. C. Millspaugh, *Public Welfare Organization* (1935); M. Stevenson, *Public Welfare Adnzinistration* (1938); S. P. Breckenridge, *Public Welfare Administration in the United States* (Rev. ed., 1938); R. C. Lowe, *State Public Welfare Legislation* (Research Monograph *XX*, Works Progress Administration, 1939); "Social Security Bulletin," (Social Security Board, monthly, since March 1938). (H. Fs.)

POOR PERSONS: *see* PRACTICE AND PROCEDURE.

POOR-WILL, the name (from its cry) of a North American bird (*Phalaenoptilus nuttalli*), allied to the whip-poor-will, nightjar and nighthawk (*qq.v.*), which it resembles in habits. It is about 8 in. long, the smallest of the family; the primaries are rusty, barred with black. It breeds west of the Mississippi north to British Columbia, and south to southern California. There are two subspecies, the frosted poor-will (*P. n. nitidus*) in Texas and Arizona, and the California poor-will (*P. n. Californicus*) in the coast region of California.

POPAYAN, a city of Colombia, capital of the department of Cauca, about 240 mi. S.W. of Bogotá, on the old trade route between that city and Quito, in 2° 26' N., 76° 49' W. Pop. (1938) 18,292. Popayán is built on a great plain sloping north-west from the foot of the volcano Puracé, near the source of the Cauca and on one of its small tributaries, 5,712 ft. above the sea. Its situation is singularly picturesque, the Puracé rising to an elevation of 15,420 ft. about 20 m. south-east of the city, the Sotara volcano to approximately the same height about the same distance south by east, and behind these at a greater distance the Pan de Azúcar, 15,978 ft. high. It has rail connection with Cali. Earthquakes have caused much damage to Popayán, especially those of 1827 and 1834.

Popayán was founded by Sebastibn Benalcbzar in 1538 on the site of an Indian settlement, whose chief, Payán, had the unusual honour of having his name given to the usurping town. It is noted as the birthplace of Caldas, the Colombian naturalist, and of Mosquera, the geographer.

POPE, an ecclesiastical title now used in the West exclusively to designate the head of the Roman Catholic church. In the 4th and 5th centuries it was frequently used by any bishop (Du Cange, *s.v.*); but it gradually came to be reserved to the bishop of Rome, becoming official. In the East, the title became restricted to the patriarchs of Alexandria, Antioch, Jerusalem and Constantinople, but is still given by popular usage to priests. Even in the case of the sovereign pontiff the word pope is officially only used as a less solemn style: though the ordinary signature and heading of briefs is, *e.g.*, "Pius P.P.X.," the signature of bulls is *Pius episcopus ecclesiae catholicae*, and the heading, *Pius episcopus, servus servorum Dei*, this latter formula going back to the time of St. Gregory the Great. Other styles met with in official documents are *Pontifex*, *Summus pontifex*, *Romanus pontifex*, *Sanctissimus*, *Sanctissimus pater*, *Sanctissimus dominus noster*, *Sanctitas sua*, *Beatissimus pater*, *Beatitudo sua;* while the pope is addressed in speaking as *"Sanctitas vestra,"* or *"Beatissime pater."*

Jurisdiction.—The pope is pre-eminently, as successor of St. Peter, bishop of Rome. Writers are fond of viewing him as representing all the degrees of the ecclesiastical hierarchy; they say that he is bishop of Rome, metropolitan of the Roman province, primate of Italy, patriarch of the Western Church and head of the universal Church. This is strictly correct, but with the exception of the first and last, these titles are seldom to be found in documents. And if these terms were intended to indicate so many degrees in the exercise of jurisdiction they would not be correct. As a matter of fact, from the earliest centuries (*cf.* can. 6 of Nicaea, in 325), we see that the popes exercised a special metropolitan jurisdiction not only over the bishops nearest to Rome, the future cardinal bishops, but also over all those of central and southern Italy, including Sicily (*cf.* Duchesne, *Origines du culte*, ch. 1), all of whom received their ordination at his hands. Northern Italy and the rest of the western Church, still more the eastern Church, did not depend upon him so closely for their administration. His influence was exercised, however, not only in dogmatic questions but in matters of discipline, by means of appeals, petitions and consultations, not forgetting to mention spontaneous intervention.

Primacy.—The primacy of the pope, a primacy of honour and jurisdiction, involving the plenitude of power over the teaching, the worship, the discipline and administration of the Church, is received by the pope as part of the succession of St. Peter, together with the episcopate of Rome. The whole episcopal body, with the pope at its head, should be considered as succeeding to the apostolic college, presided over by St. Peter; and the head of it, now as then, as personally invested with all the powers enjoyed by the whole body, including the head. Hence the pope, as supreme in matters of doctrine, possesses the same authority and the same infallibility as the whole Church; as legislator and judge he possesses the same power as the episcopal body gathered around and with him in oecumenical council. Such are the two essential prerogatives of the papal primacy: infallibility in his supreme pronouncements in matters of doctrine *(see* INFALLIBILITY); and immediate and sovereign jurisdiction, under all its aspects, over all the pastors and the faithful. These two privileges, having been claimed and enjoyed by the popes in the course of centuries, were solemnly defined at the Vatican Council by the constitution *Pastor aeternus* of the 18th of July 1870. For the history of the papacy, and associated questions *see* PAPACY, CONCLAVE, CURIA ROMANA, CARDINAL, VESTMENTS. For restoration of the temporal power, *see* VATICAN. For particulars regarding the lives of the different popes, *see* the separate articles.

POPE, ALEXANDER (1688–1744), English poet, was born in Lombard street, London, on May 21, 1688. His father, Alexander Pope, a Roman Catholic, was a linen-draper who afterwards retired from business with a small fortune and fixed his residence about 1700 at Binfield in Windsor forest. Pope's education was desultory. Before he was 12 he had obtained a smattering of Latin and Greek from various masters; by his 17th year excessive study had undermined his health and he had developed the personal deformity which later on largely distorted his view of life. Under the treatment, however, of the famous physician John Radcliffe, he recovered his health and continued his studies.

Pope was early an eager aspirant to the highest honours in poetry, and his connections with neighbouring Roman Catholic families of influence in the literary world gave direction to his ambitions. Pope was thus brought under the notice of Sir William Trumbull, a retired diplomatist, living at Easthampstead. Thomas Dancastle, lord of the manor of Binfield, took an active interest in his writings, and at Whiteknights, near Reading, lived another Roman Catholic, Anthony Englefield, "a great lover of poets and poetry." Through him Pope made the acquaintance of Wycherley and of Henry Cromwell, the former introducing him to William Walsh, then of great renown as a critic. Before the poet was 17 he was admitted in this way to the society of London "wits" and men of fashion, and was cordially encouraged as a prodigy.

Pope recognized soon that a long course of preparation was needed for the translation of *Homer* into English verse, on which he had decided. He learnt most, as he acknowledged, from Dryden, but the harmony of his verse also owed something to an earlier writer, George Sandys, the translator of Ovid. At the beginning of the 18th century Dryden's success had given great vogue to translations and modernizations. Dryden had rewritten three of the *Canterbury Tales;* Pope tried his hand at the *Merchant's Tale, Prologue to the Wife of Bath's Tale,* the *House of Fame,* and further experimented with translations from some Latin authors and the *Odyssey.*

Precocious Pope was, but he was also industrious; and he spent nine years in arduous discipline, before anything of his appeared in print. His first publication was his "Pastorals"; they appeared in May 1709 at the end of the sixth volume of Tonson's *Poetical Miscellanies,* containing contributions from Ambrose Philips, Sheffield, Garth and Rowe, with "January and May," Pope's version of Chaucer's "Merchant's Tale."

Pope's next publication was the *Essay on Criticism* (1711), written two years earlier, and printed without the author's name. The sales were slow until Pope caused copies to be sent to Lord Lansdowne and others, but its success was none the less brilliant for the delay. The town was fairly dazzled by the young poet's learning, judgment, and felicity of expressions, and Pope gained credit for much that might have been found where he found it, in the *Institutes* of Quintilian, in the numerous critical writings of RenC Rapin, and in RenC le Bossu's treatise on epic poetry. Addison has been made responsible for the exaggerated value once set on the essay, but Addison's paper *(Spectator,* No. 253) was not unmixed praise. He and Pope became acquainted and Pope's sacred eclogue, "Messiah," was printed as No. 378 of the *Spectator.* In the *Essay on Criticism* Pope provoked one bitter personal enemy in John Dennis, the critic, by describing him as Appius, who "stares, tremendous, with a threat'ning eye." Dennis retorted in *Reflections . . . upon a late Rhapsody . . .* (1711), abusing Pope among other things for his personal deformity; and Pope never forgot this brutal attack.

The *Rape of the Lock,* in its first form, appeared in 1712 in *Lintot's Miscellanies;* the "machinery" of sylphs and gnomes was an afterthought, and the poem was republished as we now have it early in 1714. William, 4th Baron Petre, had surreptitiously cut off a lock of Miss Arabella Fermor's hair, and the liberty had been resented; Pope hearing of this, caught at the hint, and treated the subject in mock heroic vein—the result being a poem which is generally admitted to be a masterpiece of airiness, ingenuity, and exquisite finish. It was followed by the publication in March, 1713, of *Windsor Forest,* which was begun, according to Pope, when he was 16 or 17. Hitherto, Pope had avoided politics, but this work appeared with a flattering dedication to the secretary for war, George Granville, Lord Lansdowne, and an opportune allusion to the Treaty of Utrecht. When the poem appeared, it was made the subject of an insidious attack by the Addison coterie, who about this time became estranged from Pope. Addison disavowed connivance of this coarse attack, but a coolness between the two friends ensued.

The attacks upon *Windsor Forest* appeared in a series of papers on "Pastorals" which were published in the *Guardian* (Nos. 22, 23, 28, 30 and 32). No mention was made of the poem, but everyone knew to whom the general principles referred. In the articles the introduction of Greek names, customs and deities was ridiculed and as *Windsor Forest* was fairly open to criticism on this ground, the real subject of the papers was manifest. The real sting of the criticisms, however, lay in their extravagant praise of the second-rate poet Ambrose Philips and the implied comparison with Pope. The latter characteristically succeeded in revenging himself. He secured the publication in the *Guardian* of an anonymous article which ostensibly attacked his own poems, but which actually, by quotation, disposed of the pretensions of Ambrose Philips, and ridiculed the *Guardian's* principles.

The links that attached Pope to the Tory party were strengthened by a new friendship. His first letter to Swift, who became warmly attached to him, is dated Dec. 8, 1713. Swift had been a leading member of the Brothers' Club, from which the famous Scriblerus Club seems to have been an offshoot. The leading members of this informal literary society were Swift, Arbuthnot, Congreve, Bishop Atterbury, Pope, Gay and Thomas Parnell. Their chief object was a general war against the dunces, waged with great spirit by Arbuthnot, Swift and Pope.

The estrangement from Addison was completed in connection with Pope's translation of Homer, which was definitely undertaken in 1713, and was published by subscription. Men of all parties subscribed, their unanimity being a striking proof of the position Pope had attained at the age of 25. But the unanimity was broken by a discordant note. A member of the Addison clique, Tickell, attempted to run a rival version. Pope suspected Addison's instigation; Tickell had at least Addison's encouragement. Pope's famous character of Addison as "Atticus" in the *Epistle to Dr. Arbuthnot* (ii. 193–215) was, however, inspired by resentment at insults that existed chiefly in his own imagination.

The translation of Homer was Pope's chief employment for 12 years. The new pieces in the miscellanies published in 1717, his "Elegy on an Unfortunate Lady," and his "Eloisa to Abelard," were probably written some years before their publication. The *Iliad* was delivered to the subscribers in instalments in 171j, 1717, 1718 and 1720. Pope's own defective scholarship made help necessary. William Broome and John Jortin supplied the bulk of the notes, and Thomas Parnell the preface. For the translation of the *Odyssey* he took Elijah Fenton and Broome as coadjutors, who between them translated 12 out of the 24 books. (1, 4, 19 and 20 are by Fenton; 2, 6, 8, 11, 12, 16, 18, 23, with notes to all the books, by Broome.) It was completed in 172j. Opinions have varied on the purely literary merits of the poem, but with regard to it as a translation few have differed from Bentley's criticism, "A fine poem, Mr. Pope. but you must not call it Homer." In 1722 he edited the poems of Thomas Parnell, and in 1725 made a considerable sum by an unsatisfactory edition of Shakespeare, in which he had the assistance of Fenton and Gay.

Pope, who cleared £8,000 by the two translations, was thus rendered independent and enabled to live near London. The estate at Binfield was sold, and he removed with his parents to Mawson's buildings, Chiswick, in 1716, and in 1719 to Twickenham, to the house with which his name is associated. Here he practised elaborate gardening on a small scale, and built his famous grotto, which was really a tunnel under the road connecting the garden with the lawn on the Thames. He was constantly visited at Twickenham by his intimates, Dr. John Arbuthnot, John Gay, Bolingbroke (after his return in 1723), and Swift (during his brief visits to England in 1726 and 1727), and by many other friends of the Tory party. With Atterbury, bishop of Rochester, he was on terms of affectionate intimacy, but he blundered in his evidence when he was called as a witness on his behalf in 1723.

In 1717 his father died, and he appears to have turned to the Blounts for sympathy in what was to him a very serious bereavement. He had early made the acquaintance of Martha and Teresa Blount, having probably met them first at the house of his neighbour, Englefield of Whiteknights, who was their grandfather. Their home was at Mapledurham, near Reading. He began to correspond with Martha Blount in 1712, and after 1717, the letters are much more serious in tone. He quarrelled with Teresa, who had apparently injured or prevented his suit to her sister, but his friendship with Martha lasted all his life. So long as his mother lived he was unwearying in his attendance on her, but after her death in 1733 his association with Martha Blount was more constant. His earlier attachment to Lady Mary Wortley Montague was apparently a literary passion, which perished under Lady Mary's ridicule.

The year 1725 may be taken as the beginning of the third period of Pope's career, when he made his fame as a moralist and a satirist. Edward Young's satire, *The Universal Passion,* had just appeared, and been received with more enthusiasm than any thing published since Pope's own early successes. Swift was finishing Gulliver's *Travels,* and the survivors of the Scriblerus Club resumed their old amusement of parodying and otherwise ridiculing bad writers, especially bad writers in the Whig interest; four volumes of their *Miscellanies in Prose and Verse* were published from 1727 to 1732. According to Pope's own history of the *Dunciad, an Heroic Poem in Three Books,* which first appeared on May 28, 1728, the idea of it grew out of this. Among the Miscellanies was a "Treatise of the Bathos or the Art of Sinking in Poetry," which gave rise to a torrent of abusive falsehoods and scurrilities from those who thought themselves injured by it.

The *Dunciad* was Pope's answer to them, and among the most prominent objects of his satire were Lewis Theobald, Colley Cibber, John Dennis, Richard Bentley, Aaron Hill and Bernard Lintot, who, in spite of his former relations with Pope, was now classed with the piratical Edmund Curll. The book was published anonymously with the greatest precautions. When the success of the poem was assured, it was republished in 1729, and a copy was presented to the king by Sir Robert Walpole. Names took the place of initials, and a defence of the satire, written by Pope himself, but signed by his friend William Cleland, was printed as "A letter to the Publisher." Various indexes, notes and particulars of the attacks on Pope made by the different authors satirized were added. To avoid any danger of prosecution, the copyright was assigned to Lord Oxford, Lord Bathurst and Lord Burlington, whose position made them practically unassailable. The most unprovoked assault was on Richard Bentley, whom he satirized in the reconstruction and enlargement of the *Dunciad* made in the last years of his life at the instigation, it is said, of William Warburton. In the earlier editions the place of hero had been occupied by Lewis Theobald, who had ventured to criticize Pope's *Shakespeare.* In the edition which appeared in Pope's *Works* (1742), he was dethroned in favour of Colley Cibber; Warburton's name is attached to many new notes, and one of the preliminary dissertations by Ricardus Aristarchus on the hero of the poem seems to be by him.

The four epistles of the *Essay on Man* (1733) were also intimately connected with passing controversies. The subject was suggesled to him by Henry St. John, Lord Bolingbroke, who had returned from exile in 1723 and was a fellow-member of the Scriblerus Club. Bolingbroke is said—and the statement is supported by the contents of his posthumous works—to have furnished most of the arguments. In this didactic work, as in his *Essay on Criticism,* Pope put together on a sufficiently simple plan a series of happy sayings, separately elaborated, picking up the thoughts as he found them in miscellaneous reading and conversation and trying only to fit them with perfect expression. His readers were too dazzled by the verse to be severely critical of the sense. Pope himself had not comprehended the drift of the arguments he had adopted from Bolingbroke, and was alarmed when he found that his poem was generally interpreted as an apology for the freethinkers. Warburton is said to have qualified its doctrines as "rank atheism," and asserted that it was put together from the "worst passages from the worst authors." The essay was soon translated into the chief European languages, and in 1737 its orthodoxy was assailed by a Swiss professor, Jean Pierre de Crousaz, in an *Examen de l'essay de M. Pope sur l'homme.* Warburton now saw fit to revise his opinion of Pope's abilities and principles—for what reason does not appear. In any case he now became as enthusiastic in his praise of Pope's orthodoxy and his genius as he had before been scornful, and pro. ceeded to employ his unrivalled powers of sophistry in a defence of the orthodoxy of the conflicting and inconsequent positions adopted in the *Essay on Man.* Pope was wise enough to accept with all gratitude an ally who was so useful a friend and so dangerous an enemy, and from that time onward Warburton was the authorized commentator of his works.

The *Essay on Man* was to have formed part of a series of philosophic poems on a systematic plan. The other pieces were to treat of human reason, of the use of learning, wit, education and riches, of civil and ecclesiastical polity, of the character of women, etc. Of the ten epistles of the *Moral Essays,* the first four, written between 1731 and 1735, are connected with this scheme, which was never completed.

There was much bitter, and sometimes unjust, satire in the *Moral Essays* and the *Imitations of Horace.* In these epistles and satires, which appeared at intervals, Pope was often the mouthpiece of his political friends, who were all of them in opposition to Walpole, then at the height of his power, and Pope chose the objects of his attacks from among the minister's adherents. Epistle III., "Of the Use of Riches," addressed to Allen Bathurst, Lord Bathurst in 1732, is a direct attack on Walpole's methods of corruption and on his financial policy in general; and the two dialogues (1738) known as the "Epilogue to the Satires," professedly a defence of satire, form an eloquent attack on the court. Pope was attached to the prince of Wales's party and he did not forget to insinuate, what was indeed the truth, that the queen had refused the prince her pardon on her death-bed. The "Epistle to Dr. Arbuthnot" contains a description of his personal attitude towards the Scriblerus and is made to serve as a "prologue to the satires." The gross and unpardonable insults bestowed on Lord Hervey and on Lady Mary Wortley Montague in the first satire "to Mr. Fortescue" provoked angry retaliation from both. The descriptions of Timon's ostentatious villa in Epistle IV., addressed to the earl of Burlington, was generally taken as a picture of Canons, the seat of John Brydges. duke of Chandos, one of Pope's patrons. Epistle II., addressed to Martha Blount, contained the picture of Atossa, which was taken to be a portrait of Sarah Jennings, duchess of Marlborough.

One of the worst imputations on Pope's character was that he left this passage to lie published when he had in effect received a bribe of £1.000 from the duchess of Marlborough for its suppression through the agency of Nathanael Hooke (d. 1763). As the passage eventually stood, it might be applied to Katherine, duchess of Buckingham, a natural daughter of James II. Pope may have altered it with the intention of diverting the satire from the original object. To appreciate fully the point of his allusions requires an intimate acquaintance with the political and social gossip of the time, but apart from their value as a brilliant strongly-coloured picture of the period, Pope's satires have a permanent value as literature. It is justly remarked by Mark

Pattison (in his edition of the *Satires and Epistles*, 1866), that "these *Imitations* are among the most original of his writings." The vigour and terseness of the diction is still unsurpassed in English verse.

Pope's wit had won for him the friendship of many distinguished men, and his small fortune enabled him to meet them on a footing of independence. He paid long visits at many great houses, especially at Stanton Harcourt, the home of his friend Lord Chancellor Harcourt; at Oakley, the seat of Lord Bathurst; and at Prior Park, Bath, where his host was Ralph Allen. He died on May 30, 1744, and was buried in the parish church of Twickenham. He left the income from his property to Martha Blount till her death, after which it was to go to his half-sister Magdalen Rackett and her children. His unpublished mss. were left at the discretion of Lord Bolingbroke, and his copyrights to Warburton.

If we are to judge Pope fairly there are two features of his times that must be kept steadily in view—the character of political strife in those days and the political relations of men of letters. The age of Queen Anne was pre-eminently an age of intrigue. The Government was almost as unsettled as in the early days of personal monarchy, but it was policy rather than force upon which men depended for keeping their position. Secondly, men of letters were admitted to the inner circles of intrigue as they had never been before and as they have never been since; and Queen Anne's statesmen paid their principal literary champions with social privileges and honourable public appointments. Hence men of letters were directly infected by the low political morality of the unsettled time.

Pope's own ruling passion was the love of fame, and he had no scruples where this was concerned. His vanity and his childish love of intrigue are seen at their worst in his petty manoeuvres to secure the publication of his letters during his lifetime. These intricate proceedings were unravelled with great patience and ingenuity by Charles Wentworth Dilke, when the false picture of his relations with his contemporaries which Pope had imposed on the public had been practically accepted for a century. After manipulating his correspondence so as to place his own character in the best light, Pope deposited a copy in the library of Edward, second earl of Oxford, and then had it printed. The sheets were offered to Curll by a person calling himself P.T., who professed a desire to injure Pope, but was no other than Pope himself. The copy was delivered to Curll in 1735 after long negotiations by an agent who called himself R. Smythe, with a few originals to vouch for their authenticity. P.T. had drawn up an advertisement stating that the book was to contain certain answers from various peers. Curll was summoned before the House of Lords for breach of privilege, but was acquitted, as the letters from peers were not in fact forthcoming. Difficulties then arose between Curll and P.T., and Pope induced a bookseller named Cooper to publish a *Narrative of the Method by which Mr. Pope's Private Letters were procured by Edmund Curll, Bookseller* (1735). These preliminaries cleared the way for a show of indignation against piratical publishers and a "genuine" edition of the *Letters of Mr. Alexander Pope* (1737, fol. and 4to).

Unhappily for Pope's reputation, his friend Caryll, who died before the publication, had taken a copy of Pope's letters before returning them. This letter-book came to light in the middle of the 19th century, and showed the freedom which Pope permitted himself in editing. The correspondence with Lord Oxford, preserved at Longleat, afforded further evidence of his tortuous dealings. But against Pope's petulance and "general love of secrecy and cunning" have to be set, in any fair judgment of his character, his exemplary conduct as a son, the affection with which he was regarded in his own circle of intimates, and many well-authenticated instances of genuine and continued kindliness to persons in distress.

BIBLIOGRAPHY.—Various collected editions of Pope's *Works* appeared during his lifetime, and in 1751 an edition in nine volumes was published by a syndicate of booksellers "with the commentaries of Mr. Warburton." In 1769–1807 an edition was issued which included Owen Ruffhead's *Life of Alexander Pope* (1769), which was largely inspired by Warburton. The notes of many commentators, with some letters and a memoir, were included in the *Works of Alexander Pope,* ed. W. L. Bowles (10 vols., 1806). His *Poetical Works* were edited by Alexander Dyce (1856); by R. Carruthers (1858) for Bohn's Library; by A. W. Ward *(Globe Edition*, 1869), etc. Materials for a definitive edition were collected by John Wilson Croker, and formed the basis of what has become the standard version, *The Works of Alexander Pope* (10 vols., 1871–98), including unpublished letters and other new material, with introduction and notes by W. Elwin and W. J. Courthope. The life of Pope in vol. v. was contributed by Prof. Courthope. The chief original authnrity besides Pope's correspondence and Ruffhead's *Life* is Joseph Spence's *Anecdotes,* published by S. W. Singer in 1820. Samuel Johnson gives a good estimate of Pope in his *Lives of the Poets.* The best modern lives are that by Prof. Courthope already mentioned; and *Alexander Pope,* by Sir L. Stephen, in the *English Men of Letters* series (1880). *See* also George Paston, *Mr. Pope: his Life and Times* (1909). The first check to the admiration that prevailed during Pope's lifetime was given by the publication of Joseph Warton's *Essay on the Genius and Writings of Pope* (vol. i., 1757; vol. ii., 1782). Thomas Campbell's criticism in his *Specimens of the British Poets* provoked a controversy to which William Hazlitt, Byron and W. L. Boules contributed. For a discussion of Pope's position as one of the great men of letters in the 18th century who emancipated themselves from patronage, *see* A. Beljame, *Le Public et les hommes de lettres en Angleterre au dix-huitième siècle* (1881); a section of Isaac D'Israeli's *Quarrels of Authors* is devoted to Pope's literary animosities; and most important contributions to many vexed questions in the biography of Pope, especially the publication of his letters, were made by C. W. Dilke in *Notes and Queries* and the *Athenaeum.* These articles were reprinted by his grandson, Sir Charles Dilke, in 1875, as *The Papers of a Critic.*

POPE, JOHN (1822–1892), American soldier, was born at Louisville, Ky., on March 16, 1822. He graduated at the United States military academy in 1842 and was assigned to the engineers. He served in the Mexican War, subsequently engaged in engineering and exploring work, and was commissioned captain in 1856. Early in the Civil War he was placed, as a brigadier general U.S.V., in charge of the district of Missouri, which by vigorous campaigning against guerrilla bands he quickly reduced to order. In 1862, along with the gunboat flotilla (commanded by Commodore A. H. Foote) on the Mississippi, Pope obtained a great success by the capture of the defences of New Madrid and Island No. 10, with nearly 7,000 prisoners. Pope subsequently joined Halleck, and in command of the Army of the Mississippi took part in the siege of Corinth. He was now a major general (U.S.V.). The reputation he had thus gained as an energetic leader quickly placed him in a high command, to which he proved to be quite unequal. The "Army of Virginia," as his new forces were styled, had but a brief career. At the very outset of his Virginian campaign Pope, by a most ill-advised order, in which he contrasted the performances of the western troops with the failures of the troops in Virginia, forfeited the confidence of his officers and men. The feeling of the Army of the Potomac (which was ordered to his support) was equally hostile, and the short operations culminated in the disastrous defeat of the second battle of Bull Run. Pope was soon compelled to realize the impossibility of retrieving his position, and resigned the command. Later, in command of the department of the North-West, he showed his former skill and vigour in dealing with Indian risings. In 1882 he was promoted to the full rank of major general, U.S. army. He died at Sandusky, O., on Sept. 23, 1892.

He was the author of various works and papers, including railway reports *(Pacific Railroad Reports* vol. iii.) and *The Campaign of Virginia* (Washington, 1865).

POPE, JOHN RUSSELL (1874–1937), American architect, was born in New York city on April 24, 1874. In 1895 he was fellow of the American Academy at Rome and in 1896–97 held the Schermerhorn travelling fellowship in architecture. In 1900, after attending the École des Beaux Arts in Paris, he began practice in New York city. In addition to many private residences he designed the Scottish Rite Temple, Washington (D.C.); Plattsburg (N.Y.) city hall; the Terminal station, Richmond (Va.); the McDonough memorial at Plattsburg; and the Lincoln memorial at Hodgenville (Ky.). He was chosen architect for the Roosevelt memorial and the Mellon art gallery in Washington (D.C.) and the Roosevelt memorial in New York city.

POPE, SIR THOMAS (*c.* 1507–1559), founder of Trinity College, Oxford, was born at Deddington, Oxfordshire, probably in 1507, and educated at Eton college, where he entered the court of chancery. As clerk of briefs in the star chamber, warden of the mint (1534–1536), clerk of the Crown in chancery (1537), and second officer and treasurer of the court for the settlement of the confiscated property of the smaller religious foundations he obtained wealth and influence. In this last office he was superseded in 1541, but from 1547 to 1553 he was again employed as fourth officer, and was enriched by grants of monastic lands. In 1537 he was knighted. The changes made by Edward VI. were repugnant to him, but at the beginning of Mary's reign he became a member of the privy council, and he retained the royal favour under Elizabeth.

As early as 1555 Pope had begun to arrange for the endowment of a college at Oxford, for which he bought the site and buildings of Durham College, the Oxford house of the abbey of Durham, from Dr. George Owen and William Martyn. He received a royal charter for the establishment and endowment of a college of the "Holy and Undivided Trinity" on March 8, 1556. The foundation provided for a president, twelve fellows and eight scholars, with a schoolhouse at Hooknorton. The number of scholars was subsequently increased to twelve, the schoolhouse being given up. On March 28, the members of the college were put in possession of the site, and they were formally admitted on May 29, 1556. Pope died at Clerkenwell on Jan. 29, 1559, and was buried at St. Stephen's, Walbrook; but his remains were removed to Trinity College, where his widow erected a monument to his memory.

The life, by H. E. D. Blakiston, in the *Dict. Nat. Biog.*, corrects many errors in Thomas Warton's *Life of Sir Thomas Pope* (1772). Further notices by the same authority are in his *Trinity College* (1898), in the "College Histories" Series, and in the *English Historical Review* (April, 1896).

POPE, SIR WILLIAM JACKSON (1870–1939), British chemist, was born in London March 31, 1870, and was educated at Finsbury technical college, and the central technical college, London. From 1897 to 1901 he was head of the chemistry department at the Goldsmith's Institute, and in 1901 he became professor of chemistry at the municipal school of technology at Manchester, occupying the chair of chemistry in the university there from 1905 to 1908. In 1908 he was appointed professor of chemistry at Cambridge, where he was later elected a fellow of Sydney Sussex College. Pope carried out much valuable research. His earliest work was in crystallography, but later he turned to pure organic chemistry and made a special study of asymmetric Compounds; he confirmed Le Bel's observation on optically active nitrogen compounds (1899) and also prepared the first sulphur (1900), tin (1900) and selenium (1902) compounds of this type. During the World War he served on Lord Fisher's Admiralty Inventions Board (1915), and was conspicuous for his work on poison gases, and for the active assistance he gave to chemical industries. Some of the results of his experimental work on "mustard-gas" and similar compounds were published in the *Journal* of the Chemical Society after the war. He was knighted in 1919, and was in addition the recipient of many British and foreign awards, including the Davy Medal of the Royal Society, in 1914.

POPERINGHE (pŏp′ur-ĭng′ẹ; popularly pŏp′ŭr-ĭng) is an ancient town in the province of West Flanders, Belgium, 12 mi. west of Ypres. Pop. (1936) 11,564. Its fine 11th century church is dedicated to St. Betin. During World War I it was the railhead, and served for rest billets for the troops in Ypres. It was here that the movement subsequently known as Toc H (*q.v.*) originated. In World War II it was occupied by Germany.

POPHAM, SIR HOME RIGGS (1762–1820), British admiral, entered the navy in 1778, and served with the flag of Rodney till the end of the war. In 1783 he was promoted lieutenant, and was for a time engaged on survey service on the coast of Africa. Between 1787 and 1793 he engaged in the Eastern trade, and undertook several surveys and rendered some services to the East India Company, which were officially acknowledged. For some years during the French Revolutionary wars he cooperated in a naval capacity with the military forces of Great Britain and her allies. He died at Cheltenham on Sept. 10, 1820. Popham was one of the most scientific seamen of his time. He did much useful survey work, and was the author of the code signals adopted by the admiralty in 1803 and used for many years.

POPHAM, SIR JOHN (c. 1531–1607), English judge, was born at Huntworth, in Somerset, about 1531. He was recorder of Bristol, and represented that city in parliament in 1571 and from 1572 to 1583. He was elected Speaker in 1580, and in 1581 became attorney-general, a post which he occupied until his appointment as lord chief justice in 1592. He presided at the trials of Sir Walter Raleigh and Guy Fawkes. Towards the end of his life Popham took a great interest in colonization, and was an advocate of the transportation system. His experiment, the Popham colony on the Kennebec river, was not a success. He died on June 10, 1607.

See Foss, *Lives of the Judges; J.* Winsor, *History of America*, vol. iii. He issued a volume of *Reports*. (1682). E.R. vol. 79.

POPILIA VIA, the name of two ancient roads in Italy. (1) A high road running from the Via Appia at Capua to Rhegium, a distance of 321 m. right along the length of the peninsula, running through the interior, not along the coast. It was built in 159 B.C. by the censor M. Popilius Laenas or in 132 B.C. by the consul P. Popilius. (2) A high road from Ariminum to Aquileia (178 m.) along the Adriatic coast. It came into use when Aquileia was founded as a frontier fortress of Italy in 181 B.C. In 132 it was reconstructed by the consul P. Popilius. It ran along the shore strip (Lido) from Ariminum to Ravenna (33 m.).

POPISH PLOT: see OATES, TITUS.

POPLAR, an eastern metropolitan borough of London, England, bounded north by Hackney, south by the river Thames and west by Stepney and Bethnal Green, and extending east to the boundary of the county of London. Pop. (1938) 134,400. The river Lea is believed to have been crossed towards the north of the modern borough by a Roman road, the existence of which is recalled by the district-name of Old Ford; while Bow (formerly Stratford-le-Bow or Stratford-atte-Bowe) was so named from the "bow" or arched bridge which took the place of the ford in the time of Henry II. South of these districts lies Bromley; in the south-east the borough includes Blackwall; and a deep southward bend of the Thames here embraces the Isle of Dogs. Poplar falls within the great area named "East End." In the north a part of Victoria park is included. In Blackwall and the Isle of Dogs streets give place to the extensive East and West India docks (opened in 1806) and Millwall dock, with shipbuilding, engineering, chemical and other works along the river. Blackwall has been a shipping centre from early times. The West India docks, situated on the northern part of the Isle of Dogs, cover an area of 241 ac., of which 92$ ac. is water. They have large warehouses where the goods are stored, being mainly hardwoods (mahogany, walnut, teak, etc.), grain, sugar, rum and dates. The West India docks include export and import docks covering a water area of $23\frac{3}{5}$ ac. and $26\frac{2}{3}$ ac. respectively, and a quayage length of 1,876 yd. and 1,983 yd., and a maximum depth of 26 ft. The north quays of these have been widened, and large transit sheds have been built there. In addition, West India docks include Blackwall basin with an area of 73 ac. and a depth of 26 ft.; Junction dock, area $1\frac{1}{4}$ ac. and depth of 25 ft.; South dock with an area of 27 ac., maximum depth of 29 ft. and quayage of 1,967 yd.; and South dock basin, area $5\frac{1}{5}$ ac. and a depth of 29 ft. New cuttings connecting West India docks with Millwall docks south of them were nearly completed at the end of 1928.

Another much appreciated improvement scheme included a new entrance lock, 590 ft. long, 80 ft. wide, with a depth of 35 ft. on the sill, which would render the docks able to deal with ships up to 600 ft. in length. The East India docks to the east consist of Import and Export docks and a basin with total water area of $31\frac{1}{4}$ ac. and 2,517 yd. of quay, the depths in the Export and Import docks being 28 ft., and in the basin 32 ft. An impounding station has been built which raises the water in the docks 2 ft. above the tidal high water level. A quarantine station has been built at the East India docks. Millwall docks, situated on the southern portion of the Isle of Dogs, cover an area of 35 ac. and have a maximum depth of 28 ft. Near the East India docks is the settlement of St. Frideswide, supported by Christ Church, Oxford. In Canning Town, which continues this district of poverty across the Lea, and so outside the county of London, are Mansfield house, founded from Mansfield college, Oxford; and a women's settlement, notable for its medical work. The metropolitan borough of Poplar includes the Bow and Bromley and the South Poplar divisions of the parliamentary borough, each returning one member. For "Poplarism" see POOR LAW.

POPLAR (*Populus*), the name of a small group of catkin-bearing trees belonging to the family Salicaceae, which includes the willows. The catkins of the poplars differ from those of willows in the absence of nectar glands; the male flowers contain from 4 to 80 stamens; the female bear a one-celled ovary, surmounted by the deeply cleft stigmas; the two- to four-valved capsule contains several seeds, each furnished with a long tuft of silky or cotton-like hairs. The leaves are generally either deltoid or ovate in shape, often heart-shaped at the base, and frequently with slender, laterally compressed petioles. Many of the species attain a large size, and all are of very rapid growth. The poplars are almost entirely confined to the north temperate zone, but a few approach or even pass its northern limit, and they are widely distributed within that area; they show, like the willows, a partiality for moist ground and often line the riversides in otherwise treeless districts. There are about 30 species, but the number cannot be very accurately defined, since there are many regional varieties and also widely diffused hybrids of uncertain origin. All yield a soft, easily worked timber. Many of the species are used for paper-making.

Of the European forms one of great importance is the white poplar or abele, P. alba, a tree of large size, with rounded spreading head and curved branches which, like the trunk, are covered with a grayish white bark, becoming much furrowed on old stems. The leaves are ovate or nearly round but with deeply waved, more or less lobed and indented margins and heart-shaped bases; the upper side is dark green, but the lower surface is clothed with a dense white down, which likewise covers the young shoots—giving, with the bark, a hoary aspect to the whole tree. A related form, P. *canescens,* the gray poplar of the nurseryman, is distinguished from the true abele by its smaller, less deeply cut leaves, which are gray on the upper side but not so hoary beneath as those of P. alba. Some authorities regard this form as a hybrid (P. alba × *tremula*).

Both trees occasionally attain a height of 90 ft. or more. The wood is very white, uith soft and even grain, and is employed by turners and toy-makers; it is also suitable for the construction of packing cases, etc. The white poplar is an ornamental tree; it has, however, the disadvantage of throwing up numerous suckers for some yards around the trunk.

P. nigru, the black poplar, is a tree of Iarge size, sometimes 100 ft. high, with dark, deeply-furrowed bark on the trunk, and ash-coloured branches; the smooth deltoid leaves, serrated regularly on the margin, are of the deep green tint which has given name to the tree; the petioles, slightly compressed, are only about half the length of the leaves. The black poplar is common in central and southern Europe and in some of the adjacent parts of Asia, but though abundantly planted in Great Britain, is not there indigenous. The wood is of a yellowish tint.

A closely related form is the well-known Lombardy poplar, P. *nigra* var. *italica,* remarkable for its tall, cypress-like shape, caused by the nearly vertical growth of the branches. It is probably a variety of the black poplar, and its native land appears to have been Persia or some neighbouring country; it was unknown in Italy in the days of Pliny, while from remote times it has been an inhabitant of Kashmir, the Punjab and Persia, where it is often planted along roadsides for shade; it was probably brought from these countries to southern Europe, and derives its popular name from its abundance along the rivers of Lombardy, where it is said to spring up naturally from seed, like the indigenous black poplar. It was introduced into Great Britain soon after 1750, if not earlier. The Lombardy poplar is valuable chiefly as an ornamental tree; its tall, erect growth renders it useful to the landscape gardener as a relief to the rounded forms of other trees, or as a contrast to the horizontal lines of the lake or riverbank. Its growth is extremely rapid and it often attains a height of 100 ft.

P. *euphratica,* believed to be the weeping willow of the Scriptures, is a large tree remarkable for the variability in the shape of its leaves, native to north Africa and western and central Asia.

In North America about 13 native species are found, together with some 15 well-marked varieties and some five or more hybrids, widely distributed throughout the continent. Most of these, especially the larger kinds, are generally called cottonwood.

The eastern cottonwood (P. deltoides), a very large, broad-headed tree, with deeply-furrowed, gray or dark brown on the older trunks, which divide into many great arms, and large, ovate, finely toothed leaves, 4 to 7 in. long, longer than broad, occurs only locally and infrequently from Vermont to Mississippi. Its immensely more abundant variety, the common cottonwood or necklace poplar (*P.* deltoides var. *virginiana*), differs chiefly in having smaller triangular or ovate-triangular leaves, about as broad as long. It grows native from Quebec to North Dakota and south to Florida and Texas, sometimes attaining a height of 150 ft. and a trunk diameter of 8 ft. The loosely-flowered fruiting aments form a pendent string, 6 to 10 in. long, of ripening pods, whence the name necklace poplar. The timber is used for lumber and pulpwood, and the tree is often planted for ornament. Numerous forms of this poplar are planted in Europe and America, probably mostly hybrids with forms of the European black poplar (P. *nigra*). Among these are the Carolina poplar (× P. camdensis), widely grown in streets and parks in the eastern states, a vigorous, upright tree, with strongly ascending branches, the trunk continuing through the top, and the Eugene poplar (× P. canadensis var. *eugeni*) which was originated in France in 1832. Both these forms bear only male flowers and hence do not produce the profusion of downy seeds which renders the common cottonwood somewhat objectionable as a street tree. The Norway or "sudden-sawlog" poplar, a very rapid-growing and hardy form, supposedly of Siberian origin, is probably either a variant of the common cottonwood or a hybrid of it. Since its distribution in 1904 from a Norwegian settlement in Minnesota it has been widely planted in the northwestern states. In seven years the "sudden-sawlog" poplar will grow from a small cutting to a height of 50 ft. or more and a trunk diameter of 6 to 8 in., producing quick shade, windbreaks, useful light timber and pulpwood.

As practically the only large tree in many parts of the interior region, where it grew along the watercourses, the cottonwood was utilized by the pioneers in an immense number of ways, but chiefly for soft lumber, fuel and quick shade. Its downy fruits. widely driven by the wind, readily take root in the wet sands of lake and river shores. Around the southern and eastern shores of Lake Michigan the cottonwood, because of this characteristic, is an important factor in the formation of dunes.

The swamp cottonwood or downy poplar (P. *heterophylla*), which is found from Connecticut to southern Illinois and southward to Florida and Louisiana, attains a height of 90 ft. and trunk diameter of 3 ft. It has dark, rough bark and large, broadly ovate Ieaves, 5 to 6 in. long, which are intensely woolly when young. This tree furnishes excellent pulpwood and the lumber known to the trade as black poplar.

The black cottonwood or California poplar (P. *trichocarpa*) together with its northern variety (var. hastata) comprise the largest broad-leaved tree indigenous to the Pacific coast region of North America, attains a height of 200 ft. and a trunk diameter of 8 ft. It grows from Alaska to Lower California and eastward to Idaho and Nevada. It has yellowish fissured bark and large ovate, finely toothed leaves 2 to 11 in. long, lustrous green above and whitish below. The timber is utilized for wooden ware and pulpwood.

The balsam poplar or tacamahac (P. deltoides *missouriensis*), the "liard" of the Canadian voyageurs, is a narrow-topped tree, sometimes 100 ft. high, with a diameter of 7 ft. at the stump. It has smooth gray bark, ovate, pointed, dark-green leaves, which are whitish below, and resinous buds with a pleasing balsamic odour. It is found along the northern border of the United States from Mains westward, southward in mountains to Colorado, Nevada and Oregon, and northward nearly throughout Canada and Alaska to the Arctic circle. Like the cottonwood in the United States, the tacamahac was put to manifold uses by the early settlers in the prairie regions of Canada. The balm-of-gilead poplar *(P. candicans)* is similar to but smaller than the balsam poplar, with broad, heart-shaped leaves and very large, resinous, highly aromatic buds. It is widely planted in the northeastern states and Canada and also occurs as if native. It is thought to be a hybrid of European origin but perhaps partly of North American parentage.

In the Rocky mountain region and adjacent plains are found the lanceleaf cottonwood *(P. angustifolia)* and a foot-hill species (*P. sargenti*).

In the arid districts of the southwestern states there are seven species of cottonwood, all of more or less limited range, among which are the Fremont cottonwood *(P. fremonti)* and the Mexican cottonwood *(P. wislizeni)*.

The white, the black, and the Lombardy poplar are widely planted in the eastern states and Canada, where the two first named have become more or less naturalized.

In 1940 the cut of cottonwood lumber in the U.S.A. was 153,562,000 bd. ft., lumbered chiefly in the Mississippi valley, mostly from the common cottonwood in the north and swamp cottonwood in the south. In 1899, the peak year of production, it was 421,575,000 bd. ft. *(See* ASPEN.)

See C. S. Sargent, *Manual of the Trees of North America* (1905, new ed. 1933); G. B. Sudworth, *Forest Trees of the Pacific Slope* (1908) and *Check List of the Forest Trees of the United States* (1927); L. H. Bailey, *Manual of Cultivated Plants* (1924).

POPLAR BLUFF, a city of south-eastern Missouri, U.S.A., at the head of navigation on the Black river; the county seat of Butler county. It is on federal highways 60 and 67, and is served by the Frisco and the Missouri Pacific railways. Pop. (1940) 11,163. It was named from the tulip poplar trees which grew on the bluff of Black river. It marks the eastern border of the Big Springs country of the Ozark mountains. Wappapello and Clearwater dams provide a mammoth lake resort area, already noted for Keener spring and cave, hideout of the outlaw Jesse James. The industries include railway shops, shoes, lumber, wood handles, staves, tents, awnings, livestock, dairying, cotton and potatoes. It was incorporated as a town in 1870, as a city in 1892.

POPLIN. A fink and plain-ribbed fabric produced from any class of textile material and comprising a variety of different textures and qualities, and containing fine ribs or cords of uniform size extending across the width of the fabric, from selvedge to selvedge, *i.e.,* in the direction of the weft. The ribbed effect in a poplin fabric is obtained by employing a relatively high number of warp threads of fine counts of yarn and interweaving these on the principle of the plain calico weave, with picks of weft of coarse counts. Hence, during weaving, the finer and weaker warp threads bend or interlace quite freely under and over the *coarser* and stronger picks of weft which, therefore, lie in a perfectly straight line across the entire width of the fabric and thus develop the fine ribs or cords that characterize all poplin fabrics. Cotton poplin fabrics are used for making blouses, dresses, shirts and other garments. Irish poplin is composed of silk warp and worsted weft, and used for ties, dresses, coats and many other articles of clothing.

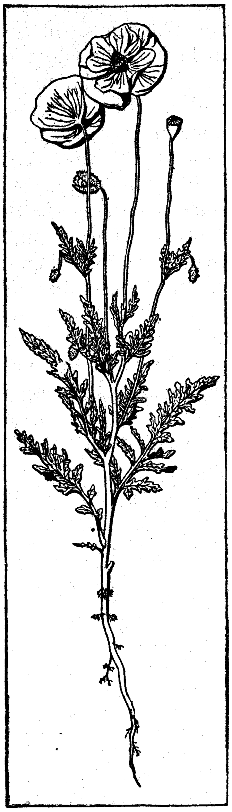
The manufacture is of French origin and was brought to England by the Huguenots.

POPOCATEPETL (Aztec *popoca* "to smoke," *tepetl* "mountain"), a dormant volcano in Mexico 18° 59' 47″ N., 98° 33′ 1″ W., which with the neighbouring Ixtaccihuatl (Aztec "white woman") forms the south-eastern limit of the great basin known as the "Valley of Mexico." As it lies in the State of Puebla and is the dominating feature in the views from the city of that name, it is sometimes called the Puebla Volcano. It is the second highest summit in Mexico, its shapely, snow-covered cone rising to a height of 17,876ft., or 438ft. short of that of Orizaba. This elevation was reported by the Mexican geological survey in 1895, and as the Mexican Geographical society calculated the elevation at 17,888ft., it may be accepted as nearly correct. The bulk of the mountain consists of andesite, with some porphyry, obsidian, trachyte, basalt, and other similar rocks. It has a stratified cone which shows a long period of activity. At the foot of the eastern slope stretches a vast lava field—the "malpays" (*malapais*) of Atlachayacatl—which, according to Humboldt, lies 60 to 80ft. above the plain and extends 18,000ft. east to west with a breadth of 6,000ft. Its formation must be of great antiquity. The ascent of Popocatepetl is made on the north-eastern slope, where rough roads are kept open by sulphur carriers and timber cutters. Describing his ascent in 1904, Hans Gadow states that the forested region begins in the foothills a little above 8,000ft., and continues up the slope to an elevation of over 13,000ft. On the lower slopes the forest is composed in great part of the long-leaved *Pinus liophylla,* accompanied by deciduous oaks and a variety of other trees and shrubs. From about 9,500ft. to 11,500ft. the Mexican "oyamel" (*Abies religiosa*) becomes the principal species interspersed with evergreen oak, arbutus and elder. Above this belt the firs gradually disappear and are succeeded by the short-leaved *Pinus montezumae,* or Mexican "ocote"—one of the largest species of pine in the republic. These continue to the upper tree-line, accompanied by red and purple *Pentstemon* and light blue lupins in the open spaces, some ferns, and occasional masses of alpine flowers. Above the tree-line the vegetation continues only a comparatively short distance, consisting chiefly of tussocks of coarse grass, and occasional flowering plants, the highest noted being a little *Draba.* At about 14,500ft. horses are left behind, though they could be forced farther up through the loose lava and ashes. On the snow-covered cone the heat of the sun is intense, though the thermometer recorded a temperature of 34° in September. The reflection of light from the snow is blinding. The rim of the crater is reached at an elevation of approximately 17,500ft. The crater is elliptical in form, 2,008 by 1,312ft., and has a depth of 1,657ft. below the summit of the highest pinnacle and 673ft. below the lowest part of the rim, which is very irregular in height. The steep, ragged walls of the crater show a great variety of colours, intensified by the light from the deep blue sky above. Huge patches of sulphur, some still smouldering, are everywhere visible, intermingled with the snow and ice that fills the crevices and covers the ledges of the black rocks.

It is believed that Diego de Ordaz was the first European to reach the summit of Popocatepetl, though no proof of this remains further than that Cortés sent a party of ten men in 1519 to ascend a burning mbuntain. In 1522 Francisco Montano made the ascent and had himself let down into the crater a depth of 400 or 500ft. No second ascent is recorded until April and Nov., 1827 *(see* Brantz Mayer, *Mexico,* vol. ii.). Other ascents were made in 1834, 1848 and subsequent years, members of the Mexican geological survey spending two days on the summit in 1895.

POPPY, any plant of the genus *Papaver,* the type of the family Papaveraceae. They are annual and perennial erect herbs containing a milky juice, with lobed or cut leaves and generally long-stalked regular showy flowers, which are nodding in the bud stage. The sepals, which are usually two in number, fall off as the flower opens, the four (very rarely five or six) petals, which are crumpled in the bud stage, also fall readily. The numerous stamens surround the ovary, which is surmounted by a flat or convex rayed disk bearing the stigmas. The ovary develops into a many-seeded short capsule opening by small valves below the upper edge. The valves are hygroscopic, responding to increase in the amount of moisture in the atmosphere by closing the apertures. In dry weather the valves open, and the small seeds escape through the pores when the capsule is shaken by the wind. The genus contains about 140 species, mostly natives of central and south Europe and temperate Asia. Five species occur in Great Britain; *P. rhoeas* is the corn poppy found in fields and waste places. Cultivated forms of this, with exquisite shades of colour and without any blotch at the base of the petals, are known as Shirley poppies. *P. somniferum,* the opium poppy, with large white or blue-purple flowers, is widely cultivated. *(See* OPIUM.)

The Oriental poppy (*P. orientale*) and its several varieties are fine garden plants, having huge bright crimson flowers with black blotches at the base, Many hybrid forms of varying shades of colour have been raised of late years. The Iceland poppy (*P. nudicaule*), is one of the showiest species, having grey-green pinnate leaves and flowers varying in colour from pure white to deep orange-yellow, orange-scarlet, etc. The Welsh poppy belongs to an allied genus, *Meconopsis;* it is a perennial herb with a yellow juice and pale yellow poppy-like flowers. It is found in the southwest and north of England, and in Wales; also in Ireland and western Europe. The prickly poppy belongs to the related, tropical American genus *Argemone.*



COMMON CORN POPPY (PAPAVER RHOEAS) OF "FLANDERS FIELDS"

A. grandiflora is a popular Central American annual with large, white flowers. To the same family belongs the horned poppy, *Glaucium flavum,* found on sandy seashores and characterized by the waxy bloom of its leaves and large golden-yellow short-stalked flowers. The plume poppies *(Macleaya)* are ornamental foliage plants of great beauty. The snow poppy *(Eomecon chionantha)* is a pretty Chinese perennial, having roundish slightly lobed leaves and pure white flowers about 2 in. across The Mexican tulip poppy (*Hunnemannia fumariaefolia*), a perennial usually grown as an annual, has very showy yellow flowers.

The poppy group is well represented in western North America, especially in California, where about 20 native species, together with numerous varieties, are found. The best known is the California poppy (*Eschscholtzia californica*), with brilliant, orange-coloured flowers, widely grown in gardens and extensively naturalized in Australia and India. Other noteworthy Californian species, more or less cultivated, are the tree poppy *(Dendromecon rigida),* a rigid, leafy shrub, 2 to 10 ft. high, with golden-yellow flowers, about 2 in. across; the Matilija poppy *(Romneya coulteri)*, a widely branched sub-shrub, 3 to 8 ft. high, with large, white, fragrant flowers, 6 in. across; the cream-cups (*Platystemon californicus),* a low, delicate annual, with light yellow flowers, 1 in. across; and the flaming poppy or wind poppy *(Meconopsis heterophylla)*, bearing brick-red flowers, 2 in. across. (N. TR.; X.)

POPPY HEADS, in architecture, the finials or other ornaments which terminate the tops of bench ends of pews or stalls. They are sometimes small human heads, richly carved images, knots of foliage or finials and sometimes *fleurs-de-lis* simply cut out of the thickness of the bench end and chamfered. The term is probably derived from the French *poupée,* doll or puppet, rather than from the flower.

POPPY OIL *(Oleum papaveris)*, **a** vegetable oil obtained by pressure from the minute seeds of the garden or opium poppy, *Papaver somniferum.* The white-seeded and black-seeded varieties are both used for oil-pressing; but, when the production of oil is the principal object of the culture, the black seed is usually preferred. The qualities of the oil yielded by both varieties and the proportion they contain (from 50 to 60%) are the same. By cold pressing seeds of fine quality yield from 30 to 40% of virgin or white oil *(huile blanche),* a transparent limpid fluid with a slight yellowish tinge, bland and pleasant to taste, and with almost no perceptible odour. On second pressure with the aid of heat an additional 20 to 25% of inferior oil *(huile de fabrique* or *huile russe*) is obtained, reddish in colour, possessed of a biting taste, and a linseed-like smell. The oil belongs to the linoleic or drying series, having as its principal constituent linolein; and it possesses greater drying power than raw linseed oil. Its specific gravity at 15°C. is 0·925.

Poppy oil is a valuable and much used medium for artistic oil painting. The fine qualities are largely used in the north of France (*huile d'oeillette)* and in Germany as a salad oil, and are less liable than olive oil to rancidity. The absence of taste and characteristic smell in poppy oil also leads to its being much used for adulterating olive oil. The inferior qualities are principally consumed in soap-making and varnish-making, and for burning in lamps. The oil is very extensively used in the valley of the Ganges and other opium regions for food and domestic purposes. By native methods in India about 30% of oil is extracted, and the remaining oleaginous cake is used as food by the poor. Ordinary poppy-oil cake is valuable feeding material, rich in nitrogenous constituents, with an ash showing an unusually large proportion of phosphoric acid. The seed of the yellow horned poppy, *Glaucium luteum,* yields from 30 to 35% of an oil having the same drying and other properties as poppy oil; and from the Mexican poppy, *Argemone mexicana,* is obtained a non-drying oil used as a lubricant and for burning.

POPULATION. About two-thirds of the inhabitants of the world are now periodically enumerated by means of a census. Whenever a census is taken a number of questions is asked concerning each person. Thus with respect to two-thirds of the inhabitants of the world there is a considerable volume of information of a fair degree of accuracy. The questions asked vary considerably from country to country. Information is nearly always required regarding age, sex and marital condition and therefore the inhabitants of different countries of which the population is periodically enumerated can be compared in respect of these matters. But with regard to the asking of questions concerning other matters much variation exists, and comparisons are often rendered impossible. There is no question regarding religion in the English census, for example, and comparisons in this respect between England and other countries where such information is collected are therefore not possible. For the remaining third of the world population it is necessary to rely upon estimates. No great degree of confidence can be placed upon these estimates, and a wide margin of error must be allowed for. Furthermore, estimates can only be made for the total population. It is impossible to estimate the distribution of the population in respect to age or sex, and as to these matters, therefore, for the remaining third of the world population there is no information.

The information obtained by the taking of a census can be analysed and tabulated. The results of so doing can be compared with the results of analysing former censuses. It will almost certainly be found that important changes have occurred since the taking of the last census. The population may have increased or diminished; the sex ratio may have altered. The taking of a census brings such changes to light but does not explain them. A census is, as it were, a snapshot of the population, and for the study of population changes more is required than a series of snapshots taken at different dates. An increase in the population of a country, such as a census may show, might be due to the immigration of people into the country, to an increase in the birth-rate or to a decrease in the death-rate. In those countries where a census is taken, data are also collected regarding births, deaths, marriages, movement into and out of the country and other matters. There is considerable variation in the methods of taking these data as there is in the taking of a census from country to country. These data are not only of interest in themselves but they can be used to throw light upon the changes which occur between one census and another.

These registration statistics of births, marriages and deaths may provide immediate explanations of some of the changes exhibited by the taking of a census. They may show, for instance, that the slackening of the rate of increase of the population of a country is due to a decline in the birth-rate. We are in that case led on to enquire into the causes of the decline of the birth-rate, or it may be in other cases into the causes of an increase in the death-rate or in the immigration rate. It is likely that to some extent an examination of the census figures and of the registration statistics will assist us in any effort we may make to explore these more distant matters. A detailed examination, for instance, of changes in the birth-rate over a number of years will almost certainly contribute towards the solution of the problem of the decline in the birth-rate. But it will seldom be found that the evidence of census and registration figures will be conclusive regarding these more distant problems. Biological questions are frequently involved. It may, for example, be shown that the statistics of the decline in the birth-rate are compatible with the increasing use of contraceptive methods. But before any conclusion can be come to on the point, it is necessary to enquire into the possible influence of diet upon fertility and other purely biological problems. Evidently the pursuit of explanations as to how the population of any country has come to be what it now is can lead us very far afield. It is not possible in this article to follow up these matters further than the point at which census and registration data cease to throw light upon them; nor can more than incidental reference be made to the results of population changes.

(1) WORLD POPULATION AND ITS DISTRIBUTION

(a) **Geographical Distribution.**—The best known estimates of the population of the world are those of the International Statistical Institute. In Table I. are given the estimates of the institute for the world as a whole and for the five continents about the years 1920 and 1926. It never happens that there is up-to-date information for every country in the same year. The data available nearest the year named are used and therefore in the table the word "about" is introduced. To what extent can these estimates be relied upon? There is a certain margin of doubt. The estimate for the institute for 1920 is 1,811 millions, while the independent estimates of the International Institute of Agriculture for 1921 and 1925 are 1,820 and 1,871 millions respectively. Other independent estimates show no very serious divergences and it is not likely that the totals are greatly in error. When we come to examine the estimates for each continent we find that the figures for Europe and North America

TABLE I. *Estimated Area and Population of the World*

Region	Area in thousands of square miles	Population in thousands		Density per square mile
		about 1920	about 1926	in 1926
Europe	3,700	449,727	467,092	126·2
America	16,663	209,409	233,106	13·0
Africa	11,053	132,139	138,249	12·4
Asia	17,008	1,012,122	1,032,381	60·6
Oceania	3,299	7,615	8,767	2.6
Total	56,613*	1,811,012	1,879,595	33·2

*Including 4,890,000 square miles of arctic and antarctic lands.

may be taken as approximately accurate, though some doubt arises concerning Russia and Mexico. The figures for Oceania are probably more accurate than those for any of the other remaining areas. While very considerable progress has been made in the enumeration of the inhabitants of certain South American countries, especially of Brazil, Argentina, Chile and Uruguay, there remains a large measure of doubt concerning the total population of the Southern half of the American Continent. The figures for earlier dates are still more open to suspicion, and the relatively large increase in the total population which would appear to have taken place during the present century is probably in part due to incomplete enumeration at earlier dates.

The figures for Asia are still less trustworthy. For some Asiatic countries there are reliable figures. One of the greatest achievements in the history of the enumeration of peoples has been the taking of a census in India. But important as is India from the point of view of numbers, China is still more important. Until recently, estimates of the population of China differed by more than a hundred millions. They still differ widely but there is a general tendency among those who have given most study to the matter to accept a high rather than a low estimate. In 1921 an estimate of 445,000,000 was made for China, Manchuria and the Chinese dependencies by the Chinese postal administration, and this estimate agrees closely with those made by the Chinese maritime customs for 1922 and by the China Continuation Committee for 1918. Those who accept lower estimates have apparently been influenced by the census of 1910. This was a census of households and not of persons and in order to obtain the number of persons it is necessary to multiply by a factor—a proceeding which leaves the results open to a wide margin of error. The estimate by the International Statistical Institute of the world population in 1926 includes a figure of 433,000,000 for China and this figure is based upon special information furnished by the Chinese Minister of the Interior. It is evident that in view of the uncertainty regarding the population of China and of the tendency to accept higher estimates, no great importance can be attributed to the apparent growth of the population of Asia in recent years which figures generally show. Similarly no confidence can be placed in the figures which seem to show a decrease in the population of Africa during the last half century. The estimates for this continent are less trustworthy than for any other continent. It would seem that in the last century observers tended greatly to overestimate the negro population. These estimates have since been considerably reduced and this reduction accounts for the apparent decrease in the population of the continent. At the same time parts of the continent have been ravaged by sleeping sickness and other diseases in late years and it is thus unlikely that there has been any true increase in the population.

TABLE II. *The Proportion of the Total Population of Europe* (=100) *America* (=100), *Africa* (=100) *and Asia* (=100) *contributed by certain European, American, African and Asiatic countries at various dates*

Europe

Country	1880	1910	1920	1926
England & Wales	7.77	8·06	8·42	8.36
Scotland	1 12	1·06	1·09	1·05
Ireland	1·55	·98	·97	·91
France	11·20	8.76	8.72	8.72
Germany	13·54	14·52	13·31	13·50
Austria	6.63	6.38	1·43	1·42
Belgium	1·65	1·66	1·66	1·69
Hungary	4·71	4.67	1·77	1·81
Italy	8·52	7·75	8.62	8.65
Russia	25.82	29·13	22.62	21·82
All other countries	17·49	17·03	31·39	32·07

Africa

Country	1920	1926
Abyssinia	8·70	7·23
Egypt	10·01	10·25
Belgian Territory	7·68	9·73
British "	38·17	37·49
French "	27·10	26·51
Portuguese	5·21	5·65
All other countries	3 13	3·14

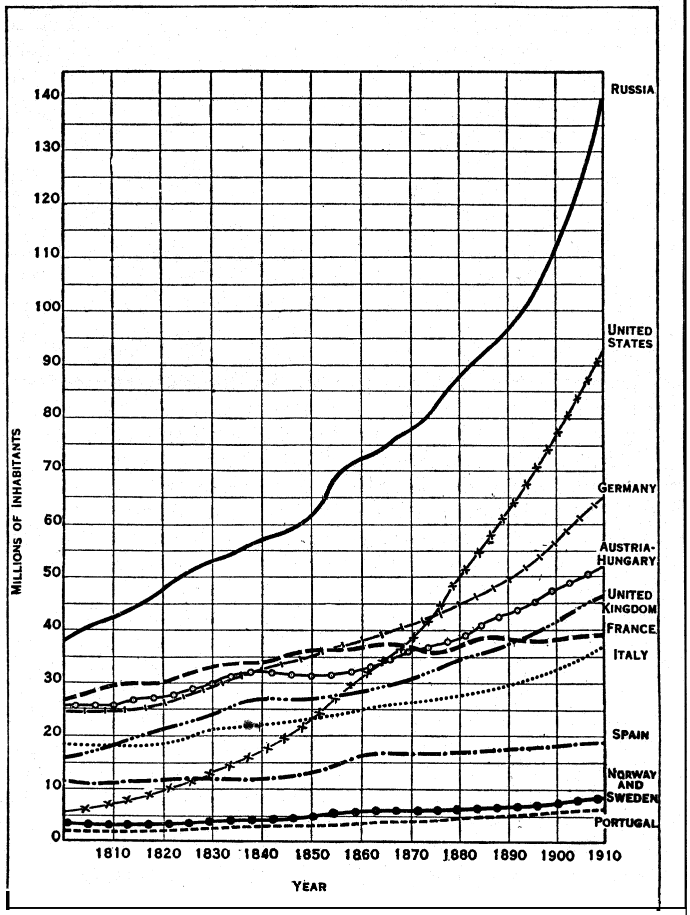
America

Country	1910	1920	1926
Argentine	3·93	4 11	4·33
Brazil	12·98	14·63	16·02
Canada	3·99	4·20	4·02
Chile	1·80	1·79	1·71
Colombia	2.83	2·94	2·90
Cuba	1·19	1·38	1·49
Mexico	8·40	6.83	6·14
Peru	2·49	2·65	2.36
U.S.A.	59·98	50·48	50·2[illegible]
Venezuela	1·48	1·15	1·30
All other countries	9·93	9·84	9.48

Asia

Country	1920	1926
China	42·82	41·98
Dutch Territory	4.88	4·94
French "	2·17	2·12
India	31·51	30·89
Japan	5·53	5·79
Russia (in Asia)	2·95	3.66
All other countries	10·14	10·62

(b) Changes in Geographical Distribution.—For the reasons given above it is not possible to obtain any accurate measurement of the proportion of the world population represented by the inhabitants of different countries during the last century and of the changes which have occurred since. But comparisons of this kind can be made for countries in Europe because trustworthy European statistics are available over a long period



FROM DR. EAST, "MANKIND AT THE CROSSROADS" (CHARLES SCRIBNER S SONS)

FIG 1.—GRAPH OF GROWTH OF POPULATION IN VARIOUS COUNTRIES 1800–1910, SHOWING THE RAPID INCREASE IN THE UNITED STATES AND RUSSIA CONTRASTED WITH THE SLOW INCREASE IN FRANCE

of years. In Table II. figures are given showing the proportions which the inhabitants of various European countries formed of the total population of Europe for various dates beginning with 1880. The same table gives similar data for America beginning with 1910 and for Africa and Asia beginning with 1920. Between 1880 and 1910 there were no changes in the frontiers of European countries, and the alterations in the relative positions of the various countries are due to varying rates of increase. The notable features are the decline in the position of France and the advance in the position of Russia. Between 1910 and 1920 there were large losses and large gains of territory in many countries. In addition, many European countries experienced an increased death-rate. Thus, in the case of the 1920 figures the changes due to varying rates of increase are overshadowed by the effects of the War. These effects have been remarkable. It is noticeable that France, in spite of an increase in territory, has not quite maintained her position, and that Germany, in spite of a large decrease in territory, has suffered comparatively little. Austria and Hungary, so greatly changed as political units by the War, now contribute less than 2% each to the population of Europe. The figures for America are interesting in that they show that the various countries tend to maintain their relative positions. The United States have lost slightly; Brazil and Argentina are gaining. The figures for Africa and Asia are chiefly of interest, rather in respect of the present relative importance of the various countries, than of any changes which they reveal. The dominating positions of India and China in Asia are generally recognised but the similarly dominating positions of British and French territories in Africa are not so well known. Looking at the relative world position of different countries and their territorial possessions, not from the point of view of population but of extent of territory, we find that Great Britain comes first with approximately 14·2, Russia second with 9.2, and thereafter France with 4.3, the United States with 3.7, Brazil with 3.2, and China with 3 million square miles.

It is evident that changes in the relative positions of different countries in respect of the proportion which their inhabitants form of the population of the continent in which they live, or of the world, are of the utmost interest and importance. Power and prestige in general go together. Behind the large populations are the big battalions. Therefore we may extend our view and look at the matter in another way. The figures for the total population of the United States and of the principal European countries are known since 1800 and in the accompanying graph (fig. 1) taken from Dr. E. M. East's *Mankind at the Crossroads*, the growth in absolute numbers of the inhabitants of these countries is shown. It is seen that the population of the United States which in 1800 only exceeded three of the European countries for which data are given, grew to surpass in turn the population of all the chief European countries with the exception only of Russia. Looking next at the European countries we find that they did not maintain their relative positions. France began by being second only to Russia but was passed in turn by Germany, Austria Hungary and the United Kingdom. The other changes need no comment. It is evident that these facts are full of significance in connection with international relations.

(c) Racial Distribution.—It is necessary to exercise the greatest caution in the use of the term "race." If by racial groups are meant groups of men exhibiting in common certain inherited character differences, then we may legitimately employ the term. There are groups of men exhibiting in common certain inherited characteristics in respect of hair, pigmentation and other physical features, and it may be asked what proportion of the population of the world falls into each of the larger groups. To this question no satisfactory answer can be returned. Not only in South America, for example, is the total population not accurately known but trustworthy data as to the proportion which each racial group, Caucasian, Negroid and Amerindian, contributes respectively to the estimated total are wholly lacking. The same applies to Asia and Africa.

It is estimated that the white branch of the Caucasian racial group and the Mongoloid group between them account for about two-thirds of the population of the world. In the absence of accurate information as to the constitution of the population of the world to-day it is clearly impossible to discover whether the different racial groups are maintaining their relative positions or whether one or more groups have improved their relative positions since 1900 or 1880. It can only be said that the white element of the Caucasian group, which was during the greater part of the last century considerably improving its position, is in any case not now doing so in the same ratio if indeed it is improving it at all.

(d) Growth of World Population.—The present population of the world is approximately 1,900 millions. Estimates of world population before 1880 are not very trustworthy. Sir George Knibbs, however, considers that Michelot's estimate of 1,009 millions for 1845 is as well founded a guess as can be made. Accepting this estimate it can be calculated that between 1845 and 1914 the average annual increase of the world population was about ·7%. It was in other words increasing at a rate which would double the population in less than 100 years. This rate of increase is considerably less than that found among the more advanced countries which compile registration statistics. Taking 26 such countries and calculating the rate of increase for the period 1906 to 1911 it works out at over 1·1%. These 26 countries were increasing at a rate which would double their populations in about 60 years. Putting the rate of increase at ·628% per annum, which was the rate of increase of the world population between 1901 and

1924, and supposing this rate to continue indefinitely, the world population would number 4,000 millions in 2031, 8,000 millions in 2131 and 16,000 millions in 2231. These calculations suggest certain reflections. Evidently the rate of increase must have been far lower on the average in past times. Knibbs has shown that the progeny of a single pair of human beings increasing at the average rate of 1% would come to equal in numbers the present population of the world in 1,900 years. It is probable that there have been flyctuations of numbers in earlier centuries of civilization. It is certain that disregarding these fluctuations the rate of growth in former times taken over several centuries was very small and that the rate of growth during the last century was wholly abnormal.

The causes of changes in the rate of increase and the prospects for the future will call for mention later when we come to consider birth-rates and death-rates. One aspect of the present situation has received attention lately and may be noticed here. How much more room is there? This question has frequently been put of late years. The answers, as might be expected, differ widely. There is no agreement as to how much food is needed on the average by each person, there are marked differences of opinion regarding the extent of soil available for important crops such as wheat and there is the difficult question of the allowances to be made for improvements in the technique of food production which may be expected. Estimates of the possible maximum world population vary from as little as 3,000 millions to as much as 7,000 millions. It is not possible to say more than that there is a limit and that it lies between these totals on the assumptions commonly made. It is easy to calculate that if the present rate of increase continues there will be no more room after a certain date. If, however, it is grasped that, had the present rate obtained in the past, the earth would have been full up long ago, it will be realized that there is nothing inevitable about the present rate of increase and that no inevitable catastrophe awaits us. For the greater part of human history the population has probably been approximately stable in numbers or has been increasing so slowly that the increase was hardly perceptible. It may well become stable again.

(2) DENSITY AND URBANIZATION

(a) Density of Population. — In Table I. is shown the density per square mile of the population of each continent. The five million square miles of arctic and antarctic lands have not been included in the continents though they are included in the total land area. When they are taken into account the average density for the whole land surface is about 33·2 per square mile. If they were excluded the average density would be perceptibly raised. It should be noticed that no deduction has been made on account of the many large barren and almost uninhabitable tracts that are included within every continent except Europe. Their inclusion somewhat exaggerates the true density of the European population on the one hand and gives a somewhat false impression of the sparseness of population elsewhere on the other hand. The true position of Australia, for instance, does not emerge so long as no account is taken of the presence of the great central deserts, and the same applies to Africa when no account is taken of the Sahara. Taking the figures as they appear in the table it is found that Europe and Asia are the most crowded continents, Europe being twice as crowded as Asia. The remaining continents are, relatively speaking, empty.

Among countries and areas which are regarded as distinct units from the point of view of political organization, Barbados is the most densely populated, having (in 1921) 952 per sq m., while Java comes next with (in 1920) 689 per sq. mile. Belgium is the most densely populated among European countries with 635 per sq.m. (in 1920), while Great Britain has 482 per sq.m. (in 1921). It is worthy of notice that England and Wales have a density of 649 per sq.m. (in 1921) and are therefore more densely peopled than Belgium. Such comparisons can be widely extended and up to a point are informative. It should be remembered that they may also be very misleading. The area of Egypt is, for example, 383,000 sq.m., and the total population amounts to 14,227,000, giving an average density of 37 per sq. mile. But the population of Egypt is almost wholly confined to the valley and delta of the Nile, the areas of which contain 13,616 sq.m., giving a density of 1047 per sq.m. of the inhabited area.

The figures of density given above fail to bring out certain important facts. An examination of a map of the world showing density of population without regard to political boundaries makes it at once apparent that there are three densely populated regions of no great size. The first region is that part of Europe which lies south of the parallel 60° north latitude. The second is that made up of the greater part of India and Ceylon; the third includes Japan, the greater part of Manchuria and China and a strip along the coast of Tonking. It may be roughly estimated that the population of these regions amounts to 440,000,000, 480,000,000 and 300,000,000 and the areas to 2,900,000, 2,000,000 and 1,200,000 sq.m. respectively. We thus find over 1,200 million people living on about 6,000,000 sq.m., or in other words about two-thirds of the world population living on about one-eighth of the habitable area. There are four other very much smaller regions which are densely peopled, the New England area of the United States, the Nile valley, the tip of the Malay Peninsula and Java.

What lies behind density of population? The densely populated areas are of two kinds. There are the rice producing countries such as China, Japan and Java. Rice requires a warm damp climate and, wherever rice has been introduced into lands with such a climate, population has become dense. Rice culture is capable of providing more food per acre than any other type of agriculture. There are also the industrial countries and, as Ellsworth Huntington has pointed out, they mostly lie in regions with a temperate climate, neither too hot nor too cold and at the same time of a stimulating nature. According to Ellsworth Huntington it is climate rather than soil which determines density of population. A stimulating climate is what is required in order that men should engage in industrial activities. Raw materials can be brought from elsewhere. A warm and damp climate is required for rice cultivation and in such a climate even a poor soil under rice will support a relatively dense population. The theory that climate is of predominant importance is probably true though it should not be pushed too far. So far as it is true, it renders open to doubt the view that the tropics are destined to support very dense populations. The enervating climate, the poverty of the food products, the difficulty of preserving not only organic materials such as food but also inorganic materials of which machinery is composed, the destructiveness of pests, are all obstacles.

(b) Urbanization. — The study of urbanization is the study of an aspect of the problem of density. It is a very important aspect and as such has not received the attention it deserves. It is probable that no change of so fundamental a nature has ever occurred in the lives of the mass of the people as that which has converted the greater part of the population of industrial communities from country dwellers to town dwellers during the last century. It is thus desirable to obtain a measure of urbanization but it is not an easy matter to do so. The census returns of most countries classify the population into urban and rural, but while these figures are useful for comparing changes in the same country between two dates, they are of little use when comparing two countries. This is so because the classification is based upon very different methods in different countries. Thus, owing to differences in local government between England and Scotland, the figures giving the percentages of urban dwellers out of the total populations are not comparable. Again, those officially classed as urban dwellers often live under what to most people would appear as rural conditions. English urban dwellers include, for instance, according to the official classification, those who live in the areas of urban district councils and, as is well known, to live in such an area is often regarded as having escaped from a town. The best method is perhaps to note, in Table III., the percentage of the total population living in towns having a population of 100,000 and over.

This table must be interpreted with caution. The method of calculating urbanization here adopted is not perfect. The urbanization of Australia, for example, is exaggerated. The urban population of Australia is concentrated in five large towns and there are few towns of relatively small size. If 50,000 instead of 100,000

TABLE III. *Density of Population and Urbanization: 1926*

Country	Population per square mile	Percentage of population living in towns having 100,000 inhabitants and over
Egypt (cultivated area only) . .	1,047	12·2
England and Wales .	668	39·1
Japan . . .	403	14 6
Italy	338	14·5
Germany . . .	350	26.6
France.	192	15·5
India	177	3·6
China . .	101	4·5
Russia (in Europe) . .	63	5·2
United States . . .	38	26.5
Canada (excluding North West territories) .	4	17·7
Australia	2	45'5

was taken as the lower limit, Australia would come out as relatively less urbanized than under the present method of calculating urbanization. Allowing for its defects, the table does show that there is little association between density of population and urbanization. Densely populated countries may or may not have a high degree of urbanization; Australia is an example of a sparsely peopled country with a high degree of urbanization. Further examination of the table shows that urbanization goes with industrialization rather than with density. In other words, a high degree of density without industrialization does not lead to urbanization, whereas urbanization can go a long way where industrialization prevails, even though the population is sparse. The countries which have a high degree of density without urbanization are those such as China, India and Egypt, where intensive agriculture is practised. Density thus accompanies intensive agriculture and may also be attained under industrial condition.

TABLE IV. *Proportion of the Sexes Living and at Birth About 1910 and 1920, in Certain European Countries*

Country	No. of females to 1,000 males		No. of male births to 1,000 female births about 1920		
	about 1910	about 1920	Born living	Born dead	Total
Germany . .	1026	1091	1072	1260	1077
Austria . . .	1036	1089	1073	1327	1080
Belgium . .	1016	1032	1068	1287	1069
Bulgaria .	961	1002	1068	1378	1069
Denmark	1060	1053	1044	1231	1049
Spain . . .	1056	1062	1099	1402	1106
France . . .	1035	1103	1059	1395	1073
England. . .	1067	1091	1052	. .	
Scotland . . .	1062	1079	1043		
Ireland . . .	1002		. .		
Greece . . .	986	1010	1163	1511	1167
Italy . . .	1036	1028	1060	1276	1069
Norway . . .	1099	1053	1056	1229	1060
Holland . . .	1020	1012	1063	1246	1069
Portugal . . .	1107	1113	1048	1301	1057
Rumania . . .	973		1061		
Russia . . .	1038	1224		. .	
Serbia . . .	945	. .			
Sweden . . .	1046	1037	1064	1296	1069
Switzerland . .	1033	1070	1065	1293	1071

(3) DISTRIBUTION BY SEX AND AGE

(a) Sex.—Among the questions asked where a census is taken there is always one concerning sex. Therefore for every country where a census exists we know the number of males and females comprised in the population. It is usual to state the facts by giving the number of females to 1,000 males and this number is called the sex ratio. It is well kaown that in most European countries females outnumber males and that in most non-European countries the opposite is the case. The facts are set out in Table IV. for certain European countries and in Table V. for certain non-European countries. For many European countries given, there is information for 1910 as well as for 1920.

TABLE V. *Proportion of the Sexes Living and at Birth in Certain Non-European Countries About 1920*

Country	No. of females to 1,000 males about 1920	No. of male births to 1,000 female births about 1920		
		Born living	Born dead	Total
U.S.A.		1057		
Canada		1065	1402	1075
Egypt	997	1093	1512	1097
South Africa*	943	1076	. .	. .
Japan	979	1045	1176	1053
India	928			
Australia	968	1062	. .	. .

*Excluding coloured population.

It will be seen that in the case of the countries neutral during the war there has been little change on the whole in the proportion between the sexes, whereas in the case of belligerent countries the former considerable excess of females was increased. Belligerent countries are therefore abnormal in respect of the existing large excess of females, and the increased disparity between the sexes is due to deaths of males during the war. The exceptional case of the lately belligerent countries may be thus left out of account, and the proportions about 1910 taken as more normal for Europe.

The conditions normal for Europe, however, are not those normal for non-European countries where males as a rule preponderate to at least as great an extent as females usually preponderate in Europe. In order to throw light upon this matter it is necessary to anticipate part of the discussion relating to distribution by age and to birth and death rates. This for the sake of convenience we may now do.

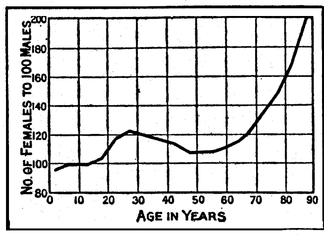
The sex ratio holds for the entire population. It does not necessarily hold for each group in the population. It might be that, while in the population as a whole there was an excess of females, there was at the same time an excess of males among that element of the population which fell between certain ages. This in fact is found to be the case in England and Wales as the following table shows. The figures in this table can be better appreciated when set out in the form of a graph (Graph II.). In England and Wales in 1921 males outnumbered females in the earlier age groups. There were in fact more males than females among those under 15 years of age. Among all those over 1; females were in excess and the older the group the greater in general was the excess of females. Among those 85 years old and over there were more than two women to each man.

TABLE VI. *Sex Ratio: Females to 1,000 Males. England and Wales, 1921*

Age	0–4	5-9	10–14	15–19	20–24	25–29	30–34	35–39	40–44	45–49
Ratio.	976	992	992	1,027	1,176	1,209	1,186	1,156	1,127	1,070
Age	50–54	55–59	60–64	65–69	70–74	75–79	80–84	85–	*All* ages	
Ratio	1,074	1,086	1,132	1,194	1,342	1,476	1,685	2,052	1,096	

These facts set us upon the track of an explanation. Obviously the next step is to investigate the sex ratio at birth. Tables IV. and V. give the number of male births to 1,000 female births for the countries under consideration. In every case there are more male than female births. This fact accounts for the excess of males among the younger age groups. But how does it come about that males lose their preponderance in the higher age groups? An examination of Table VII. gives the answer. Table VII shows that in England and Wales and in the United States registration area during the years 1911–5 females in every age group experienced a lower death-rate than males with the one exception of the age group 10–15 in England and Wales, where the males have the lower death-rate. The answer is that males die off more quickly than females.

It thus comes about that, although in the earliest age groups males outnumber females because more boys are born than girls, females soon come to outnumber males and in fact preponderate in the age group 15–20 in England and Wales and in all succeeding age groups. Thus, taking the population as a whole, females outnumber males. It may then be asked why females have this more favourable experience. There are two reasons which account for this fact. The female sex is more hardy than the male sex, and on the whole resists disease and the wear and tear of daily existence better than does the other sex. Again, females are less exposed to accidents than males. Industrial accidents fall rather upon the latter than upon the former. Men, in fact, lead a more hazardous existence, and more often lose their lives at work or at play than do females. The outbreak of war is only a special case of the extra exposure of males to risk.



FROM CARR-SAUNDERS AND CARADOG JONES, "SOCIAL STRUCTURE OF ENGLAND AND WALES" (CLARENDON PRESS, OXFORD)

FIG. 2.—SEX RATIO IN RELATION TO AGE

Males predominate in the earliest years, females in middle and old age

These facts explain the sex ratio and its distribution by age for such countries as England and Wales but they leave unexplained the situation in such countries as the United States. There also males outnumber females at birth as Table V. shows and there again males die off more rapidly than females as Table VII. makes clear. Why then are there more males than females in the American population as a whole? The explanation is to be found in the fact that large numbers of emigrants from Europe have entered the United States during recent years, and that among these emigrants males preponderate. This tendency for males to migrate more than females accounts also in some degree for the deficiency of males in those European countries from which movement takes place. The excess of males in the United States is found chiefly among the foreign-born whites and not amongst the native-born whites and negroes. Again, in the densely settled regions of that country females outnumber males. The same factor explains the excess of males in the British Dominions. This factor cannot, however, explain the position in India, Japan and Egypt.

There is no gain of males by immigration into these latter countries. If we look into the figures for these countries we find that as in all other countries for which figures are given in the Tables there is an excess of male births. But the death-rate does not as in other countries favour females. Table V. shows that in Japan the female sex experiences a higher mortality than the male sex between the ages of 1 and 40. Therefore males maintain their initial preponderance. It is outside the scope of this article to discuss the determination of sex. The figures in Table IV., however, carry us somewhat further back. So far, reference has only been made to the figures for living births, which show that more males are born alive than females. Reference may now be made to the figures for still births, and it will be observed that males bear a higher proportion to females among still births than they do among living births in every country for which figures are available. Males thus suffer a high mortality at birth, and the original disproportion between the sexes must be higher than the statistics for living births show. Evidence derived from observations upon miscarriages and from other sources goes to show that males suffer a disproportionately heavy mortality at a still earlier stage during pre-natal life. It thus follows that the proportion of males to females must be very much higher at conception than at birth.

(b) Age.—When a census is taken a question about age also is always asked. When populations of different countries are examined it is found that there are remarkable differences in respect to age distribution. These differences are of interest from two points of view. First, the proportion of persons of working age is important because upon their efforts depend the rest of the non-working population, both young and old. Again, only when the age distribution is known can the figures for birth-rates and death-rates be interpreted. It may be known that there are a certain number of births per 1,000 of the population and a certain number of deaths per 1,000 of the population in a certain area during a certain year, but, unless it is also known how many wives of child-bearing age and how many old persons there are in every 1,000 of the population, this information is of little use in enabling comparisons to be undertaken between one country and another or between one town and another. Thus, old people might retire in large numbers to a healthy town and live there until their death, thus causing a high death-rate and giving the appearance of bad conditions in what was in fact a healthy town. To this may be added the fact that age distribution must have an important influence upon the outlook of the population as a whole. Where the young are relatively numerous the outlook will not be the same as where the old are relatively numerous. In Table VIII. is set

TABLE VII. *Death-rate Among Males Expressed as a Percentage of the Death-rate Among Females at Different Age Periods*

Country	under 1	Age periods 1–4	5–9	10–14	15–19	20–24	25–34	35–44	45–54	55–64	65–74	75 and over
England and Wales 1911–5 . . .	119	103		115	125	125	125	128	130	125	116	111
U.S.A. Registration Area 1911–5 . .	1	1	1	1	1	116	112	127	120	114	106	

Country	Age Periods under 1	1–19	20–39	40–60	60 and over
Japan 1918	125	88	81	118	97

TABLE VIII. *Number of Persons at Different Ages per 1,000 of the Total Population About 1911 and 1920*

Ages	England and Wales 1911	England and Wales 1920	Scotland 1911	Scotland 1920	U.S.A. 1911	U.S.A. 1920	Australia 1911	Australia 1920	France 1911	Germany 1911	Prussia 1920	Japan 1920	England & Wales 1881
Under 5	107	88	112	97	116	110	119	116	89	120	74	129	136
5–15	199	189	210	198	205	209	199	206	169	220	221	222	229
15–25	182	176	185	186	197	177	202	167	160	183	194	179	188
25–45	299	293	282	276	292	296	288	298	291	273	284	261	259
45 and over	213	254	211	243	190	208	192	213	291	204	227	209	188
All ages	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000

out the age distribution in certain countries for various dates. Figures such as these are not of a very high order of accuracy. Ignorance and mis-statement vitiate the data to some extent. There seems to be a tendency for persons below a certain age to understate their age and for persons above a certain age to overstate their age. This may be due to vanity. But the figures are of sufficient accuracy to bring out some remarkable differences.

When these figures are examined it is found that the conditions represented in different countries and in the same country at different dates form a graded series. At one extreme the young are relatively numerous and at the other the old are relatively numerous. Taking the latter case first we find that France in 1911, Prussia in 1920, England and Wales in 1920 and Scotland in 1920, show conditions where the old are numerous and the young relatively deficient. The opposite case is illustrated by England and Wales in 1881 and Japan in 1920. An intermediate position is represented by England and Wales in 1911, Scotland in 1911, the United States in 1911 and 1920, Australia in 1911 and 1920 and Germany in 1911.

Figures such as these give the age distribution in the most summary manner possible. A more elaborate analysis of age distribution is not without its uses as Table IX., giving the age distribution of males in Great Britain and in the United States for a 40-year period shows. We may regard boys under 15 and men over 65 as constituting the dependent section of the population. They depend for their living upon the efforts of others—those between 15 and 64. In 1891 the dependent section of the male population constituted 41% in Great Britain and 39·5% in the Cnited States. In 1926 the proportions were 34% and 36·5%. Thus the working section had relatively increased. But this is not the full story. There were during these years important changes in the constitutions both of the dependent section and of the working section. The dependent section came to consist to a greater extent of old men than of children. The working section is thus to an increasing extent labouring to support the pensioners rather than the coming recruits to industry. Further, the increase in the working section is confined to those between 45 and 64. Those in the age of full vigour, *i.e.*, between 15 and 45, represent approximately the same proportion of the community as before.

Table IX. Age distribution of males: Great Britain and United States

Age last birthday	Great Britain					United States				
	Numbers	Percentage of year's total				Numbers	Percentage of year's total			
	1921	1921	1911	1901	1891	1920	1920	1910	1900	1890
0–4	1,920,000	9	11	12	13	11,573,000	10·9	11·6	12·1	12·2
5–14	4,091,000	20	21	22	24	22,039,000	20.9	20·5	22·3	23·3
15-44	9,359,000	46	47	48	45	49,986,000	47·3	48·9	47·6	47·4
45-64	3,950,000	20	16	14	14	17,030,000	16·2	14·6	13·7	13·1
65 and over	1,103,000	5	5	4	4	4,933,000	4·6	4·1	4·0	3·7
0–14	6,011,000	29	32	34	36	33,612,000	31·8	32·1	34'4	35'5
15-64	13,309,000	65	63	62	59	67,016,000	63.5	63·5	61·3	60·5

We are now led to enquire into the reasons for these changes in age distribution. It is obvious that if in any area over a long period of years the birth-rate and the death-rate remained the same and there was no migration a particular age distribution would be brought about and would remain constant. It follows that it is to changes in the birth rate, the death rate and to migration that we must look for the reasons for changes in the age distribution. Since it is the young for the most part who migrate, the effect of migration is to raise the proportion of the young in countries who receive immigrants and to lower this proportion in the countries who send them. Migration thus in part explains the differences in age distribution which now exist between Great Britain on the one hand and Australia and the United States on the other hand. A decrease in the birth-rate will tend to diminish the proportion of young and a decreasing death-rate will tend to raise the proportion of old. The birth-rate and the death-rate have both been decreasing in England and Wales for fifty years and this explains the remarkable change in the age distribution between 1881 and 1920 which the table shows. As an illustration of this it may be mentioned that the number of children under 15 years of age in 1921 was much the same as in 1891 though the total population had increased by nearly ten millions during these 30 years. It may be added that the number of scholars on the books of Public Elementary Schools in England and Wales reached its highest point in 1915 when it stood at over six millions. Since that date it has steadily declined. Japan, it may be observed, now shows approximately the age distribution of England and Wales 60 years ago. At that time England and Wales had high birth and death-rates as Japan now has.

It still remains to draw out the full significance of a peculiar age distribution such as now exists in Great Britain, though to do so involves to some extent an anticipation of the subject matter of the concluding section of the article. The significance in question is that relating to the probable trend of the population in the future. The census of 1921 disclosed a certain age distribution due to half a century of decline in both birth and death-rates. Starting with this age distribution as a basis and assuming that the annual number of births remains the same as in 1921–23, that the death-rates are the same as in 1910–12 and that there is no migration, Professor Bowley has calculated the future population of Great Britain and its age distribution, as shown in Table X.

Table X. *The Population of Great Britain*

(On the hypotheses that the annual number of births is the same as in 1921–23, that death-rates are as in 1910–12, and there is no migration)

Ages	1921	1931	1941	1951	1971	1991	2011
Thousands							
Males							
	6,011	5,666	5,788	5,788	5,788	5,788	5,788
15-45	9,358	10,241	10,690	10,726	10,564	10,564	10,564
45–65	3,949	4,463	4,538	4,954	5,381	5,389	5,389
65–	1,103	1,386	1,737	1,662	2,110	2,191	2,223
Total	20,421	21,756	22,753	23,330	23,843	23,932	23,964
15–65	13,307	14,704	15,228	15,680	15,945	15,953	15,953
Females							
0–15	5,929	5,585	5,713	5,713	5,713	5,713	5,713
15–45	10,657	11,125	10,974	10,683	10,515	10,515	10,515
45-65	4,279	5,125	5,595	5,949	5,797	5,676	5,676
65–	1,480	1,790	2,247	2,602	2,991	2,860	2,836
Total	22,345	23,625	24,529	24,947	25,016	24,764	24,740
15-65	14,936	16,250	16,569	16,632	16,312	16,191	16,191
20–45	8,643	9,182	9,138	8,847	8,679	8,679	8,679
Total M. & F.	42,766	45,381	47,282	48,277	48,859	48,696	48,704
Percentages of Total Population							
0–15 M. & F.	28	25	24½	24	23½	23½	23½
15–65 M.	31	32	32	32½	32½	32¾	32¾
15–65 F.	35	36	35	34½	33½	33¼	33¼
65–M. & F.	6	7	8½	9	10½	10½	10½

It appears that on these assumptions we may anticipate a slow increase in the population of Great Britain up to the middle of the century where it will stabilize at between 48 and 49 millions. The disproportion between the sexes will diminish. The age distribution will change in that there will be a shift from the youngest to the oldest class. It is anticipated that in 1971 those between 15 and 65 will form 66% of the total population as they did in 1921 and that those under 15 will form 23½% as against 28% and those over 65 10½% as against 6%. When the assumptions made are borne in mind and it is remembered that at the beginning of the period the population was increasing by nearly half a million annually, these results are at first sight very surprising. The explanation lies in the peculiar age distribution. It is assumed that the annual number of births remains the same. It is not assumed that the annual number of deaths remains the same. It is merely assumed that the average number of persons per 1,000 in any age group who die in a year remains constant. Now this number is higher, the older the age group. Further the older age groups will become relatively more populous. That this will be so is evident if we remember that when those now over 60 years were born the population of the country was little more than half its present size. We have with us little more than half the number of persons over 65 that is, so to speak, proper for a population of the size of the present. It follows that, though the death-rate remains the same, the number of deaths will increase and it appears that they will increase until they balance the assumed number of births. The importance of a peculiar age distribution and of the factors leading up to it is thus well brought out.

Before leaving this matter it is important to realize that Professor Bowley's calculation was made some five years ago. We now (1928) know that the annual number of births in Great Britain is not keeping constant but is decreasing year by year. There were 895,209 births in 1922 in Great Britain, 870,033 in 1923, 836,833 in 1924, 814,719 in 1925, 797,347 in 1926 and 778,337 in 1927. The decline in the annual number of births will tend to bring nearer the date at which the number of births and number of deaths will be the same and at which the population will cease to increase. On the other hand the death rate has not been declining during these five years in such a fashion as to counterbalance the effect of a diminishing number of births. It may also be stated that Professor Bowley takes no account of loss by emigration. The net loss by emigration is not inconsiderable. In 1926 it amounted to more than 100,000. Therefore we must anticipate that the population of Great Britain will cease to increase at an earlier date than that given in the above table and that it might thereafter begin to decline if the number of births continues to fall.

(4) REGISTRATION STATISTICS

It now remains to consider registration statistics. In the first place, marriage, birth and death rates demand separate attention, and, in the second place, the bearing of these rates upon the building up of the population must be reviewed.

(a) Marriage Rate. — The simplest method of measuring the amount of marriage is to record the annual number of marriages per 10,000 of the population. This rate is open to the objection excluding all those who are married. The annual number of marriages per 10,000 of the marriageable section thus defined is then calculated. This latter method is to be preferred though it is applicable only to countries with European standards and habits. It is not applicable, for instance, to India where marriages often take place at an early age. In India in 1921 there were 110,684 boys and 218,463 girls married under five years of age and 757,405 boys and 2,016,687 girls married between the ages of five and ten. Further, there were over two million boys and six million girls married between the ages of ten and fourteen.

In Table XI. there are set out the marriage rates for a number of European countries for two different periods. It appears in the first place that the countries included in the table fall roughly into two groups. There is a group of western European countries where the rate runs to about 500 and a group of eastern European countries where it approaches and sometimes exceeds 1,000. Secondly, a comparison of the rates in each country for the two periods shows that there has been no great change in the amount of marriage during the thirty to forty years which separate the periods. A closer inspection of the course of the marriage rate

TABLE XI. *Mean Annual Number of Marriages per 10,000 Marriageable Persons*

Country	Period	Proportion	Period	Proportion
Austria	1908–14	536	1876–85	551
Belgium	1910	533	1876–85	437
Bulgaria	1910–11	1,223	1896–1905	1,111
Denmark	1907–14	513	1875–1884	540
England and Wales'	1907–14	507	1876–85	568
France	1910–11	539	1877–86	496
Holland	1905–14	572	1875–84	536
Hungary	1906–15	778	1876–85	1,038
Ireland	1909–12	254	1876–85	260
Italy	1907–14	574	1877–86	545
Norway	1907–14	418	1881–85	458
Prussia	1907–14	585	1876–85	578
Rumania	1912–13	990	1896–1903	873
Scotland	1907–14	411	1876–85	445
Serbia	..	..	1896–1905	1,386
Spain	1907–14	522	1900–01	652
Sweden	1908–13	367	1876–85	417
Switzerland	1906–15	429	1876–85	432

shows the following: It has been demonstrated for certain countries, Great Britain for instance, that the rate fluctuates with economic conditions as represented by the state of the export trade, the amount of employment and amount cleared at the bankers' clearing house. Apart from these well-known fluctuations there has been in many European countries a decline in the marriage rate during the last fifty years. In Great Britain and Holland the decline amounts to about 10%. Unlike the decline in the birth-rate, however, to which reference is made in what follows, the decline in the marriage rate has not been general. The rate has increased in certain countries — notably in Belgium.

TABLE XII. *Mean Age at Marriage of Those Not Previously Married*

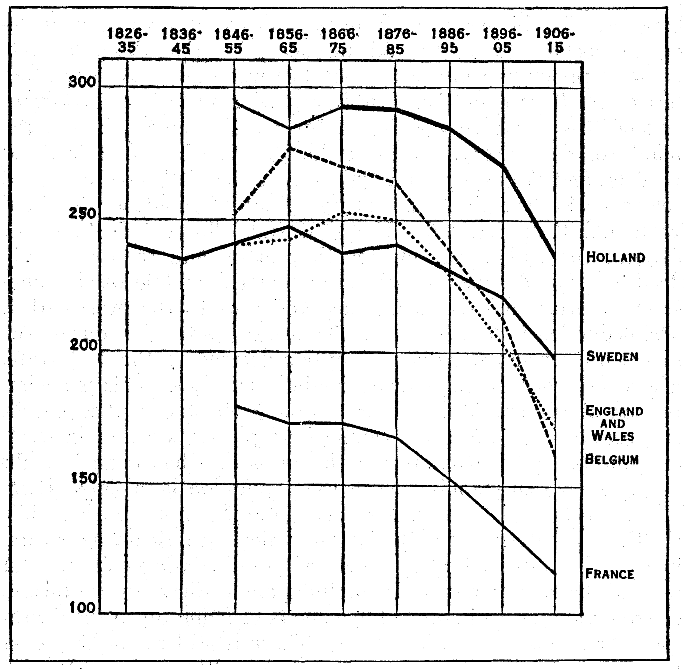
Country	1876–85		1886–95		1896–1905		1906–10		1911–15	
	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.
England and Wales	25·9	24·4	26·4	24·9	26·8	25·3	27·2	25·6	27·4	25·7
France	28·0	23·9	27·9	23·4	27·9	23·6	28·0	23·7	..	..
Germany	..	..	..	..	..	..	..	..	27·4	24·7
Holland	28·3	26·5	28·0	26·1	27·9	25·9	27·7	25·9	27·6	25·8
Italy	..	..	..	..	27·4	23·9	27·1	23·6	27·2	23·6
Scotland	..	..	..	..	27·6	25·6	27·8	25·8	27·8	25·8
Sweden	28·7	27·1	28·7	27·0	28·6	26·6	28·7	26·3	28·8	26·4
Switzerland	..	..	28·5	26·1	28·4	26·0	28·3	25·8	..	..

that in the same country at different times and in different countries at the same time the proportion which the marriageable persons form of the whole population may vary. This is so because, as we have seen, the age distribution may change. It is more satisfactory to refer the number of marriages to the number of marriageable persons in the population. The marriageable section of the population may be taken as consisting of the males 18 years of age and over and of the females 15 years of age and over

Another matter of considerable importance is the mean age at marriage. In giving figures for the mean age at marriage it is best to omit marriages of widowed and divorced persons. It is the age at marriage of bachelors and spinsters that is of importance, and the facts as to the age at marriage of these persons are obscured if other marriages are taken into account. The mean age at marriage is of course not the same as the most usual age at marriage. Thus, the mean age at marriage in England and Wales in 1920 was not far from 28 for bachelors and 26 for spinsters, whereas the most common ages at marriage in the same year were 24 for men and 21 for women.

Table XII. shows that the mean age at marriage is very similar in all countries for which figures are given. The age for men is a little over 27, while that for women varies from 23–26. Furthermore, there has been but little change in the mean age for fifty years: in France it has remained practically the same; in England and Wales there has been a tendency towards postponement; whereas in Holland the tendency has been the other way.

(b) Birth-rate and Death-rate. — The figure most usually given to represent the birth-rate is the number of births per 1,000 of the population in a year. This may be called the crude birth-rate. As a measure of the true fertility of the population it is inadequate and may be seriously misleading. The reason is the same as that which renders the crude marriage rate inadequate. Just as in order to obtain a true measurement of the amount of marriage it is necessary to refer the number of marriages to the number of marriageable persons, so in order to obtain a true measurement of fertility it is necessary to refer the number of births to the wives of child-bearing age. When this reference is made the crude birth ratio is said to be "corrected." Newsholme gives the following example of using this method of correction. In Ireland, the crude birth-rate was 24.5 in 1881 as compared with 33.9 in England and Wales, and 23·1 in 1901 as compared with 28.4. When these crude rates are corrected they become for Ireland 35·2 in 1881 and 36.1 in 1901, and for England and Wales 34.7 in 1881 and 28.4 in 1901. Thus, the true fertility in Ireland was in fact as high as that in England and Wales in 1881 and much higher in 1901. The explanation of the remarkable differences between the two countries lies in the fact that, whereas in England in 1901 the number of females aged 15 to 45 per 1,000 of the total population was 250 and in Ireland 235, the wives at ages 15 to 45 in England formed 46.8% and in Ireland only 32·5%



FROM "ECONOMICA," BY COURTESY OF SIR WILLIAM BEVERIDGE

FIG. 3.— FALL OF HUMAN FERTILITY IN EUROPE
All countries illustrated show a fall, beginning at about the same date

of the females at the same age. The crude birth-rate, however, does represent an important fact, It represents the additions by birth during the year to every 1,000 of the population. Similarly the crude death-rate represents the losses by death during the year to every 1,000 of population. In other words they represent additions to, and subtractions from, every 1,000 of the population. When the additions exceed the subtractions we may speak of "natural increase," and the problem of natural increase will occupy us later. For the present, however, we have to deal with changes in the birth and death-rates. We may consider the birth-rate first. It is well known that during the last half century the crude birth-rate of every European country has declined. In most cases the decline has been very marked. The crude birth-rate for England and Wales was 33.5 for the period 1871–75 and had declined to 18·8 in 1924. To what has this remarkable decline been due? In those countries where the amount of marriage has decreased the decline of the birth-rate is in part due to the decline in the marriage rate. But in no country has the decline in the marriage rate played a large part. Other causes overshadow it. Thus the decline in the crude birth-rate has been as marked in Belgium where the marriage rate has increased as it has been in England where the latter rate has decreased. If we consider, not the crude birth-rate, but the births per 1,000 married women age 15 to 49, we eliminate the influence of the amount of marriage and also to a certain extent of changes in age distribution. In the accompanying graph (Fig. 3, taken from a paper by Sir William Beveridge) the legitimate birth-rate per 1,000 married women aged 15 to 49 is plotted for five European countries for the last 60 years. In each of the five countries the fall has been marked.

Evidently there has been a decrease in the fertility of married women and this fact, and not the decline (if any) of the proportion which married women form of the whole population, has been the chief factor in bringing about the decrease in the crude birth-rate. It is still possible that changes in the ages of wives may have something to do with the decline. It is well known that women under 45 are not equally fertile and that the older the wife the less chance of bearing a child. Let us put this matter to the test for one of the countries which figures in the graph, namely England and Wales. We find that the number of wives under 45 years of age per 1,000 of the total population has not sensibly changed. It was 115 in 1871 and 121 in 1921. But out of 1,000 wives under 45 the proportion under 35 has decreased, being 607 in 1871 and 538 in 1921. Clearly the increasing age of wives is in part responsible for the decline in the number of children born to wives in England and Wales. How far it is so responsible can be ascertained and is shown in Table XIII.

TABLE XIII. *Indices Showing the Effect on the Birth-rate (Births per 1,000 Married Women Aged 15–45)* Not allowing *for the Ages of Mothers* Birth-rate Index age Rate= 100)

Year	Not allowing for age	Allowing for age
	166	
	162	150
1891	150	148
1901	134	125
1911	112	110
1921	100	100

From this table it is to be deduced that part of the decline, but a small part only, is due to the increasing age of wives. The greater part of the decline in England and Wales, and in other countries also, remains to be explained. This Important matter cannot be thoroughly explored here. It may be pointed out that in the opinion of many authorities the facts when closely examined are not merely concordant with an explanation based on deliberate family limitation but demand such an explanation. (See BIRTH CONTROL.) Those who look to this explanation lay stress on such facts as the following. (a) The birth-rate began to fall at the time when a widespread propaganda was begun in favour of family limitation. (b) The decline has been greatest in those classes—namely the higher social grades—most likely to be influenced by the propaganda. *(c)* The decline has been least in Roman Catholic countries where family limitation is discouraged This has been well brought out by the investigations of Sir William Beveridge who has shown that the fall has been least in those Dutch provinces where the proportion of Catholics in the population is highest. (d) Several minor details concerning the English birth-rate are strongly suggestive of such an explanation. It has been shown by the English census authorities that "the fertility of non-domestic coachmen, grooms, motor car drivers and gardeners is in all cases definitely higher than that of those following domestic employ." It is well known that the possession of a large family is a drawback to those desirous of obtaining and keeping domestic employment and it is reasonable to suppose that the lower fertility of domestic employees is due to deliberate limitation of the size of the family. Evidence of this kind can be multiplied. It is claimed that no explanation founded on a supposed lessening of reproductive power is either itself probable or can be made to fit the facts. On the other hand there are persons whose opinion cannot be disregarded, Dr. Raymond Pearl, for instance, who are not convinced that the whole explanation lies here.

The study of the death-rate contains no problems of such general interest as does that of the birth-rate. The crude death-rate is reckoned by calculating the number of deaths per 1,000 of the population in any year. The crude death-rate is important, just as the crude birth-rate is important, and we shall presently use both of them in connection with the study of increase. In order to judge of the health of any group it is necessary to bring the number of deaths into relation with the sex and age contribution of the population. When corrected it is in general found that the death-rate has markedly decreased in all civilized countries during the last century. The improvement first affected adults and later children and infants. The infantile death-rate for England and Wales dropped from 146 per 1,000 in 1900–02 to 75 per 1,000 in 1925. The reason for this improvement is not mysterious. It is obviously the result of improvement in hygiene, sanitation, medical knowledge and medical services.

(c) Natural Increase.—When the crude birth-rate exceeds the crude death-rate the difference is known as the natural increase. Natural increase is obviously a matter of great practical importance. Table XIV. shows the natural increase for various countries in recent years.

TABLE X'IV. Birth-Rates, Death-Rates and Natural Increase

	Year	Birth rate	Death rate	Natural increase
Australia . . .	1926	22·0	10·5	11·5
Austria . . .	1926	19·2	14·9	4'3
Belgium . . .	1926	18·9	12·8	6·1
Bulgaria . . .	1925	37·0	19·2	17·8
Canada . . .	1926	24·2	11·3	12·9
Ceylon . . .	1925	38.6	23·5	15·1
Chili	1926	40·1	27·2	12·9
Denmark . . .	1926	20·5	11·0	9'5
England and Wales	1926	17·8	11·6	6.2
Egypt . . .	1926	44·0	26.6	17·4
France . . .	1926	18·8	17·5	1·3
Germany . . .	1926	19·5	11·7	7·8
Greenland. . .	1925	45·2	39·7	5·5
Holland . . .	1926	23.8	9·8	14·0
Hungary . . .	1926	27·3	16·6	10·7
Italy	1926	27·2	16·8	10·4
Japan . . .	1925	34'9	20·3	14·7
New Zealand . .	1926	21·2	8·8	12·4
Norway . . .	1926	19·7	10·6	9·0
Philippines . .	1925	34·0	18·1	15·9
Rumania . . .	1925	35·2	21·0	14·2
Scotland . . .	1926	20·9	13·0	7'9
South Africa (European population) . . .	1925	26.5	9·4	17·1
Spain . . .	1926	29·7	19·1	10·6
Sweden . .	1926	16·9	11·8	5·1
Switzerland . .	1926	18·2	11·7	6·5
United States (Registration area)	1926	20·6	12·2	8·4
Uruguay . . .	1925	25·4	11·7	13·8

It will be seen that the crude birth-rates varied from 37·0 in Bulgaria to 18.2 in Switzerland during the period under review. The crude death-rates varied from 39.7 in Greenland to 8.8 in New Zealand. The highest natural increase was in Bulgaria and the lowest in France. While it so happens that Bulgaria had the highest crude birth-rate and the highest natural increase, a glance at the table will show that there is in general no correspondence between a high birth-rate and a large natural increase. Thus Greenland, with a birth-rate nearly as high as Bulgaria, had, next to France and Austria, the lowest natural increase. The table shows that countries with a high birth-rate often have a high death-rate and thus do not exhibit a large natural increase. The association of a high birth-rate with a high death-rate has been much discussed. What the precise nature of the association may be is not clear; to some extent, no doubt, a high birth-rate renders the care of children by the mother more difficult, and to this extent a high birth-rate may be said to cause a high death-rate. At the same time, however, a high death-rate tends to call forth the birth of more children to fill the vacant places, and to this extent the relation is reversed and a high death-rate is the cause of a high birth-rate. It is worthy of note that, as a comparison of Table XI. with Table XIV. shows, those countries with a high birth-rate are in general also those with a high marriage rate.

But the most interesting and important fact which emerges from Table XIV. is that the same natural increase is found in countries which have widely divergent birth and death-rates. Thus, the United States and Japan had both the same natural increase for the periods under review, but, whereas the former had relatively low birth and death-rates, the latter had high rates. The contrast is even more striking between New Zealand, with its low rates and natural increase and such a country as Ceylon, with a death-rate nearly as high as its high birth-rate and in consequence a low natural increase. Apart from the question whether increase is desirable and if so to what extent, it is clear that, if there is to be increase at all in any country, those conditions are to be preferred by which it is attained by a margin between a low birth-rate and a low death-rate rather than between a high birth-rate and a high death-rate.

In the earlier part of this article reference was made to the increase of the world population. It was pointed out that the rapid increase which took place during the last century was altogether exceptional. In other words natural increase, which in previous centuries has been non-existent or small, then became large. Apart from migration a population which is neither increasing nor decreasing can only begin to increase if either one of two things happens. The birth-rate may increase or the death-rate may decrease. There is a widespread misconception that the great outburst of population in the last century was due to an increasing birth-rate. This is not so. Our information regarding birth-rates and death-rates is very deficient for most countries before the middle of the century. So far as the facts can be ascertained for England and Wales it would appear that the birth-rate increased somewhat in the eighteenth century, remained steady up to about 1876 and then declined. The death-rate fluctuated somewhat towards the end of the eighteenth century and then markedly declined. The decline was arrested about the middle of the nineteenth century and then continued and lasts to the present day. The deduction is that the great increase of population during the nineteenth century was due mainly to a decrease in the death-rate. The same probably holds true of other countries. This is an important result and it has bearings on problems of the present and future. The death-rate cannot be rapidly decreased in western Europe and in that region the birth-rate has been brought down so low that stabilization of the population is in sight. Eastern European countries are further behind in the same path while the United States and the British Dominions are, so far as natural increase is concerned, in a somewhat intermediate position. But what of the great communities of India and China? In the former country in any case improved hygiene is bringing down the death-rate. The population is increasing. There is still room for a vast improvement in sanitary conditions and health services. If such an improvement comes about, it will in all probability cause a huge increase in the population because there is no reason to anticipate that a sensible diminution of the birth-rate will occur for a long time to come. This is a development to be feared both in the interests of these countries themselves and of the world in general. This expression of opinion requires a few words of explanation.

(d) Migration.—It does not follow that, because within a given period in a country there has been a certain excess of births over deaths, the population of the country will have increased by that amount. Migration movements have to be taken into account. A country might lose its whole natural increase through migration. What is important to know is the net movement inward or outward for any country and until recently migration statistics have been so defective that there has been little precise information on the subject. The general importance of migration can be shown by the estimate that between 1820 and 1925, 33,000,000 persons left Europe and settled in the United States. Its particular relevance in this discussion is twofold. The white races are still very unevenly distributed over the territories which are fitted for them to inhabit. There are powerful motives leading the more crowded peoples to desire to go to these half empty countries and at the same time there are motives leading those in possession of the latter territories to restrict entrance. Here is a cause of possible international friction. Again for the peoples of India and China among whom increase is to be anticipated there is little opportunity of relief by migration. Attempts by Indians and Chinese to migrate are likely to lead to resistance on the part of those powers who control the territories where Indians and Chinese are likely to want to go.

(e) Economic Problems.—The mention of possible increase led us to refer to migration; and migration was found to raise political problems of the first magnitude. The question of increase also raises economic problems. When speaking of India and China it was said that increase of population might raise internal difficulties for those countries quite apart from troubles arising from external friction. The reference was to the possibility of over-population. A country is over-populated when the number of its inhabitants exceeds the "optimum number" (*q.v.*) and it is an indispensable condition of economic welfare that the population should approximate to the optimum. But relatively simple as is the conception of the optimum, no method of testing by statistics the situation of a country with reference to the optimum is known. The position of any country can only be guessed at after a survey of the conditions. It is generally held that large tracts of India and China are over-populated now, and thus there are grounds for anticipating that any further increase would seriously embarrass them internally. Here, however, the discussion passes into economics just as it was above tending to pass into politics; and the restrictions deliberately imposed upon the scope of the article bring it to an end. (See also BIRTH-RATE, DEATH-RATE, MARRIAGE-RATE, SEX-RATIO AT BIRTH AND DEATH, ILLEGITIMACY, MIGRATION, CENSUS, RURAL DEPOPULATION and URBANIZATION. See UNITED STATES: Population and Social Conditions for population problems in the U.S.)

BIBLIOGRAPHY.—E. B. Reuter, *Population Problems* (1923) (this book contains a useful list of references at the end of each chapter); Harold Wright, *Population* (1923); L. I. Dublin, *Population in the United States and Canada* (1926); E. M. East, *Mankind at the Cross-roads* (1923); *Proceedings of the World Population Congress* (1927). T. R. Malthus, *An Essay on the Principle of Population* (first edition, 1798: republished, 1926). Sir Leo Chiozza Money, *Peril of the White* (1925). (A. M. C.-S.)

POPULONIA, an ancient seaport town of Etruria, Italy (Etruscan *Pupluna*), at the north end of the peninsula of Monte Massoncello, at the south end of which is situated the town of Piombino (*q.v.*). The place, almost the only Etruscan town built directly on the sea, was situated on a lofty hill now crowned by a conspicuous mediaeval castle and a poor modern village (Populonia). It commands a fine view, and Corsica is sometimes visible, though not Sardinia, as Strabo (and following him, Lord Macaulay) erroneously state. Considerable remains of its town walls, of large irregular, roughly rectangular blocks (the form is that of the natural splitting of the schistose sandstone), still exist, enclosing a circuit of about 1½ m. The remains existing within them are entirely Roman—a row of vaulted substructions, a water reservoir and a mosaic with representations of fishes. Strabo mentions the existence here of a look-out tower for the shoals of tunny-fish. There are numerous tombs outside the town, from the Villanova period (9th century B.C.) to the middle of the 3rd century B.C. Under heaps of ancient slag removed for resmelting at the present day, a considerable number of chambered inhumation tombs of the 8th–7th century B.C. have been discovered; all were originally covered by circular mounds of earth; the roof was a false dome, formed by the projection of each course of stones beyond the one below it. The remains of a temple, devastated in ancient times, were also found. The iron mines of Elba, and the tin and copper of the mainland, were owned and smelted by the people of Populonia; hot springs too lay some 6 m. to the E. (Aquae Populaniae) on the high road—Via Aurelia—along the coast. At this point a road branched off to Saena (Siena). According to Virgil the town sent a contingent to the help of Aeneas, and it furnished Scipio with iron in 205 B.C. It offered considerable resistance to Sulla, who took it by siege; and from this dates its decline, which Strabo, who describes it well, already notes as beginning, while four centuries later Rutilius describes it as in ruins. The harbour, however, continued to be of some importance, and the place was still an episcopal see under Gregory the Great.

See A. Minto, *Populonia* (Florence, 1922) for a full description.

PORBANDAR, a native state of India, in the Western India States Agency, Bombay, extending along the south-west coast of the peninsula of Kathiawar. Area, 636 sq.m.; pop. (1931) 115,673. Tribute, to the British Government, Baroda and Junagadh, £2,232. The chief is a Jethwa Rajput. Limestone is largely produced, and ghi exported. The town of PORBANDAR is the maritime terminus of the Kathiawar railway system. Pop. (1931), 33,383. A large trade is conducted with coastal ports, the Persian gulf, and the east coast of Africa. There are manufactures of silk and cotton, cement; and cotton ginning and pressing factories.

PORBEAGLE (*Lamna cornubica*), a species of shark, belonging to the Selachians (*q.v.*). The body is short and stout and contrasts strikingly with its much attenuated tail which is strengthened by a keel on each side and terminates in a powerful caudal fin. Its dentition differs from other sharks, and it is not dangerous to man. The porbeagle attains a length of 10 to 12 ft. and is a pelagic fish chiefly of warm seas but not rare in the North Atlantic and Mediterranean and frequently wandering to British and more rarely to North American shores as far as Cape Cod. See SHARK.

PORCELAIN: *see* POTTERY AND PORCELAIN.

PORCELAIN ENAMELLING. A porcelain enamel is a ceramic enamel. It is a thin layer of glass fused to a metal to enhance its beauty, to prevent corrosion, or both. Porcelain enamelled iron is used extensively for both domestic and industrial articles. In addition to its use for kitchen ware, bathtubs and sinks, it is used extensively for table tops, refrigerators, washing machine tubs, and stoves. Industrially it is used for advertising signs, chemical and food tanks of large sizes, for hospital furniture, meat market, grocery, and restaurant equipment, and has found extensive application in architecture for the facing of the outsides of buildings.

A porcelain enamel, being a glass, has the properties of glass; namely, its hard glossy surface and resistance to solution, corrosion, and scratching. The metal backing and design greatly influence its strength and resistance to damage.

The quality of porcelain enamels varies greatly, depending upon the glass used, the design, and the manufacturing technique. (See also ENAMEL; GLASS.)

History.—Although the term "porcelain enamel" did not come into common use until about 1929, porcelain enamelling, vitreous enamelling, or enamelling, as it was sometimes called, actually dates back to a very early period in history. No date can be set concerning the beginning, but the first enamelling was in the form of glass beads fused to copper, gold, and silver decorative ware. This type of ware was classed as jewellery and highly prized.

Later, a type of ware called Cloisonné was gradually developed. Cloisonné was made by first outlining areas on a gold surface by soldering tiny gold wires in place. A finely milled paste made from powdered glass and water was spread into the area between these wires. This was dried and then the ware was placed in a furnace at a temperature sufficient to melt the glass to a smooth layer. Several applications were generally made to give sufficient thickness, and various colours were used in the different areas, thus producing elaborate designs. After the final application of the enamel, the ware was polished off smooth with an abrasive so that the gold wires appeared as uniform boundaries between the different areas of enamel.

Champlevé was made by a modification of this process in which the metal was gouged out, leaving ridges between the areas to be enamelled.

Another interesting early development was that of miniature painting in which the powdered glass suspended in water was used by artists for painting small pictures.

Manufacture. — Although these early developments took many years, the transition from an art to an industry in the early part of the 19th century proceeded very rapidly. Cast iron dry process enamels were the first to be used on a large scale. In this process, the castings, such as bathtubs, were first sand blasted to give them a clean surface. The grip or ground coat was then applied. This ground coat consisted of a powdered glass, clay, water suspension with a consistency about like that of cream. This was dipped, slushed, or sprayed on the cool casting and allowed to dry. The ware was then introduced into a furnace at about 900° C. and allowed to come to the temperature of the furnace. The hot ware was withdrawn from the furnace and powdered glass dusted through a screen over it. This powdered glass melted as it fell on the hot ware and formed a continuous layer of enamel.

Several applications were generally applied, returning the ware to the furnace for reheating before each application. This process is particularly applicable to the manufacture of heavy castings.

Another process which has come into common use is that of wet process cast iron enamelling. This is used on light weight or thin castings and has been adopted extensively in the stove industry. In this process, the ground coat is generally applied, as a suspension of the glass with clay in water, dried, and then fired in a furnace at about 750° C. The ware is removed from the furnace, cooled, the second coat applied, and then refired.

This process is sometimes known as the American process for enamelling cast iron.

Sheet steel enamelling has become the most extensive process used for porcelain enamels. In this process, the sheet steel is fabricated and put through a cleaning and pickling process which prepares the surface for enamelling. Sheet steel enamelling requires a ground coat containing a small percentage of cobalt to give it adherence. This ground coat is applied by the wet process, dried, and then fired in a furnace at about 830° C. After the ware has been removed from the furnace and cooled, a second coat of cover enamel is applied by the wet process. This cover coat may be of any desired colour and may have very special properties depending upon the use to which the ware is to be put. It is commonly sprayed or dipped onto the ware, allowed to dry, and then fired at about 830° C. Additional coats of enamel are sometimes applied, and finally the decoration is applied and fired into the last coat.

Although enamelling is an important industry in most countries, the use of automatic equipment, technical control, and mass production is outstanding in the United States.

BIBLIOGRAPHY.—A. I. Andrews, *Enamels* (1935); Ludwig Stuckert, *Die Emailfabrikation* (1929); J. E. Hansen, *A Manual of Porcelain Enameling* (1937); Laurence Mernagh, *Enamels* (1928). (A. I. A

PORCH, originally a roofed structure, usually open at the sides, to protect the entrance of a building; loosely used of any projecting portico, or even of any colonnade, and, in America, of any roofed structure open at the sides and front, attached to a house or other building; synonymous with veranda or piazza. Thus a sleeping porch is such a structure usually opening from an upper storey, arranged for sleeping in the open air.

Of the porch proper there are few extant remains prior to the classic period, although Egyptian wall paintings seem to indicate their occasional use with houses. The most important Greek porches are those of the Tower of the Winds at Athens (1st century B.C.), in which two columns of a simple Corinthian order carried a pediment. A similar porch exists in the so-called villa of Diomed at Pompeii. Houses in Rome sometimes had long colonnades facing the street which served as porches. During the Romanesque period simple projecting porches covering the western doors of churches gradually replaced the earlier basilican colonnaded narthices. Especially interesting are the projecting porches of the Italian Romanesque, such as are found in Zeno Maggiore at Verona (12th century), in which the columns are carried on marble lions (as frequently in Lombard work) and at Modena (12th century) and Parma (13th century). In Apulia there are many similar porches of distinct Lombard character.

In France, especially in Burgundy, an even greater development of the porch occurred, in which it became a vaulted structure of great height and importance, two or more bays long, and sometimes as wide as the entire church. The great porch of the abbey church at Vezelay (1132–40), sometimes termed an ante-church, is the largest and most rich. In Norman work in England church porches are more frequently at the sides of the nave than at the west end. An interesting example is that at Southwell minster (early 12th century).

The English love of picturesqueness sometimes developed the porch to such an extent that it became almost a separate building which was called a "galilee," like that at Durham (1175). Galilees in mediaeval churches are supposed to have been used sometimes as a court of law, or a place where corpses were placed before interment, but the galilee probably served chiefly as a chapel for penitents before their admission to the body of the church. Many fantastically rich projecting porches occur in French flamboyant churches, such as that of the church of Notre Dame at Alençon (c. 1500); the pentagonal porch of S. Maclou at Rouen (c. 1520) and the little side entrance of the cathedral at Albi (early 16th century).

The same richness of porch design is not found in English Gothic churches, where western doors are often small and unimportant; an exception, all the more remarkable for its unique character, is the west front of Peterborough cathedral (*c.* 1220), in which the doors are deeply recessed within great arches, 81 ft. high, forming a most impressive porch. The other type of porch, the small projecting gabled feature projecting from the north or south walls of the nave, was, however, highly developed throughout the course of English Gothic. In small examples, in parish churches, the porches are usually of wood, with a richly decorated bargeboard, running up the gable, and often panels of intricate tracery at the sides. In the larger city churches there was frequently a room over the porch, sometimes known as a porch chamber, and sometimes incorrectly termed a parvis (*q.v.*). These seem to have been used sometimes as vestries, sometimes as treasuries and sometimes as chantry chapels. Similar porches, with chambers above, occur occasionally in Tudor mansions, as in the house of Compton Winyates (c. 1520).

In Germany churches of the Flamboyant Gothic period are frequently decorated with western porches of the most fantastic richness, with a great use of cusping, pierced tracery and canopy work. Such is the double arched entrance of the cathedral at Ulm (*c.* 1390), by von Ensingen, and the triangular porch of the cathedral at Regensburg, by M. Roritzer (1482–86).

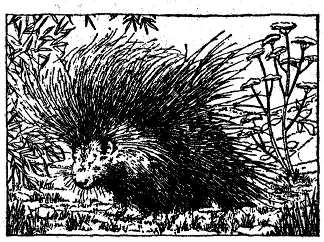
During the Renaissance the porch was usually treated as a portico (*q.v.*), but simple porches of two or four columns were exceedingly common features of the late 18th century houses of England and America. (T. F. H.)

PORCHER, FRANCIS PEYRE (1825–1895), American physician and botanist, was born in St. John's, S.C., on Dec. 14, 1825, and was graduated with a bachelor's degree from South Carolina college in 1844. He took his medical degree three years later from the Medical College of the State of South Carolina and studied in France and Italy for two years thereafter. In 1849 he began practice in Charleston, S.C., and in that year also he published *Sketch of the Medical Botany of South Carolina.* In Charleston he was one of the founders of the city's preparatory medical school and was surgeon at the marine and municipal hospitals; he was also professor at the Medical College of the State of South Carolina. In 1855 he organized a hospital for Negroes.

Dr. Porcher served the Confederacy throughout the Civil War, as surgeon to the Holcombe legion, to the Naval hospital at Ft. Nelson, Norfolk harbour, and to the South Carolina hospital at Petersburg, Virginia. In 1863 he published his monumental *Resources of the Southern Fields and Forests,* which was intended as an inventory of the Confederate States' botanical resources for war, and which became an authoritative reference work. It was revised in 1869.

Among the offices held by Dr. Porcher were the presidency of the South Carolina Medical Association and the vice-presidency of the American Medical Association. He was also one of the editors of The Charleston Medical *Journal* and Review for several years. He died Nov. 19, 1895.

PORCUPINE, the name of the largest European terrestrial rodent, distinguished by the spiny covering from which it takes its name. The European porcupine (*Hystrix cristata*) is the typical representative of a family of Old World rodents, the *Hystricidae*, all the members of which have the same protective covering. They range over the south of Europe, the whole of Africa, India and the Malay Archipelago as far east as Borneo. They are all stout, heavily-built animals, with blunt rounded heads, fleshy mobile snouts, and coats of thick cylindrical or flattened spines, which form the whole covering of their body, and are not intermingled with ordinary hairs. Their habits are strictly terrestrial. The common porcupine, which occurs throughout the south of Europe and North and West Africa, is replaced in South Africa by H. *africaeaustralis* and in India by the hairy-nosed porcupine (Acanthion *leucura*).



BY COURTESY OF THE LONDON ZOOLOGICAL SOCIETY
CRESTED PORCUPINE (HYSTRIX CRISTATA)

There are several smaller species with long tails in north-east India, the Malay region and Africa. In the New World the porcupines are represented by the family *Erethizontidae*. The spines are mixed with long soft hairs. They are less nocturnal in their habits; and with one exception live entirely in trees, having in correspondence with this long prehensile tails. They include three genera, of which the first is represented by the Canadian porcupine (*Erethizon* dorsatum), a stout, heavily-built animal, with long hairs almost or quite hiding its spines, four front- and five hind-toes, and a short, stumpy tail. It is a native of the greater part of Canada and the United States, wherever there is any remnant of the original forest left. *Synetheres* contains some eight or ten species, known as tree-porcupines, found throughout tropical South America, with one extending into Mexico. They are of a lighter build than the ground-porcupines, with short, close spines, often mixed with hairs, and prehensile tails. The hind-feet have only four toes, owing to the suppression of the first.

PORDENONE, IL (1483–1539), Italian painter of the Venetian school. He was born at Corticelli, near Pordenone, in Friuli. His real name was Giovanni Antonio de Sacchi. Vasari's statement that his family name was Licinio has been disproved. In 1535 King John of Hungary knighted him, and thenceforth he called himself Regillo. Il Pordenone was a pupil of Pellegrino di S. Daniele, of the Friulian school of painting, but the leading influence which formed his style was that of Giorgione, and in his early works, such as his fine altarpiece at Susegana and the frescoes in the Palace chapel of S. Salvatore, this influence is very apparent. His later work displays the influence of Correggio and Michelangelo. He executed many works at Pordenone, Spilimbergo, and elsewhere in Friuli. He worked in Treviso, Mantua, Genoa and Cremona. He was asked to execute large mural designs in Venetian palaces, and was so popular in Venice that he seems to have fancied himself the equal of Titian. On one occasion the senate gave him a commission in preference to the great master of Cadore. Unfortunately, his fresco work in Venice has perished. In 1529 he worked in Piacenza, where is one of his most celebrated pictures "St. Catherine disputing with the Doctors of Alexandria." By Hercules II. of Ferrara he was commissioned to execute a series of designs for tapestry illustrating the Odyssey. These were described in detail by Ridolfi but are no longer extant. That duke invited him to Ferrara, in 1538, to execute some work in perspective, but Pordenone died there soon after his arrival and was buried on Jan. 14, 1539. Of his pictures in the Venetian academy "The Glory of S. Lorenzo Giustiniani" is the most notable.

See C. Ridolfi, Le *Meraviglie dell' Arte* (edit. v. Hadeln, 1914–24).

PORDENONE, a town of the province of Udine, Venetia, Italy, 30 m. W. by S. of Udine on the railway to Treviso. Pop. (1936) 12,179 (town); 22,174 (commune). It was the birthplace of the painter generally known as Il Pordenone (*q.v.*). Paintings from his brush adorn the cathedral (which has a fine brick campanile), and others are preserved in the Gothic town hall. Cotton industries are active, also silk and pottery.

PORFIRIUS, PUBLILIUS OPTATIANUS, Latin poet, possibly a native of Africa, flourished during the 4th century A.D. He has been identified with Publilius Optatianus, who was *praefectus urbi* (329 and 333), and may have been a Christian. For some reason he had been banished, but having addressed a panegyric to the Emperor Constantine the Great, he was allowed to return. Twenty-eight poems are extant under his name, of which 20 were included in the panegyric. They have no value except as curiosities and specimens of perverted ingenuity. Some of them are squares, others represent in their shape a syrinx, an organ or an altar; while the 28th poem (the versus anacyclici) may be read backwards without any effect upon sense or metre. The best edition of the poem is by L. Müller (1877).

See O. Seeck, "Das Leben des Dichters Porphyrius," *Rhein. Mus.* (1908).

PORI, formerly Björneborg, a seaport of Finland in 61° 29' N., 21° 43' E., on the Kumo river, 18 m. from its harbours, Reposaari and Mantyluoto. Pop. (est. 1939) 21,201. It imports coal, coke and flour, and exports timber and timber products. The river is 9 ft. deep. The town has ship-repairing yards, but vessels larger than 300 or 400 tons have to be careened. Reposaari, the "town harbour," used only for local traffic, is usually icebound from December to March, Mantyluoto is the new harbour, equipped with cranes, railroad tracks, and quays for five large steamers, being ice-free until January.

PORIFERA, a phylum and class of the animal kingdom comprising the sponges (*q.v.*).

PORISM. *Porisms* is the title of a lost treatise by Euclid, the author of the Elements, for our knowledge of which we are indebted to the Collection of Pappus of Alexandria, who mentions it and gives a number of lemmas necessary for understanding it. Pappus states that the porisms of Euclid are neither theorems nor problems, but are in some sort intermediate; and they were regarded accordingly by many geometers, who looked merely at the form of the enunciation, as being actually theorems or problems, though the definitions given by the older writers showed that they better understood the distinction between the three classes of propositions. They regarded a theorem as directed to *proving* what is proposed, a problem as directed to constructing what is proposed and finally a porism as directed to finding what is proposed (εἰς πορισμὸν αὐτοῦ τοῦ προτεινομένου). Pappus goes on to say that this last definition was changed by certain later geometers, who defined a porism on the ground of an accidental characteristic as τὸ λεῖπον ὑποθέσει τοπικοῦ θεωρήματος, that which falls short of a locus-theorem by a (or in its) hypothesis.

Proclus points out that the word was used in two senses. One sense is that of corollary, a result unsought, but seen to follow from a theorem. On the *porism* in the other sense he adds nothing to the definition of the older geometers except to say that the finding of the centre of a circle and the finding of the greatest common measure are porisms (Proclus, ed. Friedlein, p. 301).

Pappus gives a complete enunciation of a porism derived from Euclid, and an extension of it to a more general case. This porism, expressed in modern language, asserts that—given four straight lines of which three turn about the points in which they meet the fourth, if two of the points of intersection of the three lines lie each on a fixed straight line, the remaining point of intersection will also lie on another straight line. The general enunciation applies to any number of straight lines, say $(n+1)$, of which n can turn about as many points fixed on the $(n+1)$th. These n straight lines cut, two and two, in $\frac{1}{2}n(n-1)$ points, $\frac{1}{2}n(n-1)$ being a triangular number whose side is $(n-1)$. If, then, they are made to turn about the n fixed points so that any $(n-1)$ of their $\frac{1}{2}n(n-1)$

points of intersection, chosen subject to a certain limitation, lie on (n—1) given fixed straight lines, then each of the remaining points of intersection, $\frac{1}{2}$ (n—1) (n—2) in number, describes a straight line. Pappus gives also a complete enunciation of one porism of the first book of Euclid's treatise. This may be expressed thus: If about two fixed points P, Q we make turn two straight lines meeting on a given straight line L, and if one of them cut off a segment AM from a fixed straight line AX, given in position, we can determine another fixed straight line BY, and a point B fixed on it, such that the segment BM' made by the second moving line on this second fixed line measured from B has a given ratio λ to the first segment AM. The rest of the enunciations given by Pappus are incomplete, and he merely says that he gives thirty-eight lemmas for the three books of porisms; and that these include 171 theorems.

The lemmas which Pappus gives in connection with the porisms are interesting historically, because he gives (1) the fundamental theorem that the cross or anharmonic ratio of a pencil of four straight lines meeting in a point is constant for all transversals; (2) the proof of the harmonic properties of a complete quadrilateral; (3) the theorem that, if the six vertices of a hexagon lie three and three on two straight lines, the three points of concourse of opposite sides lie on a straight line.

During the last three centuries many geometers have attempted to restore the lost porisms. The geometer P. de Fermat (1601–65) wrote a short work under the title *Porismatum euclidaeorum* renovata doctrina et sub *forma* isagoges recentioribus geometris exhibita (see Oeuvres de Fermat, i., 1891); but two at least of the five examples of porisms which he gives do not fall within the classes indicated by Pappus. Robert Simson was the first to throw real light upon the subject. He first succeeded in explaining the only three propositions which Pappus indicates with any completeness (Phil. Trans., 1723). Later he investigated the subject of porisms generally in a work entitled De *porismatibus tractatus;* quo doctrinam *porismatum satis* explicatam, et in *posterum* ab *oblivione* tutam fore *sperat auctor*, and published after his death in a volume, *Roberti Simson opera quaedam reliqua* (Glasgow, 1776). Simson's treatise, De *porismatibus,* begins with definitions of theorem, problem, datum, porism and locus.

Respecting the porism Simson says that Pappus's definition is too general, and therefore he will substitute for it the following: "Porisma est propositio in qua proponitur demonstrare rem aliquam vel plures datas esse, cui vel quibus, ut et cuilibet ex rebus innumeris non quidem datis, sed quae ad ea quae data sunt eandem habent relationem, convenire ostendendum est affectionem quandam communem in propositione descriptam. Porisma etiam in forma problematis enuntiari potest, si nimirum ea quae data demonstranda sunt, invenienda proponantur." A locus (says Simson) is a species of porism. Then follows a Latin translation of Pappus's note on the porisms, and the propositions which form the bulk of the treatise. These are Pappus's thirty-eight lemmas relating to the porisms, ten cases of the proposition concerning four straight lines, twenty-nine porisms, two problems in illustration and some preliminary lemmas.

John Playfair's memoir (*Trans. Roy. Soc. Edin.,* 1794), a sort of sequel to Simson's treatise, had for its special object the inquiry into the probable origin of porisms. Playfair remarked that the careful investigation of all possible particular cases of a proposition would show that (1) under certain conditions a problem becomes impossible, (2) under certain other conditions, indeterminate or capable of an infinite number of solutions. These cases could be enunciated separately, were in a manner intermediate between theorems and problems and were called "porisms." Playfair accordingly defined a porism thus: "A proposition affirming the possibility of finding such conditions as will render a certain problem indeterminate or capable of innumerable solutions." Though this definition of a porism appears to be most favoured in England, Simson's view has been most generally accepted abroad, and has the support of the great authority of Michel Chasles.

In *Liouville's* Journal *de mathématiques pures* et *appliquées* (1855), P. Breton published Recherches nouvelles sur les porismes *d'Euclide,* in which he gave a new translation of the text of Pappus, and sought to base thereon a view of the nature of a porism more closely conforming to the definitions in Pappus. This was followed in the same journal and in La Science by a controversy between Breton and A. J. H. Vincent, who disputed the interpretation given by the former of the text of Pappus, and declared himself in favour of the idea of F. van Schooten, put forward in his *Mathematicae exercitationes* (1657), in which he gives the name of "porism" to one section. According to Schooten, if the various relations between straight lines in a figure are written down in the form of equations or proportions, then the combination of these equations in all possible ways, and of new equations thus derived from them, leads to the discovery of innumerable new properties of the figure, and here we have porisms. These discussions, however, did not carry forward the work of restoring Euclid's Porisms, which was left ior Chasles. His work (Les Trois *livres* de porismes *d'Euclide,* 1860) makes full use of all the material found in Pappus, but we may doubt its being a successful reproduction of Euclid's actual work. An interesting hypothesis as to the Porisms was put forward by H. G. Zeuthen (Die Lehre von den Kegelschnitten im Alterturn, 18863. Observing, *e.g.,* that the intercept-Porism is still true if the two fixed points are points on a conic, and the straight lines drawn through them intersect on the conic instead of on a fixed straight line, Zeuthen conjectures that the Porisms were a by-product of a fully developed projective geometry of conics. It is a fact that Pappus's Lemma 31 (though it makes no mention of a conic) corresponds exactly to Apollonius's method of determining the foci of a central conic (Conics, iii. 45–47 with 42).

The three porisms stated by Diophantus in his *Arithmetica* are propositions in the theory of numbers which can all be enunciated in the form "we can find numbers satisfying such and such conditions"; they are sufficiently analogous therefore to the geometrical porism as defined in Pappus and Proclus.

BIBLIOGRAPHY.—A. Richter, Porismen nach Simson bearbeitet (Elbing, 1837); M. Cantor, "Ueber die Porismen des Euklid und deren Divinatoren," in *Schlömilch's* Zeitsch. f. Math. *u.* Phys. (1857), and *Literaturzeitung* (1861); T. Leidenfrost, *Die Porismen des Euklid* (Programm der Realschule zu Weimar, 1863); F. Buchbinder, Euclids Porismen und Data (Programm der kgl. Landesschule Pforta, 1866); J. L. Heiberg, Litterargeschichtliche Studien *über* Euklid (Leipzig, 1882).

(T. L. H.)

PORK is the flesh of swine, fresh or salted, used for food. Although a large proportion of pig-meat is consumed in the form of bacon or ham, a greater proportion is consumed in an uncured state, as pork (*see* BACON).

POROS or PORO ("the Ford"), Greece, an island off the east coast of the Morea, separated at its western end by a narrow channel from the mainland at Troezen, and consisting of masses of limestone and trachyte connected by a sandy isthmus. The harbour town faces S. toward the mainland. The English, French, and Russian plenipotentiaries met at Poros in 1828 to discuss the basis of the Greek government.

The ancient Calauria, with which Poros is identified, was traditionally given by Apollo to Poseidon in exchange for Delos; and in historic times was famous for a temple of the latter, the centre of an amphictyony of maritime states—Hermione, Epidaurus, Aegina, Athens, Prasiae, Nauplia, and Orchomenus, the distribution and legends of which suggest that their association goes back to Minoan times. Here Demosthenes took sanctuary with "gracious Poseidon," and, when this threatened to fail him, sought death. The temple of Doric architecture, excavated in 1894, lay on a ridge commanding a view of Athens and the Saronic Gulf. Traces also of porticoes and other buildings remain.

See Chandler, Travels; Leake, Morea; Le Bas, Voyage *archéologique;* Curtius, *Peloponnesos;* Pouillon-Boblaye, *Recherches;* Bursian, *Geographie von Griechenland;* Rangabé "Ein Ausflug nach Poros," in Deutsche Revue (1883); and S. Wide, in Mitteilungen d. *deutsch. Inst. Athen.* (1895), vol. xx.

PORPHYRIO, POMPONIUS, Latin grammarian and commentator on Horace, possibly a native of Africa, flourished during the 2nd century A.D. (according to others, much later). His scholia on Horace, which are still extant, mainly consist of rhetorical and grammatical explanations. It is probable that the *scholia* have been much altered by copyists.

See edition of the *Scholia* by A. Holder (1894). *See* also C. F. Urba, *Meletemata porphyrionea* (1885); E. Schweikert, *De Porphyrionis . . . scholiis Horatianis* (1865); F. Pauly, *Quaestiones criticae* de . . . *Porphyrionis commentariis Horatianis* (1858).

PORPHYRY (Πορφύριος) (A.D. 233–*c.* 304), Greek scholar, historian, and Neoplatonist, was born at Tyre, or Batanaea in Syria. He studied grammar and rhetoric under Cassius Longinus (*q.v.*). His original name was Malchus (king), which was changed by his tutor into Porphyrius (clad in purple), a jesting allusion to the colour of the imperial robes. In 262 he went to Rome, attracted by the reputation of Plotinus, and for six years devoted himself to the study of Neoplatonism. Having injured his health by overwork, he went to live in Sicily for five years. On his return to Rome, he lectured on philosophy and endeavoured to render the doctrines of Plotinus intelligible to the ordinary understanding. His most distinguished pupil was Iamblichus. When advanced in years he married Marcella, a widow with seven children and an enthusiastic student of philosophy. Nothing more is known of his life, and the date of his death is uncertain.

Of his numerous works on a great variety of subjects the following are extant: *Life of Plotinus* and an exposition of his teaching in the Ἀφορμαὶ πρὸς τὰ νοητά (*Sententiae ad intelligibilia ducentes,* Aids to the study of the Intelligibles). The *Life of Pythagoras,* which is incomplete, probably formed part of a larger history of philosophy down to Plato. His work on Aristotle is represented by the *Introduction* (εἰσαγωγή) to and *Commentary* (ἐξήγησις, in the form of questions and answers) on the *Categories.* The first, translated into Latin by Boetius, was extensively used in the middle ages as a compendium of Aristotelian logic; of the second only fragments have been preserved. His Χρονικά, a chronological work, extended from the taking of Troy down to A.D. 270. Other grammatical and literary works are Ὁμηρικὰ ζητήματα (*Quaestiones homericae*); and *De antro nympharum,* in which the description in the *Odyssey* (xiii. 102–112) is explained as an allegory of the universe. The Περὶ ἀποχῆς ἐμψύχων (*De abstinentia*), on abstinence from animal food, is especially valuable as having preserved numerous original statements of the old philosophers and the essence of Theophrastus' Περὶ εὐσεβείας (*On Piety*). It also contains a long fragment from the *Cretans* of Euripides. The Πρὸς Μαρκέλλαν is an exhortation to his wife Marcella to practise virtue and self-restraint and to study philosophy. The letter to the Egyptian priest Anebo, dealing with religious questions, was answered by a member of the school of Iamblichus, who called himself Abammon, in the *De mysteriis.* It is frequently referred to by Eusebius, Cyril and Augustine. Eusebius preserved fragments of the Περὶ τῆς ἐκ λογίων φιλοσοφίας (*De philosophia ex oraculis haurienda*), in which he expressed his belief in the responses of the oracles of various gods as confirming his theosophical views. Porphyry is well known as a violent opponent of Christianity and defender of Paganism; of his Κατὰ Χριστιανῶν (*Adversus Christianos*) in 15 books, perhaps the most important of all his works, only fragments remain. Porphyry's view of the book of Dsniel, that it was the work of a writer in the time of Antiochus Epiphanes, is given by Jerome. There is no proof of the assertion of Socrates, the ecclesiastical historian, and Augustine, that Porphyry was once a Christian.

BIBLIOGRAPHY.—There is no complete edition of the works of Porphyry. Separate editions: *Vita Plotini* in the *Enneades* of Plotinus (edit. R. Volkmann, 1883); *Sententiae* (edit. B. Mommert, Leipzig, 1907); *Vita Pythagorae, De antro nympharum, De abstinentia, Ad. Marcellam* (edit. A. Nauck, Leipzig, 1885); *Isagoge et in Aristotelis categorias commentarium* in *Commentaria in Aristotelem graeca* (edit. A. Busse, 188;); *Boethii in Isagogen Commenta* (edit. S. Brandt, Vienna, 1906); fragments of the *Chronica* in *Fragmenta historicorum graecorum* (edit. C. W. Müller, 1849); *Quaestiones homericae* (edit. H. Schrader, 1880, 1890); *Letter to Anebo* in Iamblichus, *De mysteriis* (edit. W. Pharthey, 1857); *De philosophia ex oraculis Haurienda* (edit. E. Wolff, 1856); fragments of the *Adversus Christianos* (edit. A. Georgiades, Leipzig, 1891); English trans., Thomas Taylor, *De abstinentia, De antro nympharum* and *Sententiae* (1823), *De antro nympharum* (new ed. 1917); T. Davidson, *Sententiae,* in *Journal of Speculative Philosophy* (vol. iii., 1869); S. Hibberd, *De abstinentia* (1857), and A. Zimmern, *Ad. Marcellam* (1896).

On Porphyry and his works generally, *see* J. A. Fabricius, *Bibliotheca Graeca* (edit. Hailes, 1790–1809); article in *Suïdas* (edit. G. Bernhardy, 1853); Eurapius, *Lives of the Philosophers* (with Eng. trans. by W. C. Wright, 1922); Lucas Holstenius, *De vita et Scriptis Porphyrii* (Cambridge, 1655); M. N. Bouillet, *Porphyre, son rôle dans l'école neoplatonicienne* (1864); A. I. Kleffner, *Porphyrius der Neuplatoniker* (Paderborn, 1896); W. Christ, *Geschichte der griechischen Litteratur* (1898); J. E. Sandys, *History of Classical Scholarship* (1906); J. Bidey, *Vie de Porphyre* (Ghent, 1913). *See* also C. P. Mason in W. Smith, *Dict. of Greek and Roman Biography* (1849), and for philosophy, T. Whittaker, *The Neo-Platonists* (2nd ed., 1918) and NEO-PLATONISM.

PORPHYRY, in petrology, a beautiful red volcanic rock (Gr. πορφύρεος, Lat. *purpureus,* purple), which was much used by the Romans for ornamental purposes when cut and polished. The famous red porphyry (*porfido rosso antico*) came from Egypt, but its beauty and decorative value were first recognized by the Romans in the time of the emperor Claudius. It was obtained on the W. coast of the Red Sea, where it forms a dike 80 or go ft. thick. For a long time the knowledge of its source was lost, but the original locality has been re-discovered at Jebel Dhokan, and the stone is again an article of commerce. In a dark red ground-mass it contains many small white or rose-red plagioclase felspars, black shining prisms of hornblende, and small plates of iron oxide. The red of the felspars and of the ground-mass is unusuaf in rocks of this group, and arises from the partial conversion of the plagioclase felspar into thulite and manganese-epidote. These minerals also occur in thin veins crossing the rock. Many specimens show effects of crushing and in extreme cases this has produced brecciation.

Many igneous rocks possess the scattered crystals of larger size in a fine-grained ground-mass which characterize the porphyries (*see* PETROLOGY), and most lavas and many of the rocks which occur as dikes and sills have porphyritic structure. The use of the term porphyry is now restricted to a series of rocks which are of intrusive origin and contain much porphyritic felspar (with or without quartz or nepheline). The porphyritic intrusive rocks with large crystals of augite, olivine, biotite and hornblende are for the most part grouped under the lamprophyres. Furthermore, it has become usual to subdivide the porphyries into two classes; in one of these the phenocrysts are mainly orthoclase, in the other mainly plagioclase felspar. The first series is known as the "porphyries," the second as the "porphyrites." There are porphyries which correspond chemically and mineralogically to granites, syenites and nepheline-syenites; while the porphyrites form a series parallel to the diorites, norites and gabbros. In each case the porphyritic type occurs generally as dikes and thin sheets which consolidated beneath the surface but probably at no great depth (hypabyssal rocks).

The principal subdivisions of the group are the granite-porphyries, the syenite-porphyries and the elaeolite-porphyries. In all of them porphyritic orthoclase or alkali felspar is the characteristic mineral. The granite-porphyries and quartz-porphyries consist mainly of orthoclase, quartz and ferro-magnesian mineral, usually biotite but sometimes hornblende, augite or enstatite. Granite-porphyries are exceedingly common in all regions where acid intrusive rocks occur. Many granite masses are surrounded by dikes of this kind, and in some cases the chilled margin of a granite consists of typical porphyry.

The syenite-porphyries, like the syenites, are less common than the granite-porphyries and granites. They are characterized by an abundance of orthoclase and a scarcity or absence of quartz. The phenocrysts are orthoclase (and oligoclase), biotite, hornblende or augite; the ground-mass is principally alkali felspar with sometimes a little quartz. In many specimens the felspars of the second generation form a mosaic of ill-shaped grains, in others they are little rectangular crystals which may have a fluxion arrangement (orthophyric type of ground-mass). Some of the rocks formerly known as orthoclase-porphyries belong to this group; others are ancient trachytic lavas (orthophyres). Closely related to the syenite-porphyries is the rhomb-porphyry of south Norway and West Africa. In these the large felspars have rhomb-shaped sections owing to their peculiar crystalline development. Olivine, augite and biotite occur in these rocks, but there is no quartz or soda-lime felspar. The porphyritic felspars contain both soda and potash and belong to anorthoclase. Rhomb-porphyries occur as dikes connected with the syenites (laurvikites of southern Norway), and many ice-borne boulders of these rocks have been found among the drift deposits of the east of England.

Elaeolite- and leucite- (syenite) porphyries form apophyses and dikes around nepheline- and leucite-syenite intrusions. The former contain porphyritic nepheline which is often weathered to soft, finely crystalline aggregates of white mica and other secondary products, as in the well-known liebenerite-porphyry of Tirol and gieseckite-porphyry of Greenland. The felspars of these rocks are albite, orthoclase and anorthoclase and they often contain soda-augite and amphiboles. Elaeolite-porphyries occur along with nepheline-syenites in such districts as the Serra de Monchique, south Norway, Kola, Montreal. Allied to them are the tinguaites (so called from the Serra de Tingua, Brazil), which are pale green rocks with abundant alkali felspar, nepheline, needles of green aegirine, and sometimes biotite and cancrinite. As a rule, however, these are not porphyritic. Grorudites are quartz-tinguaites free from nepheline, and solvsbergites are tinguaitic rocks in which neither quartz nor nepheline occur. The two last have been described from the Oslo district in Norway, but tinguaites are known with nepheline-syenites. in many parts of the world, *e.g.,* Norway, Brazil, Portugal, Canada, Sweden, Greenland.

The following analyses of porphyries of different types show the chemical composition of a few selected examples:—

	SiO_2	Al_2O_3	Fe_2O_3	FeO	MgO	CaO	K_2O	Na_2O	H_2O
I.	72·51	13·31	tr.	3·87	1·50	0·60	6·65	0·43	0·60
II.	67·18	16·65	0·55	2·15	1·54	2·35	2·91	4·03	0·75
III.	71·60	13·60	2·40	..	0·21	2·30	3·53	5·55	0·70
IV.	58.82	21·06	3.26	0·70	1·38	3·03	3·70	6.83	1·26
V.	45·18	23·31	6·11		1·45	4.62	11·16	5.94	1·14
VI.	54·46	19·96	2·34	3·33	0·61	2·12	8·68	2·76	5·20
VII.	75·20	12·65	1·53	0·28	0·26	0·60	4·14	5.67	0·12

I., Elvan or granite porphyry (with pinite after cordierite)—Prah Sands, Cornwall. II., Granophyre—Armboth, Cumberland. III., Granophyre—Carrock Fell, Cumberland. IV., Rhomb-porphyry—Tönsberg, Norway. V., Elaeolite-porphyry—Beemerville, New Jersey. VI., Tinguaite—Kola. VII., Grorudite—Assynt, Scotland.

Porphyrites.—The porphyrites as above mentioned are intrusive or hypabyssal rocks of porphyritic texture, with phenocrysts of plagioclase felspar and hornblende, biotite or augite (sometimes also quartz) in a fine ground-mass. The name has not always been used in this sense, but formerly signified rather decomposed andesitic and basaltic lavas of Carboniferous age and older. Both the red and green porphyry of the ancients are more properly classified in this group than with the granite-porphyries, as their dominant felspar is plagioclase and they contain little or no primary quartz. Porphyrites occur as dikes which accompany masses of diorite, and are often called diorite-porphyrites; they differ from diorites in few respects except their porphyritic structure. The phenocrysts are plagioclase, often much zoned, with central kernels of bytownite or labradorite and margins of oligoclase or even orthoclase. In a special group there are corroded blebs of porphyritic quartz: these are called quartz-porphyrites, and are distinguished from the granite-porphyries by the scarcity or absence of orthoclase. The hornblende of the porphyrites is often green but sometimes brown, resembling that of the lamprophyres, a group from which the porphyrites are separated by their containing phenocrysts of felspar, which do not occur in normal lamprophyres. Augite, when present, is nearly always pale green; it is not so abundant as hornblende. Dark brown biotite is very common in large hexagonal plates. The ground-mass is usually a crystalline aggregate of granular felspar in which plagioclase dominates, though orthoclase is rarely absent. Diorite-porphyrites have almost as wide a distribution as granite-porphyries, and occur in all parts of the world where intrusions of granite and diorite have been injected; they are in fact among the commonest hypabyssal rocks.

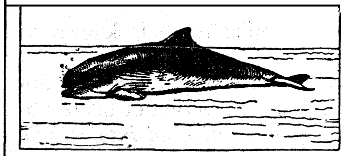
To gabbros and norites certain types of porphyrite correspond which have the same mineral and chemical composition as the parent rocks but with a porphyritic instead of granitic structure. Norite-porphyrites have porphyritic plagioclase (labradorite usually) with hypersthene or bronzite, often altered to bastite. They accompany norite masses in Nahe (Prussia) and Tirol.

	SiO_2	Al_2O_3	Fe_2O_3	FeO	CaO	MgO	K_2O	Na_2O	H_2O
I.	64.94	17·50	0·69	3.94	2·59	2.83	3·11	3.44	1·36
II.	61·58	18·84	4.68	..	6·59	2·04	1·49	4·27	1·61
III.	56·85	16·70	5·92	7·13	5·97	3·25	1·91	2·78	0·54

I., Quartz-porphyrite—Lippenhof, Schwarzwald. II., Porphyrite—Esterel, France. III., Norite-porphyrite—Klausen, Tirol.

(J. S. F.)

PORPOISE, the name often applied to all the smaller cetaceans, but properly restricted to the genus *Phocaena.* The porpoise attains a length of $5\frac{1}{2}$ft. The head is rounded in front, lacking the characteristic beak of the dolphins, and the under-jaw projects slightly. The wide mouth is bounded by stiff, immobile lips. The low dorsal fin is triangular. In colour the porpoise is black or dark grey above and white below, with black flippers. The shape of the porpoise's teeth is characteristic. The porpoise prefers bays, estuaries and coasts to the open sea and inhabits the North Atlantic, entering the Baltic in summer; but it is rare in the Mediterranean. It feeds on salmon, mackerel, pilchards and herrings. In former days it was a common article of food. The "porpoise-hide" of commerce is now obtained largely from the beluga (*q.v.*). A second species, which may, however, be merely a variety, inhabits the Black sea; one or, more probably, two other species inhabit the La Plata region. The Pacific porpoise is now placed in a separate genus. The allied *Neomeris phocaenoides* from the Indian ocean and Japan has no dorsal fin. (*See* CETACEA.)



BY COURTESY OF THE N.Y. ZOOLOGICAL SOCIETY

THE COMMON PORPOISE (PHOCAENA PHOCAENA)

Porpoise oil, obtained from the soft fat of the head and jaw of the common porpoise has recently come into general use as a lubricant in the manufacture of watches, clocks and other delicate mechanisms made of hard steel. Its value lies chiefly in the fact that it is free from a tendency either to gum or thicken by oxidation or to corrode metal, and in its ability to withstand exposure to very low temperatures without freezing or thickening to any great extent.

PORPORA, NICCOLA [or NICCOLO] **ANTONIO** (1686–1767), Italian operatic composer and teacher of singing, was born in Naples on Aug. 19, 1686. His first opera, *Basilio,* was produced at Naples; his second, *Berenice,* at Rome. Both were successful, and he followed them up by innumerable compositions of like character; but his fame rests chiefly upon his unequalled power of teaching singing. At the Conservatorio di Sant' Onofrio and the Poveri di Gesu Cristo he trained Farinelli, Caffarelli, Mingotti, Salimbeni, and other celebrated vocalists. Unfortunately no written account of his method exists; all that remains is the tradition as handed down by his pupils. In 1725 Porpora visited Vienna, but the Emperor Charles VI. disliked his florid style, especially his constant use of the *trillo.* He then settled in Venice, teaching regularly in the schools of La Pietà and the Incurabili. In 1729 he was invited to London as a rival to Handel; but his visit was unfortunate. Little less disastrous was his second visit to England in 1734, when even the presence of his pupil, the great Farinelli, failed to save from ruin the dramatic company of Lincoln's Inn Fields theatre, set up in opposition to that directed by Handel. The sequence of dates and visits in Porpora's life are variously stated by different biographers. The electoral prince of Saxony and king of Poland had invited him to Dresden to become the singing master of the electoral princess, Maria Antonia, and in 1748 he is supposed to have been made Kapellmeister to the prince. Difficult relations, however, with Hasse and his wife resulted in his departure, of which the date is not known. From

Dresden he is said to have gone to Vienna, where he gave lessons to Joseph Haydn (*q.v.*), and then to have returned some time between 1755 and 1760 to Naples. From this time Porpora's career was a series of misfortunes. His last opera, *Camilla,* failed; and he became so poor that the expenses of his funeral were paid by subscription.

PORRENTRUY (1,400 ft.), a town in the northern or French speaking part of the canton of Berne, Switzerland, a station on the railways Basle-Delémont Delle and Altkirch-Mulhouse. It has famous schools and is an industrial centre with 2,348 inhabitants the great majority of whom are Roman Catholics. The castle overlooking the town was once the residence of the bishop of Basle. Population of commune (1930) 5,805.

PORSENA (or PORSENNA), **LARS,** king of Clusium in Etruria. He is said to have undertaken an expedition against Rome in order to restore the banished Tarquinius Superbus to the throne. He gained possession of the Janiculum, and was prevented from entering Rome only by the bravery of Horatius Cocles (*q.v.*). Porsena then laid siege to the city, but was so struck by the courage of Mucius Scaevola that he made peace on condition that the Romans restored the land they had taken from Veii and gave him 20 hostages. He subsequently returned both the land and the hostages (Livy, ii. 9–15; Dion. Halic., v. 21–34; Plutarch, *Poplicola,* p. 16–19). This story is probably an attempt to conceal a great disaster. According to other authorities, the Romans were obliged to surrender the city, to acknowledge Porsena's supremacy, to abandon their territory north of the Tiber, to give up their arms, and in future to use iron for agricultural purposes only. It is curious that, in spite of his military success, Porsena made no attempt to restore the Tarquinian dynasty. Hence it is suggested that the attack on Rome was merely an incident of the march of the Etruscans, driven southward by the invasion of upper Italy by the Celts, through Latium on their way to Campania. This would account for its transitory effects, and the speedy recovery of the Romans from the blow. With the departure of Porsena all traces of Etruscan sovereignty disappear *(see* Tacitus, *Hist.* iii. 72; Pliny, *Nat. Hist.* xxxiv. 39 [14]; Dion. Halic. v. 3j, 36, vii. 5). The tomb at Chiusi described by Pliny (*Nat. Hist.* xxxvi. 19) as that of Porsena cannot have been his burial-place *(see* CLUSIUM).

For a critical examination of the story, *see* Schwegler, *Römische Geschichte,* bk. xxi. 18; Sir G. Cornewall Lewis, *Credibility of Early Roman History,* ch. xii. 5; W. Ihne, *Hist. of Rome,* vol. *i.; E.* Pais, *Storia di Roma,* i. ch. iv. (1898). Macaulay's *Lays of Ancient Rome* gives a dramatic version of the story.

PORSON, RICHARD (1759–1808), English classical scholar, was born on Dec. 25, 1759, at East Ruston, in Norfolk, of humble parents. After attending the village school, he was entered on the foundation of Eton in 1774, and in 1778, through the generosity of Sir George Baker, the physician, entered Trinity college, Cambridge, of which he became a fellow four years later. The publication of his *Notae breves ad Toupii emendationes in Suidam* in 1790 established his fame as a scholar. During the same year, in the *Gentleman's Magazine,* he wrote the three letters on Hawkins's *Life* of *Johnson,* which have been reprinted in Kidd's *Tracts and Criticisms of Porson,* and in a volume of Porson's *Correspondence.* They are admirable specimens of his dry humour, and prove his intimate acquaintance with Shakespeare and the other English dramatists and poets. In the same periodical, in the course of 1788 and 1789, the *Letters to Archdeacon Travis, on the spurious verse i. John v. 7* (collected in 1790 into a volume), written in defence of Gibbon, had appeared. In 1792, his fellowship being no longer tenable by a layman, Porson moved to London, but in November of the same year was elected to the Greek professorship at Cambridge. Apart from his duties, the tragedians, Aristophanes, Athenaeus, and the lexicons of Suidas, Hesychius and Photius occupied most of his time.

In 1795, the year of his marriage to Mrs. Luman, appeared his anonymous edition of *Aeschylus* in folio, and in 1806 a small edition, also anonymous; these have formed the substratum for all subsequent editions. After his 1797 edition of the *Hecuba* of Euripides he published the *Orestes* in 1798 the *Phoenissae* in 1799 and the *Medea* in 1801, the last with his name on the title-page. Meanwhile he collated the Harleian ms. of the Odyssey for the Grenville *Homer* issued in 1801. When the London Institution was founded in 1806, he was appointed principal librarian. Porson died on Sept. 19, 1808.

In learning he was superior to Valckenaer, in accuracy to Bentley. His minute collations of mss. and his brilliant emendations marked a great advance in Greek scholarship, though in his day comparative philology scarcely existed.

See Barker, *Porsoniana* (London, 1852); Kidd, "Imperfect Outline of the Life of R.P.," prefixed to his collection of the *Tracts and Criticisms;* the *Life* by J. S. Watson (1861); *Dict. Nat. Biog.;* and J. E. Sandys, *History of Classical Scholarship,* ii. (1908). Porson's publications include: *Notae in Xenophontis anabasin* (1786); *Appendix to Toup* (1790); *Letters to Travis* (1790); *Aeschylus* (1795, 1806); *Euripides* (1797–1802); *Adversaria* (Monk and Blomfield, 1812); *Tracts and Criticism* (Kidd, 1815); *Aristophanica* (Dobree, 1820); *Notae in Pausaniam* (Gaisford, 1820); *Photii lexicon* (Dobree, 1822); *Notae in Suidam* (Gaisford, 1834); *Correspondence* (Luard, edited for the Cambridge Antiquarian Society, 1867). Dr. Turton's vindication appeared in 1827.

PORT: *see* PORT WINE; *see* also RULE OF THE ROAD AT SEA.

PORT ADELAIDE: *see* ADELAIDE.

PORTADOWN, market town, urban district, Co. Armagh, N. Ireland, on the river Bann and the G.N.R., 2j mi. W.S.W. of Belfast. Pop. (1937) 12.440. Area 1 2 sq.mi Linen and cotton are manufactured; there is considerable agricultural trade.

PORTAELS, JEAN FRANÇOIS (1818–1895), Belgian painter and teacher of art, was born at Vilvorde, Belgium, on April 30, 1818, and studied at the Brussels academy. In **1874** Portaels was appointed director of the academy of Brussels. His works include decorative paintings in the church of St. Jacques-sur-Caudenberg; biblical scenes and genre pictures, portraits, oriental scenes and pictures of fancy female figures, many of which are in the Brussels gallery. But it is as a teacher of art that Portaels is famous. He died at Brussels on Feb. 8, 1895.

See E. L. de Taeye, *Peintres belges contemporains.*

PORTAGE, a city of Wisconsin, U.S.A., 30 mi. N. of Madison, on the Wisconsin river; the county seat of Columbia county. It is at the western end of the ship canal connecting the Wisconsin and the Fox rivers; is on federal highways 16 and 51; and is served by the Chicago, Milwaukee, St. Paul and Pacific and the Soo Line railways. Pop. (1930) was 6,308; 1940 it was 7,016. It is a shipping point for dairy products, grain, tobacco, sandstone, granite, jasper and the products of its several manufacturing plants. As the Fox and the Wisconsin rivers are here only 2 mi. apart, this was the natural point for the portage on the route from Lake Michigan to the Mississippi. It was used by Radisson and Groseilliers in 1655 and by Marquette and Joliet in 1673. From about 1712 to 1743 the Fox Indians intermittently disputed the white man's right to passage. The first white settler (1793) was Lawrence Barth. In 1797 Jacques Vieau established a trading post here, which by 1820 was a thriving fur depot. A temporary military post was established by the United States during the Red Bird uprising (1827). Ft. Winnebago was begun in 1828. The canal was completed in 1856.

PORTAGE LA PRAIRIE, a port of entry and the chief city of Portage la Prairie county, Manitoba, Canada, 50 mi. W. of Winnipeg, on the Canadian Pacific and Canadian Northern railways at an altitude of 856 ft. above the sea. Pop. (1941) 7,187. The name had its origin in the fact that its situation on the Assiniboine is at the south end of a portage from Lake Manitoba used by the French fur traders.

PORTALEGRE, a Portuguese district and a city on the Lisbon-Madrid railway. City pop. (1930), 11,005. Portalegre is the Roman *Amaea* or *Ammaia,* and Roman and prehistoric remains have been discovered there. Pop., dist. (1940), 186,373.

PORTALIS, JEAN ÉTIENNE MARIE (1746–1807), French jurist, was born at Bausset in Provence on April 1, 1746. In 1778–81 he was one of the assessors or administrators of Provence. In November 1793, after the republic had been proclaimed, he came to Paris and was thrown into prison, being the brother-in-law of Joseph Jérôme Siméon, the leader of the Federalists in Provence. On being released he practised as a lawyer in Paris; and in 1795 he was elected by the capital to the *Conseil* *des Anciens,* becoming a leader of the moderate party opposed to the directory. As a leader of the moderates he was proscribed at the *coup d'état* of Fructidor, but he escaped to Switzerland, and did not return till Bonaparte became First Consul. Bonaparte made him a *conseiller d'état* in 1800, and then charged him, with F. D. Tronchet, Bigot de Préameneu, and Jacques de Maleville, to draw up the *Code Civil.* Of this commission he was the most industrious member, and many of the most important titles, notably those on marriage and heirship, are his work. In 1801 he was placed in charge of the department of *cultes* or public worship, and had the chief share in drawing up the provisions of the Concordat. He died at Paris on Aug. 25, 1807.

PORT ANGELES, a city of north-western Washington, U.S.A., on the Strait of Juan de Fuca, opposite Victoria, B.C., 60 mi. from the Pacific ocean at Cape Flattery and 90 mi. N.W. of Seattle; a port of entry and the county seat of Clallam county. It is on the Olympic Highway and is served by the Chicago, Milwaukee, St. Paul and Pacific and the Port Angeles Western railways, by auto-ferries and steamers to the cities on Puget sound, and by ocean steamship lines. Pop. (1940) 9,409. It is the gateway for the Olympic national park. The city fronts on Port Angeles Bay, a fine natural harbour, very deep, without a bar, rock or shoal. Mt. Angeles (7,000 ft.) is the immediate background, and beyond rise the peaks of the majestic Olympics, many of which are still unnamed and unexplored. Port Angeles has manganese mines, and manufactures lumber, shingles and paper. It was incorporated in 1890 and in 1921 adopted a commission form of government.

PORT ARTHUR, a city and harbour on Thunder bay, a northwestern arm of Lake Superior, Canada, and on the Canadian National and Canadian Pacific railways, and the Trans-Canada highway. The passenger and freight ships of the Great Lakes transportation systems meet the rail lines of western Canada there. The grain storage and shipment capacity is the largest on the continent. The city has large pulp and paper mills. There are gold mining plants in the tributary area to the northeast, and extensive and rich hematite iron ore deposits are tributary and under development to the west. Pop. (1941) 24.426. Drydock and shipbuilding are among the more important industries.

PORT ARTHUR (Ryojun), a harbour in S. Manchuria at southern extremity of the Liao-tung peninsula (38° 48' N. and 121° 20' E.)—the only part of the relatively short coast-line of Manchuria which is ice-free throughout the year. The town was given this name by Admiral Seymour when British forces were there in 1860. It occupies a particularly strong strategic position; commanding the entrance to the Gulf of Pechihli and the opposite peninsula of Shantung. Its main interest is historical. Until the Chino-Japanese War it was the chief Chinese naval arsenai, but in 1894 it fell to Japan which was, however, forced by the European Powers to retrocede it to China, along with the whole Liao-tung peninsula, almost immediately after the ratification of the Treaty of Shimonoseki. Russia was anxious to secure an ice-free Chinese port as a base for her Pacific fleet, and the capture of Kiaochow by the Germans in 1897 provided the necessary occasion for her to occupy with warships Port Arthur and Talienwan (Dairen). The British Government was "not opposed to the lease by Russia of an ice-free commercial port connected by rail with the Trans-Siberian Railway," but it was pointed out that "questions of an entirely different kind were opened if Russia obtained control of a military port in the neighbourhood of Peking." Russia, regarding Port Arthur as necessary for the protection of Talienwan, refused to change its status as a closed military port. In 1898 by agreement, Russia acquired from China the lease of the Liao-tung peninsula (including Port Arthur) for 25 years and the right to construct the branch railway from Harbin to Port Arthur and Talienwan. Subsequent events showed that Russia had been seeking a fortress rather than an ice-free port on the Pacific. Port Arthur was made an apparently impregnable stronghold and along with Talienwan accommodated 20.000 Russians by the end of 1899. During the Russo-Japanese War, it was the main strength of Russia and only fell to the Japanese after a terrific siege by land which cost Japan some 30–40,000 casualties. By the treaty of Portsmouth (1905) Port Arthur was transferred to Japan. As part of the famous Twenty-one demands in 1915 the Japanese lease of Kwantung and the railway as far as Changchun was extended to a period of 99 years. Port Arthur is at present the seat of Government of the Japanese leased territory of Kwantung, but its importance has diminished since it was the stronghold of Russian influence on the Pacific, and the chief town in South Manchuria, with a population of more than 42,000. The port, based on a fine natural harbour, entirely land-locked save on the south, is not now used as a naval base. A branch railway and excellent motor-road connect it with Dairen, the second port of China, and the real terminus of the South Manchuria Railway. The new town, dating from the Russian occupation, has been constructed on modern lines and is a popular summer resort because of its splendid beaches. Port Arthur has a population of 145,286, of whom 13,391 are Japanese. The town contains modern hotels and hospitals and advanced education facilities. *(See* Kwantung.)

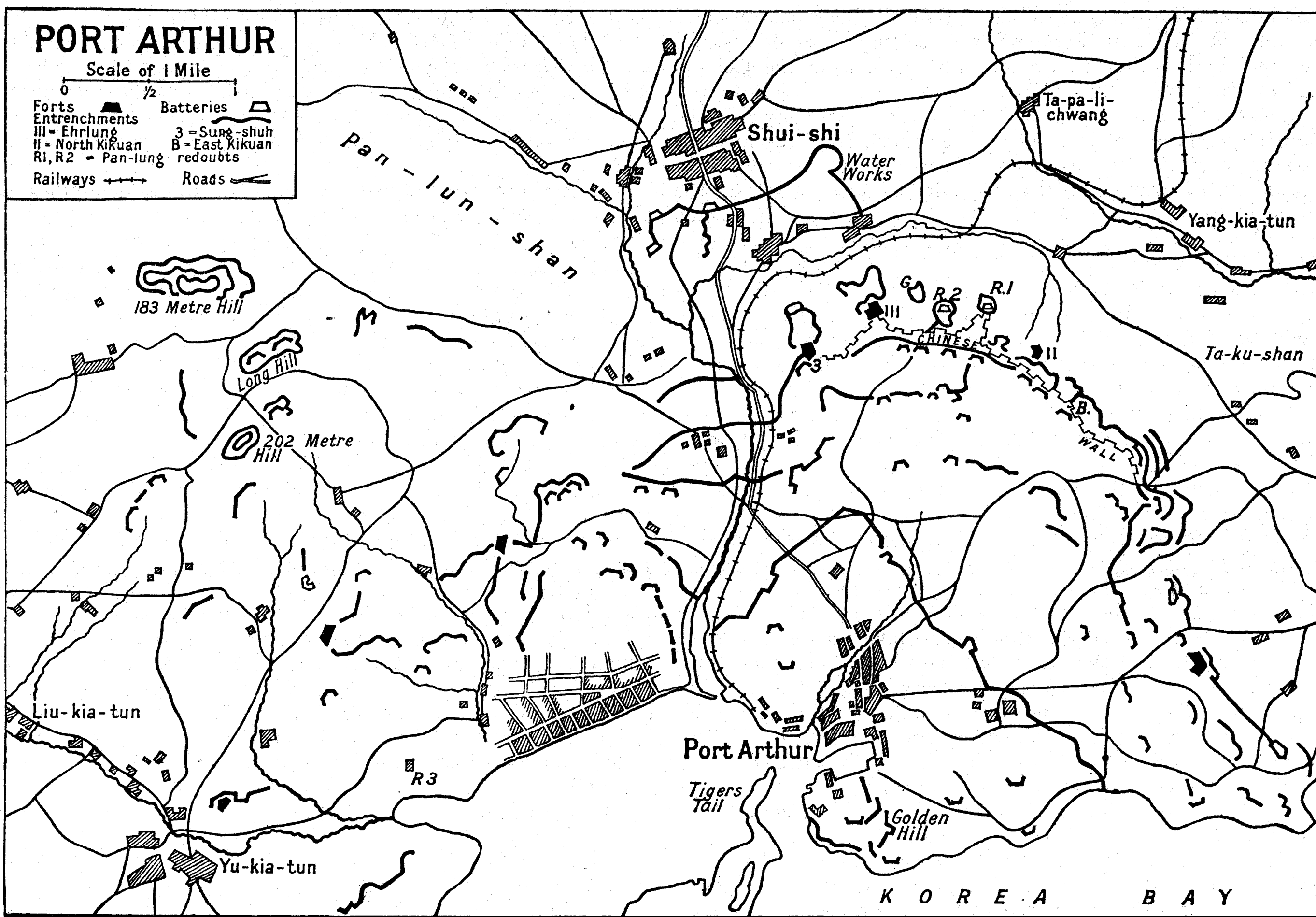
SIEGE OF PORT ARTHUR, 1904

While the fortunes of the siege of Port Arthur had undoubtedly a considerable influence on the outcome of the Russo-Japanese war (*q.v.*), its execution was separated both in space and design from the main operations of the field armies. The first clash of the armies took place on the Yalu on May 1, 1904, and five days later, Gen. Oku's 2nd Army, which had been waiting at Chinampo for the ice to melt, landed near Pitszewo. By storming Nanshan Hill, he gained command of the narrow isthmus which connected the Port Arthur peninsula with the mainland. This mission was a prelude not only to the siege, but to the 2nd Army's advance northward, its place being taken by the 3rd Army under Gen. Nogi.

Nogi landed on June 1, and his army (1st and 11th Divisions) gradually separated itself from Oku's and got into position for the advance on Port Arthur. Dalny, the commercial harbour, was seized without fighting, and a month was spent in preparing a base there. But so far from retiring within his fort-line, the Russian commander, Gen. Stossel took up a strong position outside. Dislodged from this on June 26, the Russians checked Nogi's further advance on July 3–4, by a fierce, though unsuccessful, counter-stroke. Having been reinforced by the 9th Division and two extra brigades of infantry, Nogi advanced again on the 26th. The Russians, having had a month wherein to intrench themselves, held out all along the line; but after two days and one night of fighting amongst rocks and on precipitous hill-sides, the Japanese broke through on the night of July 27–28. Stossel then withdrew in good order into Port Arthur, which, in the two months he had gained by his fighting manoeuvre, had been considerably strengthened. Nogi had already lost 8,000 men.

The defences of Port Arthur, as designed by the Russians in 1900, and owing to the meagre allotment of funds only partially carried out before the war, had some tincture, but no more, of modern continental ideas. The main line of defence followed the outer edge of the amphitheatre of hills surrounding the harbour. These hills had their greatest development on the north-east side, their outer crests being some 4,000yd. from the Old Town. Running south-west and south back to the coast, the line gradually drew in quite close to the south-west end of the harbour. The total length from sea to sea was some 12 miles. Its most obvious weakness was that 5,000yd. N.W. of the harbour and New Town, the now famous "203-Metre Hill" overlooked both. Here it had been intended to construct permanent works, but consideration of expenditure had caused this to be deferred.

The permanent works along the main line were supplemented before the siege began by a prodigious development of semi-permanent works and trenches. Every knoll had its redoubt or battery, and the trenches were arranged line behind line, to give supporting, cross and enfilade fire in every direction. On the north-west front, 203-Metre Hill, in advance of the main line, was occupied by strong, semi-permanent works, with trenches and redoubts on either flank. Wire entanglements were disposed in repeated lines in front of the defences, but they were not of a strong



type. The Russians, with the resources of the fleet at their disposal (just as at Sevastopol, in the Crimean War), used great numbers of machine guns and electric lights, and the available garrison at first was probably, including sailors, 47,000 men.

Such were the defences that the Japanese attacked, with a force at the outset (July 30) barely superior in numbers to the defenders, and an entirely inadequate siege train (18 6-in. howitzers, 60 4.7-in. guns and howitzers, and about 200 field and mountain guns). They were imperfectly informed of the strength of the garrison and the nature of the defences. Recollections of their easy triumph in 1894 and perhaps thoughts of Sevastopol, German theories of the "brusque attack," the fiery ardour of the army, and above all the need of rapidly crushing or expelling the squadron in harbour, combined to suggest a bombardment and general assault. The bombardment began on Aug. 19 and continued for three days, while the infantry was spreading along the front and gaining ground where it could. The real assault was made on the night of the 21st on the two Pan-Lung forts (semi-permanent) on the centre of the north-eastern front. Although the stormers captured the two forts they were unable to make any further progress under the fire of the permanent forts Erh-Lung and Chi-Kuan on either side of, and the Wan-tai fort behind, Pan-Lung. Every attempt to bring up support to the captured positions failed. On the night of the 23rd–24th, just as the assault was being renewed, Stössel delivered a fierce counter-attack against the lost positions, and the result of an all-night battle was that though the forts were not recaptured, the assault was repulsed with over 5,000 casualties, and the Japanese in Pan-Lung were isolated. This sortie raised the spirits of the Russians to the highest pitch. They seemed, indeed, to have broken the spell of defeat. On the Japanese side 15,000 men had been killed and wounded in three weeks, and their army had now to resign itself to a methodical siege. Small sorties, partial attacks[1] and duels between the Japanese guns and the generally more powerful ordnance of the fortress continued. The siege approaches were first directed against the Temple-Waterworks group, which was stormed on Sept. 19 and 20. Pan-Lung was connected with the Japanese lines by covered ways, approaches were begun towards several of the eastern forts, and on Sept. 20, 180-Metre Hill was stormed, though the crest was untenable under the fire from 203-Metre Hill. Further progress on the western side of the fortress was foiled after hard fighting, and the eastern forts remained the principal objective. Heavier howitzers had been sent for from Japan and on Oct. 1 the first batteries of 28-centimetre (11in.) howitzers came into action. They fired a shell weighing 48j lb. On the 12th, the Japanese took the trenches between the Waterworks Redoubt and the Erh-Lung, and from this time forward there was a desperate struggle at the sap-heads on the north front.[2] A lodgement on the counterscarp of Sung-Shu prepared the way for mining. On Nov. 17, seven mines were exploded.

On Nov. 26, another assault was made on the same lines as the earlier ones By this time the besiegers were sapping under the escarps of the northern forts, and it would have been better to delay. But the situation was serious in the extreme. In Manchuria Kuropatkin's army had reasserted itself. From Europe Rozhestvenski's squadron was just setting sail for the Far East. Marshal Oyama sent his principal staff officers to stimulate Nogi to fresh efforts, and some exhausted units of the besieging army were replaced by fresh troops from Japan. With 100,000 men and this urgent need of immediate victory, Nogi and the marshal's staff officers felt bound to make a third general assault. The siege works had, indeed, made considerable progress. The ditches of

[1]A feature of these constant night-fights was the effective use of the defenders' searchlight, both to show up the enemy and to blind him.

[2]Hand grenades and extemporized trench mortars were used on both sides with very great effect. The Japanese hand grenades consisted of about 1-lb. of high explosive in a tin case; the Russian cases were all sorts, including old Chinese shell The Japanese employed wire-netting screens to stop the Russian grenades. Various means were tried for the destruction of entanglements. Eventually it was found that the best plan was to sap through them.

Sung-Shu and Erh-Lung were partially filled. They held most of the ditch of Chi-Kuan Fort and were cutting down the escarp, and two parallels had been made only 30yd. from the Chinese Wall at Pan-Lung.

The general attack was made at 1 P.M. At Sung-Shu the stormers got into the fort, but suffered much from the artillery on the western side of the Lun-ho valley, and were beaten out of it again in 20 minutes; 2,000 men tried in vain to get up the Lun-ho valley to take Sung-Shu in rear. At Erh-Lung they could not get over the outer parapet. At "G" they took a portion of the Chinese Wall and lost it again, other trenches with a cross fire being behind. At Pan-Lung the machine guns on the Wall prevented them from leaving the parallel. At Chi-Kuan Fort the *terreplein* of the fort had been covered with entanglements defended by machine guns on the gorge parapets, and the Japanese could make no way. Briefly, there was a furious fight all along the line, and nothing gained. On Nov. 27, after losing 12,000 men, the assault was abandoned. On the north front the Japanese returned to mining.

But so urgent was the necessity of speedy victory that the fighting had to continue elsewhere. And at last, after every other point had been attempted, the weight of the attack was directed on 203-Metre Hill. A battery of 11-in. howitzers was established only one mile away. On Nov. 28 and 30, assaults were made and failed. On Dec. 1, there was a fresh bombardment by the big howitzers, which obliged the Russians to take shelter in rear of the ruined works. On Dec. 2, the Russians tried a counter-attack. During the next two days the artillery were busy. The engineers sapped up to the ruins of the western work, saw the shelters on the reverse slope and directed artillery fire by telephone. Thirty-six guns swept the grobnd with shrapnel. Finally, on Dec. 5, the Japanese attacked successfully. Their losses in the last 10 days at 203-Metre Hill had been probably over 10,000. Those of the Russians were about 5,000, chiefly from artillery fire.

This was the turning point of the siege. At once the 11-in. howitzers, assisted by telephone from 203-Metre Hill, opened upon the Russian ships; a few days later these were wholly hors de combat, and at the capitulation only a few destroyers were in a condition to escape. The siege was now pressed with vigour by the construction of batteries at and around 203-Metre Hill, by an infantry advance against the main western defences, and by renewed operations against the eastern forts. The escarp of Chi-Kuan was blown up, and at the cost of 800 men, General Sameyeda (11th Division), personally leading his stormers, captured the great fort on Dec. 19. The escarp of Ehr-Lung was also blown up, and the ruins of the fort were stormed by the 9th Division on Dec. 28th, though a mere handful of the defenders prolonged the fighting for eight hours and the assailants lost 1,000 men. Sung-Shu suffered a worse fate on the 31st, the greater part of the fort and its defenders being blown up, and on this day the whole defence of the eastern front collapsed. The Japanese 7th and 1st Divisions were now advancing on the western main line; the soul of the defence, the brave and capable Gen. Kondratenko, had been killed on Dec. 15, and though food and ammunition were by no means exhausted, Stössel surrendered on January 2, 1905, with 24,000 effective and slightly wounded and 15,000 wounded and sick men, the remnant of his original 47,000. The total losses of the 3rd Japanese Army during the siege were about 92,000 men (58,000 casualties and 34,000 sick).

PORT ARTHUR, a city of Jefferson county, Texas, U.S.A., in the south-eastern part of the state, on the west shore of Sabine Lake at the head of the Port Arthur canal, which leads to the Port Arthur docks (at the mouth of Taylors Bayou, 7 m. S.E.), and on the route of the intracoastal waterway from New Orleans to Corpus Christi. It is served by the Kansas City Southern and the Southern Pacific railways and by steamship lines.

The population was 22,251 in 1920, 76% native white, 6·4% foreign-born white, and 17·6% Negroes, and was, in 1940, 46,140 by the federal census.

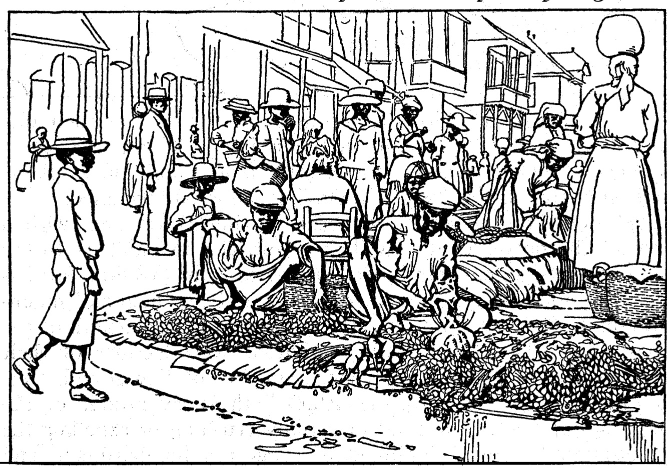
Port Arthur is a great oil-refining cenrre. The commerce of the port in 1939 amounted to 19,510,962 tons, valued at $249,710,-169, of which about 90% was petroleum and petroleum products. Port Arthur is a salt-water sport fishing centre.

PORTATIVE ORGAN, a small mediaeval organ, not to be confounded with the positive (or portable) organ (*q.v.*). These miniature organs, used during the 14th and 15th centuries, were revivals of those used by the Romans, of which a specimen excavated at Pompeii in 1876 is preserved in the museum at Naples.

The case measures 14½ in. by 9⅓ in. and contains nine pipes, of which the longest measures but 9¾ inches.

PORT AUGUSTA, at the head of Spencer gulf, an arm of the sea which penetrates far towards the interior of South Australia. This position lends Port Augusta a potential importance which, however, is somewhat impaired by a shallow approach and a channel which requires dredging. It is the natural port for the wheat-growing areas to the east, and for the pastoral areas to the north and north-west. Since the construction of the east to west trans-continental line (Perth-Brisbane), Port Augusta has become a break-of-gauge station. Pop. 3,270 (1933).

PORT AU PRINCE (originally *L'Hôpital,* and for brief periods Port *Henri* and Port *Républicain*), the capital of the Republic of Haiti, West Indies, situated about 1,400 mi. S. of New York city in 18° 33' N. and 74° 47' W. at the apex of the Gulf of La Gonaive which strikes inland for about 100 mi. between the two great peninsulas of the west coast, with its upper recesses protected by the beautiful island of Gonaive (30 mi. long and 2 mi. broad). Pop. (1940 estimate) 125,000 (mostly Negroes and mulattoes). Port au Prince is the seat of the University of Haiti with its schools of law, medicine, pharmacy, dentistry and nursing. It also has a number of seminaries maintained by religious organisations. Communication with the interior is maintained by two railway lines, by highways and by telephone and telegraph connections. The excellent harbour serves as a port of call for both American and European vessels participating in the West Indian trade. The city was first laid out by M. de la Cuza in 1749. In 1751, and again in 1770, it was destroyed by earthquakes; and in subsequent years, the city has been ravaged frequently by fire. (See HAITI.)



BY COURTESY OF THE U S. MARINE CORPS

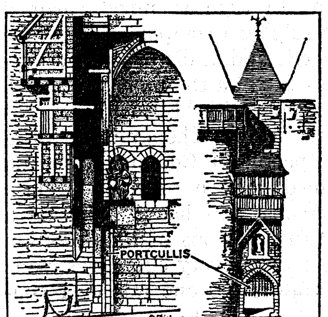
THE MARKET PLACE IN PORT AU PRINCE. CAPITAL OF HAITI, WEST INDIES

PORT AUTHORITY. For Great Britain the discussion of the constitution and powers of the different port authorities will be found in the articles on the various ports, *e.g.,* London, Liverpool, etc. The American Port Authority, in many respects peculiar, calls for special discussion. The American Association of Port Authorities issued, in April 1927, a port authorities directory for North America which indicated the adoption by an increasing number of American ports of some modification of the form of government established at European ports, notably at London and Liverpool. All facilities on the San Francisco water-front are owned by the State of California and operated by the board of State harbour commissioners. The State guarantees the bonds issued, the principal and interest of which are payable from harbour revenue. No funds are raised by taxation and the harbour has been self-supporting since its inception. Under the 1925 charter for the city of Los Angeles, the board of harbour commissioners has possession and control of the entire water-front. It may collect rates or charges for the use of facilities in connection with commerce and navigation, may acquire and operate such facilities and has power to regulate and control the construction, maintenance, operation or use of any such facility. An Act approved on March 14, 1911, authorizes the establishment of port districts in the various counties of the State of Washington, and the port of Seattle exists under this Act. It is a municipal corporation and has power to levy taxes and to issue bonds. It may acquire lands, etc. and exercise the right of eminent domain. Commissioners are elected. The port of Portland was established and incorporated by the laws of 1891. It has broad powers, among which are full control of the Willamette and Columbia rivers between Portland and the sea to the extent of the State's control, the right of eminent domain, the power to levy regular and special taxes on the property within the district and to bond the district to provide funds for carrying on its operations. The port of Houston, Texas, is operated by the navigation and canal commission. The board controls the commercial activities of the port and the maintenance and construction of the terminal facilities. A director of the port serves under the commissioners. The board of commissioners of the port of New Orleans was created by a Louisiana statute enacted in 1896. The board administers the public wharf system, has constructed and operates a public cotton warehouse, public grain elevator, public coal and bulk commodity handling plant and the great inner harbour navigation canal. The bond issues from Jan. 1, 1908, to Dec. 1, 1923, totalled $39,750,000, of which there had been redeemed as of Aug. 31, 1927, $980,000. The Virginia Assembly in 1926 created the State port authority of Virginia, superseding the Hampton Roads port commission. The board of harbour commissioners for the city of Wilmington, Del., an agency of the mayor and council of Wilmington, was created in 1917 by an Act of the General Assembly, which Act was amended in 1921 and 1925. In 1925 the commissioners were authorized to prepare a plan for the improvement of the water-front and to increase the harbour and shipping facilities of the city, and, after approval of the plan by the council, to proceed to acquire land, etc. The board was given authority to fix rates and charges for wharfage and other services rendered in the loading and unloading of vessels, as well as warehouse and storage charges. The Albany port district commission was created by the legislature of New York in 1925. It has broad powers to lease or construct and maintain and operate port facilities, to acquire real property, to contract with municipalities for the construction of port facilities, issue bonds, fix rates, charges and wharfage for the use of all port facilities and collect charges for facilities owned by the district. Provision for tax in the several municipalities in the port district is made.

The Port of New York is unique in that it is within the boundaries of two States, New York and New Jersey, each an independent sovereignty in its own land. As early as 1834 the two States found it necessary to enter into a treaty concerning the jurisdiction of each over the waters of the harbour. In 1917, in its decision in the New York harbour case, the interstate commerce commission said that "historically, geographically and commercially New York and the industrial district in the northern part of the State of New Jersey constitute a single community" and recommended that immediate steps be taken to reorganize and co-ordinate the terminal facilities at the port. In 1920, the New York-New Jersey port and harbour development commission, a bi-State commission appointed by the two States to study the problem, recommended the creation of a port authority and a port district. On April 30, 1921, the two States entered into a compact or treaty, creating the port of New York district and the port of New York authority. The consent of Congress to this treaty was given by joint resolution approved on Aug. 23, 1921. By the compact, the two States pledged, "each to the other, faithful co-operation in the future planning and development of the port of New York." The compact provided that the port authority should consist of six commissioners, three from each State, who should constitute a body, both corporate and politic, with full power and authority to purchase, construct, lease and operate any terminal or transportation facility within the port district; to own, hold, lease and operate real or personal property; to borrow money and secure the same by bonds or by mortgage upon any property held or to be held by it. No property held by any city, township or other municipality, or by either State, may be taken by the port authority without the consent of such owning body. The treaty provided for the adoption by the two States of a plan for the comprehensive development of the port. In 1922 the legislatures of both States adopted the comprehensive plan submitted and on July 1, 1922, the president of the United States approved the joint resolution of Congress granting its consent and authority to the port of New York authority to execute the comprehensive plan. Subsequent legislation adopted by the two States has authorized the construction of four bridges between the States. Two bridges across the Arthur Kill, opened to traffic in 1928, were financed by the sale of $14,000,000 port of New York authority $4\frac{1}{2}\%$ bonds. A total issue of $60,000,000 4% bonds has been authorized for the construction of the bridge over the Hudson river, between Ft. Washington, New York city, and Ft. Lee, N.J. It is expected that this bridge will be opened to traffic in 1932. Construction work on a bridge to span the Kill von Kull between Bayonne, N.J., and Port Richmond, Staten Island, N.Y., was begun in the summer of 1928. Four per cent. bonds to the amount of $12,000,000 have been issued in connection with this bridge. Redemption of the bonds and repayment of advances made by the States will be provided for out of tolls to be charged for the use of bridges. Construction of bridges forms only a small part of the port of New York authority's work and programme. It deals also with the problems of co-ordination of terminal facilities and of carfloating and lighterage arising out of the fact that most of the trunk-line railroads coming from the north and west have their terminals on the New Jersey shore of the Hudson river. It deals also with the problem of relieving the congestion of the valuable water-fronts of the Hudson, so as to leave them free for their appropriate use, that of shipping, rather than receipt and distribution of freight. The erection of union inland terminal freight stations is proposed as a means of lessening this congestion and reforming the handling of freight at the port. The port of New York authority acts also as spokesman and defender of the port's interests before the interstate commerce commission and other bodies. (J. H. Co.)

PORT BLAIR, the chief place in the Andaman islands convict settlement in the Indian ocean, situated on the south-east shore of the South Andaman island, in 11° 42' N., 93° E. It was first occupied by Lieut. Blair, R.N., in 1789, in order to suppress piracy and protect shipwrecked crews. Abandoned in 1796, it was not again occupied until 1856. It possesses one of the best harbours in Asia, while its position makes it an admirable naval rendezvous. (See ANDAMAN ISLANDS.)

PORT CHESTER, a village of Westchester county, New York, U.S.A., on Long Island sound, at the mouth of Byram river, 26 m. N.E. of the Grand Central station in New York city. It is on the Boston Post road, and is served by the New York, New Haven and Hartford railroad, interurban motorbus and truck lines. It is the largest village in New York state. Population (1940), 23,073 with 29% foreign-born white; 1930 by Federal census 22,662. It is a residential suburb, and has various manufacturing industries, with an output in 1937 valued at $12,021,204. The assessed valuation for 1941 was $44,583,575. During the Revolution the village was frequently occupied by American troops. Until 1837 Port Chester was known as Saw Pit. It was incorporated in 1868.



A PORTCULLIS: LEFT, A SECTIONAL VIEW SHOWING OPERATION; RIGHT. FRONT VIEW

PORTCULLIS, a strong-framed grating of wood, the lower points shod with iron, and sometimes entirely made of metal, counterbalanced, and hung so as to slide up and down in grooves, and intended to protect the gateways of castles, city gates, etc. The defenders having opened the gates and lowered the portcullis, could send arrows and darts through the gratings. The Romans used the portcullis in the defence of gateways. It was called *cataracta* from the Gr. *καταρράκτης*, a waterfall (*καταρρήγνυσθαι*, to fall down). Vegetius (De re *milit.* iv. 4) speaks of it as an old means of defence. Remains of a cataracta are clearly seen in the gateway of Pompeii.

PORTE, THE SUBLIME, in Turkey, the name once given to the government, derived from the high gate giving access to the building in Constantinople where the offices of the principal State departments were situated.

PORT ELIZABETH, a seaport 436 m. by sea E. of Cape Town, South Africa, in 33° 58′ S., 25° 37′ E. The white population increased from 26,303 in 1921 to 33,371 in 1926; in 1921 there were also 11,472 natives, 1,320 Asiatics and 13,203 coloured people. It is the third port of South Africa, and is situated on the shores of Algoa bay, to the east of Cape Recife.

Four distinct parts may be recognized: (1) the harbour and business quarter; (2) the "Hill," largely a residential part on the tableland overlooking the bay; (3) the "Valley," formed by the Baaken's river, and (4) the "South Hill," east of the river. Other suburbs have also grown up further from the town, such as Humewood, $1\frac{3}{4}$ m. along the shore.

The Harbour.—There is no enclosed basin, and shipping is rather exposed to the south-east winds. Schemes have been passed for the construction of a breakwater to provide an enclosed basin. There are three jetties provided with hydraulic cranes. The depths along side range from g to 24 feet. Larger vessels load and unload in the bay, by means of lighters, of which the port possesses 40, with a total capacity of 4,500 tons. Four refrigerating lighters were being constructed (1928) for the fruit export trade. The hinterland of Port Elizabeth for imports extends to Rhodesia. Its exports are mainly the products of the eastern part of the Cape Province, the most important being wool and mohair, and, until the World War, ostrich feathers. There is a growing export of fresh and tinned fruits.

History.—Algoa bay was discovered by Bartholomew Diaz in 1488. In 1754 the Dutch settlements at the Cape were extended eastward to this point. In 1799 Col. Vandeleur, after the British occupation of the Cape, built a small fort on the hill, west of the Baaken's river. By 1820, in addition to the troops, the civilian population had grown to 35. In April of that year arrived the first of the 1820 settlers. (See CAPE COLONY: History.) Under the supervision of Sir Rufane Donkin, a town was laid out at the foot of the hills. The real development of the port started when railways were constructed leading to the interior, Kimberley and the Witwatersrand. This work was begun in 1873, at the same time as the building of the existing jetties. Port Elizabeth is largely a British town.

PORTEOUS, JOHN (d. 1736), captain of the city guard of Edinburgh, whose name is associated with the riots of 1736, was the son of an Edinburgh tailor. Having served in the army, he was employed in 1715 to drill the city guard for the defence of Edinburgh in anticipation of a Jacobite rising, and was promoted later to the command of the force. In 1736 a smuggler named Wilson, who had won popularity by helping a companion to escape from the Tolbooth prison, was hanged; and, a disturbance occurring at the execution, the city guard fired on the mob. Porteous, who was said to have fired at the people with his own hand, was brought to trial and sentenced to death. The granting of a reprieve was hotly resented by the people of Edinburgh, and on the night of Sept. 7, 1736 an armed body of men in disguise broke into the prison, seized Porteous, and hanged him on a signpost in the street. It was said that persons of high position were concerned in the crime; but although every effort was made for the apprehension of the perpetrators, no one was ever convicted of participation in the murder.

See Sir Daniel Wilson, *Memorials of Edinburgh in the Olden Time* (2 vols., Edinburgh, 1848); *State Trials*, vol. xvii.; William Coxe, *Memoirs of the Life of Sir R. Walpole* (4 vols., London, 1816); Alexander Carlyle, *Autobiography* (Edinburgh, 1860), which gives the account of an eye-witness of the execution of Wilson; pamphlets (2 vols., in British Museum) containing *The Life and Death of Captain John Porteous*, and other papers relating to the subject,; W. E. H. Lecky, *History of England in the Eighteenth Century*, ii. 324, note (7 vols., London, 1892). *See* also Scott's notes to *The Heart of Midlothian.*

PORTER, DAVID (1780–1843), American naval officer, was born in Boston (Mass.), on Feb. 1, 1780. His father, David, and his uncle, Samuel, commanded American ships in the War of Independence. In 1796 he accompanied his father to the West Indies; on a second and on a third voyage he was impressed on British vessels, but he escaped. He became a midshipman in the U.S. Navy in April, 1798; served on the "Constellation" and was midshipman of the foretop when the "Constellation" defeated the "Insurgente"; was promoted lieutenant in October, 1799, and was in four successful actions with French ships in this year.

In 1803, during the war with Tripoli, he was first lieutenant of the "Philadelphia" when that vessel grounded; he was taken prisoner, and was not released until June, 1805. He was commissioned master commandant in April, 1806; from 1807 to 1810 he served about New Orleans, where he captured several French privateers, and in 1812 was promoted captain. He commanded the frigate "Essex" in her famous voyage (1812–14). In the Atlantic he captured seven brigs, one ship, on Aug. 13, 1812, the sloop "Alert," the first British war vessel taken in the War of 1812. Without orders from his superiors he then (February, 1813) rounded Cape Horn, and in the South Pacific captured many British whalers and took formal possession (November, 1813) of Nukahivah, the largest of the Marquesas islands. The United States, however, never asserting any claim to the island, it was in 1842, with the other Marquesas, annexed by France. During most of February and March, 1814, he was blockaded by British frigates in the harbour of Valparaiso, and on March 28 was defeated. Released on parole, he sailed for New York.

He was a member of the new board of naval commissioners from 1815 until 1823, when he commanded a squadron sent to the West Indies to suppress piracy. One of his officers, who landed at Fajardo (or Foxardo), Porto Rico, in pursuit of a pirate, was imprisoned by the Spanish authorities on the charge of piracy. Porter, without reporting the incident or awaiting instructions, forced the authorities to apologize. He was recalled (December, 1824), court-martialled, and suspended for six months. In August, 1826 he resigned his commission, and until 1829 was commander-in-chief of the Mexican navy, then fighting Spain. President Andrew Jackson appointed him consul general to Algiers in 1830, and in 1831 created for him the post of *chargk d'affaires* at Constantinople, where in 1841 he became minister. He died in Pera on March 3, 1843.

He wrote a *Journal of a Cruise made to the Pacific Ocean in the U.S. Frigate "Essex" in 1812–13–14* (1815; 2nd ed., 1822), and *Constantinople and its Environs* (1835), *a* valuable guide-book. *See* the *Memoir of Commodore David Porter* (Albany [N.Y.], 1875), by his son, Adniiral David D. Porter.

PORTER, DAVID DIXON (1813-IS~I), American naval officer, son of Capt. David Porter, was born in Chester (Pa.), on June 8, 1813. His first voyage, with his father in West Indian waters (1823–24), was terminated by the Fajardo affair (see PORTER, DAVID). In April, 1826, he entered the Mexican navy, of which his father was commander-in-chief, and which he left in 1828, after the capture by the Spanish of the "Guerrero," on which he was serving under his cousin, David H. Porter (1804–28), who was killed before the ship's surrender. He became a midshipman in the U.S. Navy in 1829, and was in the coast survey (1836–42). In 1839 he married the daughter of Capt. Daniel Tod Patterson (1786–1839), then commandant of the Washington Navy Yard. Porter became a lieutenant in Feb., 1841; served at the naval observatory from 1845 to 1846, when he was sent to the Dominican Republic to report on conditions there. During the Mexican War he served as lieutenant and then as commanding officer of the "Spitfire," a paddle vessel built for river use, and took part in the bombardment of Vera Cruz. In 1855 and in 1856 he made trips to the Mediterranean to bring to the U.S. camels for Army use in the south-west. In April, 1861, he was assigned to the "Powhatan," and was sent under secret orders from the President for the relief of Ft. Pickens, Pensacola. Porter was promoted commander on April 22, and on May 30 was sent to blockade the South-west pass of the Mississippi. Upon his return to New York in November, he urged an expedition against New Orleans (*q.v.*), and recommended the appointment of Commander D. G. Farragut (*q.v.*), his foster-brother, to the chief command.

In the expedition Porter himself commanded the mortar flotilla, which, when Farragut's fleet passed the forts on the early morning of April 24, 1862, covered the passage by a terrific bombardment that neutralized the fire of Ft. Jackson. At Vicksburg Porter's bombardment assisted Farragut to run past the forts (June 28). On July 9, Porter was ordered, with ten mortar boats, to the James river, where McClellan's army was concentrated. On Oct. 15 he took command of the gun-vessels and had a share in the capture of Arkansas Post (Jan. 11, 1863). In the operations for the capture of Vicksburg in 1863 unsuccessful attempts were made by Porter's vessels to penetrate through connecting streams and bayous to the Yazoo river and reach the right rear of the Confederate defences on the bluffs, but the fleet ran past the Vicksburg batteries, mastered the Confederate forts at Grand Gulf, and made it possible for Grant's army to undertake the bril-Rant campaign which led to the fall of the place (*see* AMERICAN CIVIL WAR and VICKSBURG). Porter received the thanks of Congress for "opening the Mississippi river" and was promoted rear admiral. He co-operated with Maj.-Gen. N. P. Banks in the Red river expeditions in March-May 1864, in which his gun boats, held above Alexandria by shallpw water and rapids, narrowly escaped isolation. On Oct. 12, 1864, he assumed command of the North Atlantic blockading squadron, then about to engage in a combined military and naval expedition against Ft. Fisher, N.C. Porter claimed that his guns silenced Ft. Fisher, but Maj.-Gen. B. F. Butler, in command of the land forces, refused to assault, asserting that the fort was practically intact. After Butler's removal, Porter, co-operating with Maj.-Gen. Alfred H. Terry, and commanding the largest fleet assembled at any one point during the war, took the fort on Jan. 15, 1865; for this he again received the thanks of Congress. From 1865 to 1869 he was superintendent of the U.S. Naval academy at Annapolis, which he greatly improved; his most notable change being the introduction of athletics. On July 25 he became vice admiral. From March 9 to June 25, 1869, while Adolph E. Borie (1809–80), of Pennsylvania, was secretary of the Navy in President Grant's cabinet, Porter was virtually in charge of the Navy department. In 1870 he succeeded Farragut in the grade of admiral. He died in Washington (D.C.), Feb. 13, 1891.

Porter wrote a *Life of Commodore David Porter* (1875), gossipy *Incidents and Anecdotes of the Civil War* (1885), a none too accurate *History of the Navy during the War of the Rebellion* (1887), two novels, *Allan Dare* and *Robert le Diable* (1885; dramatized, 1887) and *Harry Marline* (1886), and a short "Romance of Gettysburg," published in *The Criterion* in 1903. *See* J. R. Soley, *Admiral Porter* (1903).

Admiral Porter's three brothers were in the service of the United States: WILLIAM DAVID PORTER (1809–1864) commanded the "Essex" on the Tennessee and the Mississippi in the Civil War, and became commodore in July, 1862; THEODORIC HENRY PORTER (1817–1846) was the first officer of the American Army killed in the Mexican War; and HENRY OGDEN PORTER (1823–1872) resigned from the United States Navy in 1847, after seven years' service, fought under William Walker in Central America, returned to the American Navy, was executive officer of the "Hatteras" when she was sunk by the "Alabama," and received wounds in the action from the effects of which he died several years later.

PORTER, ENDYMION (1587–1649), English royalist, born at Aston-sub-Edge in Gloucestershire, was brought up in Spain—where he had relatives—as page in the household of Olivares. He afterwards entered successively the service of Edward Villiers and of Buckingham, and through the latter's recommendation became groom of the bedchamber to Charles I., who employed him on diplomatic business. During the Civil War Porter remained a faithful servant of the king.

At the end of 1645, when the cause of the king was finally lost, Porter abandoned England, and resided successively in France, Brussels, where he was reduced to great poverty, and the Netherlands. He returned to England in 1649, after the king's death, and was allowed to compound for what remained of his property. He died shortly afterwards, and was buried on Aug. 20, 1649, at St. Martin's-in-the-Fields. Porter had a great reputation in the world of art and letters. He wrote verses, was a generous patron of Davenant, who especially sings his praises, of Dekker, Warmstrey, May, Herrick and Robert Dover, and was included among the 84 "essentials" in Bolton's "Academy Royal." He was a judicious collector of pictures, and as the friend of Rubens, Van Dyck, Mytens and others painters, and as agent for Charles in his purchases abroad he had a considerable share in forming the king's magnificent collection. He was also instrumental in procuring the Arundel pictures from Spain. The authorship of **Εἰκὼν πιστή**, 1649, a vindication of the Εἰκὼν βασιλική, has been attributed with some reason to Porter.

AUTHORITIES.—*Life and Letters of Endymion Porter*, by D. Townshend (1897); article in the *Dict. of Nat. Biog.*, by C. H. Firth and authorities there cited; *Memoires*, by D. Lloyd (1668), p. 657; Burton's *Hist. of Scotland* (1873), vi. 346–347; *Eng. Hist. Rev.* ii. 531, 692; Waters, *The Chesters of Chichele*, vol. i., 144–149; *Eikon Basilike*, by Ed. Almack, p. 94.

PORTER, FITZ-JOHN (1822–1901), American soldier, was born at Portsmouth (N.H.) on Aug. 31,1822. He was the son of a naval officer, and nephew of David Porter of the frigate "Essex." He graduated at the U.S. Military academy in 1845; in the Mexican War he won two brevets for gallantry. He served at West Point as instructor and adjutant (1849–55), and at the outbreak of the Civil War in 1861 he was employed on staff duties in the eastern States. He became colonel of a new regiment of regulars on May 14, and soon afterwards brig.-general of volunteers. Under McClellan he commanded a division of infantry in the Peninsular campaign, directed the Union siege operations against Yorktown, and was soon afterwards placed in command of the V. Army Corps. When the Seven Days' battle (*q.v.*) began Porter's corps had to sustain alone the full weight of the Confederate attack, and though defeated in the desperately fought battle of Gaines's Mill (June 27, 1862) the steadiness of his defense was so conspicuous that he was immediately promoted maj.-general of volunteers and brevet brig.-general. His corps, moreover, had the greatest share in the successful battles of Glendale and Malvern Hill. Soon afterwards, the V. Corps was sent to reinforce Pope in central Virginia. Its inaction on the first day of the disastrous second battle of Bull Run (*q.v.*) led to the general's subsequent disgrace; but it made a splendid fight on the second day to save the army from complete rout, and shared in the Antietam campaign.

On the same day on which McClellan was relieved from his command, Porter, his friend and supporter, was suspended and tried by court-martial on charges brought against him by Pope. On Jan. 21, 1863, he was sentenced to be cashiered "and for ever disqualified from holding any office of trust under the Government of the United States." In 1878 Porter's friends succeeded in procuring a revision of the case by a board of distinguished general officers. General Grant had now taken Porter's part, and wrote an article in vol. 135 of the *North American Review* entitled "An Undeserved Stigma." Against much opposition, a, relief bill finally passed Congress, and Porter was on Aug. 5, 1886, restored to the United States army as colonel and placed on the retired list, without compensation. After the Civil War he was engaged in business in New York, and held successively many important municipal offices. In 1869 he declined the offer made by the khedive of the chief command of the Egyptian Army. He died on May 21, 1901, at Morristown (N.J.).

See, besides General Grant's art., Cox, *The Second Battle of Bull Run as connected with the Porter Case* (Cincinnati, 1882); Lord, *A Summary of the Case of F. J. Porter* (1883), and papers in vol. ii. of the pub. of the Military Hist. Soc. of Mass.

PORTER, HENRY (*fl.* 1596–1599), English dramatist, author of *The Two Angry Women of Abingdon*, may probably be identified with the Henry Porter who matriculated at Brasenose

College, Oxford, on June 19, 1589. From 1596 to 1599 he was writing plays for Henslowe for the Admiral's Men, and his closest associate seems to have been Henry Chettle. None of the plays mentioned by Henslowe as being written by him are extant, unless, as has been suggested, *Love Prevented* is another name for *The Pleasant History of the Two Angry Women of Abingdon* of which Gayley says: "No play preceding or contemporary yields an easier conversational prose, not even the *Merry Wives.*"

Alexander Dyce edited the *Angry Women* for the Percy Society in 1841; and it is included in W. C. Haalitt's edition of Dodsley's *Old Plays* (1874). It was edited by Havelock Ellis in *Nero and other plays* (1888, "Mermaid Series,") and in *Representative English Comedies* (1903), with an introduction by the general editor, Professor C. M. Gayley.

PORTER, HORACE (1837–1921), American diplomatist and soldier, was born in Huntingdon, Pa., on April 15, 1837; son of David Rittenhouse Porter (1788–1867), governor of Pennsylvania in 1839–45. During the Civil War he served in the Army of the Potomac until after Antietam; took part in the battles of Chickamauga and Chattanooga; and in April, 1864, became aide-de-camp to Gen. Grant, in which position he served until March 1869. From Aug. 1867 to Jan. 1868, while Gen. Grant was secretary of war *ad interim,* Porter was an assistant secretary, and from March 1869 to Jan. 1873, when Grant was president, Porter was his executive secretary. He resigned from the army in Dec. 1873, when he became vice president of the Pullman Palace Car Company and held other business positions. From March 1897 to May 1905 he was United States ambassador to France. At his personal expense he conducted (1899–1905) a successful search for the body of John Paul Jones, who had died in Paris in 1792. For this he received (May 9, 1906) a unanimous vote of thanks of both Houses of Congress. In 1907 he was a member of the American delegation to the Hague Peace conference. He died in New York city on May 29, 1921. His publications include *West Point Life* (1866) and *Campaigning with Grant* (1897).

PORTER, JANE (1776–1850), British novelist, daughter of an army surgeon, was born at Durham in 1776. Her life and reputation are closely linked with those of her sister, ANNA MARIA PORTER (1780–1832), novelist, and her brother, SIR ROBERT KER PORTER (1775–1842), painter and traveller. After their father's death, in 1779, the mother removed from Durham, their birthplace, to Edinburgh, where the children's love of romance was stimulated by their association with Flora Macdonald and the young Walter Scott. Mrs. Porter moved to London, so that her son might study art, and the sisters subsequently resided at Thames Ditton and at Esher with their mother until her death in 1831. Anna Maria Porter published *Artless Tales* in 1793–95, the first of a long series of works of which the more noteworthy are *The Lake of Killarney* (1804), *The Hungarian Brothers* (1807), *Don Sebastian* (1809) and *Barony* (1830).

Jane Porter—whose intellectual power, though slower in development and in expression, was greater than her sister's—had in the meantime gained immediate popularity by her first work, *Thaddeus of Warsaw* (1803), which was translated into several languages and procured her election as canoness of the Teutonic order of St. Joachim. In 1810, four years before the appearance of *Waverley,* she attempted national romance in her *Scottish Chiefs.* The picturesque power of narration displayed by Miss Porter has saved the story from the oblivion which has overtaken the works of most of Scott's predecessors in historical fiction. Her later works included *The Pastor's Fireside* (1815), *Duke Christian of Lüneburg* (1824), *Coming Out* (1828) and *The Field of Forty Footsteps* (1828). In conjunction with her sister she published in 1826 the *Tales round a Winter Hearth.* She also wrote some plays, and frequent contributions to current periodical literature. On Sept. 21, 1832, Anna Maria died, and for the next ten years Jane became "a wanderer" amongst her relations and friends. She died at Bristol on May 24, 1850.

Robert Ker Porter painted altar-pieces and battle-scenes of imposing magnitude. He went to Russia as historical painter to the emperor in 1804, travelled in Finland and Sweden, where he received knighthood from Gustavus IV. in 1806, and accompanied Sir John Moore to Spain in 1808. In 1811 he returned to Russia and married a Russian princess. He was knighted by the Prince Regent in 1813. In 1817 he travelled to Persia by way of St. Petersburg (Leningrad) and the Caucasus, returning through Bagdad and western Asia Minor. He examined the ruins of Persepolis, making many valuable drawings and copying cuneiform inscriptions. In 1826 he became British consul in Venezuela. He died at St. Petersburg on May 4, 1842.

His works include: *Travelling Sketches in Russia and Sweden* (1808), *Letters from Portugal and Spain* (1809), *Narrative of the late Campaign in Russia* (1813), and *Travels* in *Georgia, Persia, Armenia, Ancient Babylonia, etc., during the years 1817–1820* (1821–22). After leaving Venezuela (1841) he again visited St. Petersburg, and died there suddenly on May 4, 1842. Jane Porter, who had joined him in Russia, then returned to England and took up her residence with her eldest brother at Bristol, where she died on May 24, 1850.

PORTER, NOAH (1811–1892), American educationalist and philosophical writer, of Puritan ancestry, was born in Farmington, Conn., on Dec. 14, 1811. He graduated at Yale college in 1831, for two years taught in the New Haven grammar school, was for two years a tutor at Yale, then becoming a Congregational minister. He was elected professor of moral philosophy and metaphysics at Yale in 1846, and from 1871 to 1886 he was president of the college. His best-known work is *The Human Intellect, with an Introduction upon Psychology and the Human Soul* (1868), abridged as *The Elements of Intellectual Science* (1871). He died in New Haven March 4, 1892.

See *Noah Porter, a Memorial,* edited by G. S. Merriam (1893).

PORTER, WILLIAM SYDNEY: *see* HENRY, O.

PORTES GIL, EMILIO (1891–), Mexican statesman and provisional president (Dec. 1, 1928, to Feb. 5, 1930), was born at Ciudad Victoria, Tamaulipas, on Oct. 30, 1891. He studied in the law school of the National university and was graduated in 1915 at the peak of revolutionary disorders. He took a prominent part in the revolutionary movement, serving in a judicial capacity in Sonora during Calles' administration as governor and in the legal section of the War Department while Gen. Obregon was Secretary of War. In 1919 he worked in favour of the candidacy of Obregon and was imprisoned for a time for his activities. Following the overthrow of Garranza in 1920, Portes Gil acted as provisional governor of Tamaulipas and subsequently was elected a deputy from that State for four terms. He took office as elected governor of Tamaulipas in Feb. 1925 and held this post until appointed Secretary of the Interior and head of the cabinet by President Calles in Aug. 1928. While governor, he worked on behalf of labour legislation and did much for the labouring and agrarian classes of his State. The number of schools in the State was increased from 280 to over 600 and special attention was given to agricultural and industrial instruction. He also abolished gambling and established partial prohibition by closing the groggeries in villages and on haciendas.

Portes Gil was elected provisional president of Mexico by a unanimous vote of the Mexican Congress (Sept. 25, 1928) to fill a temporary gap caused by the assassination of president-elect Obregon. His selection was supported by President Calles as well as the powerful Agrarian party. His brief administration was marked by a revolt in Vera Cruz and northern Mexico, and he retired in 1930 after the election of Pascual Rubio. In 1931 and 1932 he was minister to France and from 1932 to 1934 attorney-general of Mexico. In the latter year he was appointed secretary of foreign affairs in the cabinet of President Cardenas.

PORT GLASGOW, a burgh and seaport of Renfrewshire, Scotland, on the Firth of Clyde, 20¼ m. W.N.W. of Glasgow by L.M.S.R. Pop. (1938) 19,785 It is now continuous with Greenock. The industries include large shipbuilding and engineering works and sawmills. The area of the port (with wet and graving docks) is 16½ acres. The graving dock (1762) was the first dock of the kind in Scotland. In 1775 Port Glasgow was created a burgh of barony. Adjoining the town are the ruins of Newark Castle (16th century).

PORT HARCOURT, a port of Nigeria, British West Africa, on the Bonny river, 41 m. above its mouth. All ships which can cross Bonny Bar, where the depth of water is 23 to 25 ft. can ascend to the port and berth alongside the wharfs, ample facilities for loading and unloading cargo and bunkering coal being provided. Port Harcourt dates from 1914, being named after the then secretary of State for the Colonies. It owes its existence to the need of a port for the Udi coalfields. It serves a valuable oil-palm district and ranks second among the ports of Nigeria.

PORT HUDSON, a village in East Baton Rouge Parish, La., U.S.A., on the left bank of the Mississippi, about 135 m. above New Orleans. At the sharp turn of the Mississippi here the Confederates in 1862 built on the commanding bluffs powerful batteries covering a stretch of about 3 m., their strongest fortifications along the Mississippi between New Orleans and Vicksburg. On the night of March 14, 1863, Admiral Farragut, with seven vessels, attempted to run past the batteries, commanded by Brigadier-General William M. Gardner, but four of his vessels were disabled and forced to turn back, one, the "Mississippi" was destroyed, and only two, the "Hartford" and the "Albatross" got past. Gen. N. P. Banks's land attack, on May 27, was unsuccessful, the Union loss, nearly 2,000, being six times that of the Confederates. A second attack on June 14 entailed a further Union luss of about 1,800 men. But on July 9, two days after the news of the surrender of Vicksburg, after a siege of 45 days, Gen. Gardner surrendered the position to Gen. Banks with about 6,400 men, 50 guns, 5,000 small arms and ammunition, and two river steamers. The Union losses during the siege were probably more than 4,000; the Confederate losses about 800. The capture of Vicksburg and Port Hudson secured to the Union the control of the Mississippi.

PORT HURON, a city of south-eastern Michigan, U.S.A., 60 m. N.N.E. of Detroit, at the lower end of Lake Huron, on the St. Clair river at the mouth of the Black, and opposite Sarnia (Ontario), with which it is connected by a railway tunnel 6,025 ft. long and the Blue Water International bridge; a port of entry and the county seat of Saint Clair county. It is on federal highway 25, and is served by the Grand Trunk, the Pere Marquette, motor coach and truck lines and lake and river steamers. The population was 25,944 in 1920, 24% foreign-born white, and 32,759 in 1940 by the federal census. Port Huron is in a summer-resort region known as the Lake Huron beaches, stretching for 100 mi. along the lake to the north, and of the manufacturing district which borders the St. Clair for 30 mi. to the south. Its water-borne commerce is considerable.

Port Huron's factories had an output in 1940 valued at $61,643,850. A thick deposit of salt was discovered under the city in 1883, and gas and oil have also been found in the locality. Port Huron is the headquarters of the Women's Benefit association, which has assets of $42,518,238. In 1686 the French established Ft. St. Joseph within the present limits of Port Huron. It came into the possession of the British in 1761, and in 1814 was occupied by American troops and renamed in honour of General Charles Gratiot (1788–1855). The settlement which grew up around it was organized as a village in 1840, and in 1893 it was annexed to Port Huron. Another settlement (at first called La Rivière de Lude, and after 1828 Desmond) was made near the fort in 1790 by several French families. It was incorporated as the village of Port Huron in 1840 and chartered as a city in 1857.

PORTICI, a town of Campania, Italy, in the province of Naples, 5 mi. S.E. of Naples by rail, on the shores of the bay, and at the foot of Vesuvius. Pop. (1936) 26,049. The palace, erected in 1738, once contained the antiquities from Herculaneum, now removed to Naples (with the exception of some mosaic pavements), and in 1873 it became a government institute of agriculture. Just beyond Portici, on the southeast, is Resina (pop. in 1936, 30,707), on the site of the ancient Herculaneum, with several fine modern villas. The inhabitants are engaged in fishing, silk-growing and silk-weaving. The town was completely destroyed by the eruption of Vesuvius in 1631.

PORTICO, in architecture, a term loosely applied to many types of structure in which columns or colonnades are the most important part. Thus an entrance porch with columns is called a portico, and the colonnade at the end of a classic temple is also so named. In Rome an arcaded and colonnaded building surrounding an open space or temple, and built for a public covered promenade was termed a *porticus,* like the portico of Octavia (built by Augustus and restored by Septimius Severus and Caracalla, 203), of which there are extensive remains.

PORT JACKSON: see SYDNEY.

PORT JERVIS, a city of Orange county, New York, U.S.A., 70 m. N.W. of New York city, on the Delaware river at the mouth of the Neversink, where New York, New Jersey and Pennsylvania meet. It is on Federal highway 6, and is served by the Erie and the New York, Ontario and Western railways. Pop. (1920) 10,171 (90% native white); and in 1940, federal census, 9,749. Port Jervis is in a region of beautiful mountain scenery, waterfalls, lakes and trout streams. The Erie has extensive shops in Port Jervis, and the city has various other manufacturing industries.

Hydroelectric power is available from a development at Mongaup falls. Port Jervis was laid out in 1826, soon after work began on the Delaware and Hudson canal (now abandoned) and was named for the engineer who constructed the canal, John Bloomfield Jervis (1795–1885). It was incorporated as a village in 1853 and as a city in 1907.

PORT KEMBLA, a harbour and port on the east coast of New South Wales, Australia, in the Illawarra District, distant some 55 miles south of Sydney. It exports considerable quantities of coke in addition to coal from Dapto. A large electrolytic refining and smelting works treats ores (chiefly copper) from various parts of the Commonwealth (capacity: 47,000 tons refined ore per ann.), and has fertiliser and metallurgical works (copper wire, cables, etc.) associated with it. More recently Port Kembla has been chosen as the site for a steel industry. The Hoskins company (see LITHGOW)—which owns a coking-plant at Dapto—in conjunction with two English steel firms and a Melbourne shipping line, are erecting works with a view to large-scale production, while the New South Wales Government is improving the inland connections by constructing a line to Moss Vale (on the main Southern Line). Pt. Kembla is the third port of New South Wales; the shipping which used it in 1925–26 amounted to 660,000 tons. (See also WOLLONGONG.)

PORTLAND, EARL OF, an English title held by the family of Weston from 1633 to 1688, and by the family of Bentinck from 1689 to 1716, when it was merged in that of duke of Portland. Sir Richard Weston (1577–1635), according to Clarendon "a gentleman of very ancient extraction by father and mother," was the son and heir of Sir Jerome Weston (c. 1550–1603) of Skreens, in Roxwell, Essex, his grandfather being Richard Weston (d. 1572), justice of the common pleas. He was lord high treasurer from 1628 until his death on March 13, 1635. He received the earldom in 1633. The title became extinct in 1688. In 1689 it was revived by William III., who bestowed it upon William Bentinck (see below).

Sir Richard Weston must be distinguished from a contemporary and namesake, SIR RICHARD WESTON (*c.* 1579–1652), baron of the exchequer. Another SIR RICHARD WESTON (*c.* 1466–1542) was a courtier and a diplomatist under Henry VIII.; his son was SIR FRANCIS WESTON (*c.* 1511–1536), who was beheaded for his alleged adultery with Anne Boleyn. This Sir Richard had a brother, SIR WILLIAM WESTON (d. 1540), who distinguished himself at the defence of Rhodes in 1522, and was afterwards prior of the Knights of St. John in England. A third SIR RICHARD WESTON (1591–1652), was mainly responsible for introducing locks on the Wey and thus making this river navigable.

Another family of Weston produced Robert Weston (c. 1515–1573), lord chancellor of Ireland from 1566 until his death on May 20, 1573.

Much of the earl of Portland's correspondence is in the Public Record Office, London. For his political career see S. R. Gardiner, History of England (1883–84), and L. von Ranke, *Englische* Geschichte (Eng. trans., Oxford, 1875).

PORTLAND, WILLIAM BENTINCK, EARL OF (*c.* 1645–1709), English statesman, was born, according to the Dutch historian, Groen van Prinsterer, in 1645, although most of the other authorities give the date as 1649. The son of Henry Bentinck of Diepenheim, he was descended from an ancient and noble family of Gelderland. As page of honour and gentleman of the bedchamber to William, prince of Orange, he secured the friendship of William; which he justified by his prudence and ability. In 1677 he was sent to England to solicit for the prince of Orange, the hand of Mary, daughter of James duke of York, afterwards James II, and he was again in England in 1683 and in 1685. When, in 1688, William was preparing for his invasion Bentinck went to some of the German princes to secure their support, or at least their neutrality, and he was also a medium of communication between his master and his English friends. He superintended the arrangements for the expedition and sailed to England with the prince.

The revolution accomplished, Bentinck was made groom of the stole, first gentleman of the bedchamber, and a privy councillor; and in April 1689 he was created Baron Cirencester, Viscount Woodstock and earl of Portland. He fought at the battle of the Boyne (1690), the battle of Landen, and at the siege of Namur, but his main work was of a diplomatic nature. He helped to arrange the peace of Ryswick (1697); he negotiated with Louis XIV for a partition of the Spanish monarchy, and as William's representative, signed the two partition treaties. Jealous of the rising influence of Arnold van Keppel, earl of Albemarle, Portland resigned all his offices in the royal household in 1692, but he did not forfeit the esteem of the king, who continued to trust and employ him. He received 135,000 ac. of land in Ireland, and only the strong opposition of a united house of commons prevented him obtaining a large gift of crown lands in north Wales. For his share in drawing up the partition treaties he was impeached in 1701, but the case against him was not proceeded with. He was occasionally employed on public business under Anne until his death at his residence, Bulstrode in Buckinghamshire, on Nov. 23, 1709. Portland's eldest son Henry (1680–1724) succeeded as 2nd earl. He was created marquess of Titchfield and duke of Portland in 1716.

See G. Burnet, *History of My Own Time* (Oxford, 1833); Lord Macaulay, *History of England* (1854); L. von Ranke, *Englische Geschichte* (Eng. trans, Oxford, 1875); and especially Onno Klopp, *Der Fall des Hauses Stuart* (Vienna, 1875–88); M. E. Grew, *William Bentinck and William III* (1924). *See* also Dr. A. W. Ward's article in vol. iv of the *Dict. Nat. Biog.*

PORTLAND, WILLIAM HENRY CAVENDISH BENTINCK, 3RD DUKE OF (1738–1809), prime minister of England, son of William, 2nd duke (1709–1762), and grandson of the 1st duke. He was born on April 14, 1738, and was educated at Oxford. Under the marquess of Rockingham he was, from July 1765 to December 1766, lord chamberlain, and on the return of Rockingham to power in April 1782 he was made lord lieutenant of Ireland. After the short ministry of Shelburne, succeeding the death of Rockingham, the duke of Portland was selected by Fox and North as a "convenient cipher" to become the head of the coalition ministry, to the formation of which the king was with great reluctance compelled to give his assent. The duke held the premiership from April 5, 1783 until the defeat of the bill for "the just and efficient government of British India" caused his dismissal from office on Dec. 17 following. Under Pitt he was, from 1794 to 1801, secretary of state for the home department, after which he was, from 1801 to 1805, president of the council. In 1807 he was appointed a second time prime minister and first lord of the treasury. Ill health caused him to resign in October 1809, and he died on Oct. 30. He owed his political 'influence chiefly to his rank, his mild disposition, and his personal integrity.

PORTLAND, a city of eastern Indiana, U.S.A., 80 mi. N.E. of Indianapolis, near the headwaters of the Salamonie river; county seat of Jay county. It is on federal highway 27, and is served by the Nickel Plate, the Pennsylvania and electric railways. Pop. (1920) 5,958 (98% native white); 1940, 6,362.

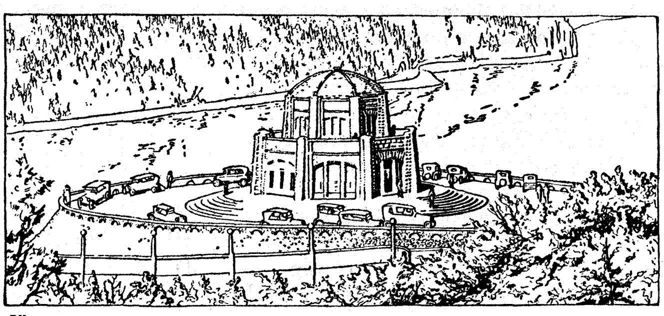
PORTLAND, the largest city of Maine, U.S.A., a port of entry and the county seat of Cumberland county; on Casco bay, 110 mi. N.E. of Boston. It is on the Atlantic highway, and is served by the Boston and Maine, the Grand Trunk, and the Maine Central railways, and by steamship lines operating to Boston and New York, the Pacific ports and the principal ports of the United Kingdom. Pop, in 1930 was 70,810 (83% native white); in 1940 it was 73,643. Its area of 21.6 sq.mi. includes a peninsula 3 mi. long and averaging less than a mile in width (the original town); another peninsula to the east, occupied by the former city of Deering (annexed in 1899); some encircling territory on the mainland; and islands aggregating 2,585 acres. The eastern promenade (161 ft. above sea level) overlooks beautiful Casco bay, its 365 islands and seven lights, the shores of Falmouth and Cape Elizabeth, to the open Atlantic beyond. From the western promenade (altitude 169 ft.) the view embraces a broad sweep of country, to the White mountains of New Hampshire. The public buildings are dignified and substantial. In Congress street (the main thoroughfare) is the Portland observatory (rising 227 ft. above tidewater) built in 1807 to sight incoming vessels. Many of the dwellings are in the simple and gracious architectural style of the 18th and early 19th century. Of special interest are the birthplace of Henry Wadsworth Longfellow and his early home in Congress street (now a museum) built by his grandfather Gen. Peleg Wadsworth in 1785–86. The Eastern cemetery (set aside in 1668) contains the graves of many citizens of note. The oldest church building in the city (1825) is that of the First Parish church (Unitarian), established in 1809. In Williston church (Congregational) the Young People's Society of Christian Endeavor was founded in 1881 by the Rev. Francis E. Clark. Portland is the seat of the Maine General hospital, a U.S. marine hospital, the Maine Institution for the Blind and has several special libraries and museums, besides the public library of 122,505 volumes.

The harbour has a water frontage of 8.5 miles. It is protected by a breakwater, and defended by Forts Preble, Levett, Williams and McKinley. The traffic in 1938 amounted to 799,000 short tons, of which almost 700,000 tons represented exports to foreign countries (largely lumber, scrap iron and canned vegetables) and about 100,000 tons imports (chiefly wood pulp, fuel oil, coal and china clay). The coastwise commerce (3,940,000 tons) consisted largely of textiles, coal, petroleum products, canned goods, paper and general merchandise. The output of the city's diversified manufacturing industries in 1937 was valued at $123,795,111. The fisheries are still important, but shipbuilding had declined but was revived in 1941. Bank clearings for 1940 aggregated $105,-480,724. The assessed valuation for 1940 was $77,164,450 for local purposes and $78,521,715 for state purposes. Since 1923 it has operated under a council-manager form of government.

The Indian name for the peninsula which constitutes the heart of Portland was Machegonne. It was first settled by George Cleaves and Richard Tucker in 1632. The early settlement, known by various names, was destroyed by the Indians in 1676, and again by the French and Indians in 1690, after which it remained desolate until 1715. In 1719 the town of Falmouth was organized, including Falmouth Neck (now Portland). On Oct. 18, 1775, it was bombarded and burned by a British fleet in punishment for showing its sympathy for the patriotic cause. Falmouth Neck was incorporated in 1786 as the town of Portland. It was the capital of the state from 1820 to 1832, and on April 30, 1832, adopted a city charter. About 200 ac. in the centre of the city was destroyed in 1866 by a fire resulting from a Fourth of July celebration. Portland was the birthplace of Henry Wadsworth Longfellow, Thomas Brackett Reed, Edward Preble, George Henry Preble, Mrs. Parton ("Fanny Fern"), Nathaniel Parker Willis, Seargent Smith Prentiss and Neal Dow, and was the home of William Pitt Fessenden, Theophilus Parsons and Simon Greenleaf.

PORTLAND, the largest city of Oregon, U.S.A., on the Willamette river, at its confluence with the Columbia, 110 mi. by water from the Pacific ocean, 118 mi. S.S.W. of Seattle, 700 mi. N. of San Francisco and 2,391 mi. from Chicago; a port of entry, the county seat of Multnomah county, and the financial, commercial and industrial centre of the vast Columbia River basin. It is at the intersection of the Pacific and the Columbia River highways; is a station on the Pacific coast airway; and is served by the Great Northern, the Northern Pacific, the Southern Pacific, the Union Pacific, and the Spokane, Portland and Seattle railways, electric interurban trolley and motor coaches, and over 50 steamship lines with sailings to all the principal ports of the world. Portland's population was 301,815 in 1930 and 305,394 in 1940. It ranked 27th in the country and had a metropolitan population of 406,406.

The city covers 63.5 sq.mi. on both sides of the Willamette river, rising to heights commanding magnificent views of the river valleys and of the snow-clad summits of Mt. Hood, 50 mi. E. by



BY COURTESY OF THE PORTLAND CHAMBER OF COMMERCE
VISTA HOUSE ON CROWN POINT. PORTLAND

S. (11,225 ft. high), Mt. Jefferson, Mt. Washington, The Three Sisters and other peaks of the Cascade range. The climate is mild and equable, with normal winter temperature 40·9°, normal summer temperature 65.3'—annual 53·1°, and an average annual precipitation of 41.6 in., of which 31.8 in. falls in the winter months. Violent storms and earthquakes are unknown. The annual rose festival in June is one of the famous events on the Pacific coast. The city park system embraces 2,292 ac., and includes 24 playgrounds, 3 public golf courses, 59 public tennis courts, 13 baseball diamonds, 7 swimming pools and a zoological garden. In one of the parks are the International Rose Test Gardens of the American Rose society. There is a public auditorium with a seating capacity for 6,600.

The municipal water supply comes from the Bull Run lake reserve, 3,000 ft. high in the Cascades, fed by melting snow from Mt. Hood. It is sufficient for a population of 2,000,000, is admirably suited for use in the colouring and manufacture of textiles, and is so pure that it does not need to be distilled for use in medical prescriptions or batteries.

The general death rate (12.9) is above average, but the infant mortality rate (35.7) is among the lowest in the country.

Since 1913 the city has operated under a commission form of government. The assessed valuation of property for 1940 was $263,376,090.

Portland is the seat of the University of Oregon Medical school, a branch of the extension division of the University of Oregon; the Northwestern College of Law, the North Pacific College of Dentistry, Pharmacy and Optometry, Albany College, Portland University, Hill Military Academy, several private junior colleges and preparatory schools; and Reed college, founded by Simeon G. Reed and his wife (pioneers of 1854) and opened in 1910.

There are 78 grade and 10 high schools.

The fine fresh-water harbour has a shore line of 29.5 mi. within the city limits, 6·5 mi. of docks, berthing space for 100 vessels and 65 ac. of cargo space. Over $50,000,000 has been invested by federal and municipal governments and private interests in channel improvement and port facilities. Rock jetties at the mouth of the Columbia protect the entrance and the river channel, which accommodates ships of 35 ft. draft at zero stage all the way to Portland. Port facilities are ample and modern. They include three municipal terminals, with cold-storage plants, a 2,053,800 bu. elevator, storage tanks for oil and molasses and efficient handling equipment; 7 lumber, 12 flour and grain, 10 oil, 10 general cargo docks, privately owned. The water-borne commerce amounted to 9,527,996 tons in 1939, valued at $308,932,477. Foreign commerce amounted to 110,336 tons of imports and 964,581 tons of exports.

Outbound cargoes consist largely of lumber, wheat, flour, canned and fresh fruits, paper and paper pulp, scrap iron, doors, furniture and ready-made houses, plywood, box shooks, battery separators, dried prunes and beans, onions and potatoes. Copra, coffee, burlap bags, sugar and bananas are leading articles among the imports.

In 1939 exports from the Oregon customs district, of which Portland is the headquarters, were valued at $30,422,795; imports at $8,269,144.

Portland is the leading wheat and lumber shipping port on the Pacific coast.

Nearly one-third the manufacturing of the state is concentrated at Portland. In 1939 the aggregate output of the 759 manufacturing establishments within the city was valued at $116,046,604. Lumber and lumber products in wide variety (shingles, sash. doors, windows, boxes, staves, shooks, furniture, ready-made houses, portable churches, barns and garages, and many smaller articles made of wood) are the leading manufactures. Others of importance are flour, cereals, bran and feeds; meat products, fruits and vegetables; machinery, logging and contractors' equipment, structural steel, automatic coal burners or stokers, oil burners, stoves, furnaces and other metal products; woollen textiles and clothing; paper and paper products; plywood, leather and rubber goods.

Debits to individual accounts in the local banking institutions amounted to $2,060,543,000 in 1940.

Portland was founded in 1845 by Francis W. Pettygrove from Maine and Amos L. Lovejoy from Massachusetts, who owned jointly a government land claim. They tossed a coin to decide whether the site should be named Portland or Boston, and Pettygrove won. By 1849 the new town was a thriving community. The city was chartered in 1851. In the year 1860, just before the Civil War, it had a population of 2,874, which increased to 8,293 in 1870 and (despite a destructive fire in 1873) to 17,577 in 1880. In 1883 railway communication with the east was established by the Northern Pacific, and in 1885 the federal government began to improve the mouth of the Columbia. By 1890 the population was 46,385, and in 1900, after annexations of territory, 90,426.

Since 1900 the area within the corporate limits has increased 50% and the population about fourfold. Since the war of 1914–18 the traffic of the port has more than doubled, and the foreign commerce has increased even more.

Building permits in the years 1935–40 represented values aggregating $45,435,045.

In 1905 an exposition and fair was held in Portland to celebrate the centennial of the expedition of Meriwether Lewis and William Clark to the region.

PORTLAND, ISLE OF, properly a peninsula on the coast of Dorsetshire, England; Chesil bank connects it with the mainland. Pop. of urban district (1938) 12,240. Area 4.5 sq.mi. It is 4 mi. long and nearly $1\frac{3}{4}$ mi. in extreme breadth, with an area of about $4\frac{1}{2}$ sq.mi. The shores are precipitous, and Portland is inaccessible from the sea except toward the south. The highest point is the Verne hill in the north. A raised beach is seen at Portland Bill. The substratum of the island is Kimmeridge clay, above uhich rest beds of sand and strata of Oolitic limestone, widely famed as a building stone. In the "dirt-bed" resting upon the Oolitic strata numerous specimens of petrified wood are found, some of great size. The G.W.R. and S.R. have a joint line south from Weymouth to Portland and Easton.

On the isle are the famous prison buildings, now a borstal institution. Portland castle, built by Henry VIII in 1520, is generally occupied by the commander of the engineers or of the regiment stationed on the island. On a rock on the eastern side are remains of a more ancient fortress, Bow and Arrow castle, ascribed to William Rufus. They are in the grounds of Pennsylvania castle, built by John Penn, grandson of William, governor of the Isle of Portland and founder of Pennsylvania.

A harbour of refuge was built by the admiralty, 1847–62. A breakwater stretching northward from the northeast corner of the island partially enclosed a large area of water naturally sheltered on the south and west. An inner arm ran nearly east from the island to a masonry head and fort, and an outer detached arm bent north to a circular fort, a narrow entrance for shipping being left between the two. Two new breakwaters were built after

1895 to close the gap between the end of the outer breakwater and the Bincleaves rocks near Weymouth. The defensive harbour thus completely enclosed has an area of 2,200 ac. to the one-fathom line, of which 1,500 ac. have a depth of not less than 30 ft. at low water.

PORTLAND CEMENT: see CEMENT.

PORT MAHON, the capital and principal seaport of Minorca, in the Spanish province of the Balearic islands. Pop. (1936) 18,000. Port Mahon is situated on the east coast, at the head of a deep inlet which extends inland for $3\frac{1}{2}$ m. It is an important harbour. (See MINORCA.) Mahon is the ancient *Portus Magonis,* which under the Romans was a municipium (Mun. *flavium* magontanurn), probably including the whole island under its authority. As the name suggests, it had previously been a Carthaginian settlement. The Moors, who occupied Minorca in the 8th century, were expelled by James I. of Aragon in 1232. Khair-ed-Din Barbarossa besieged and captured the city in 1535; and in 1558 it was sacked by a corsair called Piali. The British seized the island in 1708, and in 1718 declared Mahon a free port. In 1756 it fell into the hands of the French. Restored to the British in 1762, it was lost again in 1782. In 1802 it was finally ceded to Spain by the treaty of Amiens. Many of the houses date from the British occupation. The King's island is so called as the landing-place of Alphonso III. of Aragon in 1287; farther south-east on the shore is the village of Villa Carlos or George Town; and at the mouth of the port, on the same side, are the remains of Fort San Felipe, originally erected by Charles V. and twice the scene of the capitulation of British troops. Opposite San Felipe is the easily defended peninsula of La Mola (256 ft. high), which is occupied by extensive Spanish fortifications.

PORTO ALEGRE, a city and port of Brazil, capital of the state of Rio Grande do Sul, at the northern extremity of Lagoa dos Patos on the eastern shore of an estuary called Rio Guaiba, about 160 mi. from the port of Rio Grande at the entrance to the lake. The population of the *município* (275,678 in 1940) contains a large foreign element, chiefly German and Italian. The city has rail connection with all the main lines in the state. The Rio Guaiba, which is not a river, was once called "Viamão" because its outline is roughly that of the human hand, the rivers entering the estuary at its head corresponding to the fingers. The lower channels of these rivers (the Gravataí, Sinos, Caí, Jacuí and Taquari) are all navigable. Foreign trade is limited to light-draught steamers able to cross the bar at the entrance to the lake.

The city occupies a tongue of land projecting into the estuary, and extends along its shores. The climate is cool and bracing in winter but hot in summer. The mean annual temperature is slightly under 69" F., the average maximum being a little over 82° and the average minimum 59°. The annual rainfall is about $30\frac{1}{2}$ in. The city is laid out with broad streets. It is the chief commercial centre of the state, has shipbuilding yards and manufactures cotton fabrics, boots and shoes, iron safes and stoves, carriages, furniture, butter and cheese, macaroni, preserves, candles, soap and paper.

Pôrto Alegre was founded in 1742 by immigrants from the Azores and was first known as PBrto dos Cazaes. It was made a vila in 1803, and in 1807 the transfer of the capital from Rio Grande to PBrto Alegre was officially recognized. In 1822 it was raised to the rank of a city, and in 1841, as a reward for its loyalty in revolutionary wars of that province, it was distinguished by the title of leal e *valorosa* (loyal and valorous). The first German immigrants to settle near Pôrto Alegre arrived in 1825, and much of its prosperity and commercial standing is due to the German element.

PORTO FARINA, a town of Tunisia about 20 mi. E. of Bizerta, on the Ghar-el-Mela, a lagoon, also known as the Lake of Porto Farina, at the mouth of the Mejerda (the ancient Bagradas). Porto Farina was the naval arsenal of the piratical beys of Tunis and was bombarded by the English under Admiral Blake in 1655.

Ruins 10 mi. southwest, near the village of Bu Shater, are identified with the ancient Utica (*q.v.*).

PORTO MAURIZIO: *see* IMPERIA.

PORTO NOVO, a town of British India, on the Coromandel coast in the South Arcot district of Madras, 144 m. from Madras by rail. Pop. (1931), 13,762. It is famous for the battle in July 1781, in which Sir Eyre Coote with 8,000 men defeated Hyder Ali with 60,000 and saved the Madras presidency.

PORT OPERATION. The term "port operation" includes the receiving of ships in harbour, putting them in position to discharge or load their cargoes, the handling of the cargo and its despatch to or reception from inland destinations. The primary aim of all modern dock operation is to give ships quick despatch, *i.e.,* to keep down the time in port.

Before the cargo can be distributed it has to be landed, sorted to the various bills of lading, passed by the customs' officers, customs' and port charges paid, and the goods "released" by the shipowner to the merchant.

The shipper when despatching goods receives from the master of the ship a bill of lading, which is a negotiable document of title and which he sends to his consignee. While the goods are in the ship they are by law the property of the shipowner, and he has a prior lien on the goods for his freight. This lien is removed by the consignee taking the bill of lading to the shipowner and paying the freight, receiving in exchange a "release," which is the authority to the port authority or wharfinger to deliver the goods. But in order that the discharge of the ship shall not be delayed while the consignees are obtaining releases, the discharge of the goods is commenced at once into the transit sheds alongside. These transit sheds are, in the eye of the law, part of the ship. So long as the goods are in the transit shed the shipowner retains his lien for freight, and the port authority cannot allow the goods to leave the transit sheds until a release has been produced.

In the case of goods liable to customs' duty for which it is not desired to pay the duty at once, they are after being released passed under customs' guard into bonded warehouses. In the case of goods of high customs' value, such as wines and tobacco, the goods usually remain in bond until passed into consumption, the owner thus being relieved from the premature payment of heavy duty. Both transit sheds and bonded warehouses have, therefore, to be under double locks of the customs and wharfinger respectively, so that goods can only be handled in the presence of both parties.

To protect the customs, goods can by British law only be landed at duly authorized landing places called legal quays and sufferance wharves, the only difference between these terms is that the first is a permanent licence issued by the Treasury, and the second a restricted licence issued by the commissioners of customs. The services of the officers of the customs for watching goods in course of discharge in ordinary hours are paid for by the State, but all overtime is at the cost of the ship, and as customs' hours do not coincide with port hours, a ship working the ordinary hours has to pay at least one hour of customs' overtime, and more if she is herself working overtime.

"Rough cargoes" such as ores, timber, etc., which do not require shelter are landed at open quays, and the limitation of the shipowner's lien sometimes gives rise to difficult questions.

In the days before free trade, when nearly all goods were dutiable, it was the British custom to constitute a customs' area of the whole dock estate and to secure it within high walls and massive gates. These will still be found in the older ports, but in modern times it has become the practice to localize the control at sheds and wharves, and transit beyond these limits is free.

Custom of the Port.—A shipowner by his contract of carriage undertakes to deliver to the consignee the goods according to the bill of lading, which implies that he has to separate one man's goods from other people's goods and deliver each in one parcel. But this general rule of law is materially affected by the local "custom of the port" which varies everywhere and is a cause of much dispute and litigation. In some ports the custom ordains that the ship shall put the goods on the quay indiscriminately, and the work of sorting and removal is at the charge of the merchant; in some cases, goods are removed from the crane sling by one party, sometimes by the other, or again shared by the two parties. In some exceptional cases the cost of craning the goods from the hold is held to be on account of the merchant. For these reasons comparison of the working charges of different ports is always difficult.

The large cargoes now carried and the very mixed nature of the commodities necessitate in most cases landing on the quay for sorting before delivery. This requires much floor area, and has led to the introduction of two or more floor transit sheds to avoid excessive congestion of the cargo when landed. And for the subsequent delivery of these goods by rail or road, special facilities are needed. A single cargo of 8,000 tons of general cargo, if all had to be despatched by rail, would require 1,000 trucks to take it away. These trucks would occupy 3,000 yards of railway, which is some measure of the amount of siding accommodation which has to be provided for the efficient working of a discharging berth and also the great relief obtainable when a large part of the work is done by barge. The movement of these trucks has to be performed without interference with the work at adjacent wharves; hence the proportions which the three methods, barging, railway and road transport, bear to each other must largely affect the design of the shore equipment of a port.

The quick and economical movement of cargo is now largely obtained by the provision of mechanical appliances in substitution for manual labour, and the main staples when arriving or being despatched in whole cargoes, or in large quantities in mixed cargoes, are usually dealt with by special machinery, *e.g.,* for export, coal, and for import, grain, timber, meat and provisions, for all of which specially designed conveying machinery is installed at every port where the tonnage is sufficient to justify the expenditure. Mixed cargoes are discharged either by cranes on the shore or by the ship's gear. Such equipment is usually provided by the port authority.

The Provision of Port Machinery.— But as ships are often required to receive and deliver cargo in the open roadstead or at ports abroad not equipped with shore appliances, they must necessarily be fitted with booms and winches, and it is, therefore, often economical to make use of these appliances even when shore plant is available. In practice, however, competitive reasons compel port authorities to provide cranes, and in many cases more specialized working plant. Coal is shipped by means of (a) tips or hoists in which the wagon is lifted to a height above the ship's deck and the contents tipped into a shute to fall into the hold, (b) staithes, when the configuration of the ground permits, where the wagon is pushed to above deck level and the contents tipped into the hold, and (c) conveyors in which case the wagon at quay level is discharged on to a conveying band to the hatch. The last method is coming into increasing use. Grain is now mostly imported in bulk and is discharged by means of elevators which lift it in a continuous stream from the hold, convey it to the quay, and there deposit it on to conveying bands which carry it to silos where it is either stored or delivered by gravity into sacks for inland transport. These elevators are of either the bucket or the pneumatic type. When grain is imported in sacks the modern practice is to cut the bags in the ship and "start" the contents into bulk for discharge by this more economical method. Grain elevators may be either fixed on the quay or mounted on floating pontoons. The latter, though more costly, has the advantage of greater mobility. Grain discharging machinery has been passing through many stages of evolution during the last twenty years, and the pneumatic type seems to be gradually getting established. For inland transport in England and on the Continent (in contrast to all countries in America) the uneconomic method of carriage in sacks is still prevalent, but a small beginning has been made with bulk transport by rail.

Ores are now generally discharged by grab cranes which are self-filling and save the labour of loading into tubs. Iron is largely discharged by means of an electrified block on a crane which attracts the iron and when over the selected site releases by cutting off the current. Petroleum is usually discharged through pipe lines from the shore storage to the quays. This pipe is connected by means of a flexible hose to the ship's tank and pumped to the storage tanks. The same method is employed for vegetable oils and for molasses where the volume of trade is sufficient to justify the cost of the installation.

With free trade and the removal of customs restrictions, the tendency is increasing for the importing merchant to sell his goods "ex ship," and for goods to pass at once on discharge into consumption, but raw materials are still largely stored in dock warehouses or in adjacent warehouses of private owners for later consumption. Such deliveries are largely of a retail nature, and many of the chief ports have provided elaborate facilities for the storage, sampling, handling and accounting of warehoused goods. This branch of activity prevails in British and in some American ports more than on the Continent of Europe.

Rail Terminals and Docks.—At ports where barging is not the predominant method of handling cargo and at all modern ports to a greater or less degree, the railway facilities are an important feature as affecting the cost of distribution. There is great variety of method. At some railway-owned ports the docks are treated as a terminal goods station under main line control. At others, the railway working is self-contained under the docks superintendent. This affects the design of the railway system and the methods of working. In non-railway docks in some cases the railway company is given running powers to the quays, in others the port authority conducts its own railway operation. As in every properly conducted dock the first and principal aim is to give the ship despatch and with that object to avoid, by its rapid removal, the congestion of cargo at the ship's side, modern practice is to confide the control to the authority responsible for the despatch of the ship, providing an area away from the ship where the traffic is interchanged with the main line railway. In the United Kingdom this area is called the "exchange sidings"; in America the "belt line." One or more such points of interchange may be provided in accordance with the physical conditions of the main railways serving the port.

The post-war development of road transport has imported a new problem into the question of dock layout, and the need for providing facilities for economical loading to road vehicles in docks equipped only for loading to barge and rail requires many modifications of design.

Port Ownership.— The several descriptions of port ownership and operation may be classified under the following heads— (I) National ownership, (2) Trust ownership, (3) Municipal ownership, (4) Railway ownership, (5) Private ownership.

(1) Examples of National *Ownership* Are:— Rotterdam, and all the larger French ports. None are to be found in the United Kingdom except naval dockyards which do not come within the scope of this article.

(2) *Examples* of Trust *Ownership* Are:—In England, London and Liverpool; in Canada, Montreal and Vancouver; in United States, New York and New Orleans; in Australia, Sydney and Melbourne.

(3) *Examples* of *Municipal Ownership* Are:— In England, Bristol and Preston; on the Continent, Hamburg, which is the property of the Free City of Hamburg, and might perhaps be classed under national ownership; and Antwerp, the financing of which is divided between the State and the City.

(4) Railway Ownership.--Before the amalgamation of the railways of Great Britain in 1921 a number of docks were railway-owned, some having been acquired by railways when they had difficulty to maintain themselves as independent authorities, examples— Southampton, Hull; and others had been constructed by companies which, though nominally railway companies, were mainly ports (examples Cardiff and Newport), to serve the surrounding coal fields. Abroad the outstanding example is South Africa where all the ports are worked as part of the State owned railways. A few examples may be found in the United States, but the tendency in that country is to separate the port and railway ownership.

(5) Private *Ownership.*—In the United Kingdom few ports are to be found in this class, but the Manchester ship canal and the Gloucester Docks and Canal Company may be instanced.

The acceptance as a national liability of a larger or smaller proportion of the cost of construction, maintenance and working of a port prevails on the Continent much more largely than in the United Kingdom. For example, at Rotterdam and Antwerp the construction, dredging and maintenance of the harbour up to quay level are carried out by the State, as a national charge against the general revenues of the country, the super-structure above water level only being provided by the municipality and being the only portion of the charges to be recovered from the trade passing through the port. This is a potent cause of the lower charges prevailing on the Continent as compared with the United Kingdom. Under the policy which has generally prevailed in the United Kingdom of non-intervention by the State, economic forces have been allowed free play.

Public **Ownership.**—In the British dominions the policy of state or national ownership is almost universal, but the methods differ widely. In Australia the ports are financed by State loans and administered by nominated commissioners under the control of the Minister for Public Works; in South Africa, they are combined with the State owned railways under the general manager of the latter; in New Zealand and in India the ports finance themselves, but with the Government guarantee behind them, and are administered by a State appointed chief commissioner assisted by commissioners elected by the users of the port with, in some cases, representatives of the local inhabitants. In Canada ownership and administration are with the several States through the agency of nominated commissioners.

Port trusts are statutory bodies not working for a profit but they are obliged, in order to keep themselves solvent, to levy charges high enough to cover all their outgoings. The capital account has to bear all the cost of construction and equipping the port, and the revenue account has to bear the interest and sinking fund on such capital expenditure. Charges, therefore, have to be fixed so as to bring in sufficient revenue to pay this interest and sinking fund in addition to current working expenses. Surplus revenue is applied either to improving the facilities or reducing the charges of the port.

Municipal ports can, if the owners so desire as a matter of policy, be subsidized out of the general rates of the city, and in England these are the nearest analogy to the national ports of the Continent. As port works from their nature take a long time to construct, and as new trade offering naturally cannot wait while facilities are being provided, it is necessary if a port is to maintain its position to provide facilities in advance of the current demand. It is, therefore, in the power of a municipality, if it is prepared to accept a present burden upon its rates in the hope of being eventually recouped, to provide for the future to an extent which private enterprise cannot afford. In some cities of the United States the practice prevails of levying a specific rate on houses and property in aid of port improvements, and an early example in England is the case of Bristol, the largest municipally owned port, which from 1849 to 1897 levied a rate of £4,000 a year on houses for port purposes. Since the last date this levy has been merged in the general rate-in-aid to balance the revenue account which, however, for many years has been less than the annual contribution towards the sinking fund for the extinction of the capital.

Railway-owned docks also can, subject to certain provisions of the Railways Act of 1921 under which all the railways and their ports were amalgamated into four grouped systems, similarly meet any shortage of earnings of the port out of their general revenues, and this power similarly enables them to indulge in a more generous provision of facilities beyond the immediate needs of the trade in order to provide for future development.

Private Ownership. — In the case of the fifth class of ports, the property of private companies, the same end can only be obtained by the shareholders foregoing their dividends during a long fructifying period, which has actually been the experience of both the ports named above. In fact, in the case of the Manchester Ship Canal Company, now the outstanding example of a successful company port, the period of fruition was so long delayed that its capital and credit were exhausted and the Corporation of Manchester had to come to its aid by the provision of additional capital on which it had for a period to forego interest, and in consideration of which it was entitled to representation on the board of directors. But as the management is still with the company's directors, the classification of the undertaking here adopted remains correct.

The decadence of so many English ports under private ownership may be traced to this natural law. Ports constantly tend to become out of date owing to the increasing size of ships, and are faced with the alternative of seeing their present trade depart or of undertaking expenditure on which the return must be far distant, and which often proves to be beyond their unaided resources. London and Bristol, Southampton and Hull are examples of company owned undertakings which were becoming derelict when they obtained outside aid—the first absorbed by a powerful trust under the direct aegis of Government, the second by the local authority, and both have become self-supporting. The last two, though returning large profits to the railway companies which own them, have never directly given a commensurate return on their cost. Immingham and Fishguard, both railway owned from the beginning, have never been remunerative undertakings to their owners, or any great advantage to the trade of the country. The relation between the several classes of ports in the United Kingdom has been largely affected by the Railways Act of 1921 under which the great railway systems have become great port proprietors in competition with others dependent on their own resources. This implies a combination of the two systems of extraneous subsidy and self-containment, each of which has been applied successfully in some countries, but never before both in the same country, and it will be some years before the result can be determined.

Functions of Port Authority. — The functions of a port authority may be classified as conservancy and dock-ownership. The first head comprises all operations connected with making the port available for shipping, maintenance of navigation channels, surveying the same, buoying and lighting, removal of wrecks, signal service, pilotage service, supervision of foreshore to prevent interference with navigation channels.

The conservancy boundaries of a port are laid down in its Acts of Parliament, or in the case of ancient ports may be derived from Royal Charters, and if any portion of those waters form a highway to other ports, the lighting and charting of that portion is usually undertaken by the State, *e.g.,* Trinity House for English waters, and the Scottish Board of Lights for Scottish.

As dock owners the authority provides the equipment necessary for the accommodation of ships, their loading and discharging and the movement of their cargoes, including the provision of transit sheds, cranes and other cargo working machinery, power plants, railway lines and roads, etc.: "facilities," as working of lock gates (if any), lighting, berthing masters and everything necessary to enable a ship to get with safety to a position to discharge and load its cargo, and "services" which include everything connected with the handling of cargo, discharging or loading, receiving, sorting, despatching and storing. "Facilities" are necessarily provided by the dock owner. In regard to the rendering of "services," the practice varies within wide limits. In some ports these are rendered by the dock owners in whole, or in part. In others, the policy is to leave the services to private enterprise. The Port of Manchester is the only example in the United Kingdom of a statutory monopoly of all the services within the dock area, but all ports have power under their acts to provide services and to make "reasonable" charges therefor. The policy, however, differs materially in the various ports, some encouraging departmental working, and others favouring separate private enterprise. The principle of a complete monopoly of all services within the port limits is more prevalent in foreign ports.

The growing tendency to provide large scale equipment for handling staple commodities makes it seem possible that in the future, despite the objection that it would deprive the ship owners of the advantage of competition, economic reasons will force the more general undertaking of services by dock owners and the acceptance of the position by ship owners. In the case of Manchester the powers giving the authority the exclusive right are coupled with the proviso that their charges to their customers must not provide more than a ten per cent profit, and it is a generally accepted principle of port finance that the several departments, viz., conservancy, facilities and services should each be separately self-supporting, though many exceptions to this rule may be found.

In some cases the two functions of conservancy and dock ownership are combined in one authority; in others, they are under separate ownership and administration. There is considerable difference of opinion as to which is the better system, but it is perhaps more generally held that more satisfactory co-ordination can be secured, and therefore better efficiency and economy obtained when both functions are combined in the same authority. This is the case in most of the larger authorities of the United Kingdom, *e.g.*, London and Liverpool. Examples of ports where the conservancy authority is separate from the dock-owning authority are Southampton, Glasgow, Newport. There are cases also of which the following are examples—the East Coast rivers, the Tees, Tyne, Tay and Southampton—where the conservancy authority owns some docks, but other docks to a greater or less extent are provided either by the local railway company or by the local corporation. This entails a division of responsibility which it is sometimes complained leads to the neglect of the needs of trade.

Port Revenues.—The revenues of port authorities are principally obtained under the following heads: as conservancy authority, light dues, pilotage dues, and sometimes tonnage dues levied entirely on the shipping; as dock authority, dues on shipping calculated on the net register ton, import and export dues on the cargoes. Subsidiary, but sometimes very important, items of revenue are:—profits on the handling of cargo, warehousing, railway working round the docks, and rents of lands.

Most ports endeavour to obtain sufficient land to establish industries in the immediate neighbourhood of the docks, and owing to the high cost of inland transport, and the fact that with most commodities the finished article weighs less than the raw material required to produce it, the tendency is continually to move industries more and more from inland centres to the coast in the immediate neighbourhood of the great ports, and when possible to obtain the economic advantage of establishment within the dock area to avoid the cost of intermediate railway or road haulage.

A problem in port economics which has always been the subject of much difference of opinion is the proper distribution of the burden as between the ships and the goods they carry. The principle generally accepted is that the burden should be divided as equally as can be between the two, but this has many exceptions. Some ports adopt the policy of making the charges on shipping very light with a view that thereby freights will be kept low, greater cargoes obtained, and the revenue recouped from the tonnage of those cargoes. Other ports hold the view that the incidence of the port charges on the total expenses of a voyage is so small that it cannot affect the freight, and low charges on goods encourage manufacturers and merchants to use the port. This is the policy of all the railway-owned ports whose dues on goods are not only fixed on a low basis but who frequently render services for less than cost, recouping the cost from the profits on railway haulage.

An important factor affecting the quantum of port and harbour dues is the nature and the cost of the works necessary under the particular physical conditions of each harbour. In the United Kingdom, owing to the great variation of tides, it is in most cases necessary for the efficient working of ships to maintain a constant level in the docks by impounding the water within lock gates (a notable exception is Southampton, which has been favoured by nature with four tides in the 24 hours, reducing the difference between high and low water to a few feet). The Pacific and Indian oceans and the Mediterranean sea on the other hand, with their low rise and fall of tide, enable their ports to dispense with such expensive equipment, and the great ports of these oceans, Sydney, San Francisco, Singapore, Marseilles, etc., are examples where the features of the port as left by nature have been almost entirely retained. For this reason the capital cost, as measured by the accommodation afforded, is much lower and is reflected in the lower scale of dues which can be imposed.

The working expenses of a port are for the greater part of the nature of fixed charges, *e.g.*, interest and depreciation on the capital cost of the accommodation, working of the entrances which are the same whether they lead to few or to many berths, and whether the berths are occupied or not, and those expenses have to be distributed, as a rate per ton, over the shipping using the port. Hence economy of port charges can be obtained by concentrating the trade of a country into a few ports. But this may involve a longer and more expensive carriage to point of origin or destination, and there is constant play of these contending forces. England is a small island with a comparatively large number of ports. On the Continent of Europe, on the other hand, the area of distribution or collection runs into many thousands of square miles served in almost all cases by waterways concentrating in the mouths of a few great rivers. The number of ports is, therefore, fewer and the tonnage concentrated in each much greater than in Great Britain allowing of lower dues per ton to obtain the necessary revenue.

In England, again, the inland transport has mainly to be made by road or rail. On the Continent of Europe the goods are carried for the most part on waterways of a width and depth to take barges sometimes nearly as large as ocean-going ships.

Comparison is frequently made of the charges in English and Continental ports to the disadvantage of the former. The explanation can be found in the foregoing paragraphs, and may be summarized as—

(a) Substantial national expenditure not brought on to the port's accounts.

(b) Concentration of a greater tonnage over which to spread the fixed charges and

(c) The larger units and therefore the lower cost of transfer from ocean to land transport. (D. R.-J.)

IN THE UNITED STATES

The outline in the preceding article with respect to port operation in the United Kingdom is generally the operation found in the United States. The obligation of the steamship owner or the master, the method of cargo handling, customs regulation, provisions for customs custody and protection, are practically the same. The placing of all American port facilities under customs protection, however, depends upon the magnitude of the port's trade and the facilities with which the trade subject to customs supervision, operates. Ports commonly have all piers, or certain sections, supplied by supervisory customs agencies for the protection of customs and to facilitate the movement and clearing of merchandise. Likewise, bonded warehouses or bonded transit sheds have grown up, and the general system of providing customs facilities is similar to that of the United Kingdom.

Berthing Facilities.—A principal difference between English and American operation is in the type of facilities. In the quay system, generally adopted in European ports, the berthing structure runs parallel to the shore line and retards expansion because of the cost of land. However, this system probably provides the cheapest form of transfer from ship to shore, and is widely used. Newly created American ports have adopted, where possible in view of the cost of the necessary land and the saving in the cost of construction, the quay system. Generally, this development in America has been limited to ports built up a stream on rivers because of current conditions, lack of space and the difficulty of projecting piers at right angle to the shore line out into the stream.

The ports which avail themselves, for development purposes, of natural coast-line harbours such as Boston, New York and Newport have all adopted the pier system: the building of the structure out into the stream perpendicular to the shore line. The advantages of pier construction are: (1) increased berthing space, (2) building of facilities without interruption to the navigation of the stream itself, (3) less land per pier is required than that which would be used for a quay capable of berthing the same number of ships. A pier, suitable to accommodate four average ocean freight steamers, can be erected using only approximately 400 ft. of shore land whereas a similar structure built on the quay system would use approximately 2,500 ft. of shore front. The pier system has led to a somewhat different method of operation both respecting the loading and discharging of cargo as well as to the general port operation with respect to supporting warehouses and transferring facilities.

Mechanical Handling. — A great difference in the operation of ports in the United States and those of other countries is the absence of so-called mechanical appliances on American piers. The mechanical appliances required on the piers or quays to assist or to totally load and discharge cargoes is dependent upon the class of ships being handled. The steamships operating between American ports and other parts of the world are fully equipped to handle freight from and to the ship and the pier. No necessity has existed therefore for the installation of handling appliances on berthing structures such as are commonly seen in foreign ports.

Berthing Charges. — Another difference in European and American port operation is in business methods. Under the American system the steamship company assumes the entire charge for the berthing of the ship — paying for its berthing as well as its pier space which it uses to discharge or assemble its cargo. The shipper generally does not have imposed upon him any additional or auxiliary charges other than the freight rate which the ocean craft makes for the ocean movement or the flat rate which the inland railroad may charge for the movement to and from the port and to and from the particular pier at which a ship awaiting or discharging the cargo may be berthed.

With no progressive ocean freight or inland freight charge there is no inducement to the merchant, the shipper or consignee, to move his merchandise in any particular fashion which might reduce the cost of such movement, except where speed may be a factor. Moreover, because of the length of time which the merchant is given to move his material and because of certain local customs, the merchant prefers to have all of the merchandise discharged to the dock, sorted out and there held, availing himelf of the opportunity of selling direct from the dock or holding in case of a lower market. Thus the American system of handling merchandise at ports respecting international trade, involving the co-ordination of the inland system of transportation with the ocean system of transportation, is carried on in a relatively expensive manner. This being true, and the expenses being borne by not more than two parties — the owner of the steamship or the inland system of transportation — has caused the erroneous statement to be made that the cost of handling freight in American ports is lower per ton than in European ports.

Location and Development of Ports. — A tendency to develop greater inland ports has been noticed in recent years. Notable instances are the Canadian port of Montreal, and, in the United States, the artificially created port of Houston, Texas, also the agitation for the St. Lawrence waterway development. This latter is an effort to make ocean ports out of strictly lake ports and other interior points. Location of American ports near the coast-line generally has been possible because of favourable geographical advantages. Illustrating the advantages in this respect are the ports of New York, Norfolk, Newport News and Boston. Competition in sections of the United States for the creation of port facilities has caused some States to create ports artificially and to take other means than the general development of that of the older and more important ports on the Atlantic coast. This has sometimes led to the erection by public agencies of facilities operated at a loss in order to attract tonnage from the more important and older ports.

Until quite recently all port development in the United States has been of a private character while that of many other countries has been carried on by sovereign authority, either national, State or municipal and in many instances by a combination of the three, or through the activity of railroad companies. In 1928, however, there was a tendency to establish the development of ports by quasi-public bodies. The reason for this change of attitude is the increased importance placed on ports which the conduct of governmental operations under emergencies of war brought vividly before all public officers and public bodies. Moreover the development of ports situated in adjoining States has been of such great value to industrial progress, that the building of "outports" or smaller ports is being vigorously prosecuted. Thus due to the difficulty of development by private interests of a system of public control, the construction and operation of ports by the creation of "port authorities" is rapidly spreading.

The recently established American port authorities follow, in many respects, the fundamentals and basic organization of the port authorities of other countries. The water-front facilities have become so important to the place at which they exist that it has become a matter of police power of the sovereignty to see that public rights are protected. However, with the conflicts which exist in the legislation of some 48 States, there is no single method of port authority control in the United States. Some port authorities are organized without actual power to purchase, construct or operate port facilities but have police power. Others are formed with police power and with an indirect authority to purchase, construct, manage and operate port facilities on the basis of issuance of bonds, but without the credit of the State pledged to such bonds. Such port authorities have advantage of the low interest rates of sovereignty which creates it. In this respect alone, such authorities have an advantage in the matter of development not within the power of the private enterprise. The port authority is generally not subject to real estate taxes and other taxes which the private enterprise must bear. With this advantage, a development is more easily originated and carried to conclusion by a sovereign power operating through its agency of the port authority than might be expected for a development of the same facility by private capital.

Some of these adventures by quasi or public agencies representing a sovereign power have been attended by marked success, but the value of this phase has not been fully demonstrated to the degree of ownership, control, management and operations such as similar institutions in other countries have demonstrated. Federal regulation of ports rests with two departments of the Government. The War Department has exercised its power through the Corps of Engineers of the U.S. army. Since the World War, legislation has been passed which has placed in the hands of the War Department the duty of assisting in the matter of the development of ports and protection of ports to a greater degree than heretofore existed. Legislation creating the U.S. Shipping Board, likewise instituted a control jurisdiction over ports in certain respects by this body, comparable to that which the Interstate Commerce commission exercises over the interstate commerce of the country by railways. (P. L. G.)

PORTO-RICHE, GEORGES DE (1849–1930), French dramatist, born on May 20, 1849, at Bordeaux. When he was 20 his pieces in verse began to be produced at the Parisian theatres; he also wrote some books of verse which met with a favourable reception, but these early works were not reprinted. In 1898 he published *Théâtre d'amour*, which contained four of his best pieces, *La Chance de Françoise, L'Infidèle, Amoureuse, Le Passé.* The title given to this collection indicates the difference between the plays of Porto-Riche and the political or sociological pieces of many of his contemporaries. In Germaine, the passionate and exacting heroine of *Amoureuse,* Mme. Réjane found one of her best parts. In *Les Malefilâtres* (Odéon, 1904), also a drama of passion, the characters are drawn from the working classes. Later plays are *Le vieil homme* (1911) and *Le Marchand d'Estampes* 1918. He published in 1920, under the title *Anatomie sentimentale,* a collection of extracts from his works, which well illustrates his preoccupation with the *problème amoureux,* and his sense of the inevitableness of the continual duel between men and women. He was a member of the French Academy, and director of the Bibliothèque Mazarine. He died on Sept. 5, 1930.

See Etienne Rey, *G. de Porto-Riche* (1924); Henry Marx, *G. de Porto-Riche* (1924); and H. Charasson, *G. de Porto-Riche (1925).*

PORTO RICO or **PUERTO RICO** (second spelling, restored by the U.S. congress in 1932) is an island of the United States of America. It is the most easterly of the Greater Antilles, situated between 17° 50′ and 18° 30′ N., and 67° 30′ and 67° 15′ W. Its northern boundary is the Atlantic ocean, its southern the Caribbean sea, its western the Mona passage, its eastern the

Virgin Passage. It is situated about 70 m. E. of the island of Haiti, and about 40 m. W. of the island of St. Thomas, one of the Virgin islands and about 1,400 m. S.E. of New York city. It is nearly rectangular, with an average length from east to west of about 100 m. and a width of 35 to 40 miles. Its approximate area is 3,435 sq. miles.

Topography. — The island is the eastern extremity of a chain extending east and west over 1,000 m. and the northern extremity of a chain of smaller islands over 600 m. in length reaching to the northern coast of South America. These islands are the summits of submerged mountain ranges. The deep-sea soundings north of Puerto Rico disclose one of the most profound chasms on the globe, known as "Brownsons Deep." It measures more than 27,000 ft. The surface of Puerto Rico consists of plains from the mountains to the sea, while the interior and much the larger portion of the area consists of an irregular series of mountain ranges, the highest rising to an altitude of over 4 000 feet. These ranges extend from east to west across the island, but are broken in formation, with intervening valleys of surpassing fertility and beauty. The rivers are not navigable except for a short distance from the coast, but afford an abundance of water-power, and a supply for irrigation of the coastal plains and for the towns. The coastal plains are narrow on the southern slope. The principal mountain ranges are of the same geological period and of similar origin. They are of mixed volcanic and sedimentary formation, consisting chiefly of hornblende, gneiss and tuff, embedded in which at the higher altitudes are masses of blue limestone of the Cretaceous period. There is much underground drainage, the rivers often disappearing in chasms to reappear at a distance. Many of the mountains are honeycombed with caves, in some of which are found interesting Indian relics.

Gold mines were worked in the mountain regions and in the beds of the streams for some years in the first century of the Spanish conquest. According to official statistics, 2,700 lb. of gold were shipped to Spain from 1509 to 1536. This was probably the part belonging to the Crown of Spain, being one-fifth only of the amount secured. Some is still to be obtained by washing in the streams, but regular work has long been abandoned. Silver, lead and copper in small quantities were also discovered. Magnetic iron is found in many places in large quantities. It is of high grade and contains over 60% of metal. Transportation difficulties alone seem to prevent development. Manganese is sent to the States in considerable quantity. Marble deposits of the highest quality are found in large quantities. Granite is also found suitable for building. Limestone, gypsum, clays suitable for brick, tile and rough ceramics are abundant. Kaolin of superior quality suitable for the manufacture of porcelain is also found. No coal nor oil has so far been discovered. For the most part the mountain ranges are covered by erosion deposits forming a soil of deep, reddish clay loams and tenacious red clays. So cohesive and compact are these soils that they are maintained even in almost vertical positions. Cultivation is possible and profitable even to the tops of the mountains

Climate.—Puerto Rico is situated just within the torrid zone, but its climate is hardly tropical. The mean January temperature for the island as a whole is 73° F., and the mean July temperature is 79°, a range of only 6". The highest afternoon temperature is 86° and the lowest night temperature 68°. In the city of San Juan the highest temperature recorded is 94° and the lowest 62°. The mean annual temperature for Puerto Rico is 76·5°. The coastal plains have a somewhat higher average of about 78°. In the higher interior regions the mean temperature varies from 70° to 76°, according to the elevation above sea-level. The diurnal change in temperature from day to night is from 6" to 7°.

The average rainfall is 70 inches. For the north coastal region it is about 60 in., for the south about 30 in., and for the central mountain portion about 100 inches. This uneven distribution has been largely overcome by the irrigation systems, which collect in reservoirs the abundant rainfall of the northern side of the mountain ranges and tunnel through to the south plains which thus are regularly watered by irrigation. Winter rains are comparatively light, with a slight increase from February to May and thereafter the general average is maintained throughout the summer months. The rainfall is generally largest from September to November. The rains are sometimes heavy, but are usually of short duration. During the rare passage of a tropical hurricane the period of continuous rainfall may be extended. The average humidity during the day is about 70%, and during the night about 85%.

The trade winds, aided by the daily recurrence along the coasts of the cooi, invigorating sea breeze, constitute a most beneficent provision in the tropics. This is especially true in Puerto Rico. It is situated far out in the Atlantic ocean, nearly 1,000 mi. from the mainland. Thus it receives in full measure the trade winds which blow almost constantly from the northeast, veering sometimes to the east and southeast.

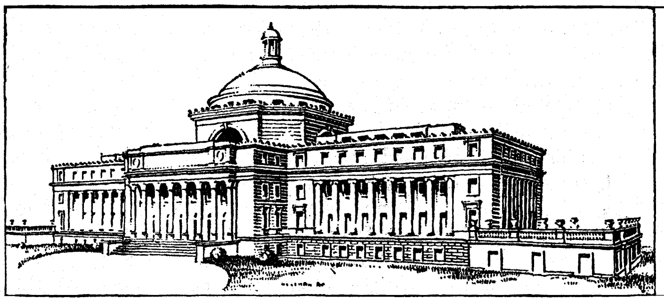
Puerto Rico is in the storm belt of the Caribbean region and is subject to occasional visits from the West Indies hurricane. It has suffered severe losses of life and property from these visitations. Fortunately these visits have been rare. Most of these storms occur from July to October.

Fauna and Flora. — Most of the domestic animals are now found in Puerto Rico. Bats, dolphins and manatees are the only indigenous mammals. As compared with many other countries of similar latitude the bird life of Puerto Rico is very poor. This is partly accounted for by its comparative isolation, and is sometimes explained by the destruction caused by tropical storms. Thus far 162 species and subspecies are recorded for Puerto Rico and the neighbouring islands. Birds of prey are rare. There is but one species of snake and specimens are rarely seen and are harmless. There are several types of the lizard group, feeding mostly on insects. They are harmless, and beneficial to plant life. There are five species of turtles, both of the small and large varieties. There are 291 species of fish.

The physical conformation of Puerto Rico, rising as it does from low coastal plains to mountains sometimes with altitudes of 4,400 ft. covered in most places with a generous and productive soil, is such as to furnish an astounding variety of plant life. The National Forest reserve at Luquillo, is a typical tropical forest with original growths of all kinds almost jungle-like in density and variety of tree and vine and shrub life. Compared with this the carefully cultivated orchards of the fruit growers afford a contrast most striking and interesting.

It is probable that before the coming of the Spaniards the entire island was densely wooded. Now little of the original forest growths remain. But there are coffee plantations, coconut groves, fruit farms and ornamental flowering trees and shrubs both indigenous and imported. There is a long list of what might be considered the common useful trees, among which are the bamboo, palm, cedar, ebony, calabash, whitewood, lancewood, boxwood and logwood. Among the fruit-bearing trees and shrubs are the avocado or alligator pear, orange, lemon, lime, grapefruit, almond, cocoa, coffee, coconut, nispero, pomegranate, gooseberry, raspberry, guava, banana, *plátano,* breadfruit, mango and papaya. Almost all the food plants are grown in Puerto Rico. Among the medicinal, useful and rare plants may be noted chicory, indigo, vanilla, castor, piumbago, ginger, sisal, mallow, pachouli, salvia, elder and aloe.

Government. — From 1493, the date of the discovery of Puerto Rico by Columbus, to 1898, when the first military governor was appointed by the president of the Gnited States, 142 governors ruled the island for Spain, the first being Ponce de León. Nearly all were army officers and most of them of inferior rank. By these officers Puerto Rico was governed practically on the same plan as other Spanish colonial possessions. The governor was supreme in military affairs, and practically so in civil The executive, legislative and judicial functions were for most of the time vested in the captain general. Whatever offices, boards or tribunals existed were used merely for the transactions of routine business. The captain general's authority was not limited except in a general way by the laws of the Indies and by royal decrees. This condition existed until 1870, when under a liberal government Puerto Rico mas made a province of Spain and given representation by deputies, elected by the people, in the Spanish Cortes. This lasted only four years when the provincial deputation was abolished and the island returned to its old status. In 1877 the deputation was re-established, and in 1897 Puerto Rico was given an autonomous government, but it never became operative because of the Spanish-American war and the consequent occupation of Puerto Rico by the American



BY COURTESY OF THE UNITED STATES BUREAU OF INSULAR AFFAIRS
THE CAPITOL IN SAN JUAN. ON THE NORTH COAST OF PUERTO RICO

army in 1898. The military government of Puerto Rico by the United States was of short duration, Oct. 18, 1898, to May 1, 1900. In April 1900 congress provided for a civil government in what was known as the "Foraker act," and on May 1, Charles H. Allen was inaugurated the first civil governor.

The first Organic act served a useful purpose, but the limitations on the exercise of self-government were unsatisfactory. As a result congress passed a new Organic act, which came into effect on March 2, 1917. Under its provisions the governor's term is made dependent on the pleasure of the president. Six executive departments were created: justice, finance, interior, education, agriculture and labour and health. Of these the heads of the departments of education and justice are appointed by the president, the others by the governor. The president also appoints the auditor and the members of the supreme court. The legislature consists of 19 senators and 39 representatives, all elected by the people. A resident commissioner to the United States, paid by the federal government, is elected by popular vote for a term of four years; he represents the island in the U.S. house of representatives, with a voice but without vote, and is recognized by all departments in Washington. There are four political organizations in the island—Union Republican, Socialist, Unification and Popular Democratic. At the 1940 election, the two first-named united on the same candidates, electing the resident commissioner. Groups of both of these parties voted with the Liberals. The Popular Democratic party won the largest number of seats in the legislature. The issues are mainly local, but there is great diversity of opinion as to what the future status of the island should be. All parties, however, seem practically united on the demand that the island be given the right to elect its own governor. Elections are held every four years. Suffrage is universal.

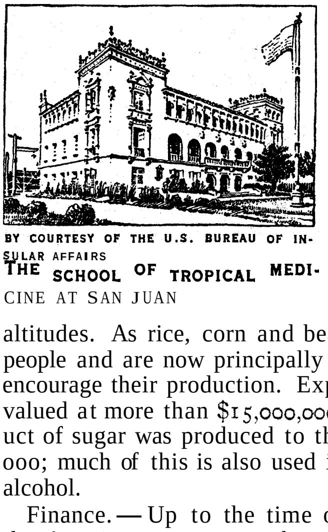
Production. — The products of Puerto Rico are principally agricultural. Sugar cane is grown and sugar is manufactured at the centrals or sugar factories. Tobacco is grown and there are cigar and cigarette factories. The principal products are sugar, tobacco, coffee and fruits.

Sugar. — It is said that in 1548 a rude sugar mill operated by oxen began the production of sugar in Puerto Rico. Eleven mills were in operation in 1581 producing 187 tons annually. With varying progress the amount produced reached 56,064 tons by 1850, and by 1899 it was 66,000 tons. By the time of the American occupancy, practically all the lands suitable for the production of cane had been brought under cultivation. While the cane lands had reached the limit so far as area was concerned, the product was small and the cost of production large. The causes were lack of fertilization, and proper cultivation, and antiquated mills and methods of operation. Then American capital was invested in sugar production, and progress since that time has been rapid. In the southern part of the island irrigation has brought some new land under profitable cultivation, otherwise the area has been almost stationary; but the production has been greatly increased. In 1901 only 68,900 tons of sugar were exported (value, $4,715,000). In 1915 the amount had increased to 427,955 tons (value, $45,000,000. The average production after 1930 was increased to over 900,000 tons. This amount is considerably below the island production capacity, which was restricted under the sugar laws of 1934 and 1937. The remarkable increase in productive capacity is the result of research and experiment, principally by insular government experts, who improved the sugar content and resisting varieties of the cane. The price of sugar has remained low. In 1938 the average price per pound was 2.94 cents; in 1939, 2.99; and in 1940, 2.79. Were it not for the increased production per acre and the conditional payments of the U.S. department of agriculture, losses would have resulted, for it is considered that the average cost of production in Puerto Rico is about 3.3 cents per pound.

Tobacco. — Tobacco has been produced for market since 1614. when by royal decree the colonists were permitted to plant and sell the crop. Small progress was made until 1870, when Cuban tobacco rose to great prominence and demand. For a time the Puerto Rican product was exported to Cuba and sold there as Cuban tobacco. This demand soon diminished and production decreased accordingly until in 1896, the tobacco exports were only one-third of the amount for 1846. Under the American administration, the United States tobacco industry entered Puerto Rico and undertook the production of tobacco and the manufacture of cigars, and the industry enjoyed a growing prosperity. The value of cigars exported increased from $306,000 (1901) to $7,196,365 (1926). The value of leaf tobacco exported increased from $1,232,058 (1907) to $20,587,484 (1927). Thereafter labour troubles and changes in American smoking habits reacted to cause a rapid decline in the Puerto Rican tobacco industry.

Coffee. — While sugar production is limited mostly to the low coastal plains and tobacco to the valleys, coffee is best produced in the higher altitudes, from 600 to 2,500 ft. In the higher valleys of the interior mountain ranges the coffee trees are principally grown. The trees are from six to 20 ft. high, with permanent leaves, a beautiful white blossom and a small flexible trunk only a few inches in diameter. Until the war of 1914–18 the industry enjoyed a growing prosperity. Its markets were mainly European, and these were never fully regained after the war. During the '20s, shipments decreased, but the product commanded a high price. The two destructive hurricanes of 1928 and 1932 still further depressed the industry.

Fruits. — About the only fruits grown in Puerto Rico of which account was made prior to the American occupancy were oranges, bananas and coconuts. The total value of fruit exports increased to $7,665,000 in 1940. The principal fruits now exported are grapefruit and pineapples. Grapefruit and pineapples are also canned extensively. Bananas and plantains are the largest fruit crop, alfhough but little exported. These are principal articles of food and are grown everywhere. Breadfruit is also extensively grown.



BY COURTESY OF THE U.S. BUREAU OF INSULAR AFFAIRS
THE SCHOOL OF TROPICAL MEDICINE AT SAN JUAN

Other Products. — After the end of prohibition, the manufacture of rum grew rapidly, 1,137,235 gal. valued at $5,567,765 being exported in 1940. Upland rice is also produced. Beans are a profitable crop. Corn is grown quite extensively in the higher altitudes. As rice, corn and beans are the habitual foods of the people and are now principally imported, every effort is made to encourage their production. Exports of needlework products were valued at more than $15,000,000 in 1940. Molasses as a by-product of sugar was produced to the value in 1940 of about $1,500,000; much of this is also used in the manufacture of commercial alcohol.

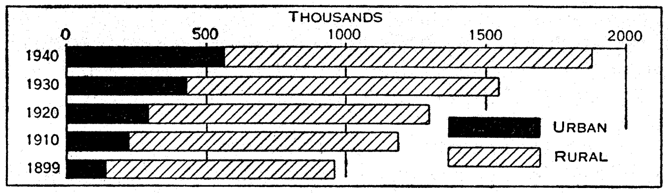
Finance. — Up to the time of the Spanish-American war and the American occupancy, the crown appropriated an annual sum for Puerto Rico; this was the chief source of revenue. In the first year of the military government of the United States, the officers managed to collect $3,316,000. Increases in the amounts of revenue collected continued under the civil government until during the last three years it had reached the following amounts: (1937–38) $16,380,975; (1938–39) $15,424,505; (1939–40) $16,867,933. The total expenditures during these years were: (1937–38) $16,946,823; (1938–39) $16,355,715; (1939–40) $15,393,801. The fiscal years begin on July 1. The principal items of revenue collected each year during the years above stated were: excise taxes $10,000,000; income taxes $3,000,000; customs $1,200,000; insular property tax $400,000; U.S. revenue $1,500,000. The principal items of expenditure were about as follows: education $5,600,000; health $1,800,000; interior $800,000; police $1,200,000; treasury $1,100,000; justice $500,000; agriculture and commerce $370,000; labour $234,000; auditor $181,000; and executive $96,000.

The bonded indebtedness in 1940 was $27,200,000. Of this about $8,000,000 was for public improvements, such as the capitol building, an insane asylum, a penitentiary, hospitals and school buildings. About $7,000,000 was expended for permanent public roads and bridges and about $8,000,000 for irrigation and harbours. These last items are not a burden on the island as a whole, for the irrigation debt is paid by the tax levied on the lands receiving the benefits, and payment of the harbour improvement bonds is entirely met by harbour dues which more than pay in full the principal and interest of the debt. No default has ever been made in the payment of the principal or interest of the insular debt. Its bonds sell at a high premium. Interest rates are not more than 4½%. A sinking fund is provided for the payment of all outstanding bonds, principal and interest at maturity. The limit of insular indebtedness is placed by the Organic act at not more than 10% of the aggregate tax valuation of its property. The assessed valuation of real and personal property in 1941 was $311,800,349.

A comprehensive banking law was passed in 1923, under which proper government supervision, investigation and reports were made. The management of the banks is conservative and increasingly beneficial. The aggregate capital, surplus and undivided profits since the enactment of the law were, in 1924, $8,064,000; in 1925, $7,996,000; in 1926, $9,543,000; and in 1939, $5,700,000. The amount of loans was $28,200,000, June 30, 1939.

Commerce and Transportation.— Trade with the United States and foreign countries was valued in 1900, at $16,602,000; in 1938, at $175,391,961; in 1939, at $169,202,638; and in 1940, at $199,377,724. More than 90% of the island's commerce is with the United States, with which it has free trade. Shipments to the United States rose from $3,000,000 in 1900, to $90,902,156 in 1940. Puerto Rican purchases from the United States increased from $6,000,000 in 1900 to $100,517,184 in 1940. This unfavourable balance was due to extraordinary importations of defence materials. Total exports were in 1936, $99,298,046; in 1937, $114,953,827; in 1938, $82,077,178; in 1939, $86,486,570; and in 1940, $92,347,242. The total number of vessels which entered and cleared in 1940 was 2,424. As San Juan is about 1,400 mi. southwest of New York, which is the principal market for Puerto Rican products, ocean transportation is important. There are two principal steamship lines carrying both passengers and freight. Puerto Rico is becoming a distributing centre for the Caribbean. San Juan has passenger, air mail and air express service by Pan American clipper with Miami, the West Indies and the east and west coasts of South America. Three commercial cables extend from Puerto Rico, and there is government and commercial wireless service. A railroad following the coastal plains extends almost around the island. There are more than 1,300 mi. of public roads which reach all the cities and towns of the island and all parts of the interior. Hundreds of thousands of tons of freight are carried inland from the ports by motor truck, and everywhere there are motor vehicle and passenger service. Automobiles are in general use, the number of motors licensed exceeding 26,000. Many visitors from the States tour the island by automobile in the winter. The number of tourists visiting the island increased from 6,027 in 1936 to 15,842 in 1940.

Population.— The population of Puerto Rico in 1899, according to a census taken shortly after the island was ceded to the United States, was 953,243. In 1920 the population had grown to 1,299,809, and in 1940, to 1,869,255. This last figure represents an increase over 1930 of 21·1%, which is the largest decennial increase recorded since 1899. The population per square mile of land area was 549·8, as compared with 44·2 for continental United States, or with 545.9 for the highly industrialized state of Massa-



BY COURTESY OF THE U.S. BUREAU OF THE CENSUS

URBAN AND RURAL POPULATION OF PUERTO RICO, 1899–1940

chusetts. Of the 1940 population, 566.357, or 30·3%, lived in urban places, that is, in cities and towns of 2,500 or more. The colour line is much less sharply drawn in Puerto Rico than in continental United States. The census returns, which placed 76·6% of the 1940 population in the white classification, may therefore be considered somewhat of an overstatement, but the proportion definitely without admixture of coloured blood is a very substantial one. Practically all of the nonwhite population is Negro or mulatto. The population of the island and its principal cities is summarized in the following table:

Area	Population			Percent of increase	
	1940	1930	1920	1930–40	1920–30
The territory	1,869,255	1,543,913	1,299,809	21·1	18·8
Urban	566,357	427,221	292,841	32·6	45.9
Rural	1,302,898	1,116,692	1,006,968	16·7	10·9
Percent urban	30·3	27 7	22 5		
Principal cities and towns:					
San Juan	169,247	114,715	71,443	47.5	60·6
Ponce	65,182	53,430	41,912	22·0	27.5
Mayagüez	50,376	37,060	19,124	35·9	93·8
Caguas	24,377	[illegible]	[illegible]	[illegible]	[illegible]

Education.— There were probably no schools outside the cities of San Juan and San Germán as late as 1799. Some increase was made in private schools where instruction was paid for, but it was not until 1845 that any public primary schools were provided. In 1899, out of a reported total but 15% could read or write. The total number in all schools at that time was 22,265, or about 2% of the population. Of these 15,108 were boys.

The American military governors at once began reforming education, inaugurating a new system as nearly as possible like the free school system of the United States. In Jan. 1899, Gen. Henry called Dr. John Eaton to assume charge of education. Many changes were made: 16 English supervisors were appointed, who were also inspectors and teachers of English; they paid the teachers, accounted for the textbooks and supplies and secured suitable buildings for the schools. In 1899 an entire new code of school laws was promulgated. Dr. Eaton was succeeded by Mr. Clark, under whose direction the new code was put in successful operation. Mr. Clark was succeeded by Dr. Groff who served until the civil government was established, as commissioner of education. Thus an efficient free school system was established with schools in many localities. The first civil governor, Charles W. Allen, appointed Dr. Martin G. Brumbaugh as the first commissioner under the new law, who, with his successor Dr. Samuel McCune Lindsay, formulated and instituted the present system. In 1940 there were employed in the public schools 6,294 teachers, of whom 4,762 were women. The total enrolment was 286,098, 148,389 in the rural schools and 137,709 in the urban. The legal school year lasts ten months, and attendance is compulsory. There are 2,267 school buildings, with 5,201 schoolrooms. All new construction is of reinforced concrete, and ranges from one-room buildings in the remote country districts to consolidated rural school buildings with ten or 12 rooms, and to beautiful and extensive grade and high schools in cities and towns. Thirty-six new schools were completed in 1940. The expenditure for current expenses for the year was $6,396,398. The total cost per pupil enrolled was $25.85. There are 42 high and 87 secondary units. Courses in agriculture, health advancement, domestic economy, needlework, dressmaking and manual training are given.

The percentage of illiteracy has been reduced to 31·2%. There are adult-adolescent schools for illiterate, English and special students, evening high and eighth grade schools, and a school of the air. In 1940–41 there mere 559 school lunchrooms serving 34,743 students daily. There were 54 private accredited schools, with 11,328 students in 1940. All these accept the requirements and standards of the public schools and are inspected regularly by the supervisors.

University Training. — The University of Puerto Rico was established by the government in 1903. It was later entirely reorganized and is now being conducted as are the state universities of the United States. Its annual students number 4,993. The expenditure for 1940 was $1,678,706. A federal grant in 1935 made possible the construction of several buildings, among them an auditorium, air conditioned and seating 2,100. A feature is being developed of a Pan-American nature, by which students from the United States who desire special training for service in Central and South American countries, and those who from those countries desire special preparation for service in the United States and other English-speaking countries, may receive it there where work in the schools and colleges is conducted in both Spanish and English. A school of tropical medicine has been established under the joint auspices of Columbia university and the Puerto Rican university.

Customs and Habits. — The sugar factories and the larger tobacco and coffee plantations employ large numbers of men and women. There has been a great change in the manners and customs of the people since the American occupancy. The bankers, merchants and other business men have connections in the States and have largely developed American methods and customs. The lawyers, physicians and chief Government officials have for the most part received their professional training in the United States. The English language is taught in the schools and is used largely in business and trade. However, the language of the people is still Spanish and most of the periodicals are printed in Spanish.

The native rural citizen, born on the soil, clings to it tenaciously. After four centuries he still retains much of his Andalusian ancestry. He is rather small in stature and dark. He is unambitious but a good and obedient worker. He is rarely a land owner, but, for the most part, both a tenant and a farm-hand. He receives such pay as his landlord chooses; $1.40 a day is considered the standard wage. The coming of the free schools has awakened an ambition to learn.

Early History. — Puerto Rico was discovered by Columbus on his second voyage to the New World, Nov. 19, 1493. He landed on the western coast and took possession of the island in the name of Ferdinand and Isabella of Spain. This landing was the first and only time the feet of Columbus trod the soil of what is now United States territory. After replenishing his supply of water Columbus proceeded to Santo Domingo, first naming the island San Juan Bautista in honour of Prince Juan, heir to the Spanish throne. Occasional visits for supplies were made subsequent to the discovery, but no attempt was made to establish a colony until many years later. There was a marked difference between Columbus' first and second voyage. After months of trial he had at last been able by favour of the queen to equip his three small craft and collect a nondescript crew of 90 men to set sail on an unknown sea westward to an unknown destination. But when he returned, giving undoubted proofs of his discovery he at once became a hero. On his second voyage 17 ships and several smaller craft and over 1,500 men joined in the venture. Among the hidalgos and persons of rank who were anxious to share with Columbus the expected glories and riches of the voyage was Juan Ponce de León. After a stay in Santo Domingo of some 15 years, during which time he rendered valuable service to the colony, Ponce de León persuaded the governor to supply him with ships and men to make an exploration of the island which Columbus had named San Juan Bautista. With these he sailed in 1508 and landed first at the point he had visited with Columbus. Pursuing his voyage along the north coast toward the east he discovered the bay which afterward became the harbour of San Juan. Because of its excellence the explorer gave it the name of Puerto Rico or Rich Port. By a strange inversion the bay and capital city became San Juan and the island became Puerto Rico. Being favourably impressed, Ponce de León secured colonists and supplies in Santo Domingo and founded a settlement known as Caparra, near the harbour in an almost inaccessible location among the foot-hills. The situation was unfortunate and the colony moved to the island in the harbour on which is now located the city of San Juan. In 1510 Ponce de León became governor by order of King Ferdinand. Explorations were made with a view of finding gold but without much success, and the future did not seem promising for the colony. Trouble with the Indians threatened owing to the efforts made by the colonists to force them to work and dig for gold.

When discovered by Columbus Puerto Rico was peopled by a tribe of Indians known as Borinqueños. These Indians were a peaceful, agricultural people who had developed some progressive tendencies. The social organization was similar to that of the Indians on the northern continent; the unit was the clan and the chief was called the cacique. The cacique lived in a larger house than the others, which always contained the Zeni, or idol of the clan; his powers were supreme, and his wives were many. There would have been no trouble with these kindly disposed natives if the Spaniards had been disposed to treat them fairly. But the settlers were eager for gold and were determined to get it at any cost. The Indians were not used to hard work, having led an Arcadian existence which required little labour to maintain. When forced to dig in the hills or wash for gold in the streams all day under a tropical sun they succumbed or fled to the mountains to escape. The original number of the natives is difficult to ascertain; estimates vary from a few thousand to 600,000. By a system of allotment the whole population was gradually enslaved, and under this treatment the race was in a short time exterminated. In 1582 it was officially reported that none were left; all had died from ill-usage or disease or had successfully escaped to other islands.

Colonial Difficulties. — During these early years of colonization the island did not prosper. While considerable gold was secured the supply was soon practically exhausted. By the enforced labour of the Indians, and then by the labour of thousands of negroes brought from Africa, the gold digging continued until it became so unprofitable that it was abandoned. Its evil influence seemed to bring bad luck, and disaster followed disaster. The Caribs, a savage, warlike tribe inhabiting the southern islands of the West Indian group, made frequent incursions, carrying away what food and property were found and murdering the defenceless inhabitants. Hurricanes destroyed homes and crops. The people began to leave the island whenever opportunity offered. Then followed the attacks of the pirates and the French, Dutch and English freebooters which brought the record of calamities to a climax. San Germán, the most important town after San Juan, was completely destroyed by the French in 1554.

Conditions were so bad that petitions and delegations clamoured for protection. Spain was finally made to see that it would be necessary either to abandon or fortify her possessions. In 1533 the building of La Fortaleza was commenced. Its site was ill chosen and it was never completed as a fort but was converted into the Governor's palace and has since been so occupied. The high point at the entrance of the harbour was then covered by an excellently built and massive fortress which is still well preserved and is known as Morro Castle. San Cristóbal, a still larger and stronger fortress, was also constructed on the Atlantic side of the city. Several other points were fortified and the entire city was enclosed in a strong stone wall, two sides of which are still well preserved. These defensive works made the city of San Juan well nigh impregnable to attack from the sea. Sir Francis Drake attempted its capture in 1595, but the defence was so effective that the attack failed and his fleet retired. Later Lord George Cumberland entered the city by a land attack, but did not capture the fortifications and soon retired. In 1625, the Dutch also attacked and took the city, but did not capture Morro, and after partially burning the city they too retired. For many years, during which the European nations were striving for supremacy, the islands of the Caribbean region became the prizes for which the maritime powers contested; but Puerto Rico was never subjugated and remained a Spanish possession until 1898.

End of Spanish Rule. — The Spanish-American war began on April 21 and closed on Aug. 13, 1898. In May of that year Admiral Sampson, in search of Admiral Cervera's fleet, bombarded Morro for a short time without serious results and then retired. Gen. Nelson A. Miles, commander-in-chief of the U.S. forces, landed his troops on the southern coast of Puerto Rico on July 25. A short campaign followed, but the defensive Spanish forces were weak and retired before the advancing Americans. The people of Puerto Rico refused to join with the Spanish forces in defence of the island, and welcomed rather than resisted the coming of the Americans. When the news of the surrender was received, hostilities ceased and the American occupancy began.

American **Administration.**—On Oct. 18, 1898, the island was turned over to the American forces and Gen. John R. Brooke became military governor. In the work of policing the country, in the accompanying tasks of sanitation, construction of highways and other public works, accounting for the expenditure of public funds, and in establishing a system of public education, the military control which lasted until May 1, 1900, proved most effective in bridging over the period of transfer from the repressive control of Spain to the semipaternal system under the American civil government. But it was hardly adapted to teach a people utterly without political experience the essential elements of self-government. To meet this problem the U.S. congress passed the "Foraker act," under which civil government was instituted in May 1900. Under this act the American element exercised the controlling power; this, however, having proved distasteful to many Puerto Ricans, the Organic law was subsequently amended to give a wider native participation in the Government. The Olmsted act, approved by congress on July 15, 1909, placed the supervision of Puerto Rican affairs in the jurisdiction of an executive department to be designated by the president. He subsequently selected the war department. The people, however, demanded a larger measure of local control. The majority also asked for American citizenship and many other changes. As a result, congress passed a new Organic act (the Jones act), which came into effect on March 2, 1917. Under its terms Puerto Rico became a territory of the United States "organized but unincorporated," and citizenship of the United States was conferred collectively on Puerto Ricans, allowing the right to retain the old status if preferred. Only 288 persons so declared.

Means of transport, educational facilities and labour conditions have greatly improved since the American occupancy. Nearly all the beneficent legislation which has reflected the changing attitude of the people toward the labourer and social betterment has been extended to P'uerto Rico, which is now one of the most advanced of the states or territories which have adopted such laws. Chief among the laws bettering conditions of labour are the following: A law regulating working hours in public works; providing for the sale of public lands to labourers; determining the procedure of claims for wages; fixing the duties of employers in case of strikes; establishing workmen's settlements in the principal cities; providing a free dispensary with minor surgeons in shops and factories; regulating the weights to be carried by labourers; providing for the settlement of strikes and lock-outs; establishing a minimum wage for women and for labourers on public works; regulating the work of women and children and protecting them from dangerous occupations; creating a homestead commission; regulating the employment of minors and providing for the compulsory attendance of children in schools; regulating contracts for wages; providing workmen's accident, sickness and death compensation; creating a general employment agency, But these welfare measures failed to solve the problems of the increasingly overpopulated island with its agrarian economy: Recurring hurricanes, as in 1928 and 1932, joined with declining exports to aggravate the economic distress of the depression. The quota limitations on sugar and the application of the fair labour standards act to Puerto Rico caused a critical condition of unemployment principally among farm workers and needleworkers. The island shared in federal relief and rehabilitation expenditures. Rural resettlement and electrification, reforestation and rural and urban housing projects were completed. The plan to make the island the keystone of the U.S. Caribbean defences resulted in large military and naval troop concentrations.

Bibliography.—R. A. Van Middeldyk, *The History of Puerto Rico from the Spanish Discovery to the American Occupation,* ed. by Martin G. Brumbaugh (1903); *Annual Reports of the Governors of Porto Rico* (1901–40); the Brookings institution, *Porto Rico and Its Problems* (1930); Richard J. and E. K. Van Deusen, *Porto Rico: A Caribbean Isle* (1931); Bailey W. and Justine White Diffee, *Porto Rico: A Broken Pledge* (1931); Antonio Pedreira, *Bibliografia Puertorriquena* (Madrid, 1932); Howard A. Meyerhoff, *Geology of Puerto Rico* (Puerto Rico, 1933); José C. Rosario, *The Development of the Puerto Rican Jibaro and His Present Attitude Toward Society* (Puerto Rico, 1935); Tombs Blanco, *Prontuario Histórico* (Madrid, 1935); Trumbull White, *Puerto Rico and Its People* (1939); Gayer, Homan and James, *The Sugar Economy of Puerto Rico* (1938); Daisy Reck, *Puerto Rico and the Virgin Islands* (1939); American Guide Series, *Puerto Rico: A Guide to the Island of Borinquen* (1940); *Reports* of U.S. Bureau of the Census (H. M. T.; X.)

PORT PHILLIP: see Melbourne.

PORT PIRIE, a seaport of South Australia situated near the northeastern extremity of Spencer Gulf. The harbour is poor, and Pirie won its place as the second port of the state because it is the nearest convenient maritime outlet for Broken Hill (*q.v.*), 205 miles inland (northeast). At Pirie the Broken Hill ores are smelted with coal from Newcastle (New South Wales), the smelters (which were burned down in 1920) being on a large scale.

The town is also the centre of an important wheat-growing area and wheat and minerals (zinc and silver concentrates and pig lead) constitute the bulk of the exports. (Pop., 1933: 11,680. Trade: £4,000,000 to £5,600,000 of which exports = £3,600,000 to £5,400,000. Total shipping, c. 750,000 registered tons. Trade figures are of 1927.)

PORTRAIT PAINTING. A portrait is a work of art representing an individual. It has been called a materialization of an individual soul. The pleasure we derive from the contemplation of a portrait is due to its value as a likeness as well as to its aesthetic qualities. A cast taken from life is not a portrait, nor is a photograph, nor any painting, drawing or sculpture which does not possess the harmony of line and colour which alone can give it aesthetic value.

A composer who wishes to give the impression of the song of birds does not imitate the notes of real birds, but invents notes which harmonize with his music. When heard alone they would have no meaning, but as part of the composition they convey to us the sensation of hearing birds sing. So the colours and lines of a picture gain significance only through their relation to each other. As in a poem not one word can be changed, so in a portrait not a touch can be added without unbalancing the whole. But whatsoever the aesthetic quality of a picture may be, it cannot be called a portrait unless it awakens in us the feeling that we are facing an individual with his physical and mental characteristics.

HISTORY

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When the ancient Egyptians buried their dead they enclosed in the tombs statues representing the dead so that the Ka might find its earthly habitat in them. For this reason the statues of the ancient empire, and again of the Saïte epoch were of amazing realism: true portraits because they were at the same time superb examples of decorative sculpture. But as far as we kno , Egyptian painting remained a mere colouring of figures which had to conform to rigid formulae dictated by the priests.

The encaustic portraits found in Egyptian tombs of the Roman period are of small artistic value. As yet no fine examples of Greek or Roman painting have been unearthed. But from contemporary writers we learn so much about them that we have reason to believe that they were equal in quality to the sculpture. Inferior copies, such as the copy in mosaic of a painting representing Alexander the Great in the Battle of Issos, give us some idea of their style and colouring. The paintings of Pompeii and Herculaneum show that the Roman artists had an impressionistic method of indicating form and dividing colour.

As early as 1326 B.C. portraiture is mentioned by the Chinese. In accordance with the doctrine of filial piety, Confucius, in the 6th and 5th centuries B.C., taught that portraits of great men should furnish to the coming generation stimulating and ennobling examples. In temples some portraits of the best period have been preserved. Limited to line, the painters succeeded in producing the sensation of perfect modelling with mere contour. The primary condition of such a picture is to decorate a flat wall; the spaces covered are flat spaces. The artist invents a harmony of colour which intensifies and gives added charm to the harmony of line.

In Europe, for more than ten centuries, the Catholic Church placed restrictions on artists similar to those of the Egyptian priests. In A.D. 325 the Council of Nicaea proclaimed that the "composition of pictures should not be the invention of the artist but the rules and traditions of the church." In the 7th century St. Gregory the pope wrote, "Let the churches be filled with paintings that they who do not know their letters may be able to read on the walls what they cannot read in the manuscripts." It goes without saying that portraiture could not flourish under these conditions, since individualization was prohibited.

In Italy in the 13th century, Giotto was the first to introduce into his frescos of religious subjects groups of spectators for which his friends posed. Thus we have in a group of citizens on the fresco "Paradise" in the chapel of Bargello, in Florence, a portrait of Dante. Filippino Lippi (1457–1504) paints himself with Botticelli and Pollaiolo in the Brancacci chapel. Ghirlandajo (1449–1494) places himself and his family and the donors on the fresco in the Capella Tornabuoni.

Fresco painting developed in the Italian artists the ability to work very rapidly and therefore, very broadly, to ignore all possible detail. In Flanders the damp climate was so unfavourable for its use the artists perfected the more durable process of oil painting, which permitted them to work on panels with the same attention to detail which they had devoted to the miniatures of the manuscripts.

In spite of the rules of the church, the Gothic sculptors and illuminators had developed an astonishing degree of realism in their work, the realism which culminates in the painting of the Van Eycks.

In his portraits, which have never been surpassed, Jan Van Eyck (1385?–1441) shows us people of solid flesh and bone, on whose faces life has traced its story, and because they are real, we see their souls. He gives poetry to reality.

Rogier Van der Weyden and Hans Memling prepare the way for Italianism.

The Flemish love for detail was often carried to an excess by German artists. However, two men of genius, Holbein and Diirer, knew how to subordinate this detail and make of it a powerful aid in characterization. Just as an orchestra brings out a soloist, so the backgrounds and accessories in their portraits evoke sensations which make the impression of the figure all the stronger. As a thinker Durer ranks with Leonardo and Michelangelo; as an objective painter of portraits Holbein equals Rembrandt and Velasquez. His portrait drawings are the most striking examples of individualization. Never have lines expressed more powerful modelling, profound psychology, rhythm and harmony. When Germany was torn by religious strife he found at the court of Henry VIII. in England the right field for his work. Lucas Cranach (1472–1553) was an independent, positive artist. Antonello da Messina (*c.* 1414–*c.* 1493), who is said to have studied in Flanders and to have introduced the technique of oil painting into Italy, combined Flemish love of realism with his Italian sense of beauty.

The classic traditions had never quite died out in Italy, and were revived by the study of antique examples. The result was a magnificent school of portraiture which brought out the finest qualities of the sitter and artist. The Renaissance worshipped heautiful aristocratic types and the artists delighted in painting them at their best, accentuating their nobility of character by harmonious composition and colouring, ignoring all disturbing detail. If Waetzoldt has compared a portrait to a lyric poem, me are reminded by these Italian portraits of Shelley's definition of poetry:

> "Poetry is the record of the best and happiest moments of the highest and best minds. . . . Poetry thus makes immortal all that is best and most beautiful in the world. . . . Poetry redeems from decay the visitation of the divinity in man."

The artists were pioneers and delighted in solving new problems.

Many of the great painters of religious subjects excelled in portraiture. Leonardo da Vinci (1452–1519), in his search for greater truth, sacrificed the pure colouring and line of the primitives, enveloping his modelling, giving depth to his shadows. Raffaello Santi (1483–1520), Andrea del Sarto (1486–1531), Andrea del Castagno, Benozzo Gozzoli (1420–98), Pontormo (1494–1557) and Bronzino (1502–72) were masters in portrait painting. The Venetian, Giambattista Moroni (1510–78) was, however, the first artist to devote himself exclusively to portraiture.

In Venice conditions were favourable to the development of a brilliant school of portraiture with Bellini and Giorgione as leaders. There were fewer religious restrictions and the general atmosphere was one of wealth and splendour, of gaiety and moral and physical health. This reflects itself in the masterpieces of Titian Vecelli, whose rich colouring and profound insight into human nature places him among the greatest portrait painters. Sir Joshua Reynolds speaks of "the unaffected air of the portraits of Titian, where dignity, seeming to be natural and inherent, draws spontaneous reverence." Tintoretto, Sebastiano del Piombo, Paolo Veronese and Lorenzo Lotto have left us portraits of great strength and beauty. When the joy of blazing new trails was over and Italian painters settled down to inventing formulas for giving their sitters the aristocratic appearance they desired, the art degenerated into mannerism.

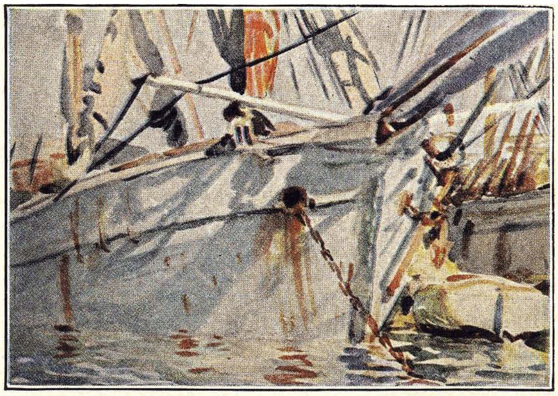
In Holland the reformation triumphed after a struggle of 80 years against the Spanish yoke. In 1579 the seven Dutch provinces had formed a republic which developed into the most civilized State of the times. Tolerance attracted to it those who were persecuted for their advanced ideas in other countries. Wise laws raised the standard of the people and a vast trade brought contacts with all countries of the world. General wealth and culture was the result. The Dutch burghers, who had accomplished so much, did not desire to ape aristocracy. Their success had given them self-respect and they wanted portraits which showed them as they were. This gave their great artists a most ideal opportunity. Their knowledge of composition had free rein in great group paintings ordered by societies and guilds to adorn their meeting halls and so perpetuate the memory of the men and women who had rendered services to their country. Little wonder that painting became the highest developed form of Dutch art. The painters reflected the love of independence in their work. They saw with their own eyes.

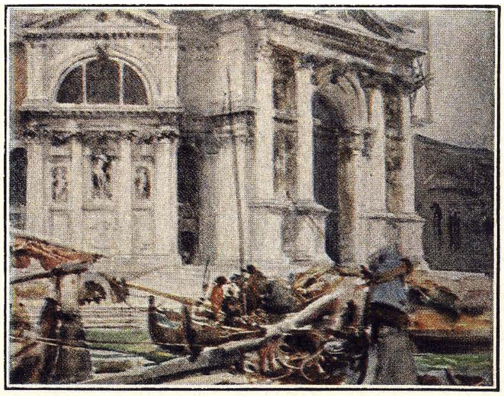
Rembrandt van Rijn (1607–69) and Frans Hals (1580–1666) are the great portrait painters. Each looked at life from an entirely different angle and treated what he saw with entirely different methods. Hals is known as the painter of laughter, but it is not only the laughter of merrymakers; it is also the smile of the man of the world too proud to show emotion—laughing so as not to weep. His amazing knowledge of anatomy permitted him to treat these fleeting expressions with an assurance and breadth of touch which fascinates.

Rembrandt was a profound student of human nature for whom every form, condition and action had its significance. Character and soulfulness interested him more than perfection of form. He saw with the eye of a lover, a lover of humanity, revealing beauty where it is least expected. What Holbein accomplished with line Rembrandt obtained with colour, with his golden light and luminous shadows. His etcher's point has left us portraits which are the classics of etching. (See DRYPOINT: Portrait of Arnold *Tholinx.*)

Among the numerous Dutch painters who devoted themselves to portraiture must be mentioned Bartolommeo Van der Helst and Jan Steen. As with all other schools, decadence began when the Dutch tried to reduce the methods of the masters to formulae.

Spanish artists always remained very free from academic tendencies. Their portraits are therefore unusually fine,





BY COURTESY OF (TOP) THE METROPOLITAN MUSEUM OF ART, NEW YORK, (BOTTOM) THE DEPARTMENT OF FINE ARTS, BROOKLYN MUSEUM

AN OIL PORTRAIT AND TWO WATER COLOURS BY SARGENT

"The Wyndham Sisters," painted in 1900 by John Singer Sargent (1856–1925), an important example of Sargent's portraiture, the type of work for which he was most widely known. He was equally a master of the technique of water colours, of which two examples are reproduced. Left "In a Levantine Port." Right "Santa Maria della Salute, Venice"

Dominico Theotocopuli, called El Greco, a Greek, born in Crete, settled in Spain after working in Titian's studio. His early influences were doubtless Byzantine. He owes perhaps to Tintoretto his impressionistic handling. Through Ribera (1588–1656) Caravaggio became the inspiration of most of the Spanish artists. Zurbaran (1598–?1669) excelled where most of the masters failed: in portraits of children.

It is difficult to trace the influences which might have affected Velasquez (1599–1660), so completely did he see with his own eyes. Even his technique was a new departure. He was the first to use oil as a sole medium in order to paint directly on his canvas without preparatory underpainting. This made possible the accurate values which give depth and air to his pictures. Although as a court painter to Philip IV. he was forced to repeat the same subjects many times, his sincerity and interest in the pictorial qualities of his sitters kept his vision keen. There was so much to fascinate him in light, colour and atmosphere besides the personality of his models, that his portraits are perhaps the most real ever painted. There is no evidence of preoccupation with technical problems. His palette was simple and his brush responded to his mind like the instrument of a great musician. His portraits make their appeal through truthfulness, refinement and reserve. Elie Faure compares him to Beethoven, because he possessed the supreme virtue—heroic simplicity.

Goya y Lucientes (1746–1828) kept alive the best Spanish tradition when in other countries artists had forgotten how to paint, and has had a great influence on modern art.

The wealth and wholesome vigour of Flanders which in the 17th century enjoyed the advantages of commerce with all parts of the world, found an interpreter in Petrus Paulus Rubens (1577–1640). The portraits of his family, especially of Helena Fourment, his second wife, are the best examples of his art and reflect his joy in life, his health and vitality. His pupil, Anthony Van Dyck, although brilliant when he painted his early portraits, as court painter to Charles I. of England, was so overwhelmed with work that he rarely painted more than the head himself, leaving the rest to assistants. The hands were painted from models and this, more than anything else, weakened the character of his portraits. He also used landscape backgrounds which shock our modern taste accustomed to the reflections and colour shadows of outdoor painting.

These insincere methods were unfortunately adopted by the English portrait painters of the 18th century. England had imported her portrait painters, Holbein, Rubens and Van Dyck, without developing any native talent except for some miniaturists such as Isaac Oliver and Samuel Cooper. (See MINIATURE PAINTING.)

Puritanism brought all art to a standstill. Under the reign of Charles II. other foreigners became the vogue—Sir Peter Lely (Dutch) and Sir Godfrey Kneller (German). William Hogarth (1697–1764) was the first native English painter of real merit. He rebelled against the prevailing insincerity in art and wrote of his "contempt of the portraits by native and foreign impostors who puffed and flattered themselves into fashion. By this inundation of folly and fuss I was much disgusted and determined to try if by any means I could stem the current and by opposing, end it." The few portraits he painted are of a high order, too true, perhaps, to make him popular.

It is a curious phenomenon that England in the 18th century should of a sudden develop a group of important portrait painters, such as Sir Joshua Reynolds, Thomas Gainsborough, George Romney, Allan Ramsay, John Opie, Hoppner, Sir Thomas Lawrence and Sir Henry Raeburn. Demand undoubtedly had a great deal to do with it. Their work reflects a refined, healthy, self-contented atmosphere that makes one feel as if one were moving in the best society. This, perhaps, explains the popularity of these pictures. Healthy complexions and beautiful clothes gave the artists an opportunity to make colourful pictures but there is little research into character. Shop methods prevailed. Like Van Dyck, Reynolds painted only the head. In this way he was able to paint about 150 portraits a year for several years.

Gainsborough's was the most artistic nature but he was more interested in a silk gown than in the sitter. Only an extravagant wife kept him from abandoning lucrative portraiture for landscape painting which he loved. (F. T. W.)

France.—Jean Fouquet (1415–1485), is the first of the great French portrait painters. Without departing from the technique of the miniature painters, with their gold background and attention to minute detail, he none the less treats the face and costume more broadly.

Jean and François Clouet (their dates are, approximately, Jean, 1485–1541?; François, 1510–72), attached to the court of Francis I. and his three successors, have bequeathed to us the physiognomy of these princes and their counsellors. Sharing in the Italianism which dominated manners at the period of the Renaissance and representing the old feudal order on which they rested their claims, these men are at once subtle and fierce; their sparkling glances, their flashing or gloomy eyes, their humble or haughty characters, their brilliant or sober costumes, all are studied with scrupulous detail, all speak to us of their hates, their fears, or their hopes. We look at their paintings like historical documents whose truth heightens their pictorial value.

Antoine Lenain (1598–1648), along with his brother Louis (1593–1648), are two portrait painters of high rank. The period which they represent is less violent; the power of royalty has triumphed over feudalism. But the realistic tradition of the Middle Ages still survives and resists the more decorative and more impersonal academic tendencies.

Philippe de Champaigne (1602–74), portrait painter of Louis XIII. and Richelieu, introduces a new element—the pomp of courts and the fashion of the official portraits. He portrays the majesty of royalty, flattering his models a bit in the way of nobility and dignity, and he paints the glowing colours of their royal vestments. Mignard (1610–95), and after him Tocqué (1696–1772), in his great portrait of Marie Leczinska, amplify and enrich the opulent style of the official portrait.

The sweeping lines of materials in rich folds become still more decorative in the eighteenth century. They give an air of awkwardness to the persons set off by them. Rigaud (1659–1743) less cold and simpler in his art, one of the fine talents of the end of the 17th century, is surpassed in brilliance by Nattier (1685–1766), whose famous "blue" has become celebrated; and especially by Largillikre (16j6–1746).

The latter returns to the naturalistic tradition with all the opulence of a palette worthy of Rubens at the service of a rather subtle understanding of the human soul. He defines the features clearly, he selects the characteristic detail to mark a momentary state of soul. He has left us a considerable number of magnificent portraits. His portraits of women have all the charm, all the grace and all the sumptuousness of that delightful century. The stiff school of Mignard is definitely vanquished by charm and light. It is not yet the famous "rayon rose" of Boucher. It is simply the harmonious balance of all, the joy of painting materials and beautiful flesh. Largillikre, like Oudry, is often influenced by Snyders and he knows how to enliven a portrait with a remarkable bit of still life, without going contrary to the spirit of the composition.

Charles Vanloo (1705–1765), in the portrait of Louis XV. at the Chase, introduces the element of landscape more extensively than ever before in portrait painting. Watteau (1684–1721), Chardin (1699–1779), Boucher (1703–1770), Fragonard (1732–1806), Greuze (1725–1805), are not actual portrait painters, but who would pass them without mention? Their varied palettes, the delicacy of their composition, their expressive design, compel us to note them and to class them among the greatest portrait painters. Perroneau and Latour, most famous of pastel painters, both broke deliberately with the tradition of official portrait painting. Latour is never constrained. All his portraits give the impression of having been fixed on the canvas at the moment when the subtlest smile of the subject is responding to a witty word. Madam Vigée-Lebrun (1755–1842), with her charm and grace, concludes the achievement of this brilliant century and fittingly introduces the next. (C. MAS.)

Already under Louis XV. the classic reaction had begun, due largely to the influence of the scholar Winckelmann. In 1764 the translation of his *History of Art Among the Ancients* appeared in which he exhorts the artists to take their models from antiquity. Piranesi's prints also served to draw attention to the art of ancient Rome. Philosophers and writers such as Diderot and Caylus attacked artists for their subservience to fashionable tastes. During the Revolution, just as in politics, theorists went to the limit of the absurd declaring that beauty could be obtained only through calculation by knowledge of the antique. Louis David (1748–1825) who became the apostle of this creed painted some truly fine portraits in which, however, reason takes the place of passion. Gérard, Girodet and Gros were not his equals. Prud'hon alone had an artist's vision, but due to the use of bitumen his paintings deteriorated.

The next generation which had grown up during the excitement of the Revolution and of the wars of the Empire rebelled against this art of reason. Géricault who died very young, and his friend, Eugène Delacroix (1798–1863), were inspired by the English landscape painters and introduced their brilliant colours and free methods. Delacroix fought classicicm with a "hate of systematic painting," but he, himself, distorted truth. For this reason his portraits are inferior to his compositions. A pupil of David, Jean Baptiste Dominique Ingres (1780–1867), enriched the field of portraiture with admirable pencil drawings. His painted portraits do not possess the same charm. His pupil Flandrin continued his decorative style. The revolt against Ingres and Delacroix was led by Courbet (1819–1877) who introduced the realism of the great Spaniards and Dutch into French art. In his "Funeral of Ornans" every figure is a portrait painted directly from the model. Rebelling against classicism and romanticism alike, he wanted to paint the life of his time in a method which his contemporaries could understand. That is the most important lesson taught by modern art, that beauty is all around us, if we only have eyes to see it.

From now on most of the best French portraits are painted by artists who did not take up portraits as a vocation. Daumier did a striking portrait of Berlioz. Jean Francois Millet's (1814–1875) portraits of his family and friends are as virile and as full of pathos, emotion and tenderness as his compositions. The landscape painter Corot (1796–1875) made a great contribution to modern painting with his exquisite portraits of woman. He sees women as pure nature, without sentimentality, and he is comparable to Jan van der Meer of Delft in the beauty of his colour and the strength of his construction. The portrait is the touchstone of an artist's ability.

Nothing bore richer fruits than the discovery of Japanese art and the influence of the Impressionists. Tired of the harsh, cold studio light, artists began posing their models in the open or in rooms flooded with sunlight. Muddy tones gave way to luminous shadows and reflections. With Edouard Manet (1823–83), Edgar Degas (1834–1917) and, above all, with Auguste Renoir (1841–1919) and Paul Cézanne (1839–1906), a new conception of painting developed. Art is at last free from the nightmare of classicism. The new ideas were applied especially to portrait painting by Anders Zorn in Sweden, Peter Severin Kröyer in Denmark, Sorolla y Bastida in Spain, and by others. It was especially the American-born James McNeill Whistler (1834–1903) who came under the influence of Japanese art. In his writings as well as his painting he focussed attention on the necessity of decorative qualities in a portrait. No one knew better than he the value of the silhouette against a background rendered interesting by discreet arrangement of flat spaces. His compatriot, John Singer Sargent (1856–1925), who, like him, spent most of his life abroad, became one of the most popular portrait painters.

It is significant that both these men made their homes abroad, while in America foreign artists, often inferior ones, were and still are popular. Yet America can boast of many able and talented portrait painters. Most of them had training abroad and their work can hold its own with that of their European contemporaries. It cannot be said, however, that a typically national style has developed. Even George Bellows (1882–1925) and Abbott Thayer (1849–1921) show European influences. The same applies to other American painters. Art has become cosmopolitan.

Fortunately the growing interest of Americans in modern art is creating a demand for colourful portraits, so artists should give their talent freer rein. Perhaps Grant Wood (1892–1942) sounded a new note in his "American Gothic" with its bold colour and uncompromising realism. The portraits of Luigi Lucioni (1900–) combine true decorative qualities with sincere characterization. He says of himself: "I try more and more to create reality with the simplest means and with all essential detail. But I feel that all this should be part of a design, which I believe every canvas must primarily possess." This should be the aim of every true portrait painter.

PROBLEMS AND TECHNIQUE

While the old masters excelled in portraits of men, man's modern attire makes it most difficult for an artist to obtain satisfactory results. The harsh collar, the drab colouring and the standardized cut all unite to ruin the effect of the finest head. Women, on the contrary, have much greater freedom than the women who posed for the old masters, with their rigid garments and their stiff attitudes prescribed by fashion and convention. However, the use of cosmetics is a great drawback. Rouge, lipstick and powder conceal, camouflage so to speak, the fine modelling on which a great portrait depends and they defeat their own purpose by rendering the surface of the skin opaque. The natural skin is semi-translucent and therefore more luminous than anything that can be applied to it. As long as cosmetics are generally used there is little hope that the finest type of portrait will be appreciated. Paint and powder are used to deceive, to produce an artificiality which does not give beauty to commonplace, and which makes common the most beautiful.

For a connoisseur, "the question of portrait painting is a matter of birth, associations and character. In other words, one cannot expect a man born and bred in a low environment and associating with people of his own status to understand the character of a noble sitter; nor can he have any insight into the essence of such a person's nature. Therefore, he cannot paint a portrait of such a one. The grand manner is a question of grand association. If it is mere imitation, it is worthless and shows how spurious it is."

Psychologically different types cannot be expected to understand each other. This must be considered when people offer their criticisms of a portrait. Portraits which are entirely satisfactory to the family of the sitter often displease outsiders. The sitter himself may be unsympathetic to them. For this reason the artist and client must be careful in accepting criticism without making due allowance for difference of temperament and the state of mind which has much to do with opinion. Mood, health, age, sex and eyesight are factors to be counted with. A man's portrait may delight girls and meet with adverse criticism from men. A shortsighted person can never see a portrait as it should be seen. A bilious critic can never be expected to find beauty in anything. From day to day we change our opinions. What we liked yesterday may not appeal to us tomorrow. An artist can class people psychologically by the remarks they make about a portrait; one will see a benevolent smile where another sees a sneer. One notices a frown where another finds thoughtfulness. Then according to the occupation of the beholder certain things attract undue attention. A physician will notice the anatomy, a tailor the clothing. Likeness, the *sine qua non* of the portrait, is after all very relative.

It is curious how blind most people are to the characteristics of those around them. The artist will often reveal traits which are unsuspected—good as well as bad. Any one who wishes a flattering likeness should endeavour to keep his relations with the artist very cordial. Abbott Thayer explains in a letter to Royal Cortissoz the reaction of the artist to his sitter: "The violin, whose strings ring whenever their note is sounded by an outside instrument, is pure symbol of the poet. In the poet cumulative images of every form of beauty begin in earliest infancy to occupy the brain, till, in his early maturity, these have become true touchstones, like the violin string. Let the painter once look upon a person who has, beneath no matter how many surface defects, one dominant greatness—purity at heart and fiery love of truth and beauty—and in his own heart the image of such a person-

PORTRAIT PAINTING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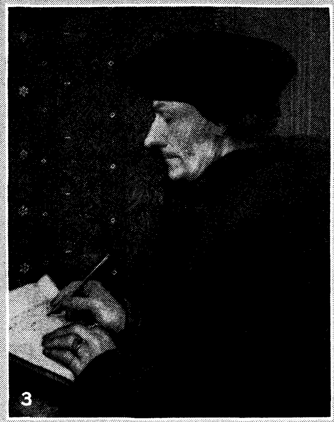
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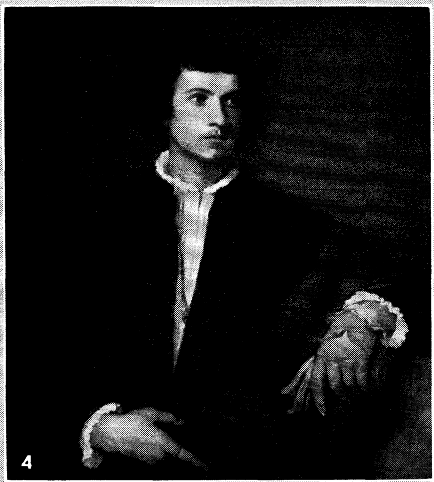
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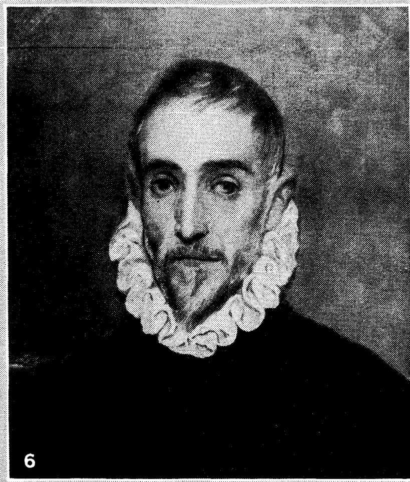
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PORTRAITS BY THE OLD MASTERS

1. "Portrait of a Man" by Jan van Eyck (1385–1440). Flemish
2. "Company of St. George" by Frans Hals (1580–1666). Dutch. In the Frans Hals Museum, Haarlem
3. "Portrait of Erasmus" by Holbein (1497–1543). German. In the Louvre
4. "Man with a Glove" by Titian (Tiziano Vecellio, c. 1477–1576). Venetian school. In the Louvre
5. "Jan Six" by Rembrandt van Rijn (1606–69). Dutch. In the Six Gallery at Amsterdam
6. "Portrait of a Man" by El Greco (Domenico Theotocopuli, c. 1542–1614). Spanish school. In the collection of Col. Michael Friedsam.
7. "Portrait of Mlle. Rivière" by Jean A.D. Ingres (1780–1867). French In the Louvre
8. Detail from "The surrender of Ereda." showing the head of General Nassau, by Diego Rodriguez de Silva y Velazquez (1599–1660). Spanish. In the Prado
9. "Mrs. Graham" by Thomas Gainsborough (1727–88). English

PORTRAIT PAINTING

BY COURTESY OF (1) FREDERICK T. WEBER, (2) THE HISPANIC SOCIETY OF AMERICA, (3) THE PHILLIPS ACADEMY, (10) NY CARLSBERG GLYPTOTHEK; PHOTOGRAPHS, (4) BERNHEIM JEUNE ET CIE, (6, 7) COLLECTION ARCHIVES PHOTOGRAPHIQUES, (9) BRAUN AND CIE, (11) GIRAUDON

16TH CENTURY PORTRAIT AND EXAMPLES OF MODERN WORK

1. "Mother and Daughter," by Frederick T. Weber (1883–), American
2. "Don Raimundo de Madrazo y Garreta," by Joaquin Sorolla y Bastida (1863–1923), Spanish
3. "Woman in Green Velvet," by Abbott H. Thayer (1849–1921), American
4. "Portrait of the Painter," by Paul Cézanne (1839–1906), French
5. "Lady Orpen," by Sir William Orpen (1878–1931), English. In the Tate Gallery, London
6. "Portrait de Jeune Fille," by Hilaire Germain Edgard Degas (1834–1917), French
7. "Portrait de Mme. Charpentier," by Pierre Auguste Renoir (1841–1919), French
8. "Phil May," by Sir J. J. Shannon (1862–1923), English. In the Tate Gallery, London
9. "Portrait of a Man in a Broad Brimmed Hat," by Hans Holbein (1497–1543), German
10. "Members of the Committee for the French exhibition of Fine Arts at Copenhagen," by P. S. Kroyer (1851–1909), Danish
11. A pencil Portrait, by Jean A. D. Ingres (1780–1867), French

ality wakes into brilliant ringing clearness and takes the helm, saying: 'Watch this being! Thou wilt surely see, now and then, the being she really is (it's now a she!) come forth and be fully in sight. Watch, then, and take in how she looks, for in those aroused moments she dominates the whole face and body, ruling all their details into her heavenly form.' " Breaking appointments, coming too late to sittings, bargaining over the price, making remarks about the portrait before the artist asks for criticism, can mar the spirit that should reign during the pose. Hatred and contempt can find their way into the portrait. We have examples of this in Goya's portraits of the Bourbons and in some of Sargent's portraits; and often when artists paint from models of a race they dislike.

The artist owes the greatest consideration to his sitter and should avoid fatiguing him. A comfortable position is necessary if the expression is to be natural and the sitting should be a delightful experience to both the artist and the sitter. Van Dyck realized this and would often invite his sitters to dine with him so that he could study their expression when they were at their ease. Most people will be self-conscious and stiff at first but after some time will fall into natural poses. It is therefore wise to make small preliminary colour sketches until a good pose is found. This method has the added advantage that it gives the client an opportunity to express his opinion before the real work begins. An artist can do many different portraits of the same person. They may be all good and yet the client will have his decided preference for one.

It is the duty of the artist to find out what his client wants. Far from being a hindrance this may lead him to new ideas, just as the restriction of rhyme can suggest new thoughts to a poet. The greater the artist the more willing he will be to put his faculties to a test. Of course, this does not mean that he should do anything against his better knowledge. Holbein painted Erasmus in many different poses but the profile in the Louvre alone gives us the impression of greatness. Often the profile is the only advantageous view of a head and yet there seems to be a prejudice against it. Some people think it is easier to do. It is said that some of the men who had their portraits done by Rembrandt in large groups refused to pay him because he did not show their full face. Needless to say, it requires just as much knowledge to build up the modelling of the side face as it does to paint any other view of the head. From a decorative standpoint a profile is certainly the most advantageous. It predominated in the early Italian portraits.

Lighting presents many difficulties and so much depends on it that it requires the greatest attention. We have seen how largely the effects of the old masters depended on lighting. Holbein, Clouet and other early painters posed their sitters in full light which cast as few shadows as possible. Leonardo let the light fall from above to accentuate modelling. Rembrandt evidently used a small window which concentrated the light on one part. Ribera and his followers are known for their harsh light effects. It is evident that by manipulating the light different characteristics can be brought out or suppressed. The old masters generally posed women facing the light; while with men they let shadows accentuate the features.

The pose of the body and hands can be a great aid in obtaining a likeness but if too much emphasis is laid on action the attention can be diverted from the head. For the ancient Greeks the body had as much significance as the head; now after ages of neglect, it is coming to its own again, and the modern artist should make the most of this opportunity. The choice of costume is of the greatest importance. As every woman knows, different dresses bring out different qualities in their face. Often when an artist is unable to obtain the desired expression he finds that changing the dress is all that is necessary. The lines of the costume react on the lines of the face just as in music a note has its overtones. This is why artists are always glad to use scarfs, furs or anything they can arrange themselves on their sitters.

One of the most difficult problems is that of the background, which is just as important as any other part of the portrait. It can be compared to the accompaniment in music, strengthening by relative values the illusion of colour and form in the figure.

Each portrait presents its own individual problem. The surest way to fail is to try to develop a formula. It is impossible to paint two subjects with the same methods. For this reason great artists often have stage-fright before beginning a portrait. The brush work which makes the work of Rembrandt, Hals and Velasquez so astonishing was certainly not planned in advance but dictated by the inspiration of the moment and the vividness of the impression made on the artist. This does not mean that the artist should make experiments on his clients. He should not accept a commission to paint a portrait before he has solved all technical problems on portraits of friends or of hired models. It is one thing to paint from a hired model, accustomed to sit for many hours and indifferent about the results, and another to deal with a client easily fatigued, pressed for time and entitled to have a word in the proceedings.

A portrait painter can rarely put his canvas aside, forget about it and take it up again after months, when his vision is fresh. For this reason he must depend on comments made by the client and his friends, trying to glean from them where the trouble lies. It is rarely where the layman thinks but with experience and a little psychology the artist can profit by learning how the portrait reacts on different people. However, remarks offered before he is ready for them can be very harmful. It is difficult for the layman to realize that a portrait cannot be a perfect likeness until it is entirely finished; nor that the artist must work up all parts of the picture simultaneously in order to make a harmonious whole. He cannot finish the head and then progress to the body and hands any more than an architect can finish one room in a building before the roof is on. Each colour, each line, in a picture affects all others. It is their relative value alone which gives the illusion of form.

Modern artists as a rule paint directly, trying to place the right tone in its right place immediately. Charles Hopkinson recommends the process probably used by many of the old masters. Over a monochrome under-painting he models carefully with red, black, white and blue, mixing the lights with red and white; the shadows with red and black. These simple tones permit him to devote his full attention to the form. When this under-painting has dried he glazes with the bright colours, the yellows, bright reds, greens, etc. Rich, luminous transparent tones are obtained in this manner and by contrasting transparent flesh tones with opaque touches in accessories a great variety of texture is obtained. Both processes have their advantages and their disadvantages. Glazes do not permit a very sincere study of colours in relation to other colours and they can endanger the durability of the painting. Many of Reynolds' canvases faded, cracked and pealed off during his life-time. The direct method is very durable if it is not retouched too soon, but many of Sargent's portraits covered with cracks are sad examples of what happens when paintings are worked upon before they are thoroughly dry. Titian and Rembrandt are said to have let their work dry for months, but few modern people would be able to let their sittings cover so long a period.

The frame should be chosen before the portrait is finished and the final work on the canvas should be done after it is framed. The frame can be toned and antiqued so that the whole is harmonious. An unsuitable frame can affect the likeness and cause great trouble to the artist. It is well for the artist to know beforehand where the portrait is to be hung. He can then arrange his colouring and lighting to harmonize with the surroundings. Some people decorate their rooms to bring out a picture. The illusion of form is more vivid if the portrait is hung with the light falling from the direction of the light in the picture. The client should live with the portrait for some time before requesting changes. Often he becomes reconciled to the artist's vision and does not wish changes made which generally impair the beauty of the whole for the sake of some detail.

The opinion seems to prevail that different subjects require different mediums. Oils are supposed to be best for men, pastels and crayons for women and children. But we must remember that Holbein's magnificent drawings of men are equal, if not superior, to any painting. Latour could render in pastel the strength of men as well as the delicacy of women and the portraits of women and children by the great English painters, or by Renoir, prove that with oil paints the most subtle qualities can be obtained. However, the lighter mediums permit the artist to abandon and take up his work at will, an important factor where capricious women and children are concerned. Oil painting requires longer sittings.

It is wise for an artist to change his medium now and then. Nothing freshens up his colour sense better than a water-colour or pastel and etchings stimulate his interest in line. Sculpture is the greatest tonic a painter can use. Most of the great masters devoted themselves to other subjects besides portraits. It is needless to mention the religious paintings of the old masters, the landscapes of Rembrandt, Rubens, Gainsborough, Whistler and Sargent. When tired of the sickly court Velasquez would take as models robust peasants. No artist can paint day after day the same type of picture without lessening the keen interest which is necessary for success. The joy which the artist takes in his work is communicated to the beholder.

It is difficult to form an opinion about contemporary portrait painting, as some of the best portraits are never exhibited. There are sincere, conscientious artists who with the right encouragement would be able to leave important work, but there are also many of the kind Hogarth attacked: those who impose on an ignorant public by painting from photographs; those who hide their ignorance and lack of talent behind all sorts of theories, claiming that likeness is not necessary; those who are more interested in paint and in clever brush work than in their sitter.

The sincere modernist in his effort to give to painting the emotional quality of music, finds in likeness as yet an obstacle, although his idols, the Orientals, Egyptians and primitives, made of it a powerful aid. He is governed by taboos and prejudices as bad as those of the academy, but rigid as are the rules and laws laid down by the modernist, they are "subject to change without notice." He is quick to admit an error in his arguments as in the case of cubism. Fortunately there is an increasing number of cultured people who know what a fine portrait is, and who have pride and standing enough to uish to be painted as they are. (See also PAINTING; OIL PAINTING; MINIATURE PAINTING.)

BIBLIOGRAPHY.—J. Collier, *The Art of Portrait Painting* (1905); A. W. Waetzoldt, *Die Kunst des Portraits* (1908); W. M. F. Petrie, "Roman Portraits and Memphis," British School of Archaeology in Egypt *Publications*, vol. xx (1911); L. Binyon, *Painting in the Far East* (1913); S. Reinach, *Apollo*, trans. by F. Simmonds; E. Faure. *Histoire de l'Art, l'Esprit des Formes* (1927) trans. by W. Pach; A. de Beruete, *Velasquez* (1906); H. Knackfuss, *Allgemeine Kunstgeschichte*, and *Monographs on Artists* (1900); J. B. Manson and Mrs. Meynell, *The Work of John Singer Sargent* (1927); C. Moreau-Vauthier, *The Technique of Painting;* C. J. Bulliet, *Apples and Madonnas* and *Emotional Expression in Modern Art* (1927); J. Huneker, *Promenades of an Impressionist* (1910); W. H. Wright, *Modern Painting, Its Tendency and Meaning* (1922); E. Waldmann, *Das Bildnis im 19 Jahrhundert* (1921); Julius Meier-Graefe, *Entwickelungsgeschichte der Modernen Kunst;* Louis Dimier, *Histoire de la Peinture de Portrait en France au XVIe Siècle;* Etienne Moreau-Nelaton, *Les Clouets et leurs Emules* (1924); Georges Lafenestre, *Jehan Fouquet* (1905); Hermann Erhard, *La Tour der Pastellmaler Ludwigs XV* (1918); Sir Martin Conway, *The Van Eycks and Their Followers* (1921); Louis Hourticq, *Art in France;* Royal Cortissoz, *American Artists* (1923); E. R. and J. Pennell, *The Life of James McNeill Whistler* (1908); Henri Guerlin, *Le Portrait* (1936); Marparet Fitzhugh Browne, *Portrait Painting* (1933); Harrington Mann, *The Technique of Portrait Painting* (1933); Philip de László, *Painting a Portrait* (1934); Cuthbert Lee, *Contenzporary American Portrait Painters* (1929); Helen Gardner, *Art Through the Ages* (1936).

(F. T. W.)

PORT RICHMOND, a community of the borough of Richmond in New York city, on the north shore of Staten island and on the Kill van Kull channel. It is one of the leading business areas of Staten island. Among its places of historic interest are the Dutch Reformed church, which is the direct successor of the church established at the Voorlezer's house (still standing) at Richmondtown, Staten island, about 1695; and the Daniel Mesereau house, built about 1787. In this house Aaron Burr spent the last years of his life, dying there on Sept. 14, 1836.

PORT ROYAL, an island in Beaufort county, South Carolina, U.S.A., at the head of Port Royal sound, about 16 mi. from the Atlantic coast, and about 50 mi, southwest of Charleston. It is about 13 mi. long and 7 mi. wide, generally flat, and with much marshland in its southern part and along the northeastern shore. The principal town is Beaufort (pop. 1940, 3,185), a port of entry and the county seat of Beaufort county. It is served by the Charleston and Western Carolina railway, has inland water communication with Savannah, Ga., and its harbour is one of the best on the South Carolina coast. Its situation and climate make it a popular winter resort. In the vicinity, cotton, rice, potatoes and other vegetables are raised, and there are groves of yellow pine and cypress. About 5 mi. south of Beaufort is the town of Port Royal (pop. 1940, 342), the terminus of the C. and W. C. railway. The island was named by Jean Ribaut (1520–65) who in May 1562, entered the harbour with a shipload of Huguenot colonists from France. Ft. Charles (probably situated on Parris island) was built and 29 volunteers under Captain de la Pierria were left as the first garrison. Soon afterward they mutinied, killed Pierria, put to sea in an insufficiently equipped vessel, from which they were rescued by an English ship and carried to England. In 1683 a settlement of Scotch families led by Henry Erskine, third Lord Cardross, was established; but three years later most of the settlers were murdered by Spaniards from Florida and the remainder fled to Charleston. In 1710 after the lords proprietors had issued directions for "the building of a town to be called Beaufort Town" in honour of Henry Somerset, duke of Beaufort, the first permanent settlement on the island was established. In Jan. 1779, during the American Revolution, the British occupied the island but were dislodged in February by Col. Moultrie. In the Civil War, Confederate forts on Hilton Head and Bay Point were reduced by the bombardment of a northern naval expedition, after which Port Royal harbour became a Federal coaling, repair and supply station.

PORT ROYAL, a celebrated Cistercian abbey, occupied a low and marshy site in the thickly wooded valley of the Yvette, at what is now known as Les Hameaux near Marly, a few miles southwest of Paris. It was founded in 1204 by Mahaut de Garlande, wife of Mathieu de Montmorenci-Marli in 1204; the church was built in 1229. During the three succeeding centuries its discipline became relaxed; reform was only attempted when Angélique Arnauld (*q.v.*) was appointed coadjutor to the abbess in 1598. Angélique's reforming energy soon brought her into contact with Jean du Vergier (*q.v.*) abbot of Saint Cyran, and chief apostle in France of the Jansenist revival.

In 1626 ague drove the nuns to Paris; they settled at Port Royal de Paris, at the end of the Faubourg Saint Jacques. The deserted buildings of Port Royal des Champs were presently occupied by "hermits," laymen, mostly relatives of the abbess, who wished for a semimonastic existence, though without taking formal vows. In 1648, however, some of the nuns returned, and the hermits retreated a short distance from the abbey. Here they set up a "little school" for the sons of Jansenist parents; and here Racine received his education. But in 1653 Innocent X condemned Jansenism and in 1656 "the hermitage" and school were broken up, and the nuns forbidden to receive new members.

In 1660 Louis XIV condemned the order and, between 1664 and 1669, the archbishop of Paris laid under an interdict those nuns who refused to subscribe to the papal censure on Jansen. In 1669, however, came the so-called "Peace of Clement IX," when the Jansenists generally were admitted to grace, and the interdict was removed from Port Royal, though the authorities broke up the convent into two distinct communities. The conformist nuns were gathered together at Port Royal de Paris, under an independent abbess, their Jansenist sisters at the original building in the country. Thereupon followed ten years of peace, through the protection of the king's cousin, Mme. de Longueville. But in 1679 she died, and Louis at once ordered the nuns to send away their novices and boarders and to receive no others. Finally, in 1705, he got from Clement XI a new condemnation of the Jansenists, which the few remaining nuns, all of whom were over sixty, refused to sign: and on the 29th of October 1709 they were forcibly removed from Port Royal by the police, and distributed among various conformist convents. In the

VAN DYCK AND REMBRANDT

Top: Anthony Van Dyck (1599–1641), "Children of Charles I.," painted in England in 1635. The original hangs in Windsor Castle
Bottom: Rembrandt Van Riln (1606–69), "Sortie of the Banning Cock Company," also known as the "Night Watch," 1642. In the Rijks Museum, Amsterdam

next year the buildings were pulled down. The land on which the convent had stood was made over to Mme. de Maintenon's college of St. Cyr; in 1825 it was bought by some descendants of Jansenist families, who have done their best to restore the grounds to their original appearance, and have built a museum rich in Jansenist relics. Port Royal de Paris was secularized at the French Revolution, and is now a maternity hospital.

For a classified list of the chief books, ancient and modern, dealing with Port Royal, *see* the *Abrégé de l'histoire de Port Royal*, by Jean Racine, ed. E. Gazier (Paris, 1908). *See* also C. A. Sainte-Beuve, *Port Royal* (6 vols. and index, Paris, 1882); Charles Beard, *Port Royal* (2 vols., London, 1861); H. Reuchlin, *Geschichte von Port Royal* (2 vols., Hamburg, 1839–44), and the books recommended under the articles ARNAULD, JANSENISM and PASCAL.

PORTRUSH, an urban district and seaside resort of Co. Antrim, Northern Ireland; the terminus of a branch of the Northern Counties (L.M.S.) railway. Pop. (1937) 3,386. Area, .8 sq.mi. It is situated on the basaltic peninsula of Ramore head, with a deep bay on either side, and a harbour protected by the natural breakwater known as the Skerries. It is the tourist centre for the Giants' Causeway, with which it is connected by an electric railway. The extensive ruins of Dunluce castle, between Portrush and Bushmills, stand on a rock separated from the mainland by a chasm spanned by a bridge. Portrush has a salmon trade.

PORT SAID (sah'ed), a seaport of Egypt, at the entrance of the Suez Canal, in 31° 15′ 35″ N., 32° 19′ 20″ E., and 145 mi. by rail N E. of Cairo, pop. (1937) 124,749, lies on the western side of the canal on the [illegible] narrow and treeless strip of land which separates the Mediterranean from Lake Menzala, the land at this point being raised and its area increased by the draining of part of the lake and by the excavation of the inner harbour. The outer harbour is formed by two breakwaters which protect the entrance to the canal; altogether the harbour covers about 570 acres and accommodates ships drawing 28 ft. The port possesses a floating dock 295 ft. long, 85 ft. broad and 18 ft. deep, capable of lifting 3,500 tons, and a patent slip taking 300 tons and ships drawing 9 ft. 9 in. water. On the western breakwater is a colossal statue of Ferdinand de Lesseps by E. Fremiet, unveiled in 1899, and a lighthouse 174 ft. high. Among the few buildings of note in the town are the offices of the Suez Canal Company and the British barracks, the last having been built by Prince Henry of the Netherlands (d. 1879) as a dépôt for Dutch trade.

Port Said dates from 1859. Originally it depended entirely upon the traffic of the canal, being the chief coaling station of all ships passing through and becoming the largest coaling station in the world. In 1902, however, a new industry was added in the export of cotton from the eastern provinces of the Delta, the cotton being brought from Mataria by boat across Lake Menzala. In 1904 the opening of a standard gauge railway to Cairo placed Port Said in a position to compete with Alexandria for the external trade of Egypt generally, besides making it a tourist route to the capital from Europe.

PORTSMOUTH, EARLS OF. In 1743 John Wallop (1690–1762) of Farley Wallop in Hampshire was created earl of Portsmouth. He belonged to an old Hampshire family and had been a lord of the treasury from 1717 to 1720, when he was created Baron Wallop. The earldom has since been held by his descendants, one of whom, Newton Wallop (b. 1856), became the 6th earl in 1891; he was a member of parliament from 1880 to 1891 and was under-secretary of state for war from 1905 to 1908.

PORTSMOUTH, LOUISE DE KEROUALLE, DUCHESS OF (1649–1734), mistress of the English king Charles II., was placed early in life in the household of Henriette, duchess of Orleans, sister of Charles II. In 1670 she accompanied the duchess on a visit to Charles II. at Dover. The king placed her among the queen's ladies-in-waiting. Her intrigue with Charles was vigorously pushed by the French ambassador, Colbert de Croissy, aided by the secretary of state, Lord Arlington, and his wife. Louise, who concealed great cleverness and a strong will under an appearance of languor and a rather childish beauty (Evelyn the diarist speaks of her "baby face"), yielded only when she had already established a strong hold on the king's affections. Her son, ancestor of the dukes of Richmond, was born in 1672.

The support she received from the French envoy was given on the understanding that she should serve the interests of her native sovereign. The bargain was confirmed by gifts and honours from Louis XIV., and was loyally carried out by Louise. The hatred openly avowed for her in England was due as much to her own activity in the interest of France as to her notorious rapacity. The titles of Baroness Petersfield, countess of Fareham and duchess of Portsmouth were granted her for life in 1673. Her pensions and money allowances of various kinds were enormous. In 1677 alone she received £27,300. Soon after the king's death she retired to France, where, except for one short visit to England during the reign of James II., she remained. Her emoluments were lost in her later years, which were spent at Aubigny, but she was protected from her creditors by Louis XIV. She died in Paris on Nov. 14, 1734.

See H. Forneron, *Louise de Kéroualle* (Paris, 1886).

PORTSMOUTH, a city, county and parliamentary borough, and seaport of Hampshire, England, 74 mi. S.W. from London, on the S.R. Pop. (est. 1938) 258,400. Area 14.4 sq.mi. The city suffered heavy air raids during World War II. About 93% of the houses were damaged, though many were repairable, but the gild hall (1890), both the main shopping centres and many public buildings were gutted.

Portsmouth owes its origin to the retreat of the sea from Porchester. No town existed there until the 12th century, when its strategical advantage induced Richard I to build one. The borough is governed by a charter granted by Charles I in 1627, modified by the municipal acts of the 19th century. The market, dating from 1194, is held on Tuesday and Saturday.

The naval station and arsenal is an aggregate of four towns, Portsmouth, Portsea, Landport and Southsea, and occupies the southwestern part of Portsea island, which lies between Portsmouth harbour and Langstone harbour, two inlets of the English Channel. Portsmouth harbour opens into Spithead, one of the arms of the Channel separating the Isle of Wight from the mainland. The harbour widens inwards in bottle form, Portsmouth lying on the east shore of the neck, with Gosport opposite to it on the west side. Portsmouth proper may be distinguished as the garrison town; Portsea as the naval station with the dockyards; Landport is occupied chiefly by the houses of artisans; and Southsea is a residential quarter and a watering-place. There is a modern Roman Catholic cathedral. The church of St. Thomas of Canterbury, a cruciform building, dates from about 1180. It was restored in 1904, and in 1935 a scheme of enlargement was begun. In 1924 the foundation of a new diocese of Portsmouth and the Isle of Wight, taken from that of Winchester, was approved, and St. Thomas's was designated as the pro-cathedral. The see was created in 1927. The garrison chapel originally belonged to the hospital of St. Nicholas, a foundation of the 13th century. Passenger steamers from Portsmouth harbour serve Ryde in the Isle of Wight. A ferry and a floating bridge connect with Gosport. The parliamentary borough was divided into central, north, and south divisions in 1918, each returning one member. The county borough was created in 1888 and raised to the dignity of a city (1926) with a lord mayor in 1928.

Nelson's flagship, H.M.S. *Victory*, on which he met his death at Trafalgar in 1805, is in dry-dock in Portsmouth; she is the flagship of the admiral of the station. (*See* NELSON.)

The dockyard dates in its earliest form from 1496, though the town was already of importance as a naval station. Its later rise began with the building of one dry and two wet-docks in 1698. In 1848 a steam basin and four new docks were opened, the dockyard ground being extended to 115 ac. In 1865 extension works decided upon included a tidal basin and a deep dock and two locks, in themselves serving as large docks, which lead to three basins and four docks. Subsequent improvements included two new dry docks (1896); the construction of jetties at the entrance to the tidal basin and at the north wall; the establishment of a coal wharf with hydraulic appliances; numerous subsidiary works; and extensive dredging of the harbour to increase the berthing accommodation for the fleet. New locks and a dry dock were completed shortly before World War I. In 1925 the government decided to reduce the dockyards at Rosyth and Pembroke to a care-and-maintenance basis and to concentrate all admiralty home dock work at Portsmouth, Devonport, Chatham and Sheerness. Portsmouth royal dockyards cover an area of 500 ac. There is a gunnery establishment on Whale Island and barracks, including those of the Royal Marine Artillery at Eastney, beyond Southsea.

PORTSMOUTH, a city of New Hampshire, U.S.A., the only seaport of the state; on the Piscataqua river, near its entrance into the Atlantic ocean. It is on federal highways 1, 4 and 16 and is served by the Boston and Maine railroad and bus lines. It is connected with Maine by two bridges, the Memorial bridge (1923) and the $3,000,000 Interstate bridge (1940). Pop. (1930) 14,495 (17% foreign-born white); in 1940 by federal census 14,821. On Fernald's and Seavey's islands, opposite the city (but in the town of Kittery, Me.), is the Portsmouth navy yard (established 1800), one of the largest in the country, and the principal yard for building. fitting out and overhauling submarines. The treaty ending the Russo-Japanese War was negotiated there in 1905. During the Spanish-American War, Admiral Cervera and other Spanish officers and sailors were imprisoned on Seavey's island, where later a large naval prison was built. Portsmouth is the seat also of a naval hospital (1891).

At New Castle (2 mi. S.E.), guarding the entrance to Portsmouth harbour, is Ft. Constitution, on the site of Ft. William and Mary (1630); and across the river, on Kittery Point, is Ft. McClary, a colonial blockhouse. Portsmouth is rich in historic associations and in beautiful buildings of the 18th and early 19th centuries, many of which are open to the public. The two oldest houses in the city were built in 1664 and 1668. Among fine examples of colonial architecture are the Wentworth-Gardner house (1760), and the Tobias Lear house (1740) both recently renovated; the Moffatt-Ladd house (1753); the mansion built by Governor Benning Wentworth in 1750; the house occupied by John Paul Jones in 1779 (built in 1758), now the home of the Portsmouth Historical society; the William Pitt tavern (before 1767); and the Assembly house, a dance hall built in 1750 and described by Washington as one of the finest in the United States. The Athenaeum, a valuable library established by a society organized in 1817, occupies a building erected in 1803. Portsmouth was the birthplace of Governors Benning Wentworth, John Wentworth and John Langdon; Thomas Bailey Aldrich (whose home is now a museum), Gen. Fitz John Porter and Celia Thaxter. Daniel Webster practised law there from 1807 to 1816.

In 1623 David Thomson, with a small company from Plymouth, England, established a fishing and trading station at Little Harbor (now Odiorne's Point in the town of Rye); and in 1630 another band, sent over by the Laconia company, occupied Thomson's house and Great Island (New Castle), and built the "Great House" on what is now Marcy street, in Portsmouth. The settlement was known as Strawberry Banke until 1653, when it was incorporated by Massachusetts under the name of Portsmouth. It was the capital of New Hampshire from 1679 (when the province was separately constituted) until 1775, and was chartered as a city in 1849. One of the first military exploits of the Revolution took place at New Castle, when the Portsmouth committee of safety, on receiving from Boston (through Paul Revere) a copy of the order prohibiting the exportation of military supplies, organized militia companies and captured Ft. William and Mary (Dec. 14, 1774). During the Civil War the "Kearsarge" and several other war vessels were built at the Portsmouth navy yard, and in the 20th century it became a centre for the construction of submarines.

PORTSMOUTH, a city of southern Ohio, U.S.A., the county seat of Scioto county; on the Ohio river, at the mouth of the Scioto. It is on federal highways 23 and 52, and is served by the Baltimore and Ohio, the Chesapeake and Ohio, and the Norfolk and Western railways, and by river packets and barges. A highway bridge across the Ohio was opened in 1927. Pop. (1920) 33,011 (94% native white); 1940 by the federal census, 40,466. It has a picturesque site on a bend in the river, protected from high water by a concrete flood wall 62 ft. above normal water stage, The Shawnee state forests, a state reservation of 45,000 ac., is near the city; and along the Ohio for 8 mi. extend earthworks of the mound builders, including the Great Serpent mound at Locust Grove (25 mi. W.). Products are iron and steel, shoes (4,000,000 pairs annually), heels and lasts, shoelaces, stoves and ranges (20,000 annually), brick (60,000,000), coke and by-products, paper boxes, and work clothing, There are large sandstone quarries which have supplied material for the Canadian parliament buildings and many other important structures of America. The city's assessed valuation for 1940 was $49,500,000. Settlement in this vicinity began in 1796. In 1799 Thomas Parker, of Alexandria, Va., laid out a village (called Alexandria) below the mouth of the Scioto, but it suffered from floods, and about 1810 the inhabitants moved to Portsmouth, which had been laid out in 1803. Portsmouth was incorporated as a town in 1815, as a city in 1851. The Ohio and Erie canal from Cleveland to Portsmouth was opened in 1832.

PORTSMOUTH, a city of southeastern Virginia, U.S.A., on the Elizabeth river (an estuary of Hampton Roads) opposite Norfolk; the county seat of Norfolk county, but independent of it. It is on federal highway 17, and is served (either directly or through the industrial Belt line which encircles Portsmouth and Norfolk) by the Atlantic Coast Line, the Chesapeake and Ohio, the Norfolk Southern, the Norfolk and Western, the Pennsylvania, the Seaboard Air Line, the Southern and the Virginian railways, and by interurban trolleys, motorbus and truck lines, ferries and steamship lines. Pop. 54.387 in 1920 (43% Negroes) and 50,745 by the federal census of 1940. On the eastern water front is the Norfolk navy yard, the oldest, and one of the most important, in the country. It has an area of 433 ac., 176 buildings with 65 ac. of floor space and 39 berths. Civilians employed in 1941 numbered 20,227; annual pay roll is $44,550,000. On a promontory about a mile west is the U.S. naval hospital. Trinity church (1762) is the oldest building in the city. Portsmouth is a shipping point for large quantities of oysters, vegetables and farm produce. Its manufactures in 1937 were valued at $10,768,307. Commercially Portsmouth is an integral part of the great port of Hampton Roads. (See NORFOLK.) The city operates under a commission-manager form of government.

Portsmouth was established in 1752 by act of the Virginia assembly, incorporated as a town in 1852 and chartered as a city in 1858. The navy yard, established by the British shortly before the Revolution, was confiscated by Virginia during the war and in 1801 was sold to the United States. In April 1861, it was burned and abandoned by the Federals, and then for a year was the chief navy yard of the Confederates. They raised the frigate "Merrimac" and transformed her into the ironclad "Virginia" which on March 9, 1862, fought the famous battle with the "Monitor" in Hampton Roads (*q.v.*). Two months later (May 9) the Confederates abandoned the navy yard and evacuated Norfolk and Portsmouth.

PORT SUDAN, a town and harbour on the west coast of the Red Sea, in 19° 37' N , 37° 14' E., 700 mi by boat S. of Suez and 495 mi. by rail N.E. of Khartoum. Pop. (1926), 21,535. It is the principal port of the Anglo-Egyptian Sudan and the headquarters of the customs aciministration. The coral reefs fringing the coast are here broken by a straight channel with deep water giving access to the harbour, which consists of a series of natural channels and basins. Depth 10 to 14 fathoms; at the permanent quays, 28 ft. On the north side of the inlet are quays (completed 1909), fitted with electric cranes, etc. Here are the customhouse, coal sheds and goods station. The town proper lies on the south side of the inlet, connected with the quays by a railway bridge. Besides government offices the public buildings include hospitals, and a branch of the Gordon college of Khartoum.

The port dates from 1905. It owes its existence to the desire of the Sudan administration to find a harbour more suitable than Suakin (*q.v.*) for the commerce of the country. The railway (which has termini both at Port Sudan and Suakin) was opened in January 1906 and the customhouse in the May following. Port Sudan immediately attracted a large trade, and became a regular port of call of British, German and Italian steamers. The imports and exports in 1925 were valued at £7,000,000, and the largest vessel yet entered was one of 27,132 tons. The imports are largely cotton goods, provisions, timber and cement; the exports gum, raw cotton, ivory, sesame, durra, senna, coffee (from Abyssinia), goat skins, etc. Forty miles north of Port Sudan is Mohammed Gul. the port for the mines of Gebet.

PORT TALBOT, Glamorganshire, Wales, a municipal borough on the Avon, near its mouth in Swansea Bay, 11 mi. E.S.E. of Swansea and 170 mi. from London by G.W.R. Pop. (1938) 40,180. Area 38.8 sq.mi. A castle once stood at Port Talbot, but, despite its apparent strategic importance, the Normans allowed it to remain in the hands of Welsh chieftains who, from the 13th century on, styled themselves De Avan or D'Avene. A town grew up around the castle; one of its charters was granted in 1372 by Edward le Despenser. During the early industrial period. Cornish pioneers were attracted to the Avon valley by its possibilities as a coal-mining and manufacturing centre. The early tendency was to take the ores to the coal and thus Cwmavon, 1½ mi. N.E. of Aberavon, flourished in the middle of the 19th century, being noted for its copper-smelting works and other metallurgical activities. Copper was brought from Cornwall and discharged at Aberavon, the ships then going to Taibach to load a return cargo of coal from the Morfa collieries. With the increase in coal production for export. the need for better shipping facilities was felt. The river below Aberavon was deflected into an artificial channel, its former mouth blocked, and its lower course converted into a dock, which was again extended in 1898. Railway enterprises linked the town with the coal-mining valleys, especially with Cwm Rhondda, and in 1921 the G W R. took charge of the docks. With the development of the port, the town took over many of the activities of Cwmavon, coal being brought down to the port to work up imported ores. Consequently, a modern industrial centre sprang up between the old centres of Aberavon and Taibach, and in 1921 the town of Aberavon and the urban district of Margam were amalgamated as Port Talbot. The town suffered severely in the depression of the 1930s, 34.4% of the insured male population being unemployed in May 1934. The establishment of a trading estate resulted in some improvement.

PORTUGAL: a republic of western Europe, forming part of the Iberian peninsula, and bounded on the N. and E. by Spain, and on the S. and W. by the Atlantic ocean. Pop. (1940), 7,174,899; area 34,234 sq.m. In shape the country resembles a roughly drawn parallelogram, with its greatest length (362 m.) from N. to S., and its greatest breadth (140 m.) from E. to W. For physical details see also SPAIN. The frontiers are partly defined by the course of the four principal rivers, the Minho and Douro in the north, the Tagus and Guadiana in the south; elsewhere, and especially in the north, they are marked by mountain ranges; but in most parts their delimitation was originally based on political considerations. The Portuguese seaboard is nearly 500 m. long. From the extreme north to Cape Mondego and thence onward to Cape Carvoeiro the outline of the coast is a long and gradual curve; farther south is the prominent mass of rock and mountain terminating westward in Capes Roca and Espichel; south of this, again, there is another wide curve, broken by the headland of Sines, and extending to Cape St. Vincent, the south-eastern extremity of the country. The only deep indentations of the Portuguese littoral are the lagoon of Aveiro (*q.v.*) and the estuaries of the Minho, Douro, Mondego, Tagus, Sado and Guadiana, in which are the principal harbours. The only islands off the coast are the dangerous Farilhões and Berlings (Portuguese *Berlengas*) off Cape Carvoeiro. Pop. Azores and Madeira isls. 534,526. area 1.190 sq m.

Physical Features. — Few small countries contain so great a variety of scenery as Portugal. The bleak and desolate heights of the Serra da Estrella are almost alpine in character; at a lower level there are wide tracts of moorland, covered in many cases with sweet-scented cistus and other wild flowers. The lagoon of Aveiro, the estuary of the Sado and the broad inland lake formed by the Tagus above Lisbon (*q v*), recall the waterways of Holland. The sand-dunes of the western coast and the Pinhal de Leiria (*q.v.*) resemble the French Landes. The Algarve and parts of Alentejo might belong to North-West Africa rather than to Europe. The Paiz do Vinho, on the Douro, and the Tagus near Abrantes, with their terraced bush-vines grown up the steep banks of the rivers, are often compared with the Rhine and the Elbe. The harbours of Lisbon and Oporto are hardly inferior in beauty to those of Naples and Constantinople. Apart from this variety, and from the historic interest of such places as Braga, Bussaco, Cintra, Coimbra or Torres Vedras, the attractiveness of the country is due to its colouring, and not to grandeur of form. The following mountain ranges belong to the Transmontane system, which is the southern extension of the mountains of Galicia: Peneda (4,728 ft.); the Serra do Gerez (4,817 ft.); La Raya Seca, a continuation of Gerez, which culminates in Larouco (4,390 ft.); Cabreira (4,196 ft.); Marão (4,642 ft.); Villarelho (3,547 ft.); Padrella (3,763 ft.); Nogueira (4,331 ft.) and Bornes (3,944 ft.). The Beira system comprises two quite distinct mountain regions. North of the Mondego it includes Montemuro (4,534 ft.); Gralheira (3,681 ft.); the Serra do Caramulo (3,511 ft.) and the Serra da Lapa (3,215 ft.). South of these ranges, but nominally included in the same system, is the Serra da Estrella, the loftiest ridge in Portugal (6,532 ft.) continued by the Serra de Lousã (3,944 ft.). They form the last link in the chain of mountain ranges, known to Spanish geographers as the Carpetano-Vetonica, which extends across the centre of the Peninsula from east to west. The Transtagan mountains consist for the most part of isolated ranges or massifs. The Serra da Arrabida (1,637 ft.) rises between Cape Espichel and Setubal. São Mamede (3,363 ft.), extends along part of the frontier of northern Alentejo. Ossa (2,129 ft.), Caixeiro (1,483 ft.), Monfurado (1,378 ft.) and Mendro (1,332 ft.) form the high ground between the rivers Sado, Sorraia and Guadiana. In the extreme south the ranges include Monchique (2,963 ft.). There are numerous large expanses of level country, the most notable of these being the plains (*campos*) of the Tagus vailey, and of Aviz, Beja and Ourique, in Alentejo and the high plateaux (*cimas*) of Mogadouro in Trazos-Montes and Ourem between the Tagus and the upper Sorraia.

The three principal rivers which flow through Portugal to the sea — the Douro, Tagus and Guadiana — are described in separate articles. The whole country drains into the Atlantic, to which all the main rivers flow in a westerly direction except the Guadiana, which turns south by east in the lower part of its course. The Minho (Spanish *Miño*) is the most northerly river of Portugal, and is only inferior to the three great waterways already mentioned. Its length is 170 m. Small coasters can ascend the river as far as Salvatierra in Galicia (20 m.), but larger vessels are excluded by a sandy bar at the mouth. Between the Minho and Douro the chief rivers are the Lima (Spanish Limia or *Antela*), the Cavado, and the Ave. Between the Douro and Tagus the Vouga rises in the Serra da Lapa and reaches the sea through the lagoon of Aveiro; the Mondego flows north-east through a long ravine in the Serra da Estrella, and then bends back so as to flow west-south-west. Its estuary contains the important harbour of Figueira da Foz; its length is 125 m. of which 52 m. are navigable by small coasters. Portugal abounds in hot and medicinal springs, such as Caldas de Monchique, Caldas da Rainha and Vidago.

Climate. — The climate of Portugal is equable and temperate. Lisbon, Coimbra, Evora and Oporto have mean temperatures between 60° and 61·5° F, and the daily variation nowhere exceeds 23°. The rainfall has been as heavy as 16 ft. in a year, and sometimes, as in the winter of 1909–1910, great damage is wrought by floods. Heavy fogs are also common along the coast, rendering it dangerous to ships. The rainfall is heaviest in the north and on the Serra da Estrella; it is least in Algarve. In the deep valleys where the mountains keep off the cool winds. it is excessively hot in summer while on the summits of the mountains snow lies for many months. The meteorological station on the Serra da Estrella, with a mean annual temperature of 44·7° F, is the coldest spot in Portugal in which systematic observations are taken. Montalegre has a mean of 48·3° and Guarda of 50·3°. Even in Lisbon the yearly variation is not less than 50° but it is less at Estoril. In Alentejo the climate is very unfavourable; Algarve (where Lagos has a mean of 63°), is hotter than Alentejo but a profuse vegetation takes away much of the tropical effect Portugal is very rarely visited by thunderstorms; but shocks of earthquake are frequent, and kecall the great earthquake of Lisbon (*q.v.*) in 1755.

Fauna and Flora.—An account of the fauna of the Iberian peninsula as a whole is given under SPAIN. Wolves are found in the wilder parts of the Serra da Estrella, and wild boars are preserved in some districts. As far as the constituents of its flora are concerned Portugal is not very dissimilar from Spain, but their distribution is peculiar. The vegetation of Spain is distributed in clearly marked zones; but over the whole of Portugal, except the hottest parts of Algarve and Alentejo, the plants of northern Europe flourish side by side with cacti, palms, aloes and tree-ferns (see CINTRA). This is largely due to the fact that the moisture-laden winds from the Atlantic penetrate almost as far inland as the Portuguese frontier, but do not reach the interior of Spain. The soil is fertile, and the indigenous flora has been greatly enriched by the importation of such plants as the agave, the Mexican opuntia, the American maple, the Australian eucalyptus, the Scotch fir and the so-called Portuguese cypress (*Cupressus* lusitanica) from the Azores. There are many fine tracts of forest, among which may be mentioned the famous convent-wood of Bussaco (*q.v.*); cork trees are extensively cultivated, Barbary oaks (Quercus bellota, Port. *azinheira*) furnish edible acorns and excellent timber for charcoal, and carob-trees (*Ceratonia siliqua,* Port. alfarrobeira) also produce edible seed-pods somewhat resembling beans. Elms, limes and poplars are common north of the Tagus, ilex, araucaria, myrtle, magnolia and a great variety of conifers in all parts. The Serra da Estrella has a rich alpine flora, and the lagoon of Aveiro contains many aquatic plants.

Inhabitants.— The birth-rate is about 30 per 1,000, while the mortality is only about 20 per 1,000. Large bodies of emigrants, chiefly recruited from the sober, hardy and industrious peasantry of the northern provinces, annually leave Portugal to seek fortune in America. A few go to the Portuguese colonies, the great majority to Brazil. Many of these emigrants return with considerable savings and settle on the land. The mortality is highest among male children, and the normal excess of females is in the proportion of 109 to 100. Six-sevenths of the population of continental Portugal inhabit the provinces north of the Tagus. The density of population is greatest in Madeira (479.5 per sq.m. in 1900), Entre-Minho-e-Douro (419·5) and the Azores (277·9), nowhere else does it reach 200 per sq.m. In Alentejo the percentage sinks to 45·1, and for the whole country, including the islands, it amounts only to 152.8.

The Portuguese people is composed of many racial elements. Its earliest known ancestors were the Iberians (*q.v.*). The peasantry, especially in the north, are closely akin to the Galician and Asturian Spaniards in character, physique and dialect; and these three ethnical groups—Portuguese of the north, Galicians, Asturians—may perhaps be regarded as the purest representatives of the Spanish stock. The Romans gave to Portugal its language and the foundation of its civilization; there is, however, no evidence that they seriously modified the physical type or character of its people. In these respects the Suevic and Visigothic conquests left a more permanent impression, especially in the northern provinces. After 711 came the long period of Moorish (*i.e.,* Arab and Berber) predominance. The influence of the Moors was greatest south of the Tagus. In Alentejo, and still more in Algarve, Arab and Berber types are common; and the influence of these races can everywhere be discerned in the architecture, handicrafts and speech of the peasantry. An intermediate "Mozarabic" population arose, Portuguese in blood, Christian in religion, but Arab in language and manners. Many of the Mozarabs even adopted the characteristic Mohammedan rite of circumcision. Under the tolerant rule of Islam the Portuguese Jews rose to a height of wealth and culture unparalleled in Europe; they intermarried with the Christians both at this period and after their forced conversion by King Emanuel I. (1495–1521). After 1450 yet another ethnical element was introduced into the nation, through the importation of African slaves in vast numbers. Negroid types are common throughout central and southern Portugal.

National Characteristics.— The normal type evolved from this fusion of many races is dark-haired, sallow-skinned, brown-eyed and of low stature. The staple diet of the labouring classes and small farmers is fish, especially the dried codfish called bacalhdo, rice, beans, maize bread and meal, olive oil, fruit and vegetables. Meat is rarely eaten except on festivals. Drunkenness is extremely rare. There is no single national dress, but a great variety of picturesque costumes are worn. The sashes, broad-brimmed hats and copper-tipped quarter-staves of the men, and the brilliant cotton dresses and gold or silver filigree ornaments worn on holidays by the women are common throughout the country and may be seen at their best at bull-fights and at the *romarias* or pilgrimages, which combine religion with the attractions of a fair. The national sport of bull-fighting (*q.v.*) is conducted as humanely as possible, for the Portuguese are lovers of animals. Although the ancient ballads are not forgotten, new words are also fitted to the plaintive folk-tunes (fados) which every farm-hand knows and sings, accompanied sometimes by a rude clarinet or bagpipe, but more frequently by the so-called Portuguese guitar—an instrument which resembles a mandolin rather than the guitars of Italy and Spain. The native dances are obviously Moorish in origin, and depend for their main effects on the movement of the arms and body. Many curious superstitions survive in the country districts, including the beliefs in witches (*feitiçeiras, bruxas*) and werewolves (*lobis-*homens); in sirens (sereias) which haunt the dangerous coast and lure fishermen to destruction; in fairies (*fadas*) and in many kinds of enchantment.

Population.— The population of Portugal, which includes the Azores and Madeira, amounted, in 1940, to 7,709,425 compared with a population of 5,957,985 in 1911. The colonies, which cover a total area of 812,606 sq.mi., have a population of 8,913,076. Emigration has tended to keep the population fairly stationary. In 1919, emigrants mainly to the United States and Brazil numbered 31,138, while between 1912 and 1922 the total emigration was estimated at 700,000. In the first ten years of the 20th century the city population increased by 15% as compared with an increase of 10% for the entire population. The number of foreigners in Portugal remained stationary, with a slight increase of Germans and English. According to the 1930 census, the population of the chief towns was as follows: Lisbon, 594,390; Oporto, 232,280; Setubal, 46,398; Coimbra, 27,333; Braga, 26,962; Evora, 22,061; Faro, 18,019; Covilha, 15,640; Tavira, 12,562; Aveiro, 12,735; Elvas, 12,413; Portalegre, 11,005.

Colonies.—At the beginning of the 19th century Portugal possessed a larger colonial empire than any European power except Grest Britain and Spain. At the beginning of the 20th century its transmarine possessions had been greatly reduced in size by the loss of Brazil, but were still only surpassed in extent by those of three powers—Great Britain, France and Germany. Their total area was about 812,606 sq.m., of which 803,634 sq.m. are in Africa. They comprised, in Africa, the Cape Verde Islands, St. Thomas and Prince's islands, Portuguese Guinea, Angola and Portuguese East Africa or Mozambique; in India, Goa, Damão and Diu; in China, Macao; and in the Malay Archipelago part of Timor. All these are described in separate articles.

BIBLIOGRAPHY.—Numerous official reports, chiefly statistical, are published periodically in Lisbon; a few are written in French, the majority in Portuguese. Read in conjunction with the British consular and diplomatic reports, they afford a comprehensive survey of the movement of population, the progress of trade, etc. The following state papers deserve special notice: *Caminhos de ferro* (1877, etc.), *Commercio e navegação* (annual, issued by the Ministry of Marine), *Le Portugal vinicole* (1900), *Le Portugal . . . agricole* (1900), *Notas sobre Portugal* (2 vols., 1908). For geology, see the section of *Le Portugal . . . agricole* written by P. Choffat and entitled "Aperçu de la géologie de Portugal," also "The Work of the Portuguese Geological Survey," by Philip Lake, in *Science Progress* (1896) v. 439–453; both these summaries refer to the most important original papers. Two illustrated volumes by Oswald Crawford, *Portugal Old and New* (London, 1880) and *Round the Calendar in Portugal* (London, 1890) contain much valuable information on agriculture, viticulture and peasant life in the northern provinces. *Through Portugal,* by Major Martin Hume (London, 1907) and *Lisbon, Cintra, etc.,* by A. C. Inchbold (London, 1907), describe the towns, etc., most frequently visited by tourists, and are illustrated in colours. *Le Portugal* (Paris, 1899), by 18 writers, is a brief but encyclopaedic description of continental Portugal. *See* also *Portugal: its Land and People,* by W. H. Koebel (London, 1909), *Por-*

tuguese Architecture, by W. C. Watson (London, 1908); *A.* Marvaud, *Le Portugal et ses Colonies* (Paris, 1912); G. Diercks, *Das moderne Portugal* (Berlin, 1913); B. Carqueja, *O Povo Portuguez* (Porto, 1916); L. Poinsard, *Le Portugal Inconnu* (Paris, 1910). *In* 1915 Portugal was included in the "Countries and Peoples" Series.

(X.)

DEFENCE

Historical.—The Portuguese army bore its full share in the expulsion of the French army in the Peninsular war. In the later days of the monarchy the army was maintained partly by conscription and partly by voluntary enlistment under an Act of 1887. The army was reorganized by subsequent acts in 1899 and 1901 and it has since passed through various changes due to those in the political situation. Two Portuguese divisions served in France with the British Army in the World War.

Recruitment and Service.—Preliminary military training is given to youths of 18 to 20 years, after which age compulsory military service in the home army is enforced. This service is for 10 years with the active army and 10 years in reserve, followed by 5 years in the territorial army, ending at the age of 45. Certain exemptions are allowed. The first training consists of a 5 months recruit course followed by 12 months further training. There is a war school to train officers and also a central sergeants school through which non-commissioned officers can obtain commissions. Recruiting for the Colonial Forces, which form an integral part of the Portuguese army, is for 15 years of which 10 years are spent in the active army and 5 years in the territorial reserve. Members of the home army who join the colonial army spend 4 years therein. Reductions are made for volunteers and for certain others, from the 10 year period of active service.

Strength and Organization.—The budget effectives in the home army in 1927 numbered 52,747, including 4,320 officers, and 25,000 recruits undergoing their 5 months recruit course. The army is organized in 22 infantry regiments (which in peace-time act as training centres, etc.); 10 battalions of light infantry, each of which contains 4 rifle companies, a machine-gun company, headquarter wing and depot section; 2 cyclist battalions, each having 2 cyclist rifle companies and a machine-gun company; and 3 machine-gun battalions. The cavalry is organized in 2 brigades, each of 3 regiments (temporarily two), one motor machine-gun squadron, one cyclist battalion, and a horse artillery group. The artillery which has headquarters in Lisbon, the Azores and Madeira, is organized in 5 regiments of light artillery, 3 of heavy artillery, in addition to a battery of heavy trench mortars, and 2 regiments of coast artillery with 3 batteries of mobile coast artillery, a submarine coast defence group (for Lisbon defences) and 2 specialist companies. The engineers contain the usual branches and include telegraphists. The National Republican Guard, distributed over all Portuguese territory, numbers about 9,joo, organized in one cavalry regiment and 8 infantry battalions. The Colonial army numbers 12,500 and possesses an Air Service.

The war minister is the head of the army. In war the Government appoints a commander-in-chief to control operations and command the troops under the war ministry. There is a supreme council for national defence, of which either the President or the prime minister acts as chairman, a chief of the army staff, and inspectorates of the various arms.

In addition to the Central Schools mentioned above, there is a military college, military school and schools for all arms of the service, for motor drivers and for military administration. Certain ports in the Azores have been classed as fortresses, but Lisbon is the only one that is provided with any modern defences. The army air force is being reorganized in one offensive and defensive group, one bombing group, and one observation group, each of 2 squadrons; and a train and depot squadron. The air service includes a command headquarters and inspectorate, aeroplane and balloon departments, anti-aircraft defence, and flying schools. There are 59 instructional machines of various types; 14 bombing machines of which 12 are Breguet 14 A2 type; 14 scouts of which 10 are of Vickers-Valparaiso type; and 14 fighters, of "Squad VII." type.

See also League of Nations *Armaments Year-book* (Geneva 1928).

(G. G. A.)

Navy.—The fleet of Portugal consists (1928) of two old cruisers, the "Vasco da Gama" (1876, reconstructed 1902), the "Adamaston" (1896, refitted 1919–22); two sloops (ex-British fleet sweeping vessels); five destroyers; five torpedo boats; four submarines; and 18 miscellaneous craft. The personnel consists of 725 officers and 4,445 men. There is a minister of marine, who is a member of the Council for National Defence. (E. A.)

ECONOMIC CONDITIONS

Agriculture.—Portugal is primarily an agricultural country, 60% of the population being engaged in agricultural pursuits, though there are signs that the country, like so many Continental states, is becoming industrialized. The land is exceedingly fertile owing to its sunny and moist climate; yet more than a third of the land awaits exploitation. The principal handicap to agricultural development is the lack of adequate transport facilities. The roads have not been adequately repaired for 15 or 20 years, and their condition is estimated to have doubled the cost of transport.

The state railways have also fallen into a serious state of disrepair and consequently it has been found cheaper to import wheat direct from the Argentine than to send supplies to the north of Portugal from the Alentejo. Lack of fertilizers is another serious handicap. The most valuable crop is wheat, the harvest averaging 230,000 tons annually. The country, however, is compelled to import between 100,000 to 150,000 tons of wheat annually, despite the efforts of successive Governments to encourage wheat growing.

Wine is the principal product of Portugal, accounting for 50% of its exports; for the first six months of 1927 over one million pounds' worth of port wine was shipped to Great Britain. Table wines are produced all over the country, and are exported to Brazil and also to France.

Portugal is the third olive-producing country in the world, her olive-trees occupying an acreage of 750,000 and giving 12,760,000 gal. of oil. Other crops grown on a large scale are maize, rye, oats and barley. About 200,000 tons of potatoes are produced and there is a large export trade in fruit, mainly to England. Livestock is about equal in number to the population and an important industry is the production of corks which reaches about 70,000 tons annually.

Commerce and Manufactures.—Portuguese trade has been considerably hampered by the political uncertainty and by the fall and instability of the escudo, whose value at par is 4s. $5\frac{1}{4}$ d, but which in 1928 was worth about $2\frac{1}{2}$d. Great Britain is still Portugal's best customer, buying the greater portion of her port and madeira, her fruit, cork, sardines and mineral ore. After wine, the most important export is canned sardines and tunny fish, the principal customers being Great Britain and the United States.

Portugal is hampered by the necessity of having to buy abroad foodstuffs, particularly wheat and maize and fish (bought from Newfoundland and Norway). The value of the oil imported now exceeds that of coal which averaged before the World War about 1,000,000 to 1,500,000 tons, almost entirely bought from Great Britain. Cotton and woollen goods are also largely imported from Great Britain; agricultural machinery comes mainly from the United States and Germany; and Belgium supplies most of the railway material. The following are the latest Portuguese figures: for the year 1926, general imports, 2,685,385 contos[1]; general exports (including re-exports) 1,072,574 contos. In 1927, according to British figures, the British imports from Portugal amounted to £4,718,733; exports to £3,889,703; re-exports to £430,645.

Portugal's principal manufacturing industry is the production of textiles, employing 45,000 work-people, half of whom are in the cotton factories of Oporto and district, the remainder being engaged in the wool, silk and linen industries. Other industries are the making of tiles and the embroideries of Madeira, the annual export of which to the United States alone amounts to about £2,000,000.

On April 30 the 35-year monopoly of the tobacco industry came

[1]The *conto* of 1,000 *escudos* is equal (1929) to about £9.5s.

to an end; it was this burning question which was the main cause of the revolutionary movement in May 1926, which brought the dictatorship into power. The Government which came into office in May 1926 considered themselves compelled to establish free conditions for the industry, but were confronted with a difficult problem owing to the number of existing factories and large personnel. Under the new régime then established, the finance minister expected a revenue of at least two million sterling.

Finance. — Portuguese financial difficulties are due to causes which may be stated thus: (1) One-half the national expenditure is devoted to the military establishment. (2) The tendency of wealthy Portuguese to send their capital abroad. (3) The hoarding habits of the peasantry. (4) The large purchases of foodstuffs and raw materials from abroad. (5) Foreign liabilities like the debt to Great Britain, which was funded in 1927 on the basis of a present cash value of £5,500,000,—the debt actually amounting, with accumulated interest, to over £22,000,000. (6) The increase in the number of civil servants and in their emoluments.

During the first nine months of the financial year June 30, 1926, to March 31, 1927, the total expenditure amounted to 1,468,486 contos, revenue falling short of this amount by 494,924 contos, or five million sterling. The official estimate of the probable deficit for the full year ending on June 30, 1927, was 564,025 contos.

See British Department of Overseas Trade, *Annual Reports* on *Portugal* (London); *Annuario Estatistico de Portugal* (Lisbon).
(N. F. G.)

HISTORY

Throughout the centuries which witnessed the destruction of Carthaginian power by Rome, the establishment and decline of Latin civilization, the invasion by Alani, Suevi and other barbarian races, the resettlement under Visigothic rule and the overthrow of the Visigoths by Arab and Berber tribes from Africa, Portugal remained an undifferentiated part of Hispania, without sign of national consciousness. The Iberian Peninsula was one: and its common history is related under SPAIN. In 1095 Portugal was still an obscure border fief of the kingdom of Leon, bounded on the north by the Minho, on the south by the Mondego. Its name (*Portucalia,* Terra *portucalensis*) was derived from the little seaport of Portus Cale or Villa Nova de Gaia, now a suburb of Oporto, at the mouth of the Douro. Its inhabitants, surrounded by Moorish or Spanish enemies and distracted by civil war, derived the rudiments of civilization from Arabic or Leonese sources.

The history of the nation comprises eight periods. (1) Between 1095 and 1279 a Portuguese kingdom was established and extended until it reached its present continental limits. (2) Between 1279 and 1415 the monarchy was gradually consolidated in spite of resistance from the Church, the nobles and the rival kingdom of Castile. (3) In 1415 began a period of crusades and discoveries, culminating in the discovery of an ocean-route to India (1497–99). (4) From 1499 to 1580 Portugal acquired an empire stretching from Brazil eastward to the Moluccas, reached the eenith of its prosperity and entered upon a period of swift decline. (5) Spanish kings ruled over Portugal from 1581 to 1640. (6) The chief event of the years 1640 to 1755 was the restoration of the Portuguese monarchy. (7) Between 1755 and 1826 the reforms of Pombal and the Peninsular War prepared the country for a change trom absolutism to constitutional monarchy. (8) In 1826 the era of constitutional government began.

Establishment **of the Monarchy.**—Among the crusading knights in Spain was Count Henry of Burgundy, an ambitious warrior who, in 1095, married Theresa, natural daughter of Alphonso VI., king of Leon. The county of Portugal, which had already been won back from the Moors (1055–64), was included in Theresa's dowry. Count Henry ruled as a vassal of Alphonso VI., whose Galician marches were thus secured against any sudden Moorish raid. But in 1109 Alphonso VI. died, bequeathing all his tersitories to his legitimate daughter Urraca, and Count Henry at once invaded Leon, hoping to add to his own dominions at the expense of his suzerain. At his death in 1112 he left Theresa to govern Portugal north of the Mondego during the minority of her infant son Affonso Henriques (Alphonso I.): south of the Mondego the Moors were still supreme.

Theresa renewed the struggle against her half-sister and suzerain Urraca in 1116–17, and again in 1120; in 1121 she was besieged in Lanhoso and captured. But a peace was negotiated by the archbishops Diego Gelmirez of Santiago de Compostela and Burdino of Braga, rival churchmen whose wealth and military resources enabled them to dictate terms. It was arranged that Theresa should be liberated and should continue to hold the county of Portugal as a fief (honor) of Leon. During the next five years she lavished wealth and titles upon her lover Fernando Peres, count of Trava, thus estranging her son, the archbishop of Braga, and the nobles, most of whom were foreign crusaders. In 1128, after her power had been crushed in another unsuccessful conflict with Leon and Castile, she was deposed by her own rebellious subjects and exiled in company with Peres. She died in 1130.

Her son, Alphonso I., was occupied in almost incessant border fighting against his Christian or Moorish neighbours. Twelve years of campaigning on the Galician frontier were concluded in 1143 by the peace of Zamora, in which Alphonso was recognized as independent of any Spanish sovereign. In 1167, war was renewed. Alphonso succeeded in conquering part of Galicia, but in attempting to capture the frontier fortress of Badajoz he was wounded and forced to surrender to his son-in-law, Ferdinand II. of Leon (1169). He was released under promise to abandon all his conquests in Galicia.

He had already won many victories over the Moors. On July 25, 1139, he defeated their combined forces on the plains of Ourique, in Alentejo. On March 15, 1147, he stormed the fortress of Santarem, and about the same time a band of crusaders on their way to Palestine landed at Oporto and volunteered for the impending siege of Lisbon. Among them were many Englishmen, Germans and Flemings, who were afterwards induced to settle in Portugal. Aided by these powerful allies, Alphonso captured Lisbon on Oct. 24, 1147. Between 1179 and 1184 the Moors retrieved many of their losses in Alentejo, but were unable to retake Santarem and Lisbon. Alphonso died on Dec. 6, 1185. He had secured for Portugal the status though not the name of an independent kingdom, and had extended its frontier southwards from the Mondego to the Tagus.

Sancho I. continued the war against the Moors with varying fortune. In 1189 he won Silves, then the capital of Algarve; in 1192 he lost not only Algarve but the greater part of Alentejo, including Alcacer do Sal. A peace was then arranged, and for the next eight years Sancho was engaged in hostilities against Alphonso IX. of Leon. He granted fresh charters to many cities, legalizing the system of self-government which the Romans had bequeathed to the Visigoths and the Moors had retained or improved. Lisbon had already (1179) received a charter from Alphonso I. Towards the close of his reign he became embroiled in a dispute with Pope Innocent III. As Sancho was in weak health and had no means of resisting papal pressure, he made full submission (1210); and after bestowing large estates on his sons and daughters, he retired into the monastery of Alcobaca (*q.v.*), where he died in 1211.

The reign of Alphonso II. ("the Fat") is noteworthy for the first meeting of the Portuguese cortes, to which the upper hierarchy of the Church and the nobies (*fidalgos* and *ricos* homens) were summoned by royal writ. The king was no warrior, but in 1212 a Portuguese contingent aided the Castilians to defeat the Moors at Las Navas de Tolosa, and in 1217 the ministers, bishops and captains of the realm, reinforced by foreign crusaders, retook Alcacer do Sal (first captured in 1158). Alphonso II. repudiated the will of his father, refused to surrender the estates left to his brothers, who went into exile, and only gave up the property bequeathed to his sisters after a prolonged civil war in which Alphonso IX. of Leon took part against them. Even then he compelled the heiresses to take the veil. His attempts to strengthen the monarchy and fill the treasury at the expense of the Church resulted in his excommunication by Pope Honorius III., and Portugal remained under interdict until Alphonso II. died in 1223.

Sancho II. succeeded at the age of 13. In 1227 he assumed control of the kingdom. He continued the crusade against the Moors, who were driven from their last strongholds in Alentejo, but his career of conquest in Algarve was cut short by a revolution (1245). The pope issued a bull of deposition in favour of Alphonso, who reached Lisbon in 1246; and after a civil war lasting two years Sancho II retired to Toledo, where he died in Jan. 1248.

One of the first acts of the usurper was to abandon the semi-ecclesiastical titles of visitor (visitador) or defender (curador) of the realm, and to proclaim himself king (rei). Shortly afterwards the conquest of Algarve deprived the Moors of their last remaining stronghold. A war with Alphonso X. of Leon and Castile followed; it ended by Alphonso III. consenting to wed Doña Beatriz de Guzman, illegitimate daughter of Alphonso X., and to hold Algarve as a fief of Castile. The celebration of this marriage, while Matilda, countess of Boulogne and first wife of Alphonso III., was still alive, entailed the imposition of an interdict upon the kingdom. The clergy suffered more than the laity under the interdict, and in 1262 Pope Urban VI. legalized the disputed marriage and legitimized Dom Diniz, the king's eldest son. In 1263 Alphonso X. renounced his claim to suzerainty over Algarve, and thus the kingdom of Portugal simultaneously reached its present European limits and attained its complete independence. Lisbon was henceforth recognized as the capital. Alphonso III. continued to reign until his death in 1279, but the peace of his later years was broken by the rebellion (1277–79) of D. Diniz, the heir-apparent.

Consolidation of the Monarchy: 1279–1415.—The chief problems now confronting the monarchy were no longer military, but political. Hostilities between Portugal and the reunited kingdoms of Leon and Castile were terminated in 1297 by a treaty of alliance, in accordance with which Ferdinand IV. of Leon and Castile married Constance, daughter of Diniz, while Alphonso, son of Diniz, married Beatrice of Castile, daughter of Ferdinand. A further outbreak of civil war, between the king and the heir-apparent, was averted in 1293 by the queen-consort Isabella of Portugal, who had married Diniz in 1281, and was canonized for her many virtues in the 16th century. Diniz earned his title of the *rei lavrador* or "farmer king" by introducing improved methods of cultivation and founding agricultural schools. He encouraged maritime trade by negotiating a commercial treaty with England (1294) and forming a royal navy (1317) under the command of a Genoese admiral named Emmanuele di Pezagna (Manoel Pessanha). In 1290 he founded the University of Coimbra (*q.v.*). He was a poet and a patron of literature and music (see Literature, p. 290). He encouraged and nationalized the military orders.

Alphonso IV. adhered to the matrimonial policy initiated by Diniz. He arranged that his daughter Maria should wed Alphonso XI. of Castile (1328), but the marriage precipitated the war it was intended to avert, and peace was only restored (1330) after Queen Isabella had again intervened. Pedro, the crown prince, afterwards married Constance, daughter of the duke of Peñafiel (near Valladolid), and Alphonso IV. brought a strong Portuguese army to aid the Castilians against the Moors of Granada and their African allies. In the victory won by the Christians on the banks of the river Salado, near Tarifa, he earned his title of Alphonso the Brave (1340). In 1347 he married his daughter Leonora to Pedro IV. of Aragon. The later years of his reign were darkened by the tragedy of Inez de Castro (*q.v.*). He died in 1357, and the first act of his successor, Pedro the Severe, was to take vengeance on the murderers of Inez. Throughout his reign he strengthened the central Government at the expense of the aristocracy and the Church, by a stern enforcement of law and order. In 1361, at the cartes of Elvas, it was enacted that the privileges of the clergy should only be deemed valid in so far as they did not conflict with the royal prerogative. Pedro maintained friendly relations with England.

During the reign of Ferdinand (1367–83) and under the regency of Leonora the ruling dynasty ceased to represent the national will. Ferdinand, a weak but ambitious and unscrupulous king, claimed the thrones of Castile and Leon, left vacant by the death of Pedro I. of Castile (1369). In 1371 Pope Gregory XI. intervened, and it was decided that Ferdinand should renounce his claim and marry Leonora, the daughter of his successful rival. Ferdinand, however, preferred his Portuguese mistress, Leonora Telles de Meneses, whom he eventually married. To avenge this slight, Henry of Castile invaded Portugal and besieged Lisbon. Ferdinand appealed to John of Gaunt, who also claimed the throne of Castile, on behalf of his wife Constance, daughter of Pedro I. of Castile. An alliance between Portugal and England was concluded; and although Ferdinand made peace with Castile in 1374, he renewed his claim in 1380, after the death of Henry of Castile, and sent João Fernandes Andeiro, count of Ourem, to secure English aid. In 1381 Richard II. of England despatched a powerful force to Lisbon, and betrothed his cousin, Prince Edward, to Beatrice, only child of Ferdinand, who had been recognized as heiress to the throne by the cortes of Leiria (1376). In 1383, however, Ferdinand made peace with John I. of Castile at Salvaterra, deserting his English allies, who retaliated by ravaging part of his territory. By the treaty of Salvaterra it was agreed that Beatrice should marry John I. Six months later Ferdinand died, and in accordance with the terms of the treaty Leonora became regent until the eldest son of John I. and Beatrice should be of age.

Leonora had long carried on an intrigue with the count of Ourem, whose influence was resented by the leaders of the aristocracy, while her tyrannical rule also aroused bitter opposition. The malcontents chose D. John, grand-master of the knights of Aviz and illegitimate son of Pedro the Severe, as their leader, organized a revolt in Lisbon, and assassinated the count of Ourem within the royal palace (Dec. 6, 1383). Leonora fled to Santarem and summoned aid from Castile, while D. John was proclaimed defender of Portugal. In 1384 a Castilian army invested Lisbon, but encountered a heroic resistance, and after five months an outbreak of plague compelled them to raise the siege. John I. of Castile, discovering or alleging that Leonora had plotted to poison him, imprisoned her in a convent at Tordesillas, where she died in 1386. Before this, Nuno Alvares Pereira, constable of Portugal, had gained his popular title of "The Holy Constable" by twice defeating the invaders, at Atoleiro and Trancoso in the district of Guarda. On April 16, 1385, the cortes assembled at Coimbra declared the crown of Portugal elective, and at the instance of João das Regras, the chancellor, D. John was chosen king.

Ferdinand had been the last legitimate descendant of Count Henry of Burgundy. With John I. began the rule of a new dynasty, the House of Aviz. The most urgent matter which confronted the king—or the group of statesmen, led by João das Regras and the "Holy Constable" who inspired his policy—was the menace of Castilian aggression. But on Aug. 14, 1385, the Portuguese army, aided by 500 English archers, utterly defeated the Castilians at Aljubarrota. In October the "Holy Constable" won another victory at Valverde; early in 1386 5,000 English soldiers, under John of Gaunt, reinforced the Portuguese; and by the treaty of Windsor (May 9, 1386), the alliance between Portugal and England was confirmed and extended. Against such a combination the Castilians were powerless; a truce was arranged in 1387 and renewed at intervals until 1411, when peace was concluded. D. Diniz, eldest son of Inez de Castro, claimed the throne and invaded Portugal in 1398, but his supporters were easily crushed. At home John I. endeavoured to reform administration, to encourage agriculture and commerce, and to secure the loyalty of the nobles by grants of land and privileges so extensive that, towards the end of his reign, many nobles who exercised their full feudal rights had become almost independent princes. Abroad, he aimed at peace with Castile and close friendship with England. In 1387 he had married Philippa of Lancaster, daughter of John of Gaunt; Richard II. sent troops to aid in the expulsion of D. Diniz; Henry IV., Henry V. and Henry VI. of England successively ratified the treaty of Windsor; Henry IV. made his ally a knight of the Garter in 1400. The convent of Batalha (*q.v.*), founded to commemorate the victory of Aljubarrota, is architecturally a monument of the English influence prevalent at this time throughout Portugal.

The cortes of Coimbra, the battle of Aljubarrota and the treaty of Windsor mark the three final stages in the consolidation of the monarchy. A period of expansion oversea began in the same reign. with the capture of Ceuta in Morocco in 1415.

The Period **of** Discoveries: **1415–1499.**—As the south-westernmost of the free peoples of Europe, the Portuguese were the natural inheritors of that work of exploration which had been carried on during the middle ages, chiefly by the Arabs. They began where the Arabs left off, by penetrating far into the Atlantic. The long littoral of their country, with its fine harbours and rivers flowing westward to the ocean, had been the training-ground of a race of adventurous seamen. It was impossible, moreover, to expand or reach new markets except by sea. The long struggle to expel the Moors, with the influence of foreign Crusaders and the military orders, had given a religious sanction to the desire for martial fame.

It was the genius of Henry of Portugal (*q.v.*) that co-ordinated and utilized all these tendencies towards expansion. Prince Henry placed at the disposal of his captains the vast resources of the Order of Christ (the Portuguese branch of the Knights Templars, reformed and renamed in 1319), the best information and the most accurate instruments and maps. On land he again defeated the Moors, who attempted to re-take Ceuta in 1418; but in an expedition to Tangier, undertaken in 1436 by King Edward (1433–38), the Portuguese army was defeated, and could only escape destruction by surrendering as a hostage Prince Ferdinand, the king's youngest brother. Ferdinand, known as "the Constant," from the fortitude with which he endured captivity, died unransomed in 1443. By sea Prince Henry's captains continued their exploration of Africa and the Atlantic. In 1433 Cape Bojador was doubled; in 1434 the first consignment of slaves was brought to Lisbon; and slave-trading soon became one of the most profitable branches of Portuguese commerce. The Senegal was reached in 1445, Cape Verde was passed in the same year, and in 1446 Alvaro Fernandes pushed on almost as far as Sierra Leone. This was probably the farthest point reached before the Navigator died (1460). Meanwhile colonization progressed in the Azores and Madeira, where sugar and wine were produced; above all, the gold brought home from Guinea stimulated the commercial energy of the Portuguese. Under Alphonso V., surnamed the African (1443–ST), the Gulf of Guinea was explored as far as Cape St. Catherine, and three expeditions (1458, 1461, 1471) were sent to Morocco; in 1471 Arzila and Tangier were captured from the Moors. Under John II. (1481–95) the fortress of São Jorge da Mina, the modern Elmina (*q.v.*), was founded for the protection of the Guinea trade in 1481–82; Diogo Cam, or Cão, discovered the Congo in the year 1482 and reached Cape Cross in 1486; Bartholomeu Diaz doubled the Cape of Good Hope in 1488, thus proving that the Indian ocean was accessible by sea. After 1492 the discovery of the West Indies by Columbus rendered desirable a delimitation of the Spanish and Portuguese spheres of exploration. This was accomplished by the treaty of Tordesillas (June 7, 1494) which modified the delimitation authorized by Pope Alexander VI. in two bulls issued on May 4,1493. The treaty gave to Portugal all lands which might be discovered east of a straight line drawn from the Arctic Pole to the Antarctic, at a distance of 370 leagues west of Cape Verde. Spain received the lands discovered west of this line. On its provisions were based both the Portuguese claim to Brazil and the Spanish claim to the Moluccas (see MALAY ARCHIPELAGO: History).

After the death of Edward further attempts to curb the power of the nobles were made by his brother, D. Pedro, duke of Coimbra, who acted as regent during the minority of Alphonso V. (1438–47). The head of the aristocratic opposition was the duke of Braganza, who contrived to secure the sympathy of the king and the dismissal of the regent. The quarrel led to civil war, and in May 1449, D. Pedro was defeated and killed. Thenceforward the grants made by John I. were renewed, and extended on so lavish a scale that the Braganza estates alone comprised about a third of the whole kingdom. An unwise foreign policy simultaneously injured the royal prestige, for Alphonso married his own niece, Joanna, daughter of Henry IV. of Castile, and claimed that kingdom in her name. At the bahtle of Toro, in 1476, he was defeated by Ferdinand and Isabella, and in 1478 he was compelled to sign the treaty of Alcantara, by which Joanna was relegated to a convent. His successor, John II. (1481–95) reverted to the policy of matrimonial alliances with Castile and friendship with England. Finding, as he said, that the liberality of former kings had left the Crown "no estates except the high roads of Portugal," he determined to crush the feudal nobility and seize its territories. The leader of the nobles, Ferdinand, duke of Braganza, was beheaded for high treason in 1483; in 1484 the king stabbed to death his own brother-in-law, Ferdinand, duke of Vizeu; and 80 other members of the aristocracy were afterwards executed. Thus John "the Perfect," as he was called, assured the supremacy of the Crown. He was succeeded in 1495 by Emanuel (Manoel) I., who was named "the Great" or "the Fortunate," because in his reign the sea route to India was discovered and a Portuguese empire founded.

(K. G. J.; A. B.)

MODERN TIMES

The Portuguese Empire: 1499–1580. In 1500 King Emanuel assumed the title "Lord of the conquest, navigation and commerce of India, Ethiopia, Arabia and Persia," which was confirmed by Pope Alexander VI. in 1502. The expansion of national interests proceeded rapidly in almost every quarter of the known world. In the North Atlantic Gaspar and Miguel Corte-Real penetrated as far as Greenland (their "Labrador") in 1500–1; but these voyages were politically and commercially unimportant. Equally barren was the intermittent fighting in Morocco, which was regarded as a crusade against the Moors. In the South Atlantic, however, the African coast was further explored, new settlements were founded, and a remarkable development of Portuguese-African civilization took place in the kingdom of Congo. (See ANGOLA.)

Pedro Alvares Cabral, sailing to India, but steering far westward to avoid the winds and currents of the Guinea coast, reached Brazil (1500) and claimed it for his sovereign. Jodo da Nova discovered Ascension (1501) and St. Helena (1502); Tristdo da Cunha was the first to sight the archipelago still known by his name (1506). In East Africa the small Mohammedan states along the coast—Sofala, Mozambique, Kilwa, Brava, Mombasa, Malindi --either were destroyed or become subjects or allies of Portugal. Pedro de Covilham had reached Abyssinia (*q.v.*) as early as 1490; in 1520 a Portuguese embassy arrived at the court of "Prester John," and in 1541 a military force was sent to aid him in repelling a Mohammedan invasion. In the Indian ocean and Arabian sea, one of Cabral's ships discovered Madagascar (1501), which was partly explored by Tristdo da Cunha (1507); Mauritius was discovered in 1507, Socotra occupied in 1506, and in the same year D. Lourenço de Almeida visited Ceylon. In the Red sea Massawa was the most northerly point frequented by the Portuguese until 1541, when a fleet under Estevdo da Gama penetrated as far as Suez. Hormuz, in the Persian gulf, was seized by Alfonso de Albuquerque (1515), who also entered into diplomatic relations with Persia. On the Asiatic mainland the first trading-stations were established by Cabral at Cochin and Calicut (1501); more important, however, were the conquest of Goa (1510) and Malacca (1511) by Albuquerque, and the acquisition of Diu (1535) by Martim Afonso de Sousa, east of Malacca, Albuquerque sent Duarte Fernandes as envoy to Siam (1511), and despatched to the Moluccas two expeditions (1512, 1514), which founded the Portuguese dominion in the Malay archipelago (*q.v.*). Fernão Pires de Andrade visited Canton in 1517 and opened up trade with China, where in 1557 the Portuguese were permitted to occupy Macao. Japan, accidentally discovered by three Portuguese traders in 1542, soon attracted large numbers of merchants and missionaries (see JAPAN). In 1522 one of the ships of Ferdinand Magellan (*q.v.*)—a Portuguese sailor, though in the Spanish service—completed the first voyage round the world.

Afonso de Albuquerque (*q.v.*), who succeeded Almeida in 1509, modified the policy formulated by his predecessor. Command of the sea could not be maintained while the Portuguese fleets were based at Lisbon. In 1510 he seized Goa; other seaports and islands were conquered or colonized in rapid succession, and by 1540 Portugal had acquired a line of scattered maritime possessions extending along the coasts of Brazil, East and West Africa, Malabar, Ceylon, Persia, Indo-China and the Malay archi-

Emanuel.

John III., b. 1502, d. 1557, m. Catherine of Austria.	**Isabel,** b. 1503, d. 1539, m. Charles V.	**Beatrice,** b. 1504, d. 1538, m. Charles III. of Savoy,	**Louis,** b. 1506, d. 1555, duke of Beja.	**Ferdinand,** b. 1507, d. 1534, duke of Guarda.	**Alphonso,** b. 1509 d. 1540. cardinal and archbishop of Lisbon.	**Henry,** b. 1512, d. 1580, cardinal and king.	**Edward,** b. 1515, d. 1545, duke of Guimarães, m. Isabel of Braganza.
John, b. 1537, d. 1554, m. Joanna of Spain.	*Philip II.* of Spain.	*Philibert Emmanuel,* duke of Savoy.	*Antonio,* prior of Crato. (illegitimate).			*Catherine,* m. duke of Braganza.	Maria, m. duke of Parma
Sebastian, b. 1554, d. 1578.							*Ranuccio,* duke of Parma.

pelago. The most important settlements in the East were Goa, Malacca and Hormuz. West of the Cape the settlements in Africa and the Atlantic were governed, as a rule, by officials directly nominated by the king. East of the Cape the royal power was delegated to a viceroy or governor, whose legislative and executive authority was almost unlimited during his term of office. The viceroyalty was created in 1505, and from 1511 the Indian capital was Goa. Between 1505 and 1580 only four holders of the office—Almeida (1505–09), Albuquerque (1509–1s), D. Vasco da Gama (1524) and D. João de Castro (1545-45)—were men of marked ability and character.

In theory the most lucrative branches of commerce, such as the pepper trade, were monopolies vested in the Crown which the Crown farmed out to individual merchants, or granted trading-licences by way of pension. Two great powers, Egypt and Turkey, challenged the naval and commercial supremacy of the Portuguese, but an Egyptian armada was destroyed by Almeida in 1509, and though Ottoman fleets were on several occasions (as in 1517 and 1521) despatched from Suez or Basra, they failed to achieve any success, and the Portuguese were able to close the two principal trade routes between India and Europe. After the arrival of the Franciscan missionaries, in 1517, Goa gradually became the headquarters of an immense proselytizing organization, which by 1561 had extended to East Africa, China, Japan and the Malay archipelago, playing an important part in missionary enterprises in the Orient (see GOA, Ecclesiastical History).

The banishment, or forcible conversion of the Jews deprived Portugal of its middle class and of its rnost scientific traders and financiers. John II. gave asylum to 90,000 Jewish refugees from Castile, in return for a heavy poll-tax and on condition that they should leave the country within eight months, in ships furnished by himself. These ships were not provided in time, and the Jews who were thus unable to depart were enslaved, while their children were deported to the island of St. Thomas, and there left to survive as best they might. In 1496 Emanuel I. desired to wed Isabella, daughter of Ferdinand and Isabella, but found that he was first required to purify his kingdom of the Jews, who were accordingly commanded to leave Portugal before the end of Oct. 1497. But in order to avoid the economic dangers threatened by such an exodus, every Jew and Jewess between the ages of four and 24 was seized and forcibly baptized. "Christians" were not required to emigrate. In October 20,000 adults were treated in the same way. These "New Christians," or "Marranos" as they were called, were forbidden to leave the country between 1498 and 1507. In April 1506 nearly 2,000 residing in Lisbon were massacred during a riot, but throughout the rest of Emanuel's reign they were immune from violence, and were again permitted to emigrate—an opportunity of which the majority took advantage. Large numbers settled in Holland, where their commercial talent afterwards greatly assisted the Dutch in their rivalry with the Portuguese. In 1536 the Holy Office was established in Lisbon, where the first auto-da-fk was held in 1540, and in 1560 its operations were extended to India.

During the reign of Emanuel I. (1495–1521) the Church was never permitted to encroach upon the royal prerogative. He even sent ambassadors to Rome to protest against ecclesiastical corruption, as well as to checkmate the Venetian diplomatists who threatened Europe with Ottoman vengeance if the Portuguese commercial monopoly were not relaxed. But Emanuel I. was the last great king of the Aviz dynasty. He had pursued the traditional policy of intermarriage with the royal families of Castile and Aragon, hoping to weld together the Spanish and Portuguese dominions into a single world-wide empire ruled by the house of Aviz. But his ambition was not fulfilled, for Prince Miguel, his eldest son, died in infancy, and the inheritance passed to the Habsburgs. John III. (1521–57) was a ruler of fair ability, who became in his later years wholly subservient to his ecclesiastical advisers. He was succeeded by his grandson Sebastian (1557–78), aged three years. Until the king came of age (1568), his grandmother, Queen Catherine, daughter of Isabella the Catholic, and his great-uncle, Prince Henry, cardinal and inquisitor-general, governed as joint regents. Both were dominated by their Jesuit confessors, and a Jesuit, D. Luiz Gonçalves da Camara, became the tutor and, after 1568, the principal adviser of Sebastian.

The king was a strong-willed and weak-minded ascetic, who entrusted his empire to the Jesuits, refused to marry although the dynasty was threatened with extinction, and spent years in preparing for a crusade against the Moors. He collected a force of some 18,000 men, chiefly untrained lads, worn-out veterans, and foreign free-lances; but on Aug. 4, 1578, they were surrounded at Al Kasr al Kebir (*q.v.*) by the superior forces of Abd el Malek, the reigning sultan, and after a brave but ineffective resistance Sebastian was killed and his nondescript army almost annihilated (see SEBASTIAN).

Cardinal Henry, who now became king, died on Jan. 31, 1580, and the throne was left vacant. There were five principal claimants—Philip II. of Spain; Philibert, duke of Savoy; Antonio, prior of Crato; Catherine, duchess of Braganza; and Ranuccio, duke of Parma—whose relationship to Emanuel I. is shown in the table above.

The "Sixty Years' Captivity": 1581–1640.—The prior of Crato was the only rival who offered any serious resistance to Philip II. D. Antonio proclaimed himself king and occupied Lisbon. The advocates of union with Spain, however, were numerous, influential, and ably led by their spokesmen in the cortes, Christovão de Moura and Antonio Pinheiro, bishop of Leiria. In 1581 a Spanish army, led by the duke of Alva, entered Portugal and easily defeated the levies of D. Antonio at Alcbntara. The prior escaped to Paris and appealed to France and England for assistance. In 1582 a French fleet attempted to seize the Azores in his interest, but was defeated. In 1589 an English fleet was sent to aid the prior, but owing to a quarrel between its commanders, Sir Francis Drake and Sir John Norris, the expedition was abandoned. D. Antonio returned to Paris, where he died in 1594.

Meanwhile, the victory of Alcdntara left Philip II. supreme in Portugal, where he was soon afterwards crowned king. His constitutional position was defined at the cortes of Thomar (1581). Portugal was not to be regarded as a conquered or annexed province, but as a separate kingdom, joined to Spain solely by a personal union similar to the union between Castile and Aragon under Ferdinand and Isabella. At Thomar Philip II. promised to maintain the rights and liberties conceded by his predecessors on the Portuguese throne, to summon the cortes at frequent intervals, and to create a Portuguese privy council.

Insurrections in Lisbon (1634) and Evora (1637) bore witness to the general discontent, but until 1640 the Spanish ascendancy was never seriously endangered. In 1640 war with France and a revolution in Catalonia had taxed the military resources of Spain to the utmost. The royal authority in Portugal was delegated to Margaret of Savoy, duchess of Mantua, whose train of Spanish and Italian courtiers aroused the jealousy of the Portuguese nobles, while the harsh rule of her secretary of state, Miguel de

Vasconcellos de Brito, provoked the resentment of all classes. Even the Jesuits, whose influence in Portugal had steadily increased since 1555, were now prepared to act in the interests of Cardinal Richelieu, and therefore against Philip IV. A leader was found in John, 8th duke of Braganza, who as a grandson of the duchess Catherine was descended from Emanuel I. On Dec. 1, 1640, various strategic points were seized, the few partisans of Spain who attempted resistance were overpowered, and a provisional government was formed under D. Rodrigo da Cunha, archbishop of Lisbon.

The Restoration: 1640-1755. On Dec. 13, 1640, the duke of Braganza was crowned as John IV., and on Jan. 19, 1641, the cortes formally accepted him as king. Thus the "Sixty Years' Captivity" came to an end and the throne passed to the house of Braganza. In the subsequent struggle the Portuguese armies were at first successful. D. Matheus de Albuquerque defeated the Spaniards under the baron of Molingen at Montijo (May 26, 1644), and throughout the reign of John IV. (1640–56) they suffered no serious reverse.

John IV. was succeeded by his second son, Alphonso VI. (1656–83), then aged thirteen. During the king's minority the queen-mother, D. Luisa, acted as regent. She prosecuted the war with vigour, and on Jan. 14, 1659, a Portuguese army defeated the Spaniards at Elvas. In March 1659, however, the war between France and Spain was ended by the treaty of the Pyrenees; and D. Luis de Haro, acting as the Spanish plenipotentiary, obtained the inclusion in the treaty of a secret article by which France undertook to give no further aid to Portugal. In May 1663 the marriage was celebrated between Charles II. of England and Catherine of Braganza and Great Britain took the place of France as the active ally of Portugal. The dowry to be paid by Portugal was fixed at £500,000 and the cession to Great Britain of Bombay and Tangier.

On June 20, 1662, the feeble Alphonso VI. declared himself of age and seized the royal authority. The count of Castello Melhor directed the policy of the nation while Schomberg took charge of its defence. The army, reinforced by British troops under the earl of Inchiquin and by French and German volunteers or mercenaries, was led in the field by Portuguese generals, who successfully carried out the plans of Schomberg. On June 8, 1663, the count of Villa Flor defeated D. John of Austria, and retook Evora, which had been captured by the invaders; on July 7, 1664, Pedro de Magalhães defeated the duke of Osuna at Ciudad Rodrigo; on June 17, 1665, the marquess of Marialva destroyed a Spanish army at the battle of Montes Claros, and Christovão de Brito Pereira followed up this victory with another at Villa Viçosa. The Spaniards failed to gain any compensating advantage, and on Feb. 13, 1668, peace was concluded at Lisbon, Spain consenting to recognize the independence of the Portuguese kingdom.

Pedro II., who by a palace intrigue had deposed and imprisoned Alphonso VI., acted as regent for 15 years. In 1683, on the death of the latter at Cintra, he became king. His reign (1683–1706) is a period of supreme importance in the economic and constitutional history of Portugal. The goldfields of Minas Geraes in Brazil, discovered about 1693, brought a vast revenue in royalties to the Crown, which was thus enabled to govern without summoning the cortes to vote supply. In 1697 the cortes met for the last time before the era of constitutional government.

On March 7, 1704, a British fleet under Sir George Rooke reached Lisbon, convoying the archduke Charles and 10,000 British troops, who were joined by a Portuguese army under D. João de Sousa, marquess das Minas, and at once invaded Spain. (For the campaigns of 1704–13, see SPANISH SUCCESSION, WAR OF THE.) In 1705 Pedro II. was compelled by failing health to appoint a regent, and chose his sister, Catherine of Braganza, queen dowager of England. On the death of the king (Dec. 9. 1706) his minister, the duke of Cadaval, arranged a marriage between his successor John V. (1706–50) and the archduchess Marianna, sister of the archduke Charles, thus binding Portugal more closely to the Anglo-Austrian cause. The strain of the war was acutely felt in Portugal, especially in 1711, when the French admiral Duguay-Trouin sacked Rio de Janeiro and cut off the Brazilian treasure-ships. On Feb. 6, 1715, nearly two years after the Treaty of Utrecht, peace between Spain and Portugal was concluded at Madrid.

The Reform of the Monarchy. — John V. was a spendthrift and a bigot. He gave and lent enormous sums to successive popes, and at the bidding of Clement XI. he joined a "crusade" against the Turks in which his ships helped to win a naval action off Cape Matapan (1717). For these services he received the title of Fidelissimus, "Most Faithful"; "Majesty" had already been adopted by John IV. instead of the mediaeval "Highness."

Pombal.—John V. was succeeded by his son Joseph (175—77). Two days after his accession, Sebastião José de Carvalho e Mello, better known as the marquess of Pombal (*q.v.*), was appointed secretary of state for foreign affairs and war. In a few months he' gained an ascendancy over the king's mind which lasted until the end of the reign, and was strengthened by the courage and wisdom shown by Pombal at the time of the great national disaster of the Lisbon earthquake (see LISBON). He sought to undo the consequences of the Methuen Treaty by the creation of national industries, establishing a gunpowder factory and a sugar refinery in 1751, a silk industry in 1752, wool, paper and glass factories after 1759. Colonial development was fostered, and the commercial dependence of Portugal upon Great Britain was reduced by the formation of chartered companies, the first of which (1753) was given control of the Algarve sardine and tunny fisheries. Both his commercial policy and his desire to strengthen the Crown brought Pombal into conflict with the Church and the aristocracy. In 1751 he had made all sentences passed by the Inquisition subject to revision by the Crown. The liberation of all slaves in Pará and Maranhão except negroes (1755), and the creation of the Pará company, were prejudicial to the interests of the Jesuits, whose administrative authority over the Indians of Brazil was also curtailed. Various charges were brought against the society by Pombal, and in Sept. 1759, after five years of heated controversy (see JESUITS), he published a decree of expulsion against all its members in the Portuguese dominions; in June 1760 the papal nuncio was ordered to leave Lisbon, and diplomatic relations with the Vatican were only resumed after the condemnation of the Jesuits by Clement XIV., in July 17j3.

In 1760 Admiral Boscawen had violated Portuguese neutrality by burning four French ships off Lagos; Pombal protested and the British Government apologized, but not before the military weakness of Portugal had been demonstrated. Two years later, when the Family Compact involved Portugal in a war with Spain, Pombal called in Count William of Lippe-Biickeburg to reorganize the army, which was reinforced by a British contingent under Brigadier-General John Burgoyne, and was increased from 5,000 to 50,000 men. The Spaniards were at first successful, and captured Braganza and Almeida; but they were subsequently defeated at Villa Velha and Valencia de Alcantara, and the Portuguese fully held their own up to the signature of peace at Fontainebleau, in Feb. 1763. After the death of King Joseph (Feb. 20, 1777) and the accession of his daughter Maria I., Pombal's dismissal, brought about by the influence of the queen-mother Mariana Victoria, did not involve an immediate reversal of his policy. The controversy with Spain was amicably settled by the Treaty of San Ildefonso (1777) and further industrial and educational reforms were inaugurated. Queen Maria, who had previously shown signs of religious mania, became wholly insane after 1788, owing to the deaths of her consort, Pedro III. (May, 1786), of the crown prince, D. Joseph, and of her confessor, the inquisitor-general, D. Ignacio de S. Caetano. Her second son, D. John, assumed the conduct of affairs in 1792, although he did not take the title of regent until 1799.

The French Revolution. — To face the revolutionary movement in France a treaty of alliance was signed at Aranjuez in March 1793 between Spain and Portugal; 5,000 Portuguese troops were sent to assist in a Spanish invasion of France; a Portuguese squadron joined the British Mediterranean fleet. But in July 1795 Spain concluded a peace with the French republic from which Portugal, as the ally of Great Britain, was deliberately excluded. In 1797 Spain, at war with Great Britain, secretly negotiated with

France for the partition of Portugal. D. John appealed for help to Great Britain, which sent him 6,000 men, under Sir Charles Stuart, and a subsidy of £200,000. In 1799 negotiations with France were reopened, but D. John rejected the demands of Lucien Bonaparte, Napoleon's emissary, and on Feb. 10, 1801, declared war upon Spain. His territories were at once invaded by a Franco-Spanish army, and on June 6, 1801, he was forced to conclude the peace of Badajoz, by which he ceded the frontier fortress of Olivenza to Spain, and undertook to pay 20,000,000 francs to Napoleon and to exclude British ships from Portuguese ports.

The Peninsular War.—By his Berlin decree of Nov. 21, 1806, Napoleon required all Continental states to close their ports to British ships. As Portugal again refused to obey, another secret Franco-Spanish treaty was signed at Fontainebleau on Oct. 27, 1807, providing for the partition of Portugal. General Junot hastened westward across Spain, at the head of 30,000 French soldiers and a large body of Spanish auxiliaries. So rapid were his movements that there was no time to organize effective resistance. On Nov. 29 D. John, acting on the advice of Sir Sidney Smith, British naval commander in the Tagus, appointed a council of regency and sailed for Brazil, convoyed by Sir Sidney Smith's squadron. On Aug. 1, 1808, Sir Arthur Wellesley, with 9,000 British troops, landed at Figueira da Foz. He defeated a French division at Roliça on the 17th, and on the 21st won a victory over Junot at Vimeiro. Fearing an attack by Portuguese auxiliaries and the arrival of British reinforcements under Sir John Moore, Junot signed the Convention of Cintra by which, on Aug. 30, 1808, he agreed to evacuate Portugal (see WELLINGTON). In Feb. 1809 Major-General 'William Carr Beresford was given command of the Portuguese army. In March Soult crossed the Galician frontier and captured Oporto, while an auxiliary force under General Lapisse advanced from Salamanca. On April 22, however, Wellesley, who had been recalled after the Convention of Cintra, landed in Lisbon. On May 12 he forced the passage of the Douro, subsequently retaking Oporto and pursuing Soult into Spain.

After his defeat by Wellesley (at that time Viscount Wellington) at Bussaco on Sept. 27, 1810, the French general, Marshal Masséna turned the position of the allied army on the Serra de Bussaco, and caused Wellington to fall back upon the fortified lines which he had already constructed at Torres Vedras. On March 5, 1811, after a winter of terrible sufferings, Masséna's retreat began; he was harassed by the allied troops all the way to Sabugal, where the last rearguard action in Portugal took place on April 3 (see PENINSULAR WAR).

The Constitutional Movement.— By a decree dated Jan. 16, 1815, Brazil was raised to the rank of a separate kingdom. The importance of this change became apparent when Queen Maria I died (March 1816) and D. John succeeded to the united thrones as John VI. The king refused to leave Brazil, partly owing to the intrigues of Carlota Joaquina, who hoped to become queen of an independent Brazilian kingdom. In 1817 a military revolt (pronunciamento) in Lisbon was crushed by Beresford, and the leader, Gen. Gomes Freire de Andrade, was executed; but on Aug. 16, 1820, after Beresford had sailed to Brazil to secure the return of John VI., a second rising took place in Oporto It soon spread southward. A new council of regency was established in Lisbon, the British officers were expelled from the army; Beresford, on his return from Brazil, was not permitted to land; a constituent assembly was summoned and drew up a highly democratic constitution. Great Britain insisted on the return of John VI., who entrusted the government of Brazil to his elder son D. Pedro and landed in Portugal on July 3, 1821. In 1822, on the advice of D. Pedro, he swore to obey the constitution (the "constitution of 1822"). But his younger son, D. Miguel, and the queen, Carlota Joaquina, refused to take the oath; and in Dec. 1822 sentence of banishment was pronounced against them, though not enforced. D Miguel appealed to the army to "restore liberty to their king," and the army, incensed by the loss of Brazil (1822), gave him almost unanimous support. At this juncture John VI., vainly seeking for a compromise, abrogated the constitution of 1822, but appointed as his minister D. Pedro de Sousa Holstein, count (afterwards duke) of Palmella and leader of the "English" or constitutional party. These half-measures did not satisfy D. Miguel, whose soldiers seized the royal palace in Lisbon on April 30, 1824. Palmella was arrested, and John VI forced to take refuge on the British flagship in the Tagus But the united action of the foreign ministers restored the king and reinstated Palmella; the insurrection was crushed; D. Miguel submitted and went into exile (June 1824).

In Brazil also a revolution had taken place. The Brazilians demanded complete independence, and D. Pedro sided with them, The Portuguese garrison of Rio de Janeiro was overpowered; on Sept. 7, 1822, D. Pedro declared the country independent, and on Oct. 12 he was proclaimed constitutional emperor.

John VI. died on March 10, 1826, leaving his daughter, D. Isabel Maria, as regent for Pedro I. of Brazil, who now became Pedro IV. of Portugal. To conciliate the Portuguese, Pedro IV. drew up a charter (the "charter of 1826") which provided for moderate parliamentary government, To conciliate the Brazilians, he undertook (by decree dated May 2, 1826) to surrender the Portuguese Crown to his daughter D. Maria da Gloria (then aged seven); but this abdication was made contingent upon her marriage with her uncle D. Miguel, who was first required to swear fidelity to the charter.

Constitutional Government.— The charter was brought to Lisbon by Sir Charles Stuart in July 1826. The absolutists had hoped that D. Pedro would abdicate unconditionally in favour of D. Miguel, and the council of regency at first refused to publish the charter. They were forced to do so (July 12) by a pronunciamento issued by the count of Saldanha, commander of the army in Oporto, who threatened to march on Lisbon if the regency did not swear obedience to the charter by July 31 In October D. Miguel took the oath and was betrothed to his niece, D Maria da Gloria (Maria II.). Pedro IV. appointed him regent in July 1827 and in Feb. 1828 he landed in Lisbon, where he was received with cries of "Viva D. Miguel I., rei absoluto!" In March he dissolved the parliament which had met in accordance with the charter. In April the Tory ministry under Wellington withdrew Clinton's division, which had been sent by Canning and was the mainstay of the charter. In May D. Miguel summoned a *cortes* of the ancient type, which offered him the Crown; and on July 7, 1828, he took the oath as king.

The Miguelite Wars.—In March 1829 Palmella established a regency in the Azores on behalf of Maria II.; and D. Miguel's fleet was defeated in Praia bay on Aug. 12. In Brazil, D. Pedro abdicated (April 1831), and determined to return to Europe and Conduct in person a campaign for the restoration of Maria II. He was received with enthusiasm by Louis Philippe. In Great Britain Palmella raised a loan of £2,000,000 and purchased a small fleet, of which Captain Sartorius, a retired British naval officer, was appointed admiral. In Feb. 1832 the "Liberators," as they were styled, sailed from Belleisle to the Azores, with D. Pedro aboard the flagship. In July they reached Portugal and occupied Oporto, but the expected constitutionalist rising did not take place. The country was almost unanimous in its loyalty to D. Miguel, who had 80,000 troops against the 6,500 (including 500 French and 300 British) of D. Pedro. But the Miguelites had no navy, and no competent general. They besieged D. Pedro in Oporto from July 1832 to July 1833, when the duke of Terceira and Capt Charles Napier, who had succeeded Sartorius, effected a daring and successful diversion which resulted in the capture of Lisbon (July 24, 1833). Maria II. arrived from France in September, D. Miguel surrendered at Evora-Monte on May 24, 1834. On Sept. 24 D Pedro died.

Maria II was 15 years old at her accession. She was twice married—in Dec. 1834 to Augustus, duke of Leuchtenberg, who died four months afterwards; and in April 1836 to Ferdinand of Saxe-Coburg, who received the title of king-consort in Sept. 1837 By a successful *coup d'état* of Sept. 9–11, 1836, the constitution of 1822 was substituted for the charter of 1826, A pronunciamento by Costa Cabral led to the restoration of the charter on Feb. 10, 1842, and Cabral, who became count of Thomar in 1845, ruled until the "War of Maria da Fonte" (May 1846) drove him into exile. Oporto was held by a revolutionary junta, and Saldanha, who had become prime minister, persuaded the Quadruple Alliance to intervene. In June 1847 the Oporto *junta* surrendered, under promise of an amnesty, to a combined British and Spanish force, and the Convention of Granada (July 24, 1847) ended the war. Saldanha was rewarded with a dukedom, and retained office until June 1849. When Thomar was reinstated his dictatorial rule provoked another successful rising on April 7, 1851. Thomar again fled from the country; Saldanha again became prime minister, but at the head of a moderate coalition. He remained in power for five years (1851–56), and carried many useful reforms. Maria II. died on Nov. 13, 1853, and was succeeded by her eldest son D. Pedro, during whose ministry the king-consort D. Ferdinand acted as regent.

Under the brothers Pedro V. (1853–61) and Luiz[1] (1861–89) Portugal obtained a respite from civil strife. Pedro V. came of age and assumed the government on Nov. 16, 1855; in 1857 he married Princess Stephanie of Hohenzollern. The king died of cholera on Nov. 11, 1861, and two of his brothers, D. Ferdinand and D. John, died shortly afterwards. D. Luiz was absent at the time, and his father, D. Ferdinand, again became regent until his return, soon after which (1862) the new king married Maria Pia, daughter of Victor Emanuel II. of Italy. In 1869 slavery was abolished in every Portuguese colony.

King Luiz died on Oct. 19, 1889, and was succeeded by his son, D. Carlos (*q.v.*). Shortly after his accession a dispute arose with Great Britain (*see* AFRICA), when a Portuguese force under Maj. Serpa Pinto invaded the Shiré highlands in order to forestall their annexation by the British, and the British government demanded satisfaction. Public opinion rendered compliance difficult until a British squadron was despatched to the mouth of the Tagus, and the British minister presented an ultimatum (Jan. 11, 1890), requiring the withdrawal of all Portuguese forces from the Shiré. Barros Gomes was then able to yield under protest; but disturbances at once broke out in Lisbon and Oporto, and the ministry resigned. A republican rising was suppressed in Lisbon, and many suspected officers were degraded.

The extravagant management of the railways guaranteed by the State had entailed such heavy deficits that the payment of the coupon of the railway State loan, due on Jan. 2, 1892, had to be suspended. A serious financial crisis arose, and in May the Portuguese government committed a formal act of bankruptcy by issuing a decree reducing the amount then due to foreign bondholders by two-thirds. The budget showed a deficit. In these circumstances the Republican Party which had been formed in 1881 rapidly gained ground.

The Dictatorship, 1906–8.—An experiment in government by decree had been made in May–Oct. 1894; it was repeated in Sept. 1905, when the king consented to prorogue the *cortes* until Jan. 1906 in order to postpone discussion of the terms upon which the tobacco monopoly was to be allocated. A general election, in Feb. 1906, was followed by three changes of ministry, the last of which, on May 19, inaugurated the *régime* known in Portugal as the *dictadura* or dictatorship. João Franco, the new prime minister, was conspicuous among Portuguese politicians for his integrity, energy and courage; he intended to reform the national finances and administration—by constitutional means, if possible. When the *cortes* met, on Sept. 29, the opposition accused King Carlos of complicity in grave financial scandals. All parties believed that the ministry would fall, when, on May 2, 1907, João Franco reconstructed his cabinet, secured the dissolution of the *cortes* and announced that certain bills still under discussion would receive the force of law.

Assassination of King Carlos.—The ministerial press from time to time announced the discovery of sensational plots against the king and the dictator. It is, however, uncertain whether the assassination of King Carlos and the crown prince (*see* CARLOS I.), on Feb. 1, 1908, was part of a widely organized conspiracy, or whether it was the act of an isolated band of fanatics, unconnected with any political party. The republican press applauded the murder; the professional politicians benefited by it. On May 6, 1908, D. Manoel (*q.v.*) swore to uphold the constitution and was acclaimed king by the *cortes*. His uncle D. Afonso (b. 1865) took a similar oath as crown prince on March 22, 1910.

(K. G. J.)

The Revolution of 1910.—At the general election of Aug. 1910 the republican candidates in Lisbon and Oporto were returned by large majorities. On Oct. 3 the murder of a distinguished republican physician, Dr. Miguel Bombarda, precipitated the revolution which had been organized to take place in Lisbon ten days later. The republican soldiers in Lisbon, aided by armed civilians and by the warships in the Tagus, attacked the loyal garrison, and municipal guards, shelled the Necessidades Palace, and after severe street-fighting (Oct. 4–6) became masters of the capital. The king escaped to Ericeira, and thence, with the other members of the royal family, to Gibraltar. Soon afterwards they travelled to England, where the king was received by the duke of Orleans. A provisional government was formed under the presidency of Dr. Theophilo Braga.

The subsequent political history of Portugal is a record of short-lived ministries and of revolutionary outbreaks. The effects of the revolution fell most heavily on the poor of the country districts and emigration increased to an unprecedented extent.

The Constitution.—The Provisional Government of the republic consisted of Dr. Theophilo Braga (1843–1924), president, Dr. Antonio Almeida (1866–1929), home affairs, Dr. Afonso Costa (justice), Col. Corrêa Barreto (war), Dr. Amaro Azevedo Gomes (marine), Dr. Bernardino Machado (foreign affairs), Dr. Basilio Telles and, later, Dr. José Relvas (finance), Dr. Antonio Luiz Gomes and, later, Dr. Brito Camacho (public works). It lasted till Aug. 24, 1911. On March 18, 1911, the new electoral law came into force. It gave the vote to all Portuguese over 21. By the law of 1918 the number of deputies was reduced to 155, returned by 51 constituencies, of which Lisbon returned 14, Oporto six. The representation in the senate, consisting of 77 members, was made regional and professional.

The constitutional assembly was opened on June 19, 1911, and a decree was passed declaring the monarchy abolished and the house of Braganza for ever banished. On Aug. 20 the new constitution was voted. It provided for two chambers, that of the deputies, consisting of 163 members to be elected every three years, and the senate, consisting of 71 members. The president of the republic was to be elected by both chambers for four years and could not be re-elected.

The first president under the new constitution was Dr. Manuel de Arriaga. Dr. João Chagas (d. 1925) was premier and minister of home affairs in the first constitutional ministry.

Church and State.—The anti-clerical policy of the provisional government had entailed serious difficulties. The bishops signed a pastoral letter of protest, and on March 8, 1911, the bishop of Oporto was removed from his see. The religious orders had been expelled by the decree of Oct. 8, 1910, their property confiscated and the convents closed. By that of Oct. 22 the teaching of religion in the primary schools was forbidden. Marriage of priests became legal. On April 20, 1911, the decree of separation between Church and State was drawn up, and the Roman Catholic religion ceased to be that of the State, which recognized all creeds as of equal authority.

The law was extended in Nov. 1913 to the Portuguese colonies, where the discouragement of Portuguese missions later gave rise to serious fears of the denationalization of the colonies through the activity of foreign missionaries. (Administrative and financial autonomy was given to the colonies on Aug. 15, 1914.) When Paes subsequently became president, one of his first acts was to redress some of the grievances suffered under the law of separation, and, by a decree of Dec. 22, 1917, banishment imposed on the priests was annulled, and the cardinal patriarch returned to Lisbon. Relations with the Vatican, broken off on July 10, 1913, were resumed in 1918.

The Royalist Invasions.—The main event of Senhor Chagas's premiership was the first royalist invasion. Capt. Paiva Couceiro crossed the frontier on Oct. 3, 1911, at the head of about 1,000 men, not a quarter of whom were armed with rifles. He advanced

[1]During the 18th and 19th centuries the name, spelt Luis in the 16th century and since 1911, was spelt Luiz.

towards Braganza, and took the small town of Vinhaes, but evacuated it on Oct. 6 and, after maintaining himself for a fortnight in the hills, recrossed the frontier. A royalist rising in Oporto, timed to coincide with this invasion, was brought prematurely to a head by Carbonario agents on Sept. 29. King Manoel and the pretender, Dom Miguel, met at Dover on Feb. 6, 1912. On July 7 Couceiro again crossed the frontier, with a slightly larger force, but most of his arms and ammunition had been seized in Belgium and Galicia. The royalists' attacks on Valença and Chaves failed, and within a week they returned to Spain.

The arrests after the invasions of 1911 and 1912 were very numerous. Special tribunals were set up in Lisbon and Oporto in Jan. 1911, to try cases of political conspiracy, and in July 1912 Parliament voted still more stringent laws of defence.

Reforms were opposed by the Carbonarios and the radical republicans, and some of the worst outrages were committed under the weak Government which succeeded that of Chagas in Nov. 1911, with Dr. Augusto de Vasconcellos as premier, and under the third coalition ministry formed by Dr. Duarte Leite in July 1912. Dr. Afonso Costa, the radical leader, came into power in Jan. 1913, and the minister of justice introduced a bill modifying the penitenciaria *re'gime,* but the general amnesty was delayed till Feb. 1914. The situation was one of growing unrest. Dr. Afonso Costa, who gave much of his attention to finance, resigned on Feb. 9, 1914, and Dr. Bernardino Machado became premier. He was in office when Portugal definitely ranged herself on the side of the Allies during the World War.

The World War.—At a special joint sitting of both chambers on Aug. 7, 1914, Portugal proclaimed her loyalty to the British alliance, and on Nov. 23 formally committed herself to participation in military operations. She served the cause of the Allies by furnishing munitions, guns and a division of artillery, and acted in close co-operation with Great Britain. On Sept. 11 the first expedition of Portuguese troops left for Africa under the command of Cols. Alves Roçadas and Massano de Amorim, and fresh contingents followed at intervals, 40,000 troops in all being despatched for the defence of the colonies. As early as Aug. 24, 1914, however, a raid by German forces was made on the Portuguese post of Maziwa on the northern frontier of Mozambique. On Oct. 19 the Germans attacked Naulila (on the Angola frontier), where more serious fighting occurred two months later, and on Oct. 30 they stormed the fortress of Kwangar and put the garrison to the sword. On April 11, 1916, Portuguese troops occupied Kionga (south of the Rovuma river), which Germany had seized in 1894, and on May 27 they crossed the Rovuma river. They were still co-operating with the British in rounding up the Germans when the war ended. The British Government had deprecated any unnecessary intervention of Portugal in the war, but agreed to the requisitioning of German ships lying in Portuguese ports, and this was carried into effect in Feb. 1916.

Consequently, Germany retaliated by declaring war on Portugal on March 9 and the declaration of war between Portugal and Austria followed on March 16. German submarines were active off the coast of Portugal during the autumn, many ships being sunk in 1917. By a decree of Jan. 17, 1917, Gen. Fernando Tamagnini de Abreu (d. 1924) was given command of the Portuguese expeditionary force, and by July there were over 40,000 Portuguese troops on the Western Front, with 20,000 in Portugal ready to reinforce them. On April g, 1918, on the Lys river, the Portuguese contingent met a formidable attack by the Germans.

Political Movements During the War.—On Dec. 13, 1914, Dr. Machado was succeeded in the premiership by the democrat, Senhor Azevedo Coutinho, but a military movement following, President Arriaga appealed to Gen. Pimenta de Castro to constitute a Government representative of a wider body of opinion in the country; the latter formed a ministry on Jan. 28, 1915.

The general election was fixed for June 6, 1915. In April an amnesty emptied the prisons. The democrats were, however, able to count on the support of the marines, and on May 14 the sailors mutinied, shot the captains of the "Almirante Reis" and "Vasco da Gama" and bombarded Lisbon, about 100 persons being killed. Pimenta de Castro resigned on May 15 and was arrested next day and transported to the Azores. The revolutionary committee nominated Chagas as premier, but on May 16 he was shot at and wounded in the train on his way to Lisbon. Chagas was succeeded by Dr. José de Castro. In a message addressed to Parliament Arriaga resigned the presidency as from May 29, 1915 (he died on March 5, 1917), and, after an interim presidency under Dr. Theophilo Braga, was succeeded, on Aug. 6, 1915, by Dr. Bernardino Machado. The Government resigned in June, Castro again becoming premier, but in November Dr. Costa returned to office. On Dec. 5, 1917, a revolution, directed against the internal policy of Costa and the Democrats, broke out at Lisbon. After two days' fighting victory was won by the insurgents, whose artillery had opened fire upon the fleet. Dr. Costa was arrested and President Machado was banished. Vice-Admiral Machado dos Santos was released from prison, and with Maj. Sidonio Paes, the leader of the movement, and Capt. Feliciano Costa, formed a revolutionary committee. A provisional government was now constituted, Maj. Paes becoming president and Minister for War and Foreign Affairs. The radical sailors mutinied on Jan. 8, 1918, and bombarded Lisbon, but the movement was quelled and several hundreds were deported to Africa.

In March 1918 Paes reconstructed his ministry, and the elections, on an enlarged franchise, were held on April 28. Paes was elected president by 500,000 votes and was proclaimed president on May g, the Powers recognizing the new *re'gime.*

The first anniversary of the revolution was celebrated with national rejoicings on Dec. 5–8, 1918, but on Dec. 14 President Paes was shot at the Rocio station by José Julio da Costa and died a few minutes later. On Dec. 16 Admiral João de Canto e Castro was provisionally elected president, and in Jan. 1919 Senhor Tamagnini Barbosa formed a ministry, reviving the office of premier. The Peace Treaty was ratified on March 30, 1920. At the Spa Conference (*q.v.*), in July 1920, Portugal secured three-fourths of one per cent as her share of the total indemnity from Germany, and also received Kionga.

On June 1, Admiral Canto e Castro resigned and was succeeded by Dr. Antonio José de Almeida on Aug. 6. There followed a succession of short-lived ministries and on March 2, 1921, a new coalition ministry was formed, under the premiership of Dr. Bernardino Machado. A military *pronunciamento* on May 20 caused the resignation of Dr. Machado. He was succeeded by a Liberal ministry under Dr. Barros Queiroz, who dissolved Parliament and held a general election on July 10.

A solemn pledge had been taken to punish all who had supported the moderate republican, President Paes; in Oct. 1921, the barbarities culminated in the murder of the new premier, Dr. Antonio Granjo, the founder of the republic, Admiral Machado dos Santos, and other prominent persons. The appearance of foreign battleships in the Tagus brought the assassins to their senses for a time. Capt. Cunha Leal formed a short-lived ministry and was succeeded in Feb. 1922 by Sr. Antonio Maria da Silva. A number of ministries, lasting two or three weeks apiece, followed his resignation 21 months later, political instability being further increased by divisions in the Democrat Party.

In the general election of Jan. 1922, the Lisbon democratic candidate, Dr. Afonso Costa, was successful by a small majority. Successive revolutionary movements took place; these had become a regular political weapon and were attended by little loss of life. Those of April and July 1925 were of a more conservative character and showed an inclination on the part of the army to expel the politicians from power. In Aug. 1923 Sr. Teixeira Gomes, Portuguese Minister in London, was elected president of the republic in succession to Dr. Antonio Almeida (1866–1929), the first president to serve his full term of four years.

The elections of Nov. 8, 1925, gave a clear majority to the Democrats, who numbered 82 against 66 for all other parties, and it seemed at last that Portugal might achieve a comparatively stable government. The resignation of the president had long been expected, and when it took effect (Dec. 10) the election of his successor Dr. Machado, took place without incident. The new Democrat ministry formed on Dec. 16 consisted of experienced politicians, with Sr. Antonio da Silva once more as premier.

But on Feb. 2, 1926, a military revolt broke out in Lisbon. It was rapidly quelled and the leaders deported. On May 30 a more serious revolutionary attempt was made. Commander Mendes Cabeçadas, leader of the revolt of July 1925, was one of the leaders; the other, Gen. Gomes da Costa, had also been implicated in former risings. The outbreak of May 30 was a revolution led by the army and provoked by the corruption and inefficiency of successive governments. On June 1 the whole country was in the hands of the revolutionaries, the president was deposed and banished, and Cabeçadas then formed a provisional government with Gen. Gomes da Costa as minister of war. The May revolution was the 18th *pronunciamento* since the foundation of the republic and Sr. da Silva's cabinet was the 40th to be overthrown in the same brief period.

Differences were immediately manifest between the army leaders and Com. Cabeçadas, representing the politicians. Gen. Gomes da Costa marched on Lisbon and Com. Cabeçadas resigned the premiership. Gen. Gomes da Costa, now premier and acting president, disagreed with his cabinet, and within a few weeks was deposed and deported to the Azores, being succeeded at Lisbon by his foreign minister, Gen. Carmona. The new government ruled peaceably (without parliament) for some months, but on Feb. 3, 1927, a revolution, fostered by Communists broke out at Oporto and Lisbon, where the marines and part of the republican guard were overcome through the energetic action of the minister of war, Col. Passos. This was the bloodiest revolution Since Oct. 1910. On April 15, 1928, Gen. Carmona was proclaimed president, having been elected by 750,000 votes. A new constitution, adopted on March 19, 1933, provided for the .president's election for seven years by direct vote of the heads of families, a privy council of ten, a National Assembly of one chamber of go deputies, elected for four years. Despite this constitution, the government became in fact a dictatorship of the president and the prime minister. On Feb. 17, 1935, General Carmona was elected unanimously for a further term of 7 years. In 1936 the Spanish civil war, and Portugal's fear of a victory for the Spanish Left, emphasized the importance of Portugal in European politics.

BIBLIOGRAPHY.—1. SOURCES.--See articles on the 15th- and 16th-century chroniclers, G. E. de Azurara, J. de Barros, D. de Goes, F. Lopes, J. Osorio da Fonseca, R. de Pina, G. de Resende and L. de Sousa; and on the 19th century historians, A. Herculano and J. P. Oliveira Martins. The most important collections of documents are *Collecção dos livros ineditos,* etc., ed. J. F. Corrês da Serra (1790–1804); *Quadro elementar das relações politicas e diplomaticas de Portugal,* ed. first by the viscount de Santarem (1856–61) and afterwards, under the title of *Corpo diplomatico portuguez,* by L. A. Rebello da Silva (vol. i.–iv.), J. J. da Silva Mendes Leal (v.–ix.) and J. C. de Freitas Moniz (x., etc.). The *Collecção de tratados,* etc. (1856–79), was ed. by Viscount J. F. Borges de Castro and J. Judice Biker; it was continued by the Royal Academy as the *Nova collecção de tratados* (1890–91).

2. GENERAL HISTORIES.—The *Historia de Portugal* by J. P. Oliveira Martins (4th ed., 1901), is a series of brilliant impressionist studies. There is a popular illustrated *Historia de Portugal,* by A, Ennes, M Pinheiro Chagas and others, in 37 parts (1877–83). *See* also H. Schaefer, *Geschichte von Portugal* (2nd ed., Hamburg, 1874); E. MacMurdo, *History of Portugal* (1888–89); H. Morse Stephens, *Portugal,* 4th ed., with additional chapter on the reign of D. Carlos, by Martin Hume (1908); F. de Almeida, *Historia de Portugal* (Coimbra, 1922–26).

3. SPECIAL PERIODS.—A. Herculano's classic *Historia de Portugal* (new ill. ed., 1914–16), covers the period up to 1279. H. da Gama Barros' *Historia da administração publica em Portugal nos seculos XII. á XV.* (1895–96, 1914), is a scientific study of the highest value. For the periods 1415–60 and 1750–77, *see* the authorities quoted under HENRY THE NAVIGATOR, and POMBAL. A critical bibliography for the period 1460–1580 is given by K. G. Jayne, in *Vasco da Gama,* etc. (London, 1910). For later history, *see* L. A. Rebello da Silva, *Historia de Portugal nos seculos XVII. e XVIII.* (1860–71); E. Prestage, *The Diplomatic Relations of Portugal with France, England and Holland from 1640 to 1668* (Watford, 1925); J. M. Latino Coelho, *Historia de Portugal desde os fins do XVIII. seculo atk 1814* (1874–91); the authorities cited under PENINSULAR WAR; S. J. da Luz Soriano, *Historia da guerra em Portugal* (1866–90); J. P. Oliveira Martins, *Portugal contemporaneo* (1826–68, 4th ed., 1906); J. L. Freire de Carvalho, *Memorias . . . para. a usurpação de D. Miguel* (1841–49); Sir C. Napier, *An Account of the War . . . between D. Pedro and D. Miguel* (1835); J. de Vilhena, *D Pedro II. e o seu reinado* (Coimbra, 1921–22); W. Bollaert, *The Wars of Succession of Portugal and Spain, from 1821 to 1840 (1870)*; A. Ribeiro, *A Revolução Portuguesa* (1913–15); C. Malheiro Dias, *Do Desafio á Desbandada* (1912); A. Marvaud, *Le Portugal et ses Colonies* (1912); P. Lebesgue, *La République Portugaise* (1914); F. Lorenzo, *Portugal: Cinco Años de República* (1915); A. Pestana, *La Educación en Portugal* (1915); A. F. G. Bell, *Portugal of the Portuguese* (1915); G. Young, *Portugal Old and Young* (Oxford, 1915); A. L. de Almada Negreiros, *Portugal na Grande Guerra* (Paris, 1917); Hans Meyer, *Das Portugiesische Kolonialreich drr Gegenwart* (1918); F. de Homem Christo, *Le Portugal contre l'Allemagne* (1918).
(A. B.)

PORTUGUESE EAST AFRICA or **MOZAMBIQUE** (Official name: A Provincia de Moçambique). This Portuguese possession, bounded east by the Indian ocean, north by Tanganyika Territory, west by the Nyasaland Protectorate, Rhodesia and the Transvaal, south by Tongaland (Natal), has an area of 770,000 square kilometres. It is divided in two by the river Zambezi. The northern portion, between the ocean and Lake Nyasa and the Shiré river is a compact block of territory, squarish in shape, being about 400 m. long by 360 m. broad. South of the Zambezi the province consists of a strip of land along the coast varying from 50 to zoo m. in depth.

Physical Features.—The coast-line extends from 26° 52′ S. to 10° 40' S., and from south to north makes a double curve with a general trend outward, *i.e.,* to the east. It has a length of 1,430 miles. Some 40 m. N. of the Natal (Tongoland) frontier is the deep indentation of Delagoa bay (*q.v*). Far to the north is the wide Zambezi delta. From this point onward the coast is studded with small islands, mainly of coral formation, on one of which is Mozambique. To the north of Mozambique the coast is much indented, abounding in high, rocky headlands and rugged cliffs. South of Mozambique the coast-line is low, sandy, and lined with swamps. The eastern scarp of the continental plateau is much broken in the lower Zambezi region but elsewhere rises to heights of 6,000–7,875 ft. in the south, though behind Delagoa bay the greatest height is only 2,070 feet. In the north the forested hills of the scarp reach 6,500–8,600 feet.

Near the south-east shore of Nyasa there is a high range (5,000 to 6,000 ft.) with an abrupt descent to the lake—some 3,000 ft. in six miles. The plateau lands west of the escarpment are of moderate elevation—perhaps averaging 2,000 to 2,500 feet. The chief rivers are the Zambezi and Limpopo, both cutting back far into the plateau.

Geology.—The central plateau consists of gneisses, granites and schists of the usual East African type which in part or in whole are to be referred to the Archaean system. Rocks of the Karroo period occur in the Zambezi basin, where at Tete they contain workable seams of coal, and have yielded plant remains of Upper Carboniferous age. Sandstones and shales, possibly of Upper Karroo age, form a narrow belt at the edge of the foot-plateau. Upper Cretaceous rocks crop out from beneath the superficial deposits along the coast belt between Delagoa bay and Mozambique. The highest Cretaceous strata occur in Conducia, where they contain the huge ammonite *Pachydiscus conduciensis.* The Eocene formation is well represented in Gazaland by the nummulitic limestones which have been found to extend for a considerable distance inland. Basalts occur at several localities in the Zambezi basin. On the flanks of Mount Milanje there are two volcanic cones which would appear to be of comparatively recent date; but the most interesting igneous rocks are the rhyolitic lavas of the Lebombo range.

Fauna and Flora.—The lion, of both the yellow and the black-maned varieties, leopard, spotted hyena, jackal, serval, civet cat, genet, hunting dog (*Lycaon pictus*) and mongoose occur in the Mozambique district. The elephant and the black rhinoceros are common, and south of the Zambezi are a few specimens of white rhinoceros (*R. simus*). The rivers and marshes are the home of hippopotami, which have, ho ever, deserted the lower Zambezi. The wart-hog and the smaller red hog are common. A species of zebra is plentiful, and herds of buffalo (*Bos caffer*) are numerous in the plains and in open woods. Many antelopes are found, but the giraffe does not occur. The scaly anteater is fairly numerous, and rodents are common. There are several kinds of monkeys and lemuroids, but the anthropoids are absent. Crocodiles, lizards, chameleons, land and river tortoises are all very numerous, as are pythons (some 18ft. long), cobras, puff-adders and vipers. Centipedes and scorpions and insects are innumerable. Among insects mosquitos, locusts, the tsetse fly, the hippo-fly, cockroaches, phylloxera, termites, soldier ants and flying ants are common plagues. As has been indicated, the Zambezi forms a dividing line not crossed by certain animals, so that the fauna north of that river presents some marked contrasts to that of the south.

Flamingoes are common in the Mozambique district. Cranes, herons, storks, pelicans and ibises are numerous, including the beautiful crested crane and the saddle-billed stork (*Mycteria* senegalensis), the last-named comparatively rare. The eagle, vulture, kite, buzzard and crow are well represented, though the crested eagle is not found. The guinea fowl, partridge, bustard, quail, wild goose, teal, widgeon, mallard and other kinds of duck are all common. A small green parrot is found.

The coconut is common in the coast regions and often attains 100ft.; the date palm, mostly in marshy ground and near rivers, is seldom more than 20ft. in height; four other palms occur. A kind of cedar is found in the lower forests; ironwood and ebony are common, and other trees resemble satin and rosewood. The large *Khaya senegalensis* found in ravines and by river banks, affords durable and easily-worked timber; there are several varieties of vitex and of ficus, notably the sycamore, which bears edible fruit. Excellent hardwood is obtained from a species of grewia. Other characteristic trees are the mangrove (along the sea shore), sandal-wood, gum copal, baobab and bombax, and, in the lower plain, dracaenas (dragon trees), candelabra euphorbia, and many species of creepers and flowering shrubs, and several prickly shrubs. Acacias are numerous, including the gum-yielding variety, while landolphia rubber vines grow freely in the forests. Coffee, cotton, indigo and tobacco plants, castor oil, bananas, mangoes and pineapples are found. The bamboo is common. Phragmites *communis,* spear grass, with its waving, snowy plumes, grows 12 to 14ft. and is abundant along the river banks and along the edges of the marshes.

Climate and Health. — Malaria is endemic on the coast and along the banks of the Zambezi. On the uplands and the plateaus the climate is temperate and healthy. At Tete, on the lower Zambezi, the annual mean temperature is 77·9°, the hottest month being November, 83·3°, and the coldest July, 72·5°. At Quelimane, on the coast, the mean temperature is 85·1°, maximum 106·7° and minimum 49·1°. The cool season is from April to August. During the monsoons the districts bordering the Mozambique channel enjoy a fairly even mean temperature of 76·1°, maximum mean 88·7°, and minimum mean 65·3°. The rainy season lasts from December to March, and the dry season from May to the end of September. November is a month of light rains. Rainfall, average mean for many years, in millimetres, is: Lourenço Marques 776, Beira 1,534, Quelimane 1,433, Mozambique 797, Tete 538, Shiré 1,885.

A scientific mission has verified endemic foci of sleeping-sickness of the Rhodesian type in 18 places in the territory studied. Cases of fever were also noted, due generally to *Laverania malariae,* but also to *Plasmodius vivax;* and malaria, recurrent fever and filariasis. The tsetse fly, mostly *morsitans,* was found in several districts. It is spreading in that of Tete. Good results had been obtained by the use of atoxil in the initial stages, and of Triparsamida in advanced cases of the disease. The mission emphasizes the necessity of the study of the disease *"nagana"* in cattle.

There are good Government hospitals at Lourenqo Marques and other centres.

Population and Towns. — Portuguese East Africa is sparsely inhabited, the native population being, in 1934, 4,028,746 90% of the inhabitants belong to various Bantu tribes, from whose ranks most of the natives employed in the Transvaal gold mines are recruited. The most important in the northern half of the province are the Yaos (*q.v.*) and the Ma Kua (Makwa). The Makwa, notwithstanding the presence of Arabs, Banyans (Hindus) and Battias in all the coast districts, have preserved in a remarkable degree their purity of race, although their language has undergone considerable change (see BANTU LANGUAGES). The Makwa are divided into four families or groups — the Low Makwa, the Lomwe or Upper Makwa, the Maua and the Medo. Yao possess the country between the Msalu river and Nyasa. The dominant race between the Zambezi and the Mazoe are the Tavala, with other tribes mainly of Zulu origin. Between the Zambezi and the Pungwe are the Barue, Batoka, etc. In the district south of the Pungwe river, known as Gazaland, the ruling tribes are of Zulu origin, all other tribes of different stock being known as Thongas, resembling the Basutos, peaceful stock-raisers and cultivators. Among them are the BaTonga south of Inhambane, and the BaRonga mainly in the Lourenqo Marques district. The BaChopi in the Inhambane district are a Bantu tribe of different origin and language. The white inhabitants are chiefly Portuguese and British, and nearly half live in Lourenqo Marques.

The most important towns are Lourenqo Marques (the capital), Mozambique, Quelimane, Inhambane, Beira and Chinde. Sofala has now little but historical interest. These towns are separately noticed. Other European settlements are Chingune (see SOFALA), Angoche and Ibo, Porto Amelia on the coast, and Sena, Tete and Zumbo on the Zambezi, Macequece and Vila João Belo. Angoche, midway between Quelimane and Mozambique, dates from the 17th century. It has become the port of one of the most important commercial centres of the district of Mozambique, the coconut industry being rapidly developed there. It is connected with the Mossuril-Mozambique motor road. In 1925–6, 761 ships entered and left the port, representing a gross tonnage of 158,188. 6,793 tons of cargo were loaded. Ibo, founded at the beginning of the 17th century, on Ibo island, one of the Querimba archipelago, stands in 12° 20′ S., 40° 38′ E., off the northern arm of Montepuesi bay. It is 180 m. north of Mozambique. The harbour is sheltered but shallow.

The Zambezi towns, Sena, Tete and Zumbo, for long marked the limits of Portuguese penetration inland. Comparatively important places in the 17th and 18th centuries, with the decline of Portuguese power they fell into a ruinous condition. The opening up of Rhodesia and British Central Africa in the last quarter of the 19th century gave them renewed life.

Sena, some 150 m. by river from Chinde, is built at the foot of a hill on the southern side of the Zambezi, from which it is now distant 2 m. It has an 18th century fort, and is the head of a circumscription with a population of 78 Europeans and 40,140 natives.

Tete, founded about the same time as Sena, is also on the south bank of the Zambezi. It is about 140 m. by river above Sena. Since 1894 there has been a regular service of steamers between Tete and Chinde. A transit trade to British possessions north and south of Tete was later developed. It is the seat of government of a district of 65,000 sq.m. with a population of 350,472, including 400 Europeans. The district is rich in minerals.

Zumbo is picturesquely situated just below the Loangwe confluence and commands iarge stretches of navigable water on the Loangwe and middle Zambezi. Zumbo is 400 km. distant from Tete, and is in 1j° 37′ 36″ S., 30° 24′ 38″ E. The sub-district has a population of 33,106 natives.

Porto Amelia, 50 m. S. of Ibo, is the main seat of government of the Nyasa company, the charter of which expires in Oct. 1929, when the State will take over the administration of the company's territory. Porto Amelia stands on Pemba bay, one of the finest harbours in the world, which, a mile and a half wide at the entrance, has an extent of seven miles by five. It is the natural port, not only of its own hinterland, but of part of the highly developed Nyasaland protectorate and perhaps a part of northern Rhodesia also. It is healthy, well drained and free from malaria. It is connected with the State telegraphs at Mozambique.

Macequece, on the railway line from Beira to Rhodesia, 17 m. from the border, is the centre of the Manica goldfields. It is 2,500 ft. above the sea, and 194 m. N.W. of Beira by rail. It is picturesquely situated in a fertile and well-wooded district with a good water supply. The climate is healthy except in February and March. On the railway line from Lourenqo Marques to the Transvaal, Moamba, the junction for the Xinavane railway and seat of the Sabie circumscription, and Ressano Garcia, the last Portuguese station, are also trading settlements, cotton being grown near the former.

Vila João Belo (formerly Chai-Chai and later Vila Nova de Gaza), 23 m. up the Limpopo river, is a growing commercial settlement doing an increasing business with the interior in agricultural products. There is a bi-weekly steamer service to Lourenqo Marques.

Communications. — The province is served by many regular lines of steamships, furnishing communication between Lourenqo Marques, South African ports, Europe, India and America. In 1927, 1,737 ships (tonnage 4,682,893) entered the ports under the direct administration of the State, disembarking 53,435 passengers and 348,289 tons of cargo, and embarking 52,194 passengers and 822,175 tons of cargo.

There are many good motor roads, especially in the district of Lourenço Marques and Inhambane, of which the most important is perhaps that linking Lourenço Marques with Goba on the Swaziland border. New constructions are roads from Tete to Blantyre, and Tete to Salisbury. An important new road linking Mocubu with Nyasaland is under construction. The province belongs to the South African Postal Union, and is in telegraphic communication with Europe via South Africa and via Zanzibar. A cable connects Mozambique with Madagascar. Inland lines connect the ports with adjacent British possessions. There are 22,640 kilometres of telegraph and telephone lines in the province. There is a direct wireless service, with g stations, to the west coast, Europe, North and South America.

The railway to the Transvaal (j j m) belongs to the State, connecting with the Union of South Africa railways at Komatipoort, and is of prime importance. In the last three months of 1927, the total receipts of the Lourenqo Marques railway were £125,623. New railway shops are to be built at Lourenço Marques. New engine sheds are nearly complete. The Swaziland line (44 m.) to Goba on the Swaziland border, is to link up eventually with the Union system at Breyten, considerably reducing the distance from Lourenqo Marques to Germiston. The Gaza railway (51 m.) with a 2 ft. 6 in. gauge, runs from Vila João Belo (Chai-Chai) to Chicomo, near the river Inharrime. This railway handles about 9,000 tons of goods per year, mostly agricultural produce. The Beira railway (200 m.) in the Mozambique Company's territory, links up with Rhodesian railways at the frontier. The Trans-Zambezia railway (156 m.) from Dondo on the Beira Junction railway to Murraqa, on the south bank of the Zambezi, was opened in 1922. The Central African railway on the north bank of the Zambezi (61 m. long, of which 45 m. are in Portuguese territory) is connected at Port Herald with the Shiré Highlands railway. The Xinavane railway from Moamba to Xinavane (55 m.) is to be prolonged via Chissano to Vila João Belo (Chai-Chai), or via Chihuto to Chicomo (70 m.). The line from Inhambane to Inharrime is 55 miles; and that from Lourenqo Marques to Marracuene is a light railway (extension to Manhiça is authorized) with gauge 0·60 metres, 32 km. long. In 1927 it carried 20,736 passengers, and receipts were £5,150 libras. The Quelimane-Mocuba line is on the river Lujella; the Lumbo line (on the mainland off Mozambique), to Mkonta, is 94 kilometres. This is to be extended to the Nyasaland border, when it will be the shortest route from the sea to Lake Nyasa, Lines projected are: the prolongation of the Gaza railway. Chicomo via Jinagai to Inharrime, 51 m., and southwards to Xinavane; Quelimane—Shiré Highlands; Port Amelia—Lagos district; Nambula and Serra de Chinde sections of the Mozambique railway.

The Zambezi is navigable by light draught steamers throughout its course in Portuguese territory with one break at the Kebrassa Rapids—400 m. from its mouth. By means of the Shiré affluent of the Zambezi there is direct steamer and railway connection with British Central Africa.

Agriculture. — The province is, on the whole, very fertile, especially between Angoche and Quelimane, and in the Limpopo valley, where, as in the valley of the Zambezi, the soil is fertilized by inundations. The chief products are: sesame, indigo, coffee, ground-nuts, gum copal, rubber, sugar, cashew-nuts, coconuts, copra, mangrove-bark, maize, tobacco, cotton, etc. The irrigation and drainage scheme for the Limpopo valley, worked out by Col. Balfour, which will affect 20,000 hectares of good land, and cost £500,000, providing work for about 40,000 natives, has been officially approved. It has recently been decided to send five students from the province to agricultural schools in the Union of South Africa, with a subsidy of £100 per ann. each, on condition of their serving the State for at least two years on their return.

The following are notes on some chief products (see further under section on Mozambique and Nyasa Companies). Cotton production has diminished south of the Save river, owing to irregular rains. Total export in 1926 was 1,154 tons, valued at £81,765. Of this, the Mozambique company exported 652 tons, value £66,709. There are 11,000 hectares under cotton in the Quelimane district. In 1926 the total sugar production (including that of the Mozambique company), showed an increase of 16,000 tons on the previous year. Of this total, 50,966 tons, value £540,982, were exported. The chief centres are the lower Zambezi, and on the Buzi and Incomati rivers. 5,524 hectares are under sugar in the Quelimane district; production in 1924–25 being 10,100 tons. The chief producers are the Incomati sugar estates at Xinavane in the Lourenqo Marques district, and the Sena sugar estates and the Companhia Colonial do Buzi, in the Nyasa company's territory.

In 1926, exports of oil seeds, etc., equalled 52,030 tons (the largest item of export), value £810,862. (This is apart from the Mozambique and Nyasa companies, of which there are no returns.) There has been a considerable increase in export of oilseeds. Macurra is increasingly exported. With the exception of the last, production of oil seeds is almost entirely limited to the districts of Mozambique and Quelimane; ground-nuts, castor-oil seeds and sesame are limited to the district of Mozambique, and copra to that of Quelimane, which exported 18,065 tons, valued at £363,454 in 1926. Tobacco is being increasingly grown, principally for cigarettes. Growers ask for stoppage of importation. 500 tons were exported in 1924–25 in Quelimane district. 74% of the tobacco used in the province is local, the rest being imported from America and the Union of South Africa. Prospects are good. Export duties in 1926 were £103,499, an increase of about £13,000. The production of tea increased from 45 tons in 1924–25, to 55 in 1926–27, and 63 in 1927–28. Wheat has given good results experimentally, and is being increasingly cultivated, especially in the Zambezi valley. In the first three months of 1927, 1,627,661 kilos of bananas were exported from Mozambique, of a value of £21,660. A recent decree regulates concessions of five years for the exploitation of wild, fibrous and rubber plants. Rubber plantations exist in the Quelimane district, but owing to the price, fresh planting has practically ceased. There was no production in 1924–25.

The conditions for growing sisal are excellent, except in the district of Lourenqo Marques. Great plantations exist in the north, especially in the territories of the Nyasa company, Mozambique company, and in the Quelimrne district. Quality is not as good as in Tanganyika sisal. There are 8,344 hectares under sisal in the Quelimane district. Over 9,000 tons were exported last year, at an expected return of £10 per ton. There are five varieties of coffee native to the province. Tney have small grains, with little caffeine. Most of that exported is grown by natives, but there are a few plantations in the Mozambique district. Maize is grown, mostly by natives, in every part of the province. In 1926 the Mozambique company exported' maize to the value of £36,722. Coconut is exploited especially in the Quelimane district, where are some of the largest plantations in the world. Copra valued at £363,454 was exported in 1926. Kapok is cultivated in the Quelimane district.

Forestry, Stock-raising and Other Industries. — The most important timbers produced are: Mahogany (Khaya *Nyassica*); Ebony or Grandilha (*Dalbergia melanoxylon*); Mussacossa or Pod Mahogany (*Afzelia Quanzensis*), called Chanfuta in the south of the province, used for furniture, vehicles, etc.; M'Bila (Ptero carpus *erinaceus*) or Bloodwood; Pau-Ferro (Swartsea *Madagas-*

carensis), suitable for high class furniture; African Sandal Wood (Excoecaria Africana) for furniture and waggon work, etc.; Ziba (*Andrades* arborea) a valuable hardwood; Moanjwa (*Cordyla* Africana); M'Zimbiti (Androstachys Johnsoni), impervious to white ants, and used for railway sleepers and piles; Panga-Panga (*Lonchocarpus Mossambicensis*) suitable for furniture; Muanga or Chuanga (*Ormosia* Angolensis) used for bridge building, being impervious to white ants; Monhé or Gone (Adina microcephala) similar to teak; Messanda (Erythophloeunz *Guineensis*), a very hard red wood, suitable for railway sleepers.

The stock industry, especially the raising of bovine stock, has increased greatly, especially in the districts of Lourenqo Marques and Tete. At the end of 1925 there were 393,798 head in the province (excluding the Nyasa company), of which 300,000 were in the Lourenqo Marques district.

A modern, well-equipped cement factory, owned by the Mozambique Portland company, is working at Matola, near Lourenqo Marques, and is capable of producing 50,000 tons of cement a year. Its products are used in the province. Tobacco is manufactured, four factories being at work. Bricks and tiles are made at Incomati, on the Lourenqo Marques railway. Oils and soaps, in the Lourenqo Marques and Inhambane districts. Milling is carried on. Tannin is extracted in the Quelimane and Mozambique districts. A Portuguese company has undertaken the production of paper and paper-pulp.

Minerals and Mining. — Mining can be carried on only under concession from the Government. In future, exclusive concessions for prospecting for minerals are not to be renewed. The chief mining centre is Manicaland, but minerals have been extensively proved elsewhere. Active prospecting is being carried on in the Lourenqo Marques and other districts. The Zambezia Development company is prospecting systematically the whole of the Tete district. Extensive coal fields exist near Zumbo. The quality is excellent. Other deposits are known at Sena and Massurize, along the Shirk and Zambezi rivers, and in the Nyasa Co.'s territory. Coal has been reported in the Lourenqo Marques district, but not proved. The Zambezia Mining company is working coal at Mantize. Malachite is found in the interior, north west of Mozambique. The whole of the region north of Delagoa bay to the Zambezi, and inland to and beyond the Portuguese frontier, is auriferous, and ancient gold workings abound. Many writers have sought to identify this region with the land of Ophir. In Manica several gold mines are worked (quartz formation). In 1906–07 a rich formation similar to the American "placer" deposits was discovered in the Manica goldfields. Gold mines are also worked at Missale and Chifumbaze, north of Tete. The Missale mines are just south of the frontier of British Central Africa.

An important tin deposit is being worked at Neves Ferreira. Iron is found at Sena and Tete, and in the area of the Nyasa company. Asbestos occurs in the area of the Nyasa company. Copper is found at Sena and Tete, along the Shirk and Zambezi rivers. It is chiefly worked near Macequece. Diamondiferous ground is known at Govuro. Wulfram also occurs and graphite is found along the Shiré and Zambezi rivers. Mineral oils occur in the lands of the Nyasa company, and near Inhambane.

Administration and Finance. — The province is divided, for administrative purposes, into the five districts of Lourenqo Marques, Inhambane, Quelimane, Tete and Mozambique, each under a governor. The capital of the province is Lourenqo Marques (*q.v.*), the capitals of the other districts being the towns after which they are named. Apart from these territories directly administered by the State, two great chartered companies, the Mozambique and Nyasa (*q.v.*), have exercised sovereign rights in areas granted to them, with power to make local regulations, but remaining integral parts of the province. Beira (*q.v.*) is the seat of the administration of the Mozambique company and Porto Amelia that of the Nyasa company. Each administrative district is divided into circumscriptions, each being under an administrator; and in some of these there are smaller dependent administrative posts. The government of the colony is carried on by a legislative council, consisting of four official members, five memhrrs nominated hy the governor-general, arid elected representatives of the five districts. This council meets twice a year. The governor-general, who resides in Lourenqo Marques, serves for four years, but may be reappointed. The local government has administrative and financial autonomy, but the Lisbon Government must be consulted. There are six legal districts, Ibo, Mozambique, Quelimane, Beira, Inhambane and Lourenqo Marques. There is a provincial court of appeal.

The Mozambique company is a Lisbon company, incorporated by royal charter (1891), for a term of 50 years, renewable on expiry. Its capital is £1,500,000, much of which is foreign, and it holds sovereign rights over the territories of Manica and Sofala, an area of 153,666 sq.km. Its main activities are agricultural, but mining operations are very promising. Its capital Beira (*q.v.*) is the natural port of Rhodesia, and the carrying trade is constantly developing. The total trade of the territory was valued at £13,156,131 in 1925. In 1924 a profit of £152,079 was recorded. Gold, both reef and alluvial is produced, as also silver, tin and copper. Coal measures are known. The chief agricultural products are: cotton, of good staple, mainly on the Zambezi, and in Manica, Chimoio, Neves Ferreira and Buzi; sisal at Chupanga on the Zambezi; maize throughout the territory; oilseeds; rice, in increasing quantity, and citrus fruits. In 1926 there were 88,060 head of cattle in the territory.

The Nyasa company, which began work in 1894, had rights similar to those of the Mozambique company. It has had under its control territories, with area 73,292 square miles, in the north, the region between the Rovuma, the Lurio and Lake Nyasa. Porto Amelia, the capital, is about 150 miles north of Mozambique. Trade is mostly in the hands of Indians, and development has been slow and inconsiderable. Agricultural and mineral possibilities are probably considerable. Active prospecting is going on, and there are said to be indications of coal, oil, graphite, mica, iron, and alluvial gold. The territory of the company is being taken over by the provincial Government in 1929.

The difficult conditions of the last few years have disappeared, and the financial condition of the colony is encouraging. The escudo currency is now on a firm basis. Transfers to Portugal now cost only 3%. Revenue is mainly derived from customs, a hut tax (for which in 1925 a poll tax was substituted) and a tax on labourers who emigrate; the last source is not available in the territories of the chartered companies. The budget for 1927–28 shows total receipts 328,483,961 escudos, of which 318,978,090 escudos rank as ordinary. This is a great increase on the preceding year. The total expenditure is 311,397,476 escudos, leaving a surplus of normal receipts over necessary expenditure of over 1,700 contos, which is to be used for development. The colony has no external debt.

Economic Conditions and Commerce. — Economic development is considerable in the province, especially in the Mozambique company's territory. The Portuguese, however, have lacked capital to carry out large enterprises, while the constant ministerial changes at Lisbon and the financial embarrassment of Portugal have reacted unfavourably on Mozambique. Development has been most marked where British interests were concerned and British capital was forthcoming. The transit trade is large, Lourenço Marques serving the eastern Transvaal, and Beira being the chief port for Rhodesia, Ratanga and British Nyasaland. A railway from Beira to the Zambezi, completed in 1922, was built with British capital to meet the needs of the Nyasaland protectorate. This railway superseded the route by the Zambezi. The Beira-Zambezi railway also opened up rich tracts suitable for sugar, cotton and other crops. Moreover it brought a step nearer the exploitation on a large scale of the coalfields on the north side of the Zambezi near Tete. Another railway, from Inhambane to Delagoa bay (280 m. long), built in sections, is open to Inharrime. This line also serves fertile regions.

Imports were, in order of value: iron, steel and machinery and building material; flour, cereals in grain, cotton stuffs, timber, petrol; others were alcoholic drinks, automobiles and rice. The chief exports were, in order of importance, sugar, copra, maize, fresh fruit, coal, sisal, mangrove bark, nuts, beans and cotton

Apart from local trade, the transit trade to British dominion;

through Lourenqo Marques and Beira is most important. The chief exports to the Union of South Africa are copra, sugar, fresh fruit and ground-nuts; the chief imports from that source being coal, maize, fresh milk, eggs, beer and potatoes. In 1926, 33·07% of imports came from the British Empire, 14·46% from the Union of South Africa, 14·11% from Germany, and 13·86% from Portugal.

Missions and Education. — The province forms a diocese (in the ecclesiastical province of Goa) of the Roman Catholic Church which has been established in the colony from the beginning, ministering to Europeans and carrying on missions and educational work among natives in many places. There are several Protestant missions, cooperating loyally with the Government. Their educational work amongst natives is especially valuable. The most important of these are the Mission Suisse Romande, in the Lourenço Marques district; the Universities' Mission in the Nyasa company's territory; the Anglican diocese of Lebombo in the districts of Lourenqo Marques and Inhambane; the Methodist Episcopal mission in the Inhambane district; the Wesleyan Methodist church in the Lourenço Marques district; the Church of Scotland in the District of Quelimane; the American Free Methodist mission in the district of Inhambane.

Complete statistics as to education are wanting. The only secondary school (liceu) in the province is in Lourenqo Marques. An elementary commercial course has been instituted in connection with this school. Training schools for native teachers are maintained by the Missiqn Suisse Romande at Rikatla, near Lourenço Marques; another at Lourenço Marques, is conducted jointly by the Anglican, Swiss and Wesleyan Methodist missions; at Lourenço Marques the Anglican mission trains teachers and evangelists; and at Kambini, Inhambane district, the Methodist Episcopal Church has a training school. In Nov. 1925, the number of children attending primary schools in Lourenço Marques was 4,766, and those attending the secondary school 65. In Dec. 1924, the total number returned as attending primary schools in the province was given as 24,296. Agricultural and industrial schools have been opened in some of the circumscriptions.

BIBLIOGRAPHY.—*Mozambique,* British Foreign Office handbooks No. 121 (1918); *A Manual of Portuguese East Africa* and *Portuguese Nyasaland,* British Admiralty publications (1920)—all with bibliographies; *The Delagoa Directory* (1927); *Report on Portuguese East Africa* (Dept. of Overseas Trade, London, 1922); *The South and East African Year Book and Guide* (London, annually). Official reports are published in the *Anuario Colonial* (Lisbon). *See* also *Boletim da Africia Geral das Colonias* (Lisbon, monthly); *Monograjias das Colonias Portuguezas* (Lisbon, 1926). (H. BP.)

HISTORY

By the 10th century A.D. the Arabs had occupied the seaboard of East Africa as far south as Sofala, and until the close of the 15th century their supremacy was unchallenged. But in 1498 Vasco da Gama entered the mouth of a river which he called Rio dos Bons Sinaes (River of Good Tokens), as there he first found himself in contact with the civilization of the East. This stream was the Quelimane river, taken by the Portuguese a little later to be the main mouth of the Zambezi. From this river da Gama continued his voyage, putting in at Mozambique and Mombasa on his way to India. Hostilities between the Arabs and. Portuguese broke out almost immediately. In 1502 da Gama paid a visit to Sofala to make enquiries concerning the trade in gold carried on at that place, and the reports as to its wealth which reached Portugal led to the dispatch in 1505 of a fleet of six ships under Pedro da Nhaya with instructions to establish Portuguese influence at Sofala. By 1510 the Portuguese, who had seized and fortified the port of Mozambique in 1507, were masters of all the former Arab sultanates on the East African coast.

Quest for the Land of Gold.—For 40 years Sofala was their only station south of the Zambezi. Thence they traded with the chief of the "Mocaranga" (*i.e.,* the Makalanga or Karanga) in whose territory were the mines whence the gold exported from Sofala was obtained. This potentate was known as the Monomotapa (*q.v.*). The efforts made by the Portuguese from Sofala to reach him were unsuccessful. It was probably the desire to penetrate to the "land of gold" by an easier route that led, in 1544, to the establishment of a station on the River of Good Tokens, a station from which grew the town of Quelimane. It was at this period also that Lourenqo Marques and a companion entered Delagoa bay and opened up trade with the natives. This was the most southerly point occupied by the Portuguese. In 1569 the East African dominions, hitherto dependent on the vice-royalty of India, were made a separate government with headquarters at Mozambique.

Francisco Barreto, a former viceroy of India, appointed governor of the newly formed province, was instpucted by King Sebastian to conquer the country of the gold mines. Unwisely the route via the Zambezi, and not that from Sofala, was chosen by Barreto. His expedition, including over 1,000 Europeans, started in Nov. 1569, and from Sena marched south. His force was so greatly weakened by deaths and disease that Barreto was obliged to return to Sena, whence he went to Mozambique to put down disorder among the Portuguese there. He returned to Sena in 1570, only to die a few days after his arrival. His successor, Vasco Fernandes Homem, made his way inland from Sofala to a region where he saw the ground being worked for gold. The comparative poorness of the mine filled him, it is stated, with disappointment, and he returned to Sofala.

Era of Decline. — The Portuguese for some time failed to make any effective use of their East African possessions Among the causes of non-success must be reckoned the "Sixty Years' Captivity" (1580–1640), when the Spanish and Portuguese crowns were united, and the neglect of Africa for the richer possessions in India and the Far East. A more permanent reason for the non-development of Mozambique province was the character of the government and the settlers. For a series of years the Jesuits and Dominicans were the most energetic sections of the white community. The first Jesuit missionaries began work in the neighbourhood of Inhambane in 1560; in the same year another Jesuit, Gonçalo da Silveira, made his way to the zimbabwe (chief kraal) of the monomotapa, by whose orders he and his converts were strangled (March 16, 1561). Mission work was soon afterwards begun by the Dominicans and for nearly two centuries the two orders between them had agents spread over the greater part of the country from Mozambique southward. Traces of their influence are still to be found among the tribes. In 1759 the Jesuits were expelled. Three attempts by the Dutch in the 17th century to capture the port of Mozambique were unsuccessful, but in the early years of the 18th century the Arabs wrested from the Portuguese their African possessions north of Cape Delgado. The merchants of Sofala and Mozambique had, since the middle of the 17th century, found a new source of wealth in the export of slaves to Brazil. This trade, due directly to the capture of the ports of Angola by the Dutch (1640–48), continued until nearly the middle of the 19th century, while slavery in the province was not abolished until 1878; and then abolition was largely nominal.

In 1752 the government of the East African possessions was again, and this time permanently, separated from that of Goa, and 20 years later Francisco José Maria de Lacerda e Almeida, a man of high attainments, made governor of the province at his own request, endeavoured to reform the administration. Lacerda is chiefly remembered for his journey to the heart of Central Africa, where he died in Oct. 1798. After his death a state of decay was again manifest throughout Portuguese East Africa. During the greater part of the 19th century the country south of the Zambezi was devastated by hordes of savages of Zulu origin (see GAZALAND).

Modern Developments. — The discoveries of David Livingstone in the period of 1850–65 led to the establishment of British settlements at the southern end of Lake Nyasa and in the Shiré highlands. These events aroused anxiety in Lisbon, which was increased when the British secured Matabele, Mashona and Manica lands—the lands of the earlier monomotapas. With sudden energy the Portuguese engaged in the "scramble for Africa," and they obtained much better terms than might have been anticipated, having regard to the extremely limited area over which they exercised jurisdiction. (The story of the partition is told in the article AFRICA.)

Under the republic the Portuguese made serious efforts to improve the administration. In 1914 a measure of autonomy, enlarged in 1920, was granted to the province. In general the treatment of the natives was satisfactory, but labour conditions left much to be desired. Compulsory unpaid labour in the province of Mozambique was not abolished until 1925. In 1927 reports were spread that Germany might acquire a mandate under the League of Nations to administer Mozambique or Angola. This led (Dec. 1927) to a reaffirmation of the ancient Anglo-Portuguese alliance which covers the Portuguese colonies. On Sept. 11, 1928, at Pretoria, after prolonged negotiations the Mozambique Convention was signed with the Union of South Africa respecting the trade of the Transvaal with the port of Lourenço Marques (Delagoa bay), the recruitment of natives in Portuguese territory for work in the Rand mines, and other matters. It replaced the Mozambique Convention which had been concluded with the Transvaal Government in 1909 and had lapsed in 1923.

BIBLIOGRAPHY.—G. M'C. Theal, *Records of South-Eastern Africa* (9 vols., 1898–1903), with texts of original documents and translations in English, and *The Portuguese in South Africa* (1896); *A Manual of Portuguese East Africa* and *Portuguese Nyasaland*, both British Admiralty publications (1920); *Mozambique*, British Foreign Office handbook (No. 121, 1918)—these three with bibliographies; *The South and East Africa Year Book and Guide* (London, annually).
(F. R. C.)

PORTUGUESE GUINEA, a Portuguese possession in West Africa, extending along the Guinea coast from Cape Roxo in 12° 9′ N. to the Cogon estuary in 10° 50′ N. Inland it reaches to 13° 40′ W., being enclosed landward by French territory, the Casaniance district of Senegal to the north and French Guinea north and south. The country has an area of about 14,000 sq.m., and a population very variously estimated. It is probably about 350,000. The country consists largely of a low-lying deltaic region, together with an adjacent archipelago of small islands called the Bissagos. The principal rivers are, in the north the Cacheu (225 m. long); in the centre the Geba, and in the south the Rio Grande, which turning north-west in its lower course falls into the same estuary as the Geba. In the coast regions the temperature varies from a mean maximum of 85° F in May to a mean minimum of 77° F in January. From December to April is the dry season, with a strong *harmattan* blowing. June and July are marked by severe thunderstorms, and the rainy season lasts to the end of November. The rainfall is about 77 in. a year, practically all between June and November.

Flora and Fauna.—Large forest regions extend behind the mangrove-lined lagoons. Their characteristic trees are the oil and date palms, the baobab, the shea-butter tree, ebony, mahogany and calabash trees, and the acacia. Rubber vines are fairly abundant. Besides the forests, densest along the river valleys, there are extensive tracts of grassland and park-like country. Fruit trees include the papaw, with fruit the size of ostrich eggs, the guava, custard apple, mango, the banana, the orange and the citron. The tobacco, indigo and cotton plants grow wild, and the coffee plant is also found. Ground-nuts and kola nuts are cultivated, and rice and millet are the chief crops grown.

The elephant is found in the district between the Geba and Grande rivers, and hippopotamus are numerous. Other animals include the panther, wild boar, various antelopes, baboons, chimpanzees and large snakes. Crocodiles and sharks abound in the rivers. Birds include the pelican, heron, marabout, the trumpet bird and innumerable yellow parrots.

Inhabitants.—The people of the interior are mostly Fulani (*q.v.*), among whom are scattered a large number of Mandinga (*q.v.*). The coast regions and the islands are inhabited by negro tribes, which live side by side, mixing little with one another and preserving their own customs. Descendants of persons of various tribes who became Christian converts are called Gurmettes; they form the bulk of the population of the towns. Of the other inhabitants, going from south to north, the chief tribes are the Nalu, who dwell by the Kasini and are keen traders; the Biafare or Biaffade, who occupy the region between the sea and the Rio Grande: the Bulam (Mankaie), living in the island of Bolama, and much given to adorning their bodies by long cuts formed into patterns; the Balanta, an industrious, agricultural race (though formerly addicted to piracy), inhabiting the banks of the Geba; the Papel (Papies) of the island of Bissao, formerly cannibals, also an agricultural people, untamed and warlike; the Manjak and a branch of the Felup peoples, these last living near the Rio Cacheu in savage isolation and much given to waylaying and pillaging strangers. The Manjak (Manjacos) inhabit the country between the Mancoa and the Cacheu, and the neighbouring islands. Excellent seamen, good artisans and sharp traders, they maintain a sort of feudal system. The seaward islands of the Bissagos are inhabited by a tribe of fishers and pirates called Bidiogos.

The non-native inhabitants include a number of mulatto descendants of the Portuguese and people from the Cape Verdi whose dialect of Portuguese known as creole is widely understood by the natives. There are Portuguese officials and soldiers.

Towns and Trade.—Bissao (Sbo José di Bissao), near the mouth of the Geba estuary, is the chief port, with a safe and deep anchorage. Bolama (pop. 4,000), on the island of the same name, is the capital of the country. It also has a good harbour, small naval workshops and an aerodrome. Cacheu is a port on the river Cacheu near its mouth, and Farim 90 m. up-stream is a trading centre, other trading-centres are Bafata on the Geba and Xitoli, on the Rio Grande. The chief exports, practically all native produce, are ground nuts and palm kernels; with hides, rubber and bees-wax in smaller values. The imports include cotton piece goods (from England) kola-nuts (from Sierra Leone), trade spirits (from Hamburg) and wines (from Portugal). No discriminatory duties were imposed on foreign goods (except wines) and before the World War fully 70% of the exports went to Germany, which supplied some 40% of the imports. Later the French took a good share of the trade. The import of trade spirits was greatly restricted. The value of exports, £46,000 in 1890, had risen to £232,000 in 1914, and was £416,000 in 1924. The imports in the years named were valued at £69,000, £312,000 and £513,000 respectively. Revenue is derived from customs and a hut tax; in modern times, revenue first exceeded expenditure in 1910–11. For 1926–27, revenue was estimated at 19,966,000 escudos (about £170,000 sterling), and expenditure at 19,685,000 escudos.

History.—Bolama (Boulam, Bulama) island was discovered by the Portuguese in 1446; in the next year Nuno Tristâo, exploring the Rio Grande (and probably seeking slaves), was attacked by the Nalu and killed, together with many of his followers. In 1462 rights over this part of the Guinea coast were granted to the Cape Verdi islanders, who appear to have founded the "factories" at Cacheu. In the 17th and 18th centuries the supplying of slaves to Brazil and Spanish America was a very flourishing industry, Bissao becoming the chief port for this commerce. Dispossessed by Dutch, French, British and other rivals of all the rest of the Seignory of Guinea, Portuguese rule in this district was only effective on the coast—and even the islands had been left for long unoccupied. In the middle of the 19th century the extension of French authority in the hinterland, and claims by Great Britain to Bolama island and the adjacent mainland, seemed to threaten to reduce the Portuguese territory to very small proportions. However, the British claim was referred to the arbitration of the United States and President Grant's award (April 21,1870) was in favour of Portugal. By a convention with France in May 1886 the inland frontiers mere fixed mainly on arbitrary lines, the frontier being demarcated in 1902–05 by a Franco-Portuguese commission. Portugal had succeeded in retaining an area about twice the size of Wales. Meanwhile, in 1879, the country had ceased to be a dependency of the Cape Verdi islands and had been made a separate province under a governor. But most of the tribes were practically independent and in 1908 there was a rising of the Papel tribe on Bissao island, and of the other tribes on the mainland. Troops sent from Portugal succeeded in restoring order. Other risings and inter-tribal warfare followed, but not of so serious a character. The disestablishment of the Church in 1912 greatly hindered the work of the missionaries, one of the most civilizing influences in the province, but in 1925 the Portuguese Government reversed its policy, restored to the missions their churches and schools, and gave them subsidies—the avowed object being to exert a national, *i.e.*, Portuguese influence on the natives (this change applied to all the Portuguese colonies).

See J. E. Giraud, "La Guinée portugaise," in *Bull. soc. géog. Marseille,* vol. xxix. (1905); A. L. de Fonseca, "Guiné" in *Bull. soc. geog. Lisboa,* vol. xxiii. (1905); R Wagner, "Portugiesische Guinea: Land und Leute," in *Deutsche Rundschau,* vol. xxvii. (1905); E. de Vasconceles, *As Colonias portuguesas* (Lisbon, 1896–97); J. Machat, *Les Rivières du sud* (Paris, 1906), in which are cited many papers dealing with Portuguese Guinea; *Portuguese Guinea,* a British Foreign Office handbook (1920), and the *Anuário Coloneal* (Lisbon).

PORTUGUESE LANGUAGE.

PORTUGUESE LANGUAGE. Portuguese-Galician constitutes the second branch of the Latin of Spain. In it we must distinguish—(1) Portuguese (Portuguez, perhaps a contraction from the old *Portugalez*=Portugalensis), the language of the kingdom of Portugal and its colonies in Africa, Asia and America (Brazil); (2) Galician (Gallego), or the language of the old kingdom of Galicia (the modern provinces of Pontevedra, La Coruña, Orense and Lugo) and of a portion of the old kingdom of Leon (the territory of Vierzo in the province of Leon). Portuguese, like Castilian, is a literary language, which for ages has served as the vehicle of the literature of the Portuguese nation constituted in the beginning of the 12th century. Galician, on the other hand, which began a literary life early in the middle ages—for it was employed by Alfonso the Learned in his *Cantigas* in honour of the Virgin—decayed in proportion as the monarchy of Castile and Leon, to which Galicia had been annexed, gathered force and unity in its southward conquest.

Vowels.—Lat. *ĕ, ŏ* with the accent have not been diphthongized into ie, uo, ue: *pé* (pedem), *bom* (bonus). On the other hand, Portuguese has a large number of strong diphthongs produced by the attraction of an *i* in hiatus or the resolution of an explosive into *i*: *raiba* (rabia), *feira* (feria), *oito* (octo). A peculiar feature of the language occurs in the "nasal vowels," which are formed by the Latin accented vowels followed by *m, n,* or *nt, nd*: *bẽ* (bene), *grã* (grandem), *bõ* (bonum). These nasal vowels enter into combination with a final atonic vowel: *irmão* (germanus); also *amão* (amant), *sermão* (sermonen), where the *o* is a degenerated representative of the Latin final vowel. In Old Portuguese the nasal vowel or diphthong was not as now marked by the *til* (˜), but was expressed indifferently and without regard to the etymology by *m* or *n*: *bem* (bene), *tam* (tantum), *disserom* (dixerunt), *sermom* (sermonem). The Latin diphthong au is rendered in Portuguese by ou (*ouro,* aurum), also pronounced oi. With regard to the atonic vowels, there is a tendency to reduce a into a vowel resembling the Fr. e "muet," to pronounce *o* as *u*, and to drop *e* after a group of consonants (dent for dente).

Consonants.—Here the most remarkable feature, and that which most distinctly marks the wear and tear through which the language has passed, is the disappearance of the median consonants *l* and *n*: *corõa* (corona), *lua* (luna), *pôr* formerly *poer* (ponere), *conego* (canonicus), *vir* (venire), *paço* (palatium), *pego* (pelagus). Lat. *b* passes regularly into *v*: *cavallo* (caballus), but, on the other hand, Lat. initial *v* readily tends to become *b*: *bodo* (votum). Lat. initial *f* never becomes *h*: *fazer* (facere). Lat. *c* before *e* and *i* is represented either by the hard sibilant *s* or by the soft *z*. Lat. *g* between vowels is dropped before e and i: *ler* for leer (legere), *dedo* (digitum); the same is the case with *d*, of course, in similar circumstances: *remir* (redimere), *rir* (ridere). Lat. *j* has assumed the sound of the French *j*. The Latin combinations *cl, fl, pl* at the beginning of words are transformed in two ways in words of popular origin. Either the initial consonant is retained while the *l* is changed into r: *cravo* (clavum); or the group is changed into *ch* (=Fr. *ch*. Catal. *x*) through the intermediate sounds *kj, fj, pj*: *chamar* (clamare), *chão* (planus), *chamma* (flamma). Within the word the same group and other groups also in which the second consonant is an l produce *l* mouillée (written lh, just as n mouillée is written nh, as in Provençal): *ovelha* (ovic'la), *velho* (vec'lus); and sometimes ch: *facko* (fac'lum), *ancho* (amplum). Lat. ss or *sc* before e and *i* gives *x* (Fr. *ch*): *baixo* (bassus), *faxa* (fascia). The group *ct* is reduced to it: *leito* (lectum), sometimes to *ut*: *douto* (doctus).

Inflexion.—The Portuguese article, now reduced to the vocalic form o, a, os, as, was *lo* (exceptionally also el, which still survives in the expression *El-Rei*), *la, los, las* in the old language. Words ending in *l* in the singular lose the *l* in the plural (because it then becomes median, and so is dropped): *sol* (solem), but *soes* (soles); those having *ão* in the sing. form the plural either in *ães* or in *ões* according to the etymology: thus *cão* (canem) makes *cães*, but *ração* makes *rações*. Portuguese conjugation has more that is interesting. In the personal suffixes the forms of the 2nd pers. pl. in *ades, edes,* ides lost the *d* in the 15th century, and have now become *ais, eis,* is, through the intermediate forms aes, ees, eis. The form in des has persisted only in those verbs where it was protected by the consonants *n* or *r* preceding it: *pondes, tendes, vindes, amardes.* Portuguese is the only Romance language which possesses a personal or conjugated infinitive: *amar, amar-es, amar, amar-mos, amar-des, amar-em*; e.g., antes de *sair-mos,* "before we go out." Again, Portuguese alone has preserved the pluperfect in its original meaning, so that, for example, *amara* (amaveram) signifies not merely as elsewhere "I would love," but also "I had loved." Among the peculiarities of Portuguese conjugation are—(1) the assimilation of the 3rd pers. sing. to the 1st in strong perfects (*houve, pude,* quiz, fez), while Castilian has *hube* and *hubo*; (2) the imperfects *punha, tinha, vinha* (from *pôr, ter* and *vir*), which are accented on the radical in order to avoid the loss of the n (*ponía* would have made *poía*), and which substitute *u* and *i* for *o* and e in order to distinguish from the present subjunctive (*ponha, tenha,* venha).

Galician.—Almost all the phonetic features which distinguish Portuguese from Castilian are possessed by Gallego also. Portuguese and Galician even now are practically one language, and still more was this the case formerly. In conjugation the peculiarities of Gallego are more marked; some find their explanation within the dialect itself, others seem to be due to Castilian influence. The 2nd persons plural have still their old form ades, *edes,* ides, so that in this instance it would seem as if Gallego had been arrested in its progress while Portuguese had gone on progressing; but with these full forms the grammarians admit contracted forms as well: *ás* (Port. *ais*), *és* (Port. *eis*), *ís* (Port. is). The 1st pers. sing. of the perfect of conjugations in er and *ir* has come to be complicated by a nasal resonance similar to that which we find in the Portuguese *mim*; we have *vendin, partin,* instead of *vendi, parti,* and by analogy this form in in has extended itself also to the perfect of the conjugation in ar, and falin, *gardin,* for *falei, gardei* are found. The second persons of the same tense take the ending *che,* ches in the singular and chedes in the plural: *falache* or *falaches* (fabulasti). The 3rd pers. sing. of strong perfect is not in *e* as in Portuguese (*houve, pode*), but in *o* (*houbo, puido, soubo, coubo,* etc.); Castilian influence may be traceable here.

BIBLIOGRAPHY.—On the general subject the most important works are F. Diez, *Grammatik der romanischen Sprachen* (5th ed., Bonn, 1882) and Etymologisches *Wörterbuch der romanischen Sprachen* (4th ed., Bonn, 1878); W. Meyer-Lübke, *Grammatik der romanischen Sprachen* (Leipzig, 1890–1894); G. Korting, *Lateinisch-romanisches Wörterbuch* (Paderborn, (1890–1891). *See* also A. Carnoy, *Le Latin d'Espagne d'après les inscriptions* (2nd ed., Brussels, 1906).

PORTUGUESE.—J. Cornu, "Die portugiesische Sprache," in G. Gröber's *Grundriss der romanischen Philologie*; F. A. Coelho, *Theoria da conjugaçao em latim e portuguez* (Lisbon, 1871), and *Questões da lingua portugueza* (Oporto, 1874); J. Leite de Vasconcellos, *A Philologia Portuguesa* (Lisbon, 1888). *See* also *Portuguese Bibliography* published by the Hispanic Society of America (1922) pp. 98–129. For Galician, *see* A. Fernández y Morales's *Ensayos poéticos de berceiano* (Leon, 1861); M. R. Rodriguez, *Apuntes gramáticales sobre el romance gallego de la crónica troyana* (La Coruña, 1898), and Saco Arce, *Gramática gallega* (Lugo, 1868); for other dialectical varieties, *see* I. J. da Fonseca, *Noçoes de philologia accomodadas á lingoa brasiliana* (Rio de Janeiro, 1885); J. Leite de Vasconcellos, *Dialectos beires* (Oporto, 1884), and *Sur le dialecte portugais* de Macao (Lisbon, 1892). *See* also Romania, *Revista lusitana.*

PORTUGUESE LITERATURE.

PORTUGUESE LITERATURE. The literature of the Portuguese is distinguished by the wealth and variety of its lyric poetry, its primacy in bucolic verse and prose, the number of its epics and historical books, and the relative slightness of its drama, biography and letters. Rich as its *romanceiro* is, its volume is far less than the Spanish, but the *cancioneiros* remain to prove that the early love songs of the whole Peninsula were writteh in Portuguese, while the primitive prose redaction of *Amadis,* the prototype of all romances of chivalry, was almost certainly made in Portugal, and a native of the same country produced in the *Diana* of Montemôr (Montemayor) the masterpiece of the pastoral novel. *The Lusiads* may be called at once the most successful epic cast in the classical mould, and the most national of poems, and the great historical monuments and books of travel of the 16th and 17th centuries are worthy of a nation of explorers who carried the banner of the Quinas to the ends of the earth. On the other hand, Portugal gave birth to no considerable dramatist from the time of Gil Vicente, in the 16th century, until that of Garrett in the 19th, and it has failed to develop a national drama.

The first literary activity of Portugal was derived from Provence, and Provençal taste ruled for more than a century; the poets of the 15th century imitated the Castilians, and the 16th saw the triumph of Italian or classical influence. Spain again imposed its literary standards and models in the 17th century, France in the 18th, while the Romantic movement reached Portugal by way of England and France; and those countries, and in less degree Germany, have done much to shape the literature of the 19th century. Nearly every Portuguese author of renown from 1450 until the 18th century, except Antonio Ferreira, wrote in Spanish, and some, like Jorge de Montemôr and Manoel de Mello, produced masterpieces in that language and are numbered as Spanish classics. Again, in no country was the victory of the Italian Renaissance and the classical revival so complete, so enduring.

Yet Portuguese literature has a distinct individuality which appears in the *romanceiro,* in the songs named *cantares de anzigo* of the *cancioneiros,* in the *Chronicles* of Fernão Lopes, in the *Historia tragico-maritima,* in the plays of Gil Vicente, in the bucolic verse and prose of the early 16th century, in the *Letters* of Marianna Alcoforado and, above all, in *The Lusiads.*

Early Period.—Though no literary documents belonging to the first century of Portuguese history have survived, there is evidence that an indigenous popular poetry both sacred and profane existed, and while Provencal influences moulded the manifestations of poetical talent for nearly zoo years, they did not originate them. A few compositions which have come down to us bear a date slightly anterior to the year 1200. One of the earliest singers was D. Gil Sanches, an illegitimate son of Sancho I., and we possess a *cantar de anzigo* in Galician-Portuguese, the first literary vehicle of the whole Peninsula, which appears to be the work of Sancho himself. The pre-Alphonsine period to which these men belong runs from 1200 to 1245 and produced little of moment, but in 1248 the accession of King Alphonso III., who had lived 13 years in France, inaugurated a time of active and rich production which is illustrated in the *Cancioneiro da Ājuda,* the oldest collection of Peninsular verse. The apogee of palace poetry dates from 1275 to 1280, when young Dinis, who had been educated by Aymeric of Cahors, proved himself the most fecund poet-king of his day, though the pleiad of *fidalgos* forming his court and the *jograes* who flocked there from all parts, were fewer in number, less productive, and lacked the originality, vigour and brilliance of the singers who versified round Alphonso III.

The principal names of the Dionysian period (1284–1325) which is illustrated in the *Cancioneiro da Vaticana* are the king himself and his bastards D. Alphonso Sanches and D. Pedro, count of Barcellos. Of the two last, the former sings of love well and sincerely, while the latter is represented by some satirical songs of *maldizer,* a form which, if it rarely contains much poetical feeling or literary value, throws light on the society of the time.

The verses of Dinis, essentially a love poet, are conventional in tone and form except when he uses the indigenous parallel-strophed or *cossante* form which gives their real originality to the Galician-Portuguese *cancioneiros.* Speaking generally, the *cancioneiros* form monotonous reading owing to their poverty of ideas and conventionality of metrical forms and expression, but here and there men of talent enaeavoured to lend their work variety by the use of difficult processes like the *lexaprem* and by introducing new forms like the *pastorela* and the *descort.* It is curious to note that no heroic songs are met with in the *cancioneiros;* they are all, with one exception, purely lyrical in form and tone. The *romanceiro,* comprising romances of adventures, war and chivalry, together with religious and sea songs, forms a rich collection of ballad poetry which continued in process of elaboration throughout the whole of the middle ages, but scarcely any of those existing bear a date anterior to the 15th century.

Epic poetry in Portugal developed much later than lyric, but the signal victory of the united Christian hosts over the Moors at the battle of the Salado in 1340 gave occasion to an epic by Alphonso Giraldes of which some fragments remain.

The first frankly literary prose documents appear in the 14th century, and consist of chronicles, lives of saints and genealogical treatises. The more important are the *Chronica breve* do *archivo nacional,* the *Chronicas de S. Cruz de Coimbra,* the *'Chronica da conquista do Algarve* and the *Livros das Linhagens,* portions of which have considerable literary interest. All the above may be found in the *Portugaliae monumenta historica. Romania* has printed some hagiographical texts, and the *Vida dos Santos Barlaão e Josafate* has been issued by the Lisbon Academy of Sciences.

Romances of chivalry belonging to the various cycles must have penetrated into Portugal at an early date, and the *Nobiliario* of the Conde D. Pedro contains the genealogy of Arthur and the adventures of Lear and Merlin. There exists a mid-14th-century *Historia do Santo Graal,* and an unprinted *Josep ab Aramatia,* and we have some evidence of the existence of a primitive Portuguese prose redaction of *Amadis de Gaula* anterior to the present Spanish text.

The 15th Century.—In the reign of John I. the court became an important literary centre, and the king himself composed a *Livro de Montaria.* His son, King Edward (Duarte), collected a precious library composed of the ancient classics, some translated by his order, as well as mediaeval poems and histories, and he wrote a moral treatise *Leal conselheiro,* and hints on horsemanship, or *Livro da ensinança de bem cavalgar toda sella.* His brother *D.* Pedro also wrote a moral treatise *Da virtuosa bemfeitoria,* and caused Vegetius's ***De re*** *militari* and Cicero's ***De*** *officiis* to be turned into Portuguese. This travelled prince brought hack from Venice a ms. of Marco Polo as the gift of the senate. The age is noted for its chronicles, beginning with the anonymous life of the Portuguese Cid, the Holy Constable Nuno Alvares Pereira, told in charming prose. Fernão Lopes (*q.v.*), the father of Portuguese history and author of chronicles of King Pedro, King Ferdinand and King John I., has been called by Southey the best chronicler of any age or nation. Gomes Eannes de Azurara completed Lopes's chronicle of King John by describing the capture of Ceuta, and wrote a chronicle of D. Pedro de Meneses, governor of the town down to 1437, and a chronicle of D. Duarte de Meneses, captain of Alcacer, but his capital work is the chronicle of the conquest of Guinea. *(See* Azurara.)

Though not a great chronicler or an artist like Lopes, Ruy de Pina is quite free from the rhetorical defects of Azurara, and his chronicles of King Edward and King Alphonso V. are characterized by unusual frankness. All these three writers combined the posts of keeper of the archives and royal chronicler, and were, in fact, the king's men, though Lopes at least seems rather the historian of a people than the oracle of a monarch. Garcia de Resende (*q.v.*) worked up Pina's chronicle of King John II. and added a wealth of anecdote and gossip. The taste for romances of chivalry continued throughout the 15th century, but of all that were produced the only one that has come down to us is the *Estorea do Zmperador Vespnsiano,* an introduction to the Graal Cycle, based on the apocryphal gospel of Nicodemus.

The Constable D. Pedro of Portugal (1429–66), son of the prince of that name already referred to, has left some verses marked by elevation of thought and deep feeling, the *Satyra de felice e infelice vida,* and the death of his sister inspired his *Tragedia de la insigne reyna Isabel* (1457); he is best remembered by his *Coplas del contempto del mundo* in the *Cancioneiro Geral.* D. Pedro, who wrote in Castilian, is one of the first representatives of those Spanish influences which set aside the Provençal manner and in its place adopted a taste for allegory and a reverence for classical antiquity, both imported from Italy. It was to the constable that the marquis de Santillana addressed his historic letter dealing with the origins of Peninsular verse. The court poetry of the reigns of King Alphonso V. and King John II. is contained in the *Cancioneiro Geral*, compiled by Garcia de Resende and printed in 1516. Some zoo authors are there represented by pieces in Portuguese and Castilian, and they include D. João Manuel, D. João de Meneses, Joio Rodrigues and de Sá e Meneses, Diogo Brandão, Duarte de Brito and Fernio da Silveira. The main subjects are love, satire and epigram. The epic achievements of the Portuguese in that century hardly find an echo, even in the verses of those who had taken part in them. Instead, an atmosphere of artificiality surrounds these productions, the influence is Spanish, and the verses that reveal genuine poetical feeling are very few, but some names appeared in the *Cancioneiro Geral* which were to be among the foremost in Portuguese literature; *e.g.,* Bernardim Ribeiro, Christovam Falcão, Gil Vicente and Sá de Miranda, who represent the transition between the Spanish school of the 15th and the Italian school of the 16th century, called *Os Quinhentistas.* Ribeiro and Falcão, the introducers of the bucolic style, put new life into the old forms, and by their eclogues in *redondilhas* gave models which subsequent writers worked by but could never equal.

Gil Vicente and the Eschola Velha.—The transition of the drama from the presentment of traditional types to the modern play can be traced in the works of Gil Vicente, the father of the Portuguese theatre. His first efforts belonged to the religious drama, and some of the more notable had edification for their object; *e.g.,* the trilogy of *Barcas,* but even in this class he soon introduces the comic element by way of relief, and in course of time he arrives at pure comedy, and develops the study of character. For a detailed description of his work, *see* VICENTE.

In the various towns where he stayed and produced his plays, writers for the stage sprang up, and these formed the Eschola Velha or school of Gil Vicente, the best known being Affonso Alvarez, author of religious pieces; Antonio Ribeiro, nicknamed "the Chiado," an unfrocked friar with a strong satirical vein who wrote farces in the Bazochian style; and his brother Jeronimo Ribeiro. In Santarem appeared Antonio Prestes, a magistrate, who evinced more knowledge of folk-lore than dramatic talent; while Camoens himself felt Vicente's influence. Another poet of the same school is Balthazar Dias, the blind poet, whose simple religious *autos* are still performed in the villages, and are continually reprinted, the best liked being the *Auto of St. Alexis,* and the *Auto of St. Catherine.* One of the last dramatists of the 16th century belonging to the old school was Simão Machado, who wrote the *Comedy of Diu* and the *Enchantments of Alfea,* two long plays almost entirely in Spanish.

Except Camoens, all these men, though disciples of Gil Vicente, are decidedly inferior to him in dramatic invention, fecundity and power of expression, and they were generally of humble social position. The favour of the court was withdrawn on the death of Gil Vicente and the old dramatists had to face the opposition of the classical school and the hostility of the Inquisition, which early declared war on the popular plays on account of their grossness. The way was thus clear for the Jesuits, who introduced Latin tragi-comedies or dramatized allegories written to commemorate saints or for scholastic festivals. The four Indexes of the 16th century give some idea of the rich repertory of the popular theatre, and of the efforts necessary to destroy it; moreover, the Spanish Index of 1559, by forbidding *autos* of Gil Vicente and other Portuguese authors, is interesting evidence of the extent to which they were appreciated in the neighbouring country.

The movement commonly called the Renaissance reached Portugal both indirectly through Spain and directly from Italy, with which last country it maintained close literary relations throughout the 15th century. King Alphonso V. had been the pupil of Matthew of Pisa and summoned Justus Balduinus to his court to write the national history in Latin, while later King John II. corresponded with Politian, and early in his reign the first printing press got to work. In the next century many famous humanists took up their abode in Portugal. Nicholas Cleynaerts taught the Infant Henry, afterwards cardinal and king, and lectured on the classics at Braga and Evora, Vasaeus directed a school of Latin at Braga, and George Buchanan accompanied other foreign professors to Coimbra when King John III. reformed the university. Many distinguished Portuguese teachers returned from abroad to assist the king at the same time, among them Ayres Barbosa from Salamanca, André de Gouvêa of the Parisian college of St. Barbe, whom Montaigne dubbed "the greatest principal of France," Achilles Estaço and Diogo de Teive.

At home Portugal produced André de Resende (*q.v.*), author of *De antiquitatibus Lusitaniae,* and Francisco de Hollanda, painter, architect, and author of *Quatro dialogos da pintura antiga.* Women took a share in the intellectual movement of the time, and the sisters Luisa and Angela Sigêa, Joanna Vaz and Paula Vicente, daughter of Gil Vicente, constituted an informal female academy under the presidency of the Infanta D. Maria, daughter of King Manuel. Luisa Sigêa was both an orientalist and a Latin poetess, while Publia Hortensia de Castro defended theses at Evora in her 18th year.

The Italian School or Os Quinhentistas.—The Italian school was founded by Sá de Miranda, a man of excellent character, who, on his return in 1526 from a six years' stay in Italy, initiated a reform of Portuguese literature which amounted to a revolution. He introduced and practised the form of the sonnet, canzon, ode and epistle in *ottava rima* and in tercets. At the same time he gave fresh life to the national octosyllabic metre *(medida velha)* by his *Cartas* or *Satiras* which with his *Eclogues,* some in Portuguese, others in Castilian, are his most successful compositions. His chief disciple, Antonio Ferreira (*q.v.*), a convinced classicist, went further, and dropping the use of Castilian, wrote sonnets much superior in form and style, though they lack the rustic atmosphere of those of his master, while his odes and epistles are too obviously reminiscent of Horace. D. Manoel de Portugal, Pero de Andrade Caminha, Diogo Bernardes, Frei Agostinho da Cruz and André Falcão de Resende continued the erudite school, which, after considerable opposition, definitively triumphed in the person of Luis de Camoens. The *Lima* of Bernardes contains some beautiful eclogues as well as *cartas* in the bucolic style, while the odes, sonnets and eclogues of Frei Agostinho are full of mystic charm. Immediately on its appearance *The Lusiads* took rank as the national poem *par excellence,* and its success moved many writers to follow in the same path; of these the most successful was Jeronymo Corte-Real (*q.v.*). All these poems, like the *Elegiada* of Luis Pereira Brandão on the disaster of Al Kasr, the *Primeiro cêrco de Diu* of the chronicler Francisco de Andrade, and even the *Affonso Africano* of Quevedo, for all its futile allegory, contain vigorous descriptive passages.

Sá de Miranda and his followers protested against the name *auto,* restored that of *comedy,* and substituted prose for verse. They generally chose the plays of Terence as models, yet their life is conventional and their types are not Portuguese but Roman-Italian. The revived classical comedy was artificial both in subject and style. Though it secured the favour of the humanists and the nobility, and banished the old popular plays from both court and university soon after Gil Vicente's death, its victory was short-lived. Jorge Ferreira de Vasconcellos, who produced in *Eufrosina* the first prose play, really belongs to the Spanish school, yet, though he wrote under the influence of the *Celestina,* which had *a* great vogue in Portugal, his types, language and general characteristics are deeply national. This and his other plays, *Ulisipo* and *Aulegraphia,* are novels in dialogue containing a treasury of popular lore and wise and witty sayings with a moral object. So decisive was the success of Jorge Ferreira's new invention, notwithstanding its anonymity, that it decided Sá de Miranda to atternpt the prose comedy. He modelled himself on the Roman theatre as reflected by the plays of Ariosto, and he avowedly wrote the *Estrangeiros* to combat the school of Gil Vicente; in it, as in *Os Vilhalpandos,* the action takes place in Italy. Antonio Ferreira, the chief dramatist of the classical school, attempted both comedy and tragedy, and his success in the latter is due to the fact that he was not content to seek inspiration from Seneca, as were most of the tragedians of the 16th century, but went straight to the fountain heads, Sophocles and Euripides. His *Bristo* is but a youthful essay, but his second piece, *O Cioso,* is almost a comedy of character, though both are Italian even in the names of the personages. Ferreira's real claim to distinction, however, rests on *Ines de Castro. (See* FERREIRA.)

Sixteenth-century History. — A pleiad of distinguished writers arose to narrate the discoveries and conquests in Asia, Africa and the ocean. Many of them saw the achievements they relate and were inspired by patriotism to record them, so that their writings gain in picturesqueness what they may lose in scientific value. In the four decades of his *Asia,* João de Barros, the Livy of his country, tells in simple vigorous language the "deeds achieved by the Portuguese." His first decade undoubtedly influenced Camoens, and together the two men fixed the Portuguese written tongue, the one by his prose, the other by his verse. The decades, which were continued by Diogo do Couto, a more critical writer and a clear and correct stylist, must be considered the noblest historical monument of the century. *(See* BARROS.) Couto is also responsible for some acute observations on the causes of Portuguese decadence in the East, entitled *Soldado practico.*

The word encyclopaedist fits Damiio de Goes, a diplomatist, traveller, humanist and bosom friend of Erasmus. One of the most critical spirits of the age, his chronicle of King Manoel, the Fortunate Monarch, which he introduced by one of Prince John, afterwards King John II., is worthy of the subject. Goes (*q.v.*) wrote a number of other historical and descriptive works in Portuguese and Latin, some of which were printed during his residence in the Low Countries. After 20 years of investigation at Goa, Fernão Lopes de Castanheda issued his *Historia do descobrinzento e conquista da India* (1 j52–54 and 1561), a book that ranks beside those of Barros and Couto. Antonio Galvio, who, after governing the Moluccas with rare success and integrity, had been offered the native throne of Ternate, went home in 1540, and died a pauper in a hospital. His brief *Tratado,* which appeared posthumously in 1563, is of unique historical value. Like the preceding writers, Gaspar Corrêa lived long years in India and embodied his intimate knowledge of its manners and customs in the picturesque prose of the *Lendas da India,* which embraces the events of the years 1497 to 1550. Among other historical works dealing with the East are the *Commentarios de Affonso d'Albuquerque,* an account of the life of the great captain and administrator, by his natural son, and the *Tratado das cousas da China e de Ormuz,* by Frei Gaspar da Cruz.

Coming back to strictly Portuguese hisiory, we have the uncritical *Chronica de D. João III.* by Francisco de Andrade, and the *Chronica de D. Sebastiho* by Frei Bernardo da Cruz, who was with the king at Al Kasr al Kebir, while Miguel Leitio de Andrade, who was taken prisoner in that battle, related his experiences and preserved many popular traditions and customs in his *Miscellanea.* The bishop Osorio, a scholar of European reputation, wrote chiefly in Latin, and his Chronicle of King Manoel, based on that of Goes, is in that tongue.

The books of travel of this century are unusually important, because their authors were often the first Europeans to visit or at least to study the countries they refer to. They include, to quote the more noteworthy, the *Descobrimento de Frolida,* the *Itinerario* of Antonio Tenreiro, the *Verdadeira informacão das terras do Preste Joant* by Francisco Alvares, and the *Ethiopia oriental* by Frei João dos Santos, both dealing with Abyssinia, the *Itinerario da terra santa* by Frei Pantaleão de Aveiro, and that much-translated classic, the *Historia da vida do padre Francisco Xavier* by Padre João de Lucena. Fernão Cardim, in his *Narrativa epistolar,* records a journey through Brazil, and Pedro Teixeira relates his experiences in Persia. But the work that holds the palm in its class is the *Peregrinação* which Fernão Mendes Pinto (*q.v.*), the famous adventurer, composed in his old age for his children's reading. The *Historia tragico-maritima,* a collection of 12 stories of notable wrecks which befell Portuguese ships between 1 j52 and 1604, contains that of the galleon "St. John" on the Natal coast, an event which inspired Corte-Real's epic poem as well as some poignant stanzas in *The Lusiads,* and the tales form a model of simple spontaneous popular writing.

Sixteenth-century Romances, etc.—The *Menina e moça* of Bernardim Ribeiro, a tender pastoral story inspired by *saudade,* probably moved Montemôr or Montemayor (*q.v.*) to write his *Diana.* To name the *Palmeirim de Inglaterra* of Moraes (*q.v.*) is to mention a famous book from which, we are told. Burke quoted in the House of Commons, while Cervantes declared that it ought to be guarded as carefully as the works of Homer. Its sequels, *D. Duardos* by Diogo Fernandes, and *D. Clarisel de Bretanha* by Soncalves Lobato, are inferior. The historian Barros tried his youthful pen in a romance of chivalry, the *Chronica do Imperador Clarimundo,* while in the Arthurian cycle the dramatist Ferreira de Vasconcellos wrote *Sagramor* or *Memorial das proesas da segunda Tavola Redonda.* A book of quite a different order is the *Contos de proveito e exemplo* by Fernandes Trancoso, containing a series of 29 tales derived from tradition or imitated from Boccaccio and others, which enjoyed favour for over a century.

Among the moralists of the time three at least deserve the title of masters of prose style, Heitor Pinto for his *Imagem da vida Christã,* Bishop Arraez for his *Dialogos,* and Frei Thomé de Jesus for his mystic and devotional treatise *Trabalhos de Jesus,* while the maxims of Joana da Gama, entitled *Ditos da Freira,* though lacking depth, form a curious psychological document. The ranks of scientists include the cosmographer Pedro Nunes (Nonius), a famous mathematician, and the botanist Garcia da Orta, whose *Coloquios dos simples e drogas* was the first book to be printed in the East (1563), while the form of Aristotelian scholastic philosophy known as *Philosophia coimbricensis* had a succession of learned exponents, who mainly used Latin, in which also Francisco Sanches wrote his notable treatise *Qvod nihil scitvr* (1581).

The 17th Century. — From a literary as from a political point of view the 17th century found Portugal in a lamentable state of decadence which dated from the preceding age. In 1536 the Inquisition began its work with the censorship of books and the Index, while between 1 j52 and 1 jjj the control of higher education passed into the hands of the Jesuits. Next the taint of Gongorism appeared, and the extent to which it affected the literature of Portugal may be seen in the five volumes of the *Fenix renascida,* where the very titles of the poems suffice to show the emphatic futilities which occupied the attention of some of the best talents. The prevailing European fashion of literary academies was not long in reaching Portugal, and 1647 saw the foundation of the *Academia dos Generosos,* which included in its ranks the men most illustrious by learning and social position, and in 1663, the *Academia dos Singulares* came into being. In bucolics there arose a worthy disciple of Ribeiro in Francisco Rodrigues Lobo (*q.v.*), author of *Corte na Aldeia* and the lengthy pastoral romance *Primavera,* the songs in which, with his eclogues, earned him the name of the Portuguese Theocritus. The foremost literary figure of the time was the encyclopaedic D. Francisco Manuel de Mello (*q.v.*), who, though himself a Spanish classic, strove hard and successfully to free himself from subservience to Spanish forms and style. Most of the remaining lyricists of the period were steeped in Gongorism or, writing in Spanish, have no place here. It suffices to mention Soror Violante do Céo, an exalted mystic called "the tenth muse"; Bernarda Ferreira de Lacerda, author of the *Soledades de Bussaco;* the *Laura do Anfrizo* of Manoel Tagarro, the *Sylvia de Lisardo* attributed to Frei Bernardo de Brito, and the poems of Frei Agostinho das Chagas, who, however, is better represented by his *Cartas espirituaes.* Satirical verse had two notable cultivators in D. Thomas de Noronha and Antonio Serrão de Castro, the first a natural and facile writer, the second the author of *Os Rntos da Inquisição,* a facetious poem composed during his incarceration in the dungeons of the Inquisition, while Diogo de Sousa Camacho satirised the slaves of Gongorism.

The gallery of epic poets is a large one, but most of their productions are little more than rhymed chronicles. These works include the *Ulyssea* of Gabriel Pereira de Castro; the *Ulysipo* of

Sousa de Macedo; the *Malaca* conquistada of Francisco de Sá de Meneses; Rodrigues Lobo's 20 cantos in honour of the Holy Constable; and the Viriato *tragico* of Garcia de Mascarenhas.

History, Oratory and **Drama.**—Frei Bernardo de Brito began his ponderous *Monarchia Lusitana* with the creation of man and ended it where he should have begun, with the coming of Count Henry to the Peninsula. His contribution is a mass of legends destitute of foundation or critical sense, but both here and in the Chronica de Cister he writes a good prose. Of the four continuers of Brito's work, three are no better than their master, but Frei Antonio Brandão, who dealt with the period from King Alphonso Henriques to King John II., proved himself a man of high intelligence and a learned, conscientious historian.

Frei Luis de Sousa, a typical monastic chronicler, although he had begun life as a soldier, worked up the materials collected by others, and after much labor limae produced the panegyrical Vida de D. Frei Bartholemeu dos Martyres, the *Historia* de S. *Domingos,* and the Annaes *d'el* rei D. *João* III. His style is excellent, but he lacks the critical sense. Manuel de Faria e Sousa (*q.v.*), a voluminous writer on Portuguese history and the commentator of Camoens, wrote in Spanish, and Mello's classic account of the Catalan War is also in that language, while in Portuguese Jacinto Freire de Andrade thought to picture and exalt the Cato-like viceroy of India by his grandiloquent Vida de D. *João* de Castro.

Other historical books of the period are the valuable Discursos of Severim de Faria, the Portugal *restaurado* of D. Luis de Meneses, conde de Ericeira, the ecclesiastical histories of Archbishop Rodrigo da Cunha, the Agiologio lusitano of Jorge Cardoso and the Chronica da *Companhia de* Jesus by Padre Balthazar Telles. The last also wrote an *Historia* da *Ethiopia,* and, though the travel literature of this century compares badly with that of the preceding, mention may be made of the Itinerario da *India por* terra ate' a *ilha* de *Chipre* of Frei Gaspar de S. Bernardino, and the *Relação* do *novo* caminho *através* da Arabia e Syria of Padre Manuel Godinho.

The Jesuit Antonio Vieira (*q.v.*), missionary, diplomat and voluminous writer, repeated the triumphs he had gained in Bahia and Lisbon in Rome, which proclaimed him the prince of Catholic orators. Vieira was a man of action, while the oratorian Manuel Bernardes lived as a recluse, hence his sermons and devotional works, especially *Luz* e Calor and the *Nova* Floresta, breathe a calm and sweetness alien to the other, while they are even richer treasures of pure Portuguese. Perhaps the most human documents of the century are the five epistles written by Mariana Alcoforado (*q.v.*), known to history as the Letters *of* a Portuguese *Nun.* Padre Ferreira de Almeida's translation of the Bible has considerable linguistic importance, and philological studies had an able exponent in Amaro de Roboredo.

The popular theatre lived on in the *Comedias* de *Cordel,* mostly anonymous and never printed; the popular autos that have survived are mainly religious, and show the abuse of metaphor and the conceits which derive from Gongora. All through this century Portuguese dramatists, who aspired to be heard, wrote, like Jacintho Cordeiro and Mattos Fragoso, in Castilian, though a brilliant exception appeared in the person of D. Francisco Manuel de Mello (*q.v.*), whose witty Auto do *fidalgo aprendiz* is eminently national in language, metre, subject and treatment. The court, after 1640, preferred Italian opera, French plays and *zarzuelas* to dramatic performances in the vernacular, with the result that both Portuguese authors and actors of repute disappeared.

The 18th Century.— In the first part of the 18th century bad taste tended to increase, but gradually signs appeared of a literary revolution, which preceded the political and developed into the Romantic movement. Men of liberal ideas went abroad to France and England, and to their exhortation and example are largely due the reforms which were by degrees inaugurated in every branch of letters. Their names were, among others, Alexandre de Gusmlo, the Cavalheiro de Oliveira, Ribeiro Sanches, Corrêa de Serra, Brotero and Nascimento. They had a forerunner in Luiz Antonio Verney, who poured sarcasm on the prevailing methods of education in his *Verdadeiro methodo de estudar.*

From time to time literary societies, variously called academies or arcadias, arose to co-operate in the work of reform. In 1720 King John V., an imitator of Louis XIV., established the academy of history. The 15 volumes of its Memorias, published from 1721 to 1756, show the excellent work done by its members, among whom were Caetano de Sousa, author of the colossal *Historia da Casa* Real portugueza; Barbosa Machado, compiler of the invaluable Bibliotheca Lusitana, and Soares da Silva, chronicler of the reign of King John I.

The Royal Academy of Sciences, founded in 1780 by the 2nd duke of Lafões, produced a Diccionario da lingua portugueza and the Memorias (1788–95), and included in its ranks nearly all the learned men of the last part of the 18th century. Among them were the ecclesiastical historian Frei Manoel do Cenaculo, bishop of Beja; the polygraph Ribeiro dos Santos; Caetano do Amaral, a patient investigator of the origins of Portugal; João Pedro Ribeiro, the founder of modern historical studies; and the critics D. Francisco Alexandre Lobo, bishop of Vizeu; Cardinal Saraiva and Frei Fortunato de S. Boaventura.

The **Arcadias.**—In 1756 Cruz e Silva (*q.v.*), with the aid of friends, established the Arcadia *Ulysiponense.* Garção, the most prominent Arcadian, composed the Cantata de Dido, a gem of ancient art, as well as some charming sonnets to friends and elegant odes and epistles. The bucolic verse of Quita, a hairdresser, has a tenderness and simplicity which challenge comparison with Bernardim Ribeiro, and the *Marilia* of Gonzaga contains a celebrated collection of bucolic-erotic verse. Their conventionality sets the lyrics of Cruz e Silva on a lower plane, but in the *Hyssope* he improves on the *Lutrin* of Boileau. In 1790 a New Arcadia came into being. Its two most distinguished members were the rival poets Bocage (*q.v.*) and Agostinho de Macedo (*q.v.*). The only other poet of the New Arcadia who ranks high is Curvo Semedo; but the Dissidents, a name bestowed on those who stood outside the Arcadias, included two distinguished men now to be cited, the second of whom became the herald of a poetical revolution. No Portuguese satirist possessed such a complete equipment for his office as Nicolao Tolentino, and though a dependent position depressed his muse, he painted the customs and follies of the time with almost photographic accuracy, and distributed his attacks or begged for favours in sparkling verse. The task of purifying and enriching the language and restoring the cult of the Quinhentistas was perseveringly carried out by Francisco Manoel do Nascimento (*q.v.*). Shortly before his death in Paris he became a convert to the Romantic movement, and he prepared the way for its triumph in the person of Almeida Garrett, who belonged to the Filintistas, or followers of Nascimento, in opposition to the *Elmanistas,* or disciples of Bocage.

Early in the 18th century an attempt at the restoration of the drama by authors sprung from the people was made at the theatres of the Bairro Alto and Mouraria, and the numerous pieces staged there belong to low comedy. The Operas *portuguezas* of Antonio José da Silva (*q.v.*), produced between 1733 and 1741, owe their name to the fact that arias, minuets and *modinhas* were interspersed with the prose dialogue, and if neither the plots, style nor language are remarkable, they have a real comic force and a certain originality. Like Silva's operas, the comedies of Nicolao Luiz contain a faithful picture of contemporary society; but except in *Os* Maridos Peraltas, his characters are lifeless and their conventional passions are expressed in inflated language. Notwithstanding their demerits, however, his comedies held the stage from 1760 until the end of the century.

Meanwhile the Arcadia also took up the task of raising the tone of the stage, but though the ancients and the classic writers of the 16th century were its ideals, it drew immediate inspiration from the contemporary French theatre. All its efforts failed, however, because its members lacked dramatic talents and, being out of touch with the people, could not create a national drama.

Garção (*q.v.*) led the way with the Theatro Novo, a bright little comedy in blank verse, and followed it up with another, Assemble^ou partida; but he did not persevere. Figueiredo felt he had a mission to restore the drama, and wrote 13 volumes of plays in prose and verse, but, though he chose national subjects, and could invent plots and draw characters, he could not make them live.

Finally, the bucolic poet Quita produced the tragedies *Segunda Castro*, *Hermione* and two others, but these imitations of the French were still-born.

The 19th Century and After.—The 19th century witnessed a general revival of letters, beginning with the Romantic movement, of which the chief exponents were Garrett (*q.v.*) and Herculano (*q.v.*), both of whom had to leave Portugal on account of their political liberalism, and it was inaugurated in the field of poetry. Garrett read the masterpieces of contemporary foreign literature during his exiles in England and France, and, imbued with the national spirit, he produced in 1825 the poem *Camões*. His poetry, like that of his fellow *émigré*, the austere Herculano, is eminently sincere and natural, but while his short lyrics are personal in subject and his longer poems historical, the verse of Herculano is generally religious or patriotic. The movement not only lost much of its virility and genuineness, but became ultra-romantic with A. F. de Castilho (*q.v.*), whose most conspicuous followers were João de Lemos and the poets of the collection entitled *O Trovador;* Soares de Passos, a singer for the sad; the melodious Thomas Ribeiro, who drew his inspiration from Zorrilla and voiced the opposition to a political union with Spain in the patriotic poem D. *Jayme*. Mendes Leal, a king in the heroic style, Gomes de Amorim and Bulhão Pato, belong more or less to the same school. On the other hand José Simões Dias successfully sought inspiration from popular sources in his *Peninsulares* (1870).

In 1865 the revolt of the younger men of letters against the primacy of Castilho took the form of a fierce war of pamphlets. The leaders in the movement were Anthero de Quental (*q.v.*) and Theophilo Braga, the first a student of German philosophy and poetry, the second a disciple of Comte and author of an epic of humanity, *Visão dos tempos,* whose immense work in the spheres of poetry, criticism and literary history cannot be judged at present. In the issue literature gained considerably, and especially poetry, which entered on a period of active and rich production. The *Campo de flores* of João de Deus (*q.v.*) contains some of the most splendid short poems ever written in Portuguese. Simplicity, spontaneity and harmony distinguished his earlier verses, which are also his best. Anthero de Quental, the chief of the Coimbrans, enshrined his metaphysical neo-Buddhistic ideas, overshadowed by extreme pessimism, and marked the stages of his mental evolution, in a sequence of finely-wrought sonnets. These place him in the sacred circle near to Heine and Leopardi, and though strongly individualistic, it is curious to note in them the influence of Germanism on the mind of a southerner. *Odes modernas,* written in youth, show him in revolutionary, free-thinking and combative mood, but the prose of his essays, *e.g., Considerations on the Philosophy of Portuguese Literary History,* has that peculiar refinement, clearness and conciseness which stamped the later work of this sensitive thinker. A subtle irony pervades the *Rimas* of João Penha, who links the Coimbrans with Guerra Junqueiro and the younger poets. Partly philosophical, partly naturalistic, Junqueiro began with the ironical composition, *A Morte de D. João;* in *Patria* he evoked in a series of dramatic scenes and lashed with satire the kings of the Braganza dynasty; and in *Os Simples* (1892) he interprets in sonorous stanzas the life of country-folk by the light of his powerful imagination and pantheistic tendencies. His last poems appeared in *Poesias Dispersas* (1921). The *Claridades de Sul* of Gomes Leal, a militant anti-Christian, at times recall Baudelaire, and flashes of genius run through *Anti-Christo,* which is alive with the instinct of revolt. The *Só* of Antonio Nobre is intensely Portuguese in subjects, atmosphere and rhythmic sweetness, and had a deep influence. Cesario Verde sought to interpret universal nature and human sorrow, and the Parnassian Gonqalves Crespo may be termed a deeper, richer Coppée. His *Miniaturas* and *Nocturnos* have been re-edited by his widow, D. Maria Amalia Vaz de Carvalho, a highly gifted critic and essayist whose personality and *cercle* call to mind the 18th-century poetess, the Marqueza de Alorna. The French symbolists found an enthusiastic adept in Eugenio de Castro, who adopted a more natural and national manner in later works, such as *Canções desta negra vida* (1922) and *Chamas de uma candeia velha* (1925), and after the death of Junqueiro stood at the head of Portuguese poets. Antonio Feijó and José de Sousa Monteiro have written verse remarkable by its form. The most admired of the younger poets of this period, Antonio Corrêa de Oliveira, draws inspiration from the soil and religion, as in the *Auto das Quatro Estações* (1911) and *Pão nosso, Vinho alegre, Azeite de candeia* (1922). *A Minha terra* (1916) contains some true poetry and technical skill.

The best known books of Augusto Gil are *Sombra de Juno* (1915) and *Alba Plena* (1916). Teixeira de Pascoaes, a sincere but nebulous pantheist, the inventor of what is called *saudosismo,* is distinguished by love of nature, but he pays too little attention to form, though his verse has a music of its own. Affonso Lopes Vieira, a writer of exquisite taste and sense of rhythm, translated the traditions of the race and the poetry of the sea in *Zlhas de Bruma* (1918) and produced *rifacimentos* of two works of world fame in his *Amadis* and *Diana,* marked by rare artistry and understanding of the originals. The last publication of the Republican politician João de Barros, prolific in verse and prose, is a poem *Sisifo,* in which he treats the classical legend in a novel way.

The Drama.—Garrett took in hand the reform of the stage, moved by a desire to exile the translations on which the playhouses had long subsisted. He chose his subjects from the national history, began with the *Auto de Gil Vicente,* and followed this up with other prose plays, among which the *Alfageme de Santarem* takes the palm; finally, he crowned his labours by *Frei Luiz de Sousa,* a tragedy of fatality and pathos, and one of the really notable pieces of the century. The historical bent thus given to the drama was continued by the versatile Mendes Leal, by Gomes da Amorim and by Pinheiro Chagas, who all, however, succumbed more or less to the atmosphere and machinery of ultra-Romanticism, while the plays of Antonio Ennes deal with questions of the day in a spirit of combative liberalism. In the social drama, Ernesto Biester, and in comedy Fernando Caldeira, also no mean lyric poet, are two of the principal names, and the latter's pieces, *A Mantilha da Reizda* and *A Madrugada,* have a delicacy and vivacity which justifies their success. The comedies of Gervasio Lobato are marked by an easy dialogue and a sparkling wit, and some of the most popular of them were written in collaboration with D. João de Camara, the leading dramatist of the day, one of whose pieces, *Os Velhos,* was translated and staged abroad. To Henrique Lopes de Mendonqa, scholar, critic and poet, we owe some strong historical plays, as well as several stirring tales of old Portugal. Dr. Marcellino Mesquita is the author of *Leonor Teles* and other historical dramas, as well as of a powerful piece, *Dôr suprema.* Julio Dantas wrote many plays remarkable for their pliant style and delicate reconstruction of the past, such as *A Severa* (1901), *Rosas de todo o anno* (1907) and *Mariana* (1915). Among other pieces may be mentioned *O herdeiro* and *Entre Giestas* of Carlos Selvagem, a talented prose writer, *D. JoZo a a mascara* (1924) and the lyrical play *Diniz e Isabel* (1919) of Antonio Patricio, *O Gebo e a Sombra* (1923), a tragedy of unrelieved gloom and considerable power by Raul Brandão, and *Egas Moniz* (1918) by Dr. Jaime Cortesão.

The **Novel.**—Herculano led the way in the historical romance by his *Lendas e narrativas* and *O Monasticon,* two somewhat laboured productions, whose progenitor was Walter Scott; they still find readers for their impeccable style. Their most' popular successors have been *A Moçidade de D. JoZo V.* and *A ultima corrida de touros reaes em Salvaterra* by Rebello da Silva, and *Um Anno na Corte* by the statesman, Andrade Corvo. The novel shares with poetry the predominant place in the modern literature of Portugal, and Camillo Castello Branco (*q.v.*), Gomes Coelho and Eça de Queiroz are names which would stand high in any country. The first, a wonderful impressionist though not perhaps a great novelist, describes to perfection the domestic and social life of Portugal in the early part of the 19th century. His remarkable works include *Amor de Perdição, Amor de Salvação,* and the series entitled *Novelas do Minho.* Gomes Coelho, better known as *Julio Diniz,* records his experiences of English society in Oporto in *A Familia ingleza.* Portuguese critics have accused him of imitating Dickens. His stories, particularly *As Pupillas do Snr. Reitor,* depict country life and scenery with loving sympathy, and hold the reader by the charm of the characters, but Diniz is a rather subjective monotonous writer and he is no psychologist. Eça de Queiroz (*q.v.*) founded the Naturalist school in Portugal by a powerful book written in 1871, but only published in 1875, under the title *The Crime of Father Amaro;* and two of his great romances, *Cousin Basil* and *Os Maias,* were written during his occupancy of consular posts in England. *The Relic* conveys the impressions of a journey in Palestine and in parts suggests his indebtedness to Flaubert, but its mysticism is entirely new and individual; while the versatility of his talent further appears in *The Correspondence of Fradique Meizdes,* where acute observation is combined with brilliant satire or rich humour. The later portion of *The City and the Mountains,* in the truth and beauty of its descriptive passages shows him as a more regional writer. Among other novelists are Oliveira Marreca, Pinheiro Chagas, Arnaldo Gama and Luis de Magalhães.

Constant political unrest has been prejudicial to letters in a small country without a numerous leisured class, and no distinguished literary figure arose during the years 1910–25, but even before 1910 a reaction had begun against revolutionary methods in politics and laxity or agnosticism in religion, which may lead to a healthier national life. This movement showed itself in the later works of Eça de Queiroz, and in the return to the church of the prose writer Ramalho Ortigão and of the poet Guerra Junqueiro. It is not only found in the writers of the Integralist school (a Portuguese counterpart to the *Action française*); most of the leading poets and prose writers are once more declared Catholics, and they have gone back to the people for inspiration, with happy results. Nationalism and regionalism have taken the place of naturalism and symbolism, which were copied from France and never commended themselves to Portuguese feeling as a whole. The inability of 60% of the country-dwellers to read, saved many of them from losing their ideals and character during the period when a Liberal, destructive and anti-religious atmosphere permeated newspapers and books.

The new manner is seen especially in the novel, though it did not touch,the austere Republican and conscienlious analyst of middle-class society Teixeira de Queiroz (d. 1919). Following in the steps of Oliveira Martins, Anthero de Figueiredo has sought to combine history and art in *D. Pedro* e *D. Ines* (1913), *Leonor Teles* (1916), and *D. Sebastião* (1924), where he revives the figure of the last crusading king, and paints a picture of the times with abundant imagination. His *Espanha* (1923), *Jornadas em Portugal* (1918) and *Senhora do Amparo* (1920) are regional works, in a glowing style, which in the second suffers from over-elaboration.

The lack of a sound classical education is too evident in modern Portuguese prose, and few dare to attempt the straightforward narrative, sparing of adjectives and uncommon words, which is the chief attraction of the classics. Raul Brandão is an exception; his *Pescadores* (1924) tells of fisher folk and the tragedy of the ocean with poignant realism, and contains magnificent descriptions of the coast scenery. The book is worthy of the author of *Os Pobres* (1921). The trilogy of Manoel Ribeiro, *A Catedral,* probably suggested by Huysmans, *O Deserto* and *A Resurreição,* constitute a remarkable performance in subject and atmosphere, without precedent in modern Portuguese, and its popularity is not less remarkable. No better proof could be adduced of the changed times than these "clerical" books by a man of far from clerical ideas. At the close of this period he initiated a new trilogy with *A Colina Sagrada* (1926) and *A Planicie Heroica* (1927). The naturalism of Eça de Queiroz found a fresh interpreter in Aquilino Ribeiro, a novelist highly considered throughout the Peninsula. He is possessed of a rich vocabulary, and no one can create characters or picture one side of country life so faithfully as he has done in *A Via Sinuosa* (1918). In 1925 he produced *Filhas de Babilonia,* an unpleasant book, and *Estrada de Santiago.* The voluminous João Grave added *Gente Pobre* (1912), *Parsifal* and *A vida e Paixão da Infanta* to his list of romances. A brilliant satire on contemporary political events is to be found in *Saude* e *Fraternidade* by Campos Monteiro.

History. — Years of persevering toil in archives and editions of old chronicles prepared Herculano for his *magnum opus,* the *Historia de Portugal.* The *Historia da Origem e Estabelecimento da Inquisição em Portugal* followed and confirmed the position of its author as the leading modern historian of the Peninsula, and he further initiated and edited the important series *Portugaliae Monumenta historica.* The Visconde de Santarem, and Judice Biker in geography and diplomatics, produced standard works; Luz Soriano compiled painstaking histories of the reign of Ring Joseph and of the Peninsular War; Silvestre Ribeiro printed a learned account of the scientific, literary and artistic establishments of Portugal, and Lieut.-Col. Christovam Ayres was the author of a history of the Portuguese army. Rebello da Silva and the voluminous and brilliant publicists, Latino Coelho and Pinheiro Chagas, wrote at second-hand and rank higher as stylists than as historians. Gama Barros (1833–1925) and Costa Lobo followed closely in the footsteps of Herculano, the first by a *Historia da Administração publica em Portugal nos Seculos XII. a XV.,* positively packed with learning, the second by a *Historia da Sociedade em Portugal no Seculo XV.* Though he had no time for original research, Oliveira Martins (*q.v.*) possessed psychological imagination, a rare capacity for general ideas, and the gift of picturesque narration; and in his philosophic *Historia de Portugal,* his sensational *Portugal contemporaneo, Os Filhos de D. João* and *Vida de Nun' Alvarez,* he painted an admirable series of portraits, and, following his master Michelet, made the past live again. Prof. Fortunato de Almeida's *Historia de Portugal* marks a great advance on its predecessors. The same scholar published in four stout volumes a *Historia da Igreja em Portugal* (1910, etc.), equally well documented. J. Lucio d'Azevedo, the authority on Pombal, produced an excellent biography of the 17th century missionary, preacher and diplomat, Antonio Vieira, S. J., and the first volume of his *Cartas* appeared in 1925. D'Azevedo's most notable book is the *Historia dos Christãos novos portugueses* (1922). The same editors published (1912–27) the Lisbon parochial Registers of the 16th century. The statesman João Franco, last minister of King Carlos, issued a number of autograph letters received by him from the King shortly before his tragic death. Affonso de Dornellas in genealogy and history and Antonio Ferrão in the latter have done considerable work.

The Conde de Sabugosa, Lord Chamberlain under the monarchy, published (1912–24) five volumes of historical studies marked by critical ability, imagination and a sense of humour. His most substantial work is *A Rainha D. Leonor* (1921). The Visconde de Santarem printed the correspondence and re-issued some of the geographical and historical works of his famous namesake, including the *Historia e Theoria das Corfes Geraes* (1924). The Integralist leader Antonio Sardinha (d. 1925) left several volumes of essays and poetry. Dr. M. Gonçalves Cerejeira made his name by a work on the Renaissance with versions of the letters of the humanist Cleynaerts. Braamcamp Freire (1849–1921), the historian, was joint editor with D. Carolina Michaelis de Vasconcellos (1851–1925) of the works of Bernardim Ribeiro and Christovam Falcão. This great Romance scholar issued the 4th of her illuminating *Notas Vicentinas* in 1922. (E. P.; A. B.)

BIBLIOGRAPHY.—The chief works of a bibliographical character are the *Bibliotheca Lusitana* of Barbosa Machado and Innocencio da Silva's *Diccionario Bibliographico Portuquez,* continued by Brito Aranha. A smaller work is the *Manual Bibliographico* (1878) by Pinto de Mattos. Dr. Fidelino de Figueiredo's *A Critica Litteraria como Sciencia,* in its 3rd ed. (1920) contains an elaborate bibliography; and in 1922 the Hispanic Society of America published a concise *Portuguese Bibliography.* The *Catalogo Razonado* (1890) of Garcia Peres, and Figanière's *Catalogo dos Manuscriptos portuguezes no Museu Britannico* (1853) contain invaluable information. The general histories are those of Theophilo Braga, in many separate volumes, with a summary in four (1909–18); *Geschichte der Portugiesischen Literatur* (1894) by Carolina Michaelis de Vasconcellos in Grober's *Grundriss;* and three volumes (1912–25) by Dr. Fidelino de Figueiredo, who deals more fully with the modern literature in his *Historia de la Literatura Portuguesa* (Barcelona, 1927). In 1922 the Clarendon Press published the first complete history of *Portuguese Literature* in English (by Mr. A. F. G. Bell). Mr. Edgar Prestage's earlier valuable criticism is dispersed over various publications. Dr. Mendes dos Remedios's compendious *Historia da Literatura Portuguesa* attained a fifth edition in 1921.

Portuguese texts are still deficient as a whole, although much valuable work has been done, in articles and editions, by C. Michaëlis de Vasconcellos, as in her edition of the *Cancioneiro da Ajuda* (2 vols., 1904); E. Prestage, J. Leite de Vasconcellos, J. J. Nunes (in *Chrestomathia Archazca,* 1905, and many early texts), Col. Esteves Pereira, and A. Braamcamp Freire. Some of the Latin texts of Portuguese humanists have been made accessible, and their poetry was published in *Corpus illustrium poetarum lusitanorum qui latine scripserunt* (1745–48). The *Parnasso Lusitano,* in 6 vols. (1826), and Costa e Silva's *Ensaio Biographico-critico* (10 vols. 1850–55) have been supplemented and superseded by Dr. Agostinho de Campo's *Antologia Portuguese.* Bouterwek's history, translated into English in 1823, is similarly out of date. No weekly or monthly literary journal exists, but the *Revista Lusitana, Lusitania* and the *Boletim* of the Academy of Sciences are published at irregular intervals.

PORTUGUESE MAN-OF-WAR (*Physalia*), a colonial jelly-fish, one of the most beautiful of the pelagic group Siphonophora, found in tropical seas; it is occasionally drifted as far as the British coasts by the Gulf Stream. Its sting is exceedingly powerful and may have serious results. See HYDROZOA.

PORTUNUS, in Roman cult, originally the god of gates and doors (Lat. *porta*), and as such connected with Janus. Gradually he was transformed into the protector of harbours (*portus*) and ensured a safe return to seafarers. (Cicero, *Nat. deor.* ii. 26; Virgil, Acn. v. 241.) With the introduction of the Greek gods, he became merged with Palaemon-Melicertes. He had a special priest (*flamen* portunalis) and temples on the Tiber near the Aemilian bridge and near Ostia, where a festival was celebrated in his honour on Aug. 17. (See G. Wissowa, *Rel. u. Kultus* der Romer, pp. 111–112.)

PORTUS, an ancient harbour of Latium, Italy, on the right bank of the Tiber, at its mouth. For its origin *see* OSTIA. Claudius constructed the first harbour here, 2½ m. north of Ostia, enclosing an area of 170 acres, with two long curving moles projecting into the sea, and an artificial island, bearing a lighthouse, in the centre of the space between them; the harbour thus opened directly to the sea on the north-west and communicated with the Tiber by a channel on the south-east. The object was to obtain protection from the prevalent south-west wind, to which the river mouth was exposed. Though Claudius, in the inscription which he caused to be erected in A.D. 46, boasted that he had freed the city of Rome from the danger of inundation, his work was only partially successful. The Via Portuensis (15 m.) ran over the hills as far as the modern Ponte Galera, and then straight across the plain. An older road, the Via Campana, ran along the right bank of the Tiber. In A.D. 103 Trajan constructed another harbour still well preserved farther inland—a hexagonal basin enclosing an area of 97 acres. It communicated with the harbour of Claudius and with the canal constructed by him (though it bears the name Fossa Trajana) now forming the navigable arm of the Tiber (reopened for traffic by Gregory XIII. and again by Paul V.). It was surrounded by extensive warehouses, remains of which may still be seen: the fineness of the brickwork of which they are built is remarkable. The perforated travertine blocks to which the ships were made fast may still be seen. Farther to the east is a circular building in brick with niches called the temple of Portumnus.

Portus eventually captured the main share of the harbour traffic of Rome, and though the importance of Ostia did not at once decrease we find Portus already an episcopal see in Constantine's time not very long after Ostia, and the only harbour in the time of the Gothic wars. Its abandonment dates from the partial silting up of the right arm of the Tiber in the middle ages, which restored to Ostia what little traffic was left. To the west of the harbour is the cathedral of S. Rufina (10th century, but modernized except for the campanile) and the episcopal palace, fortified in the middle ages, and containing a number of ancient inscriptions from the site. On the island (Isola Sacra) just opposite is the church of S. Ippolito, built on the site of a Roman building, with a picturesque 13th century campanile; 2 m. to the west is the modern village of Fiumicino at the mouth of the right arm of the Tiber, 21 m. west-south-west by rail from Rome. It is a portion of the commune of Rome. Three miles to the north is the pumping station by which the lowland (formerly called Stagno di Maccarese, now reclaimed and traversed by many drainage canals) is kept drained (Bonifica di Maccarese).

PORT WINE, a wine made from grapes grown in the valley of the Douro, fortified at the time of the vintage, and shipped from Oporto. By virtue of the Anglo-Portuguese treaties of 1914 and 1916, no other wine can legally be called port.

The quality of port depends in the first place upon the quality of the grapes from which the wine was made originally, the best wine being made only from the finer species of grapes and from the more suitable vineyards. The quality depends in the second place upon the quality and quantity of the brandy used at the vintage time to check fermentation; also upon the time and manner in which this addition is carried out. When the grapes are pressed, their sweet juice begins to ferment at once, *i.e.,* the grape sugar is being gradually converted by the natural process of fermentation into carbon dioxide and ethyl alcohol. In order to retain a certain proportion of this grape sugar, brandy is added at a given time and fermentation is immediately checked. At that stage port is a blend of fermented grape-juice (wine), distilled wine (*brandy*) and unfermented grape-juice; and its quality depends chiefly upon the length of time and manner of keeping it.

Vintage Port is a wine made in any one year, shipped from Oporto usually two years after it is made, and bottled almost immediately by the importer. Vintage port matures slowly but it retains more body and more colour, and it acquires with age a finer bouquet than any other type of port. Vintage port, to be at its best, must be a wine shipped by a reliable port shipper, and well bottled by an expert wine-merchant; it must have been kept long enough but not too long; it must be carefully decanted.

Tawny Port is a wine which has been kept in cask and has been in contact with a greater proportion of oxygen from the outside air than the early-bottled wine: it has aged more rapidly and possesses less colour and less body than the vintage port. Tawny port is not, usually, the wine of any one year's grapes but a blend of wines made in different years. Tawny port is kept by the port shipper in his "lodges," at Oporto or Villa Nova da Gaia, and is shipped when ready for consumption.

Ruby Port is a compromise between the early-bottled vintage port and the matured-in-wood tawny port. It may be the wine of one vintage kept in cask for some years and bottled whilst still deep in colour, or it may be a blend of ports of different years and styles, a blend which may be made by the port shipper, at Oporto, or by the importer at home to suit the taste of individual customers.

BIBLIOGRAPHY.—André L. Simon, *Wine and Spirits* (1919); *The Blood of the Grape* (1920); *Wine and the Wine Trade* (1921); *The Supply, the Care, and the Sale of Wine* (1923); W. J. Todd, *A Handbook on Port* (1926); G. Tait, *Practical Handbook on Port Wine* (1926); C. Sellers, *Oporto Old and New* (1899); B. C. da Costa, *O Portugal Vinicola* (1900); J. E. dos Santos, *O Vinho do Porto* (1916). (A. L. S.)

PORUS (4th century B.C.), an Indian prince, ruler of the country between the rivers Hydaspes and Acesines at the time of the invasion of Alexander the Great. In the battle on the banks of the Hydaspes he offered a desperate resistance, and Alexander, struck by his independent spirit, allowed him to retain his kingdom, which he increased by the addition of territory. From this time Porus was a loyal supporter of Alexander. He still held the position of a Macedonian satrap when assassinated some time between 321 and 315 B.C.

See Arrian v. 18, 19; Plutarch, *Alexander,* 60; Quintus Curtius viii. 14.

PORVOO (Swed. *Borgå*), a seaport in the province of Nyland, republic of Finland, situated at the entrance of the river Borgå into the Gulf of Finland, about 33 mi. E N.E. of Helsinki by rail. Pop. (1939) 7,100. It is the seat of a Lutheran bishopric which extends over the provinces of Viipuri and St. Michel with portions of Tavastehus and Nyland; it possesses a beautiful cathedral and a high school, and is the seat of a court of appeal. Once a city of great dignity, the rapid growth of Helsinki has eclipsed it. In 1809, when the estates of Finland were summoned to a special diet to decide the future of the country, Porvoo was the place of meeting, and it was in the cathedral that the Tsar Alexander I. pledged himself as grand duke of Finland to maintain the constitution of the grand duchy.

POSEIDON, in Greek mythology, god of the sea and of water generally, son of Cronus and Rhea, and brother of Zeus and Pluto (perhaps "lord of moisture"; *see* Carnoy in *Musée Belge,* xxviii. p. 175 or connected with πόσις drink, ποταμός a river). When the three brothers deposed their father, Cronus, the kingdom of the sea fell by lot to Poseidon. His home was in a golden palace in the depths of the sea near Aegae in Achaea. In his hand he bore a trident, wherewith he lashed the sea into fury, split the rocks, and caused horses and fountains to spring from them. But, while he caused storms and shipwrecks, he could also send favouring winds; hence he was known as *Sōtēr,* "the preserver." Another of his titles was *Gaieochos,* "holder (*i.e.,* encircler?) of earth." He was the god of navigation and his temples stood especially on headlands and isthmuses. Every occupation connected with the sea was under his protection, and seafaring people, especially the Ionians, regarded themselves as his descendants. As god of the sea he disputed with other deities for the possession of the land. Earthquakes were thought to be produced by Poseidon shaking the earth—hence his epithet of *enosichthon,* "earth-shaker"—and hence he was worshipped even in inland places which had suffered from earthquakes. Several striking seismic and other phenomena in historical times were attributed to him. Poseidon was also the god' of springs, which he produced by striking the rock with his trident, as he did on the acropolis of Athens when disputing with Athena for the sovereignty of Athens (Herodotus viii. 55; Apollodorus iii. 14). As such he was called *Nymphagetes,* the leader of the nymphs of springs and fountains, a god of fresh water, probably his original character, and in this connection was φυτάλμιος, a god of vegetation, frequently associated with Demeter. At Athens, he is closely associated with Erechtheus (*q.v.*), with whom many identify him. As he gave, so he could withhold, springs of water; thus the waterless neighbourhood of Argos was supposed to be the result of his anger: Black bulls were sacrificed to him and often thrown alive into rivers; in Ionia and Thessaly bull-fights took place in his honour; at a festival of his at Ephesus the cupbearers were called "bulls," and the god himself was surnamed "Bull Poseidon." The horse was especially associated with his worship. Several legends represent him as creating the first horse; horses were occasionally sacrificed to him; and he is called *Hippios* ("lord of steeds"). In the deme of Colonus he was worshipped with Athena, the reputed inventor of the bridle. Various explanations of the title ἵππιος have been given: (1) that the horse represented the corn-spirit; (2) the resemblance of the crested waves to horses; (3) the impression of horses' hoofs near the god's sacred springs, and the shaking of the earth by them when galloping (*see* Farnell, *Cults of the Greek States,* iv. 20). In the Trojan War he takes the side of the Greeks, because he had been cheated of his reward by Laomedon, king of Troy, for whom he had built the walls of the city. The blinding of his son Polyphemus by Odysseus brings upon the hero the wrath of Poseidon. He is famous for his numerous amours; his offspring were mostly wild and cruel, like the sea—the Laestrygones, Polyphemus, Antaeus, Procrustes, and the like. He was worshipped as a national god by the Ionians, who took his worship over with them from Peloponnesus to Asia Minor. His chief sanctuary was at Mycale, where the Panionia, the national festival of the Ionians, was held. Other seats of his worship were in Thessaly, Boeotia (*see* Farnell, p. 29 ff.) and Peloponnesus. At Taenarum in Laconia he had a famous cave-like temple with an asylum, and on the island of Tenos he was worshippec! as the *physician,* probably in reference to the health-giving properties of the sea air. By far the most famous of his festivals was that celebrated every alternate year on the isthmus of Corinth, at which the "Isthmian games" were held. The horse, the dolphin (the symbol of the calm sea) and the pine-tree, with wreaths of which the Isthmian victors were crowned, were sacred to him. His attributes are the trident and dolphin or tunny fish.

As represented in art, Poseidon resembles Zeus, but possesses less of his majestic calm. In modern Greece St. Nicholas has taken the place of Poseidon as patron of sailors. But the Zacynthians have a special sea god, half man, half fish, who dwells under the sea, rides on dolphins or in a car drawn by dolphins, and wields a trident. By the Romans Poseidon was identified with Neptune (*q.v.*).

See Preller-Robert, *Griechische Mythologie,* i. 566 ff. (1894); O. Gruppe, *Griechische Mythologie,* vol. ii. (1906); and especially L. R. Farnell, *Cults of the Greek States,* vol. iv. (1907).

POSEIDONIUS (130?–50 B.C.), nicknamed "the Athlete," Stoic philosopher, the most learned man of his time and perhaps of all the school. A native of Apameia in Syria and a pupil of Panaetius, he spent many years in travel and scientific researches in Spain (particularly at Gades), Africa, Italy, Gaul, Liguria, Sicily and on the eastern shores of the Adriatic. When he settled as a teacher at Rhodes his fame attracted numerous scholars; next to Panaetius he did most, by writings and personal intercourse, to spread Stoicism in the Roman world, and he became well known to many leading men, such as Marius, Rutilius Rufus, Pompey and Cicero. The last-named studied under him (78–77) B.C.), and speaks as his friend.

The titles and subjects of more than twenty of his works, now lost, are known. In common with other Stoics of the middle period, he displayed eclectic tendencies, following the older Stoics, Panaetius, Plato and Aristotle. Unquestionably more of a polymath than a philosopher, he appears uncritical and superficial. But at the time his spirit of inquiry provoked Strabo's criticism as something alien to the school (τὸ αἰτιολογικόν καὶ τὸ ἀριστοτέλιζον, ὅπερ ἐκκλίνουσιν οἱ ἡμέτεροι). In natural science, geography, natural history, mathematics and astronomy he took a genuine interest. He sought to determine the distance and magnitude of the sun, to calculate the diameter of the earth and the influence of the moon on the tides. His history of the period 146–88 B.C., in 52 books, must have been a valuable storehouse. Cicero made much use of his writings.

See Zeller, *Philosophie der Griechen,* iii. (in Eng. trans., *Eclecticism,* 56–70); C. Miiller, *Fragmenta historicorum graecorum,* iii.; *J.* Blake, *Posidonii Rhodii reliquiae* (Leiden, 1810); R. Scheppig, *De Posidonio rerum gentium terrarum scriptore* (Berlin, 1869); R. Hirzel, *Untersuchungen zu Ciceros philosophischen Schriften,* i.–iii. (Leipzig, 1877); Thiaucourt, *Essai sur les traités philosophiques de Cicéron* (1885); Arnold, *Unterszrchungen über Theophanes von Mytilene und Posidonius von Apamea* (1882); Schmekel, *Die Philosophie der mittlern Stoa* (189.2); *I.* Heinemann, *Poseidonios' metaphysische Schriften* (Breslau, 1921); K. Reinhardt, *Poseidonios* (Munich, 1921) and *Kosmos u. Sympathie, Neue Untersuchungen iiber Poseidonios* (Munich, 1926) and P. Schubert, *Die Eschatologie des Posidonius* (Leipzig, 1927). Full bibliography in Uberweg, *Grundriss der Gesch. der Philosophie,* Bd. *I.* (1926). *See* also STOICS.

POSEN: *see* POZNAN.

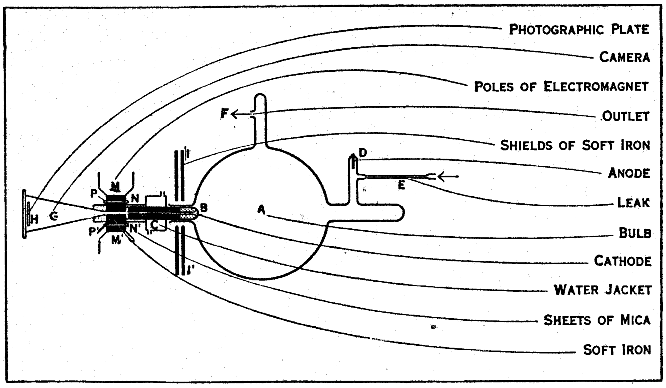
POSIDIPPUS (3rd cent. B.C.), Greek dramatist, of Cassandrea in Macedonia, the last and one of the most distinguished of the writers of the new comedy. He began to write for the stage in 289 B.C., and, according to Suïdas, wrote 40 plays, of which 17 titles and some fragments have been preserved. His comedies were frequently imitated by the Romans (Aulus Gellius ii. 23), and it is considered very probable that the *Menaechmi* (a comedy of errors) of Plautus is an adaptation from him. His statue in the Vatican is considered a masterpiece of ancient art.

Fragments in *A.* Meineke, *Poet. comic. graec. fragmenta* (1855).

POSITION ANALYSIS: see ANALYSIS SITUS.

POSITIVE (or PORTABLE) **ORGAN,** a mediaeval chamber organ which could be carried from place to place, and when played was placed on a table or stool and required a blower for the bellows, as well as a performer. It was larger and more cumbersome than the portative organ (*q.v.*).

POSITIVE RAYS. In 1886 Goldstein while experimenting with the discharge in gases at low pressures observed luminous streamers passing through perforations in the cathode and illuminating the gas behind it. The luminosity, he assumed, was due to rays of some sort which travelled in the opposite direction to the cathode rays (*q.v.*) and so passed through the aperture in the cathode. On account of the method by which they were obtained he called them "Canalstrahlen." Subsequently Wien showed that they could be deflected by means of a magnetic field. They were very fully investigated by Sir Joseph J. Thomson who called them "Positive Rays" on account of the fact that normally they are positively electrified. Recently they have been included in the general term "Mass Rays" which covers all swiftly moving particles of matter of atomic or molecular size whether charged electrically or not. The rays may be developed in many different ways, the most general being ionization of a gas at low pressure in a strong electric field. Ionization, which may be due to collision or radiation, means in its simplest case the detachment of one electron from a neutral atom. The two resulting fragments carry



FROM DR ASTON, "ISOTOPES (EDWARD ARNOLD & CO)

FIG. 1.—APPARATUS FOR THOMSON'S "PARABOLA" METHOD OF POSITIVE RAY ANALYSIS. SHOWING PARTS

charges of electricity of equal quantity but of opposite sign. The negatively charged portion is the electron, the atomic unit of negative electricity itself, and is the same whatever the atom ionized. It is extremely light and therefore in the strong electric field rapidly attains a high velocity and becomes a cathode ray. The remaining fragment is clearly dependent on the nature of the atom ionized. It is immensely more massive than the electron, for the mass of the lightest atom, that of hydrogen, is about 1,845 times that of the electron, and so will attain a much lower velocity under the action of the electric field. However, if the field is strong and the pressure so low that it does not collide with other atoms too frequently it will ultimately attain a high speed in a direction opposite to that of the detached electron, and become a "positive ray." The simplest form of positive ray is, therefore, an atom of matter carrying a positive charge and endowed, as a result of falling through a high potential, with sufficient energy to make its presence detectable. Positive rays can be formed from molecules as well as atoms, so that it will at once be seen that any measurement of their mass will give us direct information as to the masses of atoms of elements and molecules of compounds, and that this information will refer to the atoms and molecules individually, not, as in chemistry, to the mean of an immense aggregate. It is on this account that accurate analysis of positive rays is of such fundamental importance in research on the structure of atoms.

For visual effects the rays are best detected by a screen made of powdered millemite, which glows a faint green when bombarded by them. When permanent effects are required this screen is replaced by a photographic plate. The sensitivity of the plate to positive fays bears no particular relation to its sensitivity to light; so far the best results have been obtained from comparatively slow process plates of the type known as "Half Tone."

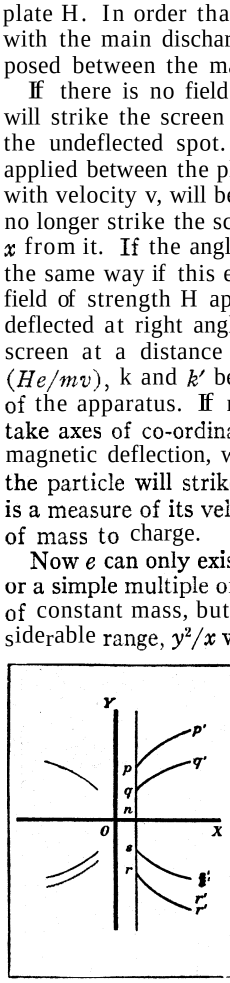
Thomson's "Parabola" Method **of** Analysis.—The method by which Sir J. J. Thomson investigated the properties of positive rays, and which still remains pre-eminent in respect to the variety of information it supplies, consists essentially in allowing the rays to pass through a very narrow tube and then analysing the fine beam so produced by electric and magnetic fields.

The construction of one of the types of apparatus used is indicated in fig. 1. The discharge by which the rays are generated takes place in the bulb A. The cathode B is placed in the neck of the bulb. Its face is of aluminium and so shaped as to present a hemispherical front provided with a funnel-shaped depression. This hole through which the rays pass is continued as an extremely fine-bore tube, mounted in a thick iron tube forming the continuation of the cathode as indicated. The finer the bore of this tube the more accurate are the results obtained, and tubes have been made as narrow as one-tenth of a millimetre, but as the intensity of the beam of rays falls off with the inverse fourth power of the diameter a practical limit is soon reached The cathode is cooled by the water-jacket C. The anode D may be placed in a side tube. The gas to be examined is led in through a fine leak E and pumped off at F. The pressure is usually adjusted so that the discharge potential is 30,000to 50,000 volts.

During the discharge all the conditions necessary for the production of positive rays are present in **A.** Under the influence of the high potentials they attain high speeds as they fly towards the cathode, and those falling axially pass right through the narrow tube emerging as a fine circular beam. This beam is subjected to analysis by causing it to pass between the pieces of soft iron P,P′ which are placed between the poles M.M′ of a powerful electromagnet. P and P' constitute the pole pieces of the magnet, but are electrically insulated from it by thin sheets of mica *N,N*, and so can be raised to any desired potential by means of the leads shown. The rays then enter the highly exhausted camera G. and finally impinge upon the fluorescent screen or photographic plate H. In order that the stray magnetic field may not interfere with the main discharge in A, shields of soft iron I,I′ are interposed between the magnet and the bulb.

If there is no field between the plates P.P′ the beam of rays will strike the screen at a point in line with the fine tube called the undeflected spot. If an electric field of strength X is now applied between the plates a particle of mass m, charge e, moving with velocity v, will be deflected in the plane of the paper and will no longer strike the screen at the undeflected spot, but at distance x from it. If the angle of deflection is small $x=k\,(Xe/mv^2)$. In the same way if this electric field is now removed and a magnetic field of strength H applied between P and P' the particle will be deflected at right angles to the plane of the paper and strike the screen at a distance y from the undeflected spot where $y=k'(He/mv)$, k and k' being constants depending solely on the form of the apparatus. If now, with the undeflected spot as origin we take axes of co-ordinates OX, OY along the lines of electric and magnetic deflection, when both fields are applied simultaneously, the particle will strike the screen at the point (x, y) where y/x is a measure of its velocity and y^2/x is a measure of e/m, its ratio of mass to charge.

Now e can only exist as the electronic charge $4{\cdot}77\times10^{-10}$ C.G.S. or a simple multiple of it. Thus if we have a beam of positive rays of constant mass, but moving with velocities varying over a considerable range, y^2/x will be constant and the locus of their impact with the screen will be a parabola pp' (fig. 2). When other rays having a larger mass m' but the same charge are introduced into the beam, they will appear as another parabola qq' having a smaller magnetic displacement. If any straight line p,q,n be drawn parallel to the magnetic axis OY cutting the two parabolas and the electric axis OX in p,q,n it will be seen at once that $m'/m=pn^2/qn^2$. That is to say, the masses of two or more particles can be compared directly by merely measuring lengths the ratio of which is entirely independent of the form of the apparatus and the experimental conditions



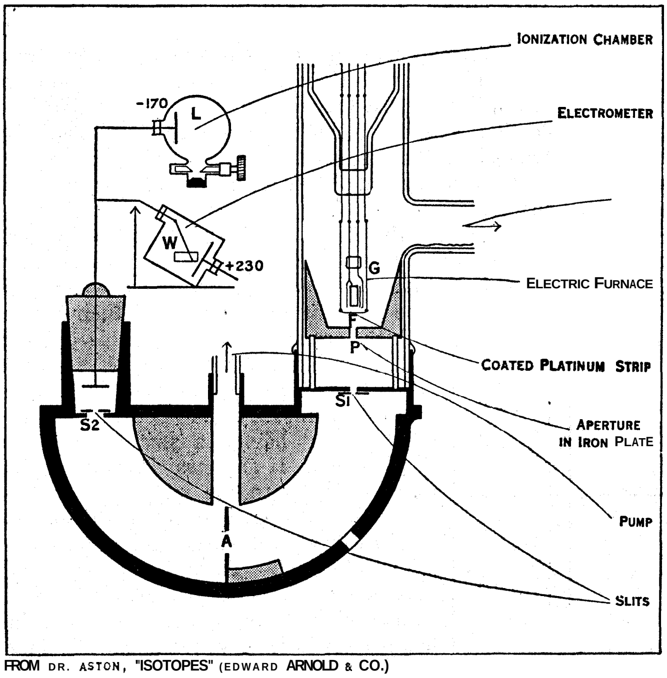
FROM DR. ASTON, "ISOTOPES (EDWARD ARNOLD & CO.)

FIG. 2—PARABOLAS OF POSITIVE RAYS
OY is the magnetic, OX the electric, axis

The principle of the method is, therefore, to obtain a photographic record upon which at least one parabola can be identified with particles of known mass; all the other parabolas can then be measured against this one and their masses deduced. In practice, since OX is an imaginary line and has no existence on the photograph, in order that the measurements may be made with greater convenience and accuracy, the magnetic field is reversed during the second half of the exposure, when—in the case we are conside ing--two new parabolas will appear rr', ss', due to m and m' respectively; the masses can now be compared by the equation $m'/m=pr^2/qs^2$ where p,q,r,s is any straight line cutting the curves approximately parallel to the magnetic axis. The measurement of these lengths is independent of zero determinations, and if the curves are sharp, can be carried out with considerable accuracy. It has been shown that the electrical displacement is in inverse proportion to the energy of the particle. This energy has a maximum limit determined by the potential of the discharge so that normal parabolas will end fairly sharply at points p,q, etc., equidistant from the magnetic axis This is clearly shown in the photographs reproduced in Plate, figs. 1 and 2.

Negatively Charged Rays.—As there is intense ionization in the fine tube the charged particles may easily collide with and capture electrons in passing through it. A singly charged particle capturing a single electron will, of course, proceed as a neutral ray, and being unaffected by the fields will strike the screen at the central spot. If, however, it makes a second collision and capture it will become a negatively charged ray. Rays of this kind will suffer deflection in both fields in the opposite direction to the normal ones, and will, therefore, give rise to parabolas of a similar nature but situated in the opposite quadrants, as indicated by the fine lines in fig. 2. Such negative parabolas are shown in the photographs. They are always less intense than the corresponding normal ones, and are usually associated with electronegative atoms.

Rays with Multiple Charges.—If during ionization more than one electron is split off, the resulting positive ray will have a double or multiple charge. Taking the case of a doubly charged particle it may give rise to two distinct effects, In the first place if it retains its double charge while passing through the analysing fields its behaviour will be quite indistinguishable from that of a normal ray of half its mass. Thus the effective mass of a doubly charged oxygen atom, written O^{++}, will be 8. Parabolas due to C^{++} and O^{++} may be seen in Plate, fig. 2. In the second place, the



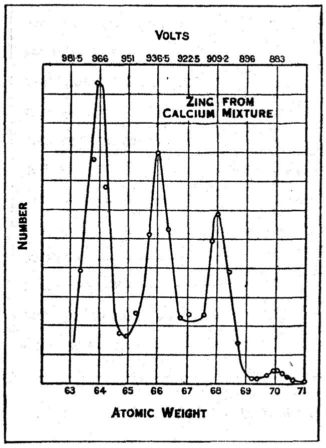
FROM DR. ASTON, "ISOTOPES" (EDWARD ARNOLD & CO.)

FIG. 3.— DIAGRAM OF APPARATUS FOR DEMPSTER'S METHOD OF ANALYSIS

particle may retain its double charge through the whole potential fall of the discharge but capture an electron in the fine tube. It will then constitute a ray of normal ratio of mass to charge but with double the normal energy, so that the normal parabola will show an extension towards the axis OY to a point half way between that axis and the line pq. The extension of the oxygen parabola due to this cause is clearly shown on the photograph.

Most elements are capable of losing two electrons, some, such as krypton, three or more, while mercury can lose no less than eight at a time. The results of the multiple charge on atoms of mercury is beautifully illustrated in Plate, fig. 3. The parabola a corresponding to normal single charge will be seen extended almost to the origin itself, while above a series of parabolas of diminishing intensity β,γ, etc., indicate the atoms which have retained two, three or more charges.

Dempster's Method of Analysis.—This method makes use of the principle first used by Classen and now generally adopted for beta-ray analysis, that a homogeneous beam of charged particles diverging from a narrow slit may be focussed by bending them through 180° in a uniform magnetic field. One form of Dempster's apparatus is shown in fig. 3. The element, the rays of which are to be analysed, is vaporized in a small electric furnace G and its vapour ionized by bombardment with electrons from a coated platinum strip F near the mouth of the furnace. The positive ions so produced pass into an accelerating field through the aperture in the iron plate P. The energy of the rays at this point is regarded as negligible so that all reach the slit S_1 with the same energy which can be controlled by varying the potential between P and S_1, usually 800–1,000 volts. The rays passing down in a narrow beam through S_1 are bent into a semicircle S_1,A,S_2 by the magnetic field, and so focussed upon a second slit S_2. Beyond this they are collected on an insulated plate and their charge measured. This is done by connecting the plate to an electrometer W and balancing the current brought up by the rays against a known and controlled leak produced in the ionization chamber L by means of a constant radioactive source.



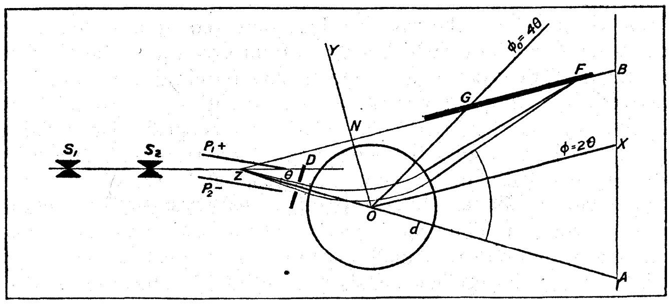
FROM DR. ASTON, "ISOTOPES" (EDWARD ARNOLD & CO.)

FIG. 4.—CURVE OBTAINED FROM ZINC, WITH A PEAK FOR EACH VALUE OF MASS IN BEAM OF RAYS

If V is the accelerating potential and r the radius of curvature it can easily be shown that $e/m = 2V/H^2r^2$. By keeping the magnetic field constant and plotting current against accelerating potential a curve is obtained having a peak for each value of mass present in the beam of rays. The ratios of the masses can be calculated from the voltages corresponding to the peaks. In this way Dempster was able to perform the first analyses of magnesium, calcium and zinc into their isotopes. *(See* ISOTOPES.) Fig. 4 shows a curve obtained from zinc.

The method is unfortunately limited in its application but it has the notable advantage that the relative abundance of the different isotopes can be directly deduced from the heights of their respective peaks.

Aston's Method of Analysis, the Mass-spectrograph.—This instrument was primarily designed to determine the constitution



FROM DR. ASTON, "ISOTOPES" (EDWARD ARNOLD & CO.)

FIG. 5.—DIAGRAM OF THE MASS SPECTROSCOPE USED IN ASTON'S METHOD OF ANALYSIS

of neon, a problem which required considerably greater accuracy than that given by the parabola method by which this element had been previously examined. In it electric and magnetic fields are employed to deflect the rays but they are so arranged that their deflections are at 180° instead of at 90° as used in the parabola method. The principle is indicated in fig. 5. The rays are collimated into an extremely thin ribbon by passing them through the two parallel narrow slits S_1,S_2. They are then deflected by

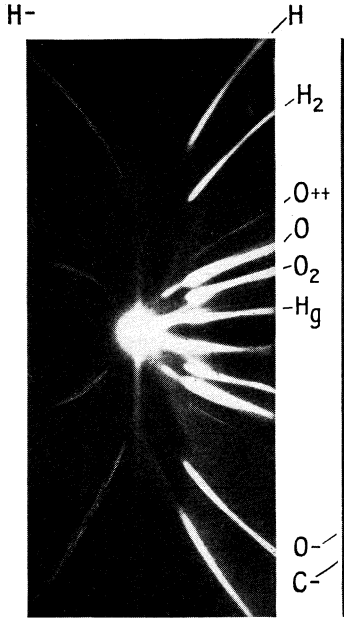


FIG. 1

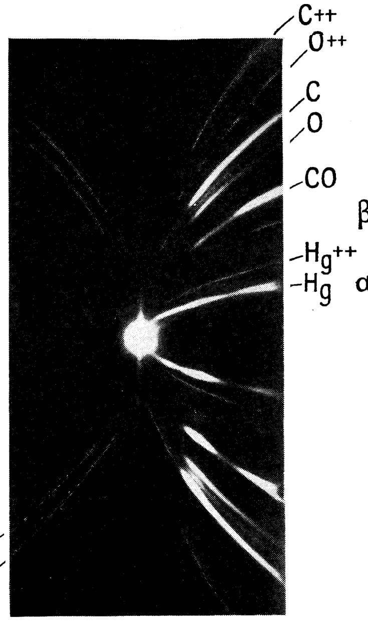


FIG. 2

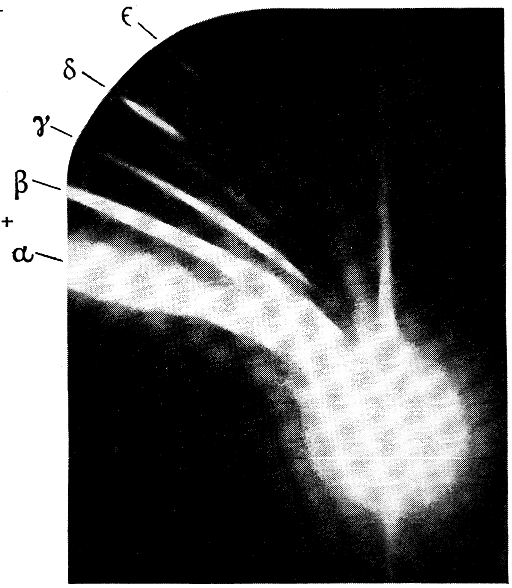


FIG. 3

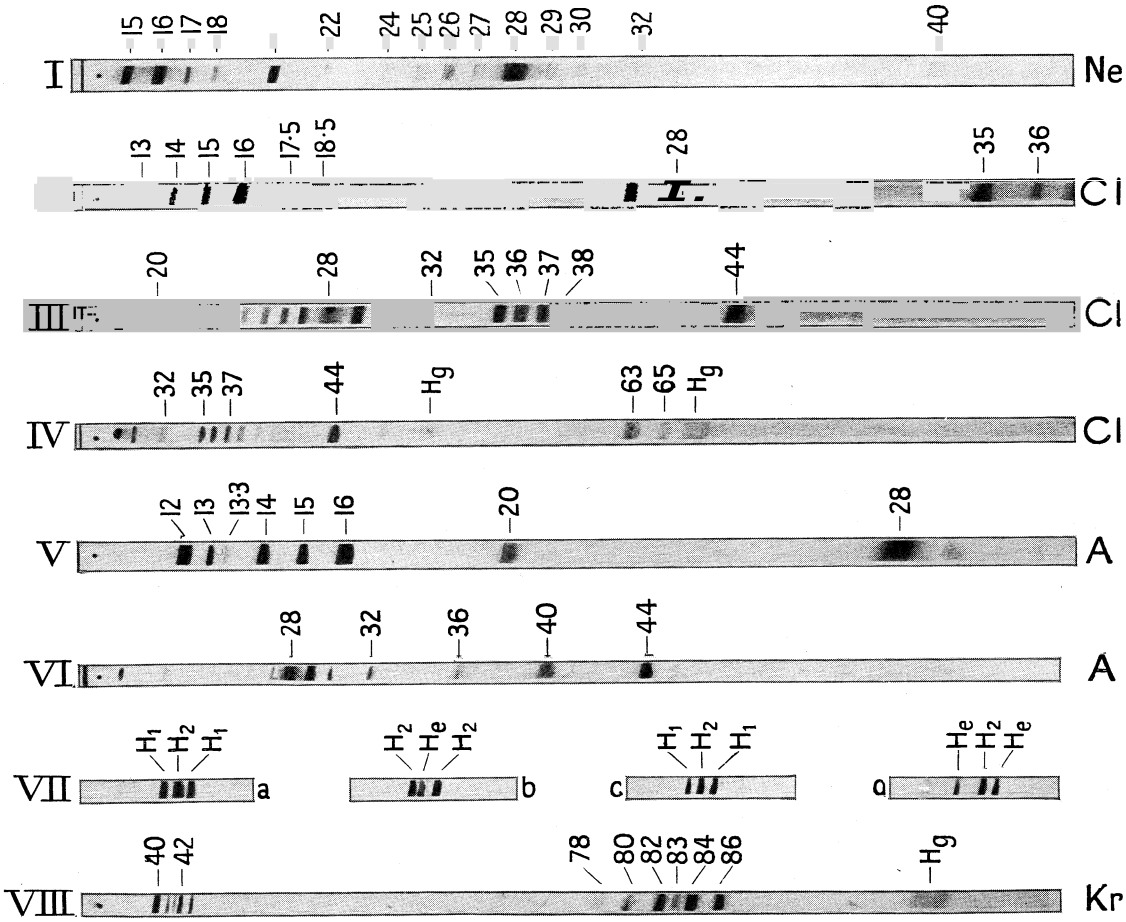


FIG. 4

PHOTOGRAPHS FROM DR. ASTON'S "ISOTOPES," BY COURTESY OF EDWARD ARNOLD AND COMPANY

POSITIVE RAYS

1. Typical positive ray parabola. Particles of like mass and charge, but of different velocities, give parabolic curves
2. Parabolas of carbon, oxygen, mercury, etc.
3. Parabolas of mercury (Hg) atoms with multiple charges
4. Typical Mass Spectra obtained from the mass-spectograph. The dark lines represent images of slits corresponding to particular masses, while the numbers above the line indicate the masses they correspond to on the ordinary chemical scale

the electric field between the plates P_1,P_2. This spreads them out into an electric spectrum in which the deflection of any particular particle is e/mv^2. After emerging from the electric field the rays may be taken, to a first degree of approximation, as radiating from a virtual source Z half way through the field. A group of these rays is now selected by means of the diaphragm D, and allowed to pass between the poles of a powerful electromagnet. For simplicity the poles may be taken as circular, the field between them uniform and of such a sign as to bend the rays in the opposite direction to the foregoing electric field.

If θ and ϕ be the angles through which the selected beam of rays is bent by passing through fields of strength X and H then $\theta v^2 = lXe/m$ and $\phi v = LHe/m$ where l,L are the lengths of the paths of the rays in the fields. From these equations it can easily be shown that if the magnetic deflection is greater than double the electric deflection all rays of constant mass, or more precisely of constant m/e, will come to a real focus F, and that the locus of the foci so generated will lie along the line GF passing through Z and parallel to the line $\phi = 2\theta$. If a photographic plate is placed at GF a spectrum depending on mass alone will be obtained. On account of its analogy to optical apparatus the instrument has been called a mass-spectrograph and the spectrum it produces a mass-spectrum.

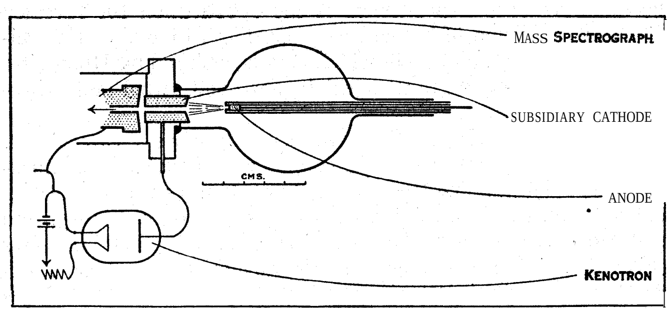
The use of slits instead of a fine circular tube, combined with the enhanced intensity obtained by means of the focussing principle, enables a very much higher resolving power to be used than was possible with the parabola method. Hence, although the photographs obtained do not afford so wide a range of general information upon the rays, the limit of accuracy in comparison of mass is notably increased. The first mass-spectrograph was set up in Cambridge in 1919 and used continually till 1925. In it θ the angle of electric deflection was one twelfth of a radian. It had a resolving power of about 1 in 130 and an accuracy of about 1 in 1,000. By its means over 50 elements were analysed and the "whole nnmber rule" established. (*See* ISOTOPES.) For details of its construction and technique the reader is referred to the works quoted at the end of this article.

Plate, fig. 4 shows a number of mass-spectra obtained by its means. Each dark line represents the image of the slits corresponding to a particular mass. The number above the line indicates the mass it corresponds to on the ordinary chemical scale O=16. The whole spectrum represents a range of mass of about 3 to 1, and the position of any line on the spectrum can be altered at will by changing the strength of the deflecting fields as shown by the positions of the chlorine group 35,36,37,38 in spectra II., III., IV. It will be noticed that the displacement to the right with increasing mass is roughly linear, a fortunate occurrence of great assistance in making the necessary calibrations. The measurements of mass are not absolute, but relative to certain reference lines which correspond to known masses. Such lines, due to hydrogen, carbon, oxygen and their compounds, are generally present as impurities or purposely added for the smooth working of the discharge tube. The two principal groups of these reference lines are the C_1 group, due to C(12),CH(13),CH_2(14),CH_3(15),CH_4 or O(16), and the C_2 group (24 to 30) containing the very strong line (28) due to CO and other bodies. The latter group and part of the former are well shown in spectrum I., where between them may be seen the lines due to the isotopes of neon 20 and 22. These two groups form with CO_2(44) a good scale of reference. The remarks already made about parabolas due to multiply charged rays apply to the lines obtained by this form of analysis. Lines due to particles carrying one, two, three, or more charges are called lines of the first, second, third or higher order, thus in spectrum II. the faint lines at 17·5 and 18·5 are chlorine lines of the second order. In spectrum V. taken with argon the third order line of its principal isotope (40) is clearly shown at $13\frac{1}{3}$ among the C_1 group of reference lines. Spectrum VIII. shows the six isotopes of krypton; on the left their second order lines can be seen close to the first order line of argon 40.

The remarkable property possessed by the atoms of mercury, of carrying multiple charges is well exhibited in mass-spectra. Mercury is a complex element and the characteristic closely packed group of lines due to its isotopes can be seen, progressively weaker in intensity up to the sixth order. Some of these groups appearing as unresolved blurrs may be recognized in the plate The lines of mercury have now been satisfactorily resolved and its constituent isotopes determined by a mass-spectrograph of higher power. (See ISOTOPES.)

Method of "Bracketing."—The method of determining masses by the position of lines with regard to known reference lines cannot be conveniently applied to the elements hydrogen and helium as these are too remote from the scale of reference. Their masses were first compared by the following principle which involves change in the deflecting fields. It is not practicable to determine the absolute values of the magnetic field but it can be kept constant without much difficulty. On the other hand, it is easy to apply electric fields whose ratios are known with certainty. From the equations already given it can be shown that for a given position on the spectrum $mv^2 \propto X$ and $mv \propto H$. Therefore if H is constant $m \propto X^{-1}$. If, therefore, after taking a spectrum we take another with the same magnetic field and, say, exactly double the electric field, the position due to a mass m on the first will be occupied by a line due to a mass $\frac{1}{2}m$ on the second. Hence if V is the original potential on the plates and v a suitable small voltage, and we take three spectra on the top of each other, one with a potential V, one with $2V+v$, and a third with $2V-v$, the magnetic field being identically the same for all, a line due to a mass m will appear bracketed on each side by lines due to $\frac{1}{2}m$. If the two to one relation between the masses is an exact one the bracket will be symmetrical as in the case of the hydrogen atom and molecule spectrum VII. c. If the bracket is not symmetrical the ratio of the masses is not 2 as in the case of the hydrogen molecule and helium atom spectrum VII. b and d. In this way it was first proved that the hydrogen atom had a mass considerably greater than a whole number on the oxygen scale, the value agreeing with 1·008, that deduced by chemical methods. This result, which has since been amply confirmed, is of great theoretical importance.

Anode Rays.—The usual source of positive rays, as has been stated, is the ordinary discharge in gases at low pressures. For examination by this process a substance must itself be volatile or capable of yielding a stable compound which can be introduced as a vapour into the discharge tube. The majority of elements are metals and do not behave in this manner. To obtain mass rays of these other methods must be used. As long ago as 1906 it was observed that halogen salts when heated and used as anode in a discharge tube behaved in a very remarkable manner giving off pencils of coloured rays. Thus the salts of lithium produced brilliant red streamers corresponding to the well-known red line



FROM DR ASTON, 'ISOTOPES' (EDWARD ARNOLD & CO)

FIG. 6.—APPARATUS FOR ACCELERATED ANODE RAYS, IN WHICH THE DISCHARGE TAKES PLACE BETWEEN ANODE AND SUBSIDIARY CATHODE

of the lithium spectrum. These were called "Anode Rays" and proved to be positively charged atoms of the metals employed. These rays are usually too slow to be suitable for direct analysis by the mass-spectrograph but they can be made so by the device illustrated in fig. 6, called the method of "accelerated anode rays." The discharge providing the rays takes place between the anode, containing halogen compounds, and a subsidiary cathode as shown. The slow rays passing through the latter are accelerated by introducing between it and the cathode of the mass-spectrograph a kenotron which will only allow a current of a value desired to pass. Now if the discharge tube becomes too hard the cathode rays from the subsidiary cathode will increase in energy heating the anode and softening the tube. If, on the other hand, the discharge becomes too soft the energy is absorbed in the kenotron, that in the cathode rays decreases and the anode cools down hardening the discharge. Also, whatever the state of the discharge tube, the energy of the rays reaching the mass-spectrograph is roughly constant, for this is governed by the watts in the high tension discharge and the current allowed to pass through the kenotron. By means of this device applied to the original mass-spectrograph the isotopic constitution of a large number of metallic elements was demonstrated. (See ISOTOPES.)

Mass-spectrographs of **High** Precision.—The accuracy and resolving power of the original mass-spectrograph have since been greatly exceeded. Costa, in 1925, described an instrument capable of an accuracy of 1 in 3,000 by which he compared the masses of the atoms of lithium and other light elements by the method of bracketing. The latest model now in use by the writer in the Cavendish laboratory has a resolving power of 1 in 600, more than sufficient to resolve the mass lines of the isotopes of any known element, and, when suitable systems of measurement are used, an accuracy of 1 in 10,000. This instrument has been used to measure the very small divergencies from the whole number rule. (See ISOTOPES.)

In conclusion, it may be stated that the discovery of positive rays gave a very valuable weapon into the hands of the physical investigator. The study of their analysis is less than 20 years old, yet already it has established facts of revolutionary importance and has provided a means of measuring the weights of atoms, free from ambiguity and of an accuracy equal to that of the finest chemical methods.

See J. J. Thomson, *Rays of Positive Electricity* (2nd ed.); F. W. Aston, *Isotopes* (2nd ed., 1924) and Bakerian Lecture, *Roy. Soc. Proc.* A. 115 (1927); W. Wien, *Kanalstrahlen* (1923). (F. W. A.)

POSITIVISM, a philosophical term, applied somewhat loosely to any system which confines itself to the data of experience and declines to recognize a priori or metaphysical speculations. In this sense the term may be applied to empirical philosophers in general. Thus Hume is a positivist in the sense that he specifically restricts philosophy to the sphere of observation, and regards the causal relation as being nothing more than what we have been accustomed to expect. Similarly Mill, Spencer and physical scientists generally view the universe from the positivist standpoint. In its commonest acceptation, however, the term is used of the philosophy of Auguste Comte, who applied the term to his system according to which knowledge is based exclusively on the methods and discoveries of the physical or "positive" sciences (*see* COMTE). The outcome of this positivism is the substitution for revealed religion of a religion of humanity—according to Huxley "Catholicism minus Christianity"—in which God is replaced by Humanity. This religion was to have its special priesthood, ritual and organization.

In England a number of prominent Positivists carried out Comte's ideal of a Church of Humanity with ritual and organization. The chief building (in Chapel Street, Lamb's Conduit Street, London)' is adorned with busts of the saints of humanity, and regular services are held. Positivist hymns are sung and addresses delivered. Among the leaders of this movement have been Frederic Harrison, Richard Congreve, E. S. Beesly and J. H. Bridges (d. 1906). Services are also held weekly in Essex Hall, London, and there are a few other centres in the provinces, including a prosperous church in Liverpool.

POSSE COMITATUS, a summons to every male in the county, between the ages of 15 and 20, to be ready and apparelled, at the command of the sheriff and the cry of the county, to maintain peace and pursue felons. In England. ecclesiastics, peers and the infirm were not compellable to attend. Owing to the establishment of county police, the sheriff does not now pursue felons, but by the Sheriffs Act, 1887, he is expressly authorized to call out the posse comitatus if he suffers resistance in the execution of a writ. Thus it is no answer by him, for non-execution of a writ, to say that he was resisted.

In the United States, where used in the states, it is the assemblage of males of 15 years and over called by the sheriff to aid him in maintaining peace.

POSSESSION, the supposed control of a human body and mind by an alien spirit, human or non-human; or the occupation by an alien spirit of some portion of a human body, causing sickness, pain, etc. The term obsession (Lat. for siege) is sometimes used as equivalent to possession; sometimes it denotes spirit control exercised from without, or it may mean no more than a maniacal monoideism. The spirit is held to have entered the person in order to foretell the future or to proclaim the will of a god; the god himself may be regarded as speaking through the mouth of his devotee. Hence the authority of a prophet. Among peoples in the lower stages of culture possession by spirits of the dead is common and is related to ancestor worship. This kind of possession is found in Africa, Polynesia and Asia. Many of the classical oracles were regarded as due to divine inspiration. The manifestations are often voluntarily induced and are provoked in many different ways; in classical times the eating of laurel leaves, the inhaling of fumes which ascended from a cleft in the rocks of Delphi, the drinking of intoxicating liquors, or of a more widely found means of inducing the phenomena—blood—were all in use. Hypnosis was produced by drugs, draughts of animal blood, or as in Siberia, America and many parts of Africa by drumming, contortions and orgiastic dancing.

Demoniacal possession is a widely spread explanation of such psychopathological conditions as epilepsy, somnambulism, hysteria, etc.; especially in the East Indian field lycanthropy (*q.v.*) and magical power (for evil) are commonly attributed to possession. Demoniacal possession is familiar to us from the New Testament narratives, in which those possessed are stated to live among the tombs, to be deaf and dumb, or blind, to be possessed by a multitude of evil spirits or to suffer from high fever as a result of possession; the demons are said to pass into the bodies of animals or to reside in waterless places. The facts recorded are explicable either as symptoms of mental disease or as results of suggestion.

In the lower stages of culture diseases are explained as due to the invasion of the body by spirits (*see* ANIMISM), but the effects are supposed to be physiological, not psychical. The wrath of an ancestor or other dead person or the malice of a spirit, such as the Malay *hantus,* or of any non-human spirit, may set up pathological conditions. Such cases may be distinguished from the inspirational form by their invariably involuntary character and are dealt with by a variety of means such as spells, purifications, sacrifices to the possessing spirit, etc. (*see* EXORCISM).

BIBLIOGRAPHY.—For anthropological data *see* Bastian, *Der Mensch;* Naevius, *Demon Possession;* Radloff, *Das Schamanentum;* Skeat, *Malay Magic;* Stoll, *Suggestion und Hypnotismus;* Tylor, *Primitive Culture;* Verdun, *Le Diable dans les missions;* Maury, *La Magic,* p. 258 *seq.;* Chamberlain, *Things Japanese, s.v.* "Fox." Details of the phenomena are given in all good modern ethnographical works. *See* bibliography to art. ANTHROPOLOGY. For discussion of New Testament facts *see* W. M. Alexander, *Demoniacal Possession* in *the New Testament;* Conybeare, in *Jewish Quarterly Review,* viii. 576, ix. 59, 444, 581; Herzog's *Realencyklopädie, s.v.* "Dämonische." For patristic literature *see* Bingham, *Antiquities,* iii.

POSSESSION (IN LAW), a term derived from Roman law. It has been said to be either a right or a fact conferring a right, or both together. The latter is the view of Savigny, the leading authority upon the subject (Recht des *Besitzes*). The definition of W. A. Hunter may be accepted: "Possession is the occupation of anything with the intention of exercising the rights of ownership in respect of it" (*Roman* Law). Possession is inchoate or incomplete ownership; it is on its way to become ownership

In both Roman and English law the possessory tended to supersede the proprietary remedies from their greater convenience—that is to say, the plaintiff based his claim or the defendant his right upon possession rather than property. The English possessory action may have been directly suggested by the interdict. Bracton (103b) identifies the assise of novel disseisin, the most common form of possessory action, with the interdict unde *vi.* In England ejectment had practically superseded other real actions before the latter were (with the exception of dower, writ of dower and *quare impedit*) expressly abolished by the Real Property Limitation Act 1833, s. *36.* The action for the recovery of land, introduced by the Judicature Acts, is the modern representative of the action of ejectment.

Possession gives in English law, speaking generally, much the same rights as in Roman law. Thus it serves to found a title (see LIMITATION, STATUTES OF; PRESCRIPTION), and to throw the onus of proof upon the claimant. In an action for the recovery of land the defendant need only allege that he is in possession by himself or by his tenant, and (where such an allegation is necessary) that he had no notice to quit.

In English law the doctrine of possession becomes practically important in the following cases: (1) Possession serves as a convenient means of division of estates. (See LAWS OF REAL PROPERTY.) One of the divisions of estates is into estates in possession and estates in reversion or remainder. It also serves as a division of personal property (*q.v.*). A chose in action is said to be reduced into possession when the right of recovery by legal proceedings has become a right of enjoyment. (2) Possession gives a title against a wrongdoer. In the case of real property it is regarded as prima facie evidence of seisin.[1] In the case of personal property the mere possession of a finder is sufficient to enable him to maintain an action of trover against one who deprives him of the chattel.[2] (3) What is called "unity of possession" is one of the means whereby an easement is extinguished. (4) Possession is very important as an element in determining the title to goods under 13 Eliz. c. 5, the Bills of Sale Act 1878 and the Bankruptcy Acts 1883 to 1890. (5) Possession of goods or documents of title to goods is generally sufficient to enable agents and others to give a good title under the Factors' Acts. (See FACTOR.) (6) In criminal law the question of possession is important in founding the distinction between larceny and embezzlement. (See Stephen, Digest of the Criminal Law, note xi.) (7) Actions of possession of ships fall within the jurisdiction of the admiralty division. This jurisdiction in the case of British vessels depends upon the Admiralty Court Act 1861 (24 Vict. c. 10, s. 8), in the case of foreign vessels (in which the jurisdiction is rarely exercised) upon the general powers of the court as a maritime court.

Under the Statutes of Limitation the only question now is, not whether possession has been adverse or not, but whether twelve years have elapsed since the right accrued.

Scotland. — In Scotland possessory actions still exist eo *nomine.* Actions of molestation, of removing, and of maills (payments) and duties are examples. A possessory judgment is one which entitles a person who has been in possession under a written title for seven years to continue his possession (Watson, Law *Dict., s.v.* "Possessory Judgment").

United States. — In American law possession carries much the same important significance that it does in English law. Except in Louisiana where the civil law prevails, possession is commonly divided into actual and constructive possession. The former concerns actual occupancy or the exercise of dominion over a thing; the latter occurs where there is no actual possession but simply ownership and the possession is either vacant or consistent with the outstanding ownership, such as possession by a servant or bailee. The doctrine of possession has an outstanding importance in practically every branch of the law, especially in the numerous cases where ownership to realty or personalty is in issue. Especially significant are the doctrines of adverse possession, where long continued and uninterrupted possession of chattels or realty under a claim of right and hostile to the true owner ripens after the statutory period into indefeasible ownership.

In addition to the authorities cited may be mentioned W. A. Hunter, *Exposition of Roman* Law (4th ed. 1903); O. W. Holmes, *The Common Law* (1882); F. Pollock and R. S. Wright, *Possession in the Common Law* (1888); *W.* Markby, *Elements of Law* (1905); *T.* H. Holland, *Elements of Jurisprudence* (13th ed. 1924).

[1] "Seisin" and "possession" are used sometimes as synonyms, as generally by Bracton; at other times thev are distinguished: thus there can be possession of a term of years, but no seisin (Noy, *Maxims,* p. 2). It seems doubtful, however, how far in English law a tenant for years has true possession, for he is in law only a bailiff or servant of the landlord. But he certainly has possessory remedies.

[2] Compare the *Code Napoleon,* art. 2,279: "*En* fait de meubles la possession vaut titre."

POSSUM, a variant name for the opossum. See OPOSSUM.

POSTAL INSURANCE: see INSURANCE: POST OFFICE FACILITIES.

POSTAL ORDER, in the United Kingdom, is a post-office facility for making small remittances. The postal order is a voucher which can be bought at any post office and is payable at any other post office either to its bearer or to the nominee if a name is filled in. Orders are sold for sums from 6d. to 21/–, and odd pence can be filled in by affixing postage-stamps. The poundage charge ranges from 1d. to 2d. Larger sums can be made up by buying several orders. Thus £3 17s. 4d. can be remitted by buying three 20/– orders and one 17/– order and affixing 4d. in postage-stamps to one of the orders. If the order is crossed it is only paid through a banker as in the case of a cheque. About £45,000,000 a year is remitted by this means. See POST AND POSTAL SERVICES.

United States Postal Notes. — By an Act of Congress signed March 3, 1883, a form of postal order known as the postal note was authorized for use in transmitting through the mails any amount less than five dollars. This postal note for which a fee of three cents was charged became immediately popular but as it was payable to bearer many complaints of loss and theft were received. Notwithstanding the increasing number of such losses and depredations the use of the note was continued until January 1894, when it was abolished and, a lower fee having been prescribed for the regular money order of small amount, the latter took the place of the postal note without any serious confusion or complaint.

POST AND POSTAL SERVICES. The history of postal services goes back to the early days of the great empires of the east, when the permanent maintenance of control over a wide area was seen to depend on the organization and maintenance of rapid and frequent communication. The posts of the Persian empire under the successors of Cyrus are the first great example; the Macedonian successors of the Persian kings appear to have maintained, on a smaller scale, a similar service. In fact one of the earliest postal documents, now in the Berlin Postal Museum, is an interesting letter bill — the forerunner of many millions of successors — of the mail for the court of one of the Ptolemies. The Roman empire brought the official postal service to a very high degree of perfection; but with the collapse of the Western empire and the relapse into barbarism there was a long eclipse of this as of the rest of the machinery of the imperial government.

The provision of a regular system of private communication formed no part of the cares of ancient or mediaeval governments, and during the middle ages such private posts as existed were maintained by the universities or by the gilds of merchants. With the renaissance of civilization the need for private communication forced itself inevitably upon the notice of the governments of the day; and in its gradual growth and expansion the policy followed can be traced to three distinct motives, the relative importance of each of which has varied considerably from century to century. These are the desire to ensure an official control or censorship, mainly of international correspondence; the search for additional sources of revenue; and the wish to provide an efficient service.

The first motive is prominent in a proclamation of Queen Elizabeth dated 1591, which prohibits the carriage of letters to and from "the Countreys beyond the seas" except by messengers duly authorized by the master of the posts. This was directed at the private posts maintained by the foreign merchants in London and seems to have been effective at the moment in bringing them to an end. In 1609 James I. extended the prohibition to the inland as well as the foreign post; but in this case the motive may have been the protection of the postmaster general's revenue. The importance of state control emerged again during the protectorate; and in Cromwell's Post Office Act of 1657 stress is laid on the importance of a centralized post office as a means not only of promoting trade but of discovering and preventing "many dangerous and wicked designs which have been and are daily contrived against the peace and welfare of this Commonwealth, the intelligence whereof cannot well be communicated but by letter of escript." Postal censorship, long discontinued, was revived during the World War.

The growth in intelligence and prosperity which' marked the

17th century soon led to deep dissatisfaction with the limited and somewhat inefficient services which prevailed under Elizabeth and James I.; and the reign of Charles I. saw the first of the great postal reformers in the person of Thomas Witherings. Witherings began his career as "postmaster of England for foreign parts" and carried out sweeping reforms of the foreign post, including the very remarkable measure of organizing a service through France, with the consent of the French Government, by his own direct employees. In 1635 he was authorized to bring into operation a reorganization of the inland posts, which he proposed to make self supporting, instead of being a charge to the crown, by the simple method of making them efficient and cheap. Witherings' scheme consisted in the organization of posts travelling night and day on each of the great post roads, and covering a minimum distance of 120 miles a day, with branch posts working to and from the post towns on the way. A letter could thus be sent to Edinburgh and a reply received in six days—an enormous improvement on anything hitherto attempted. A regular tariff of rates was established, based on the "single letter," *i.e.,* one sheet of paper. This method of charging and the zone system of postage rates remained as the underlying principles of the postal service until the reforms of Rowland Hill.

Witherings' rates on the single letter were as follows:

	d.
Under 80 miles	2
80 to 140 miles	4
Over 140 miles	6
On the borders and in Scotland	8
In Ireland	9

For letters carried on the branch posts an additional 2d. was charged. Witherings, owing to some intrigue, was removed from office in 1637; but he continued to be connected with the postal service for some years, and he appears to have succeeded in combining efficient administration with a certain amount of personal profit.

After some years of improved postal services the possibility of developing the post office as a source of revenue was taken up by the Government, and in 1653 it was decided to let the posts out to farm. In view of the fact that the rates charged by the farmers were fixed, this measure, while convenient to the State, was free from the objections usually inherent in the farming of public services. The successful tenderer paid £10,000 a year, and the system was continued under the Restoration until 1667. The revenue of the post office, however, was not considered simply as a contribution to the general expenses of government. En 1663 it was settled on the duke of York and his male heirs, and somewhat later was charged with a number of pensions; *e.g.,* the duchess of Cleveland received £4,700 and the duke of Schomberg £4,000. In 1713 these pensions amounted to £22,120, or one third of the total net revenue. The system had a singularly long life, as the last of these pensions, that payable to the duke of Grafton as successor to the duchess of Cleveland, was continued until 1856, when it was commuted for £91,000.

London Penny Post, 1680.—The next great reform came from outside the post office. In 1653 Louis XIV. had authorized the establishment of a local post in Paris at a charge of one sou (which by a notable anticipation was paid by means of a postage stamp). Profiting no doubt by this example a London merchant, William Dockwra, brought into existence in 1680 the London penny post. A rate of 1d., to be prepaid, was charged on all packets up to 1 lb. in weight, the packets being insured up to £10. Some hundreds of receiving offices were opened, from which an hourly collection was made, the letters being brought into 6 central offices, where they were sorted and date-stamped, and sent out for delivery. There were 4 to 8 deliveries a day in the greater part of London and 10 or 12 in the business centres. The area covered by this service extended from Hackney to Lambeth and from Blackwall to Westminster; and there was also a daily delivery, for which an additional 1d. was charged, to places 10 or 15 miles from London. The staff employed in London by Dockwra considerably exceeded that employed by the post office in the whole kingdom. This truly remarkable enterprise gave London a postal service which in some respects has never been equalled before or since.

For some time Dockwra struggled with serious financial difficulties; but no sooner had the penny post begun to show a profit than the duke of York, on whom the Post Office revenues were settled, asserted his monopoly. Dockwra was condemned to pay damages and his undertaking was incorporated in the General Post Office; but the London penny post long survived its creator and was maintained until 1801.

The First Postmaster General.—The act of 1657, to which reference has already been made, was the first comprehensive attempt to regulate the postal service by statute. It established a government monopoly, provided for the post of postmaster general, regulated the treatment of letters brought by private ship and prescribed the rates of postage, both inland and foreign. The act was renewed with practically no alteration, immediately after the Restoration. The inland rates were somewhat lower than those charged by Witherings, the maximum rate being 6d. for a single letter to or from Ireland.

Another Post Office Act was passed in 1711, uniting the post offices of England and Scotland, which had been separated in 1695, regulating the postal service in New York, the West Indies and the other American colonies, prohibiting post office officials from taking part in politics and lastly increasing substantially the rates of postage in order to provide for the expenses of the war with France.

The development of the posts since the reforms of Witherings had now raised a difficult administrative problem, viz., that of the "cross-posts," or letters exchanged between one town and another without passing through London. As all accounting arrangements were centralised in the capital, there was here room for a serious leakage of revenue, and adequate control of the cross-posts was becoming essential. At this juncture another reformer appeared in the person of Ralph Allen, postmaster of Bath. Allen, who had been in the postal service since his boyhood, had acquired an extraordinarily detailed knowledge of the working of the mail services in all parts of the country, and was convinced that with proper management the cross-posts could be turned into a source of revenue. In 1719 he offered to farm them for £6,000 a year, or 50% more than the net receipts at that time, and in 1721 this offer was accepted for a term of seven years. Allen's farm was after a short time a great success and the contract was renewed, at a constantly increasing rent, until his death in 1769. The secret of his success was his intimate knowledge of the roads and the post towns, the introduction of a simple system of accounting, and constant scrutiny of postmasters' accounts and inspection of their proceedings. In the 48 years for which he successfully managed this department of the post office, Allen not only built up a system far in advance of that to which he succeeded, but showed clearly the financial possibilities of improved communication, since he not only increased fivefold the revenue of the post office from the cross-posts, but accumulated a considerable fortune, which is said to have amounted to £500,000, for himself. The net revenue of the post office increased from £96,000 in 1724 to £165,000 in 1769.

The later years of the 18th century were marked by a great development of the main roads and a consequent improvement in speed of communication. Regular stage-coach services began to be established; but for some time the post office persisted in despatching its mails by the postboys of the earlier period. The result was that the coaches, travelling at double the speed of the postboys, were largely used for the illegal transmission of private letters, and the post office revenue suffered correspondingly. The establishment of the mail coach service was due to John Palmer, a theatre proprietor of Bath, who devised a scheme for organizing coaches running on regular schedules on the main roads and thus giving to letters the same speedy transmission which was available for passengers and parcels. The coaches were all to leave London at the same time—8 P.M.—and to return together as far as possible. The security of the mails was to be provided for by armed guards.

First Mail Coach, 1784.—Palmer succeeded in bringing this project under the personal notice of Pitt, who saw its merits and ordered its adoption. The first mail coach was established between

London and Bath in 1784; and within two years coaches were running to Norwich, Nottingham, Liverpool, Manchester, Leeds, Milford, Holyhead, Exeter and many other places. By 1797 there were 42 mail coach routes in operation; and Palmer's prediction that they would cost no more than the postboys was borne out by the fact that after some years their cost was only one half that of the system they superseded. The time taken from London to Holyhead was 27 hours, to Edinburgh 43 hours, to Falmouth 29 hours and so on, The development of the post was, however, severely hampered by the necessity of obtaining revenue to finance the war with France, and the rates of postage were periodically increased until in 1812 they attained the highest point they had ever reached, and at which they remained until the reforms of Rowland Hill. The charge for a single letter for a distance of 15 miles was 4d.; the graduation of the scale of distances was very steep and reached a maximum of 17d. for a distance of 700 miles. Whatever may be thought of the policy of extracting revenue from a tax on communications, it cannot be denied that it was extremely efficient up to a point, as by 1815 the post office was yielding a net revenue of £1,500,000 a year or nearly three times its total expenditure.

It is surprising that rates so high could have been retained for 25 years after Waterloo, and when Rowland Hill published his pamphlet on postage in 1836 he had behind him a substantial volume of public discontent. His main argument for reform was that in spite of the growth of trade and population the postal revenue had remained stationary for a long period, while revenue from other sources had been steadily increasing. Hill argued from this that the postal administration was conducted on principles which were in effect an obstacle to the development of postal business. The principal features of the scheme put forward were the abolition of the method of charging postage on the basis of distance—Hill arguing with great cogency, on the basis of such statistics as were available, that the actual cost of carriage varied within such extremely small limits that differences due to distance could be ignored; the abolition of the old method of charging one sheet of paper as a single letter, two sheets as a double letter, and so on, and the substitution of rates based simply on weight; the prepayment of letters by postage stamps; and the adoption of a uniform minimum rate of 1d.

Rowland Hill's Success, 1840.—So drastic a change of policy was not to be carried without a struggle; and it was only after four years of agitation and parliamentary enquiry that penny postage was finally established in 1840. This was the most signal service Great Britain has rendered to the cause of postal progress, and from the point of view of developing social relations and business communications it was an unqualified success, and established a standard to which it became the ambition of the rest of the world to attain.

This success, however, had to be paid for in another direction. Cheap postage rates are not in themselves the gold mine that certain of their enthusiastic supporters appear to imagine; and it is significant to note that the post office revenue, which in 1839 was over £1,600,000, dropped to £500,000 in the following year. It was not until 35 years after the introduction of Rowland Hill's reform, and until there had been an increase of a thousand per cent in the number of letters delivered, that the revenue again reached the level at which it had stood in 1839.

THE BRITISH POST OFFICE IN MODERN TIMES

For some years after the introduction of penny postage the post office prudently abstained from introducing any more far-reaching reforms and devoted itself to developing its existing services. The effect of the new rate on the volume of correspondence was immediate and continuous; and its effect was of course emphasized by the economic development of the country during the following years. In 1840 the number of letters posted was 169,000,000, or more than double that posted in the previous year. In ten years it had quadrupled, and by 1870 had reached the total of nearly 800,000,000, or about ten times the figure of 1839. Although other and cheaper postage rates were introduced after 1870 the 1d. letter continued to reflect the growing prosperity of the country and also the spread of education, and in spite of the check to development imposed by the war and the subsequent industrial depression it stood in 1928 at the total of 3,000,000,000 a year.

A lower initial rate was of course impracticable; and the only concessions which could be made to the public were increases in the initial weight and concessions in the rates charged on the heavier packets. The initial weight remained unchanged at the ½ oz., adopted by Rowland Hill, for over 30 years; it, was raised in 1871 to 1 oz., at which it remained until the Jubilee Reform of 1897, when the weight carried for 1d. was raised to 4 oz., the highest limit it had reached since the days of Dockwra's reform of 1680. The concessions on the heavier letters were of much less importance; various adjustments were made in 1865, 1871, 1885 and finally in 1897, when the postage on all weights above the initial 1d. was fixed at ½d. per 2 oz., the letter post rate for heavier packets being thus reduced to the low rate of 4d. a lb.

The war, among its other retrogressive results, brought about the abolition of penny postage 78 years after its first establishment. In 1918 the Government reluctantly decided to raise the letter rate to 1½d., and in view of the continued advance in working costs it was again raised in 1920 to 2d. As soon as the peak period of prices was passed the rate was again reduced to 1½d., at which it still stood at the beginning of 1929. The re-establishment of penny postage is a step which receives the careful consideration of successive governments. The argument in its favour is that it would give a much needed stimulus to trade and would extend still further private correspondence; the counter argument is that 1d. postage under present conditions would be considerably cheaper by comparison with the general level of prices than 1d. postage before the war, and that the cost of the concession would be extremely heavy, as the postmaster general estimates that even after making full allowance for the probable growth of traffic, the loss to the post office revenue would be £5,500,000 a year. The post office surplus is a considerable item in the budget; and it is for the chancellor of the exchequer to decide whether any reduction of revenue which can be contemplated should take the form of a reduction in postage rates or of some other concession to the taxpayer.

Newspapers.—For a long period, and even for some time after the establishment of penny postage, the post carried only two kinds of correspondence—letters and newspapers. The newspaper post had a varied and anomalous history. In 1840 newspapers were by statute carried free of postage. This, however, was not equivalent to the free postage which has been given on a more or less extended scale in other countries, as from the time of Queen Anne all newspapers had contributed to the revenue by the stamp duty which was levied on every copy. This state of things continued until 1855 when the duty was made optional, the privilege of free postage being continued to such newspapers and even to such periodicals as chose to pay it. Unstamped papers were forwarded by book post (*see* below). In 1870 the position was altered by act of parliament, which established a rate of ½d. for each newspaper irrespective of weight, the privilege being confined to papers published at intervals of not more than 7 days and complying with certain specified conditions. The rate, like others, was raised after the war and has not yet been reduced. The principle of a flat rate irrespective of weight has been abandoned, and the initial rate of 1d. covers only a weight of *6 oz.*

It is noteworthy that the post has never played the same part in the distribution of newspapers in England as it has in most other countries, as private distributors by concentrating on this one class of business and profiting by specially low rates of conveyance, etc., can carry it on more economically than a Government department. Incidentally the postal budget has been spared the heavy losses entailed on the revenues of so many foreign post offices by the low and unremunerative charges at which newspapers are still conveyed. The United States post office in particular has for years been endeavouring to raise its very low rates, under which it is difficult for the postal revenue to avoid showing a serious working loss, to a level more commensurate with its costs, but hitherto with only partial success. Before the war some 200,000,000 newspapers annually were delivered in Great Britain through the post, a large part of these of course being for places to which distribution by other means was impossible; at the present time the number is about 165,000,000.

Book Post.—The first special rate of postage introduced after 1840 was the book post, instituted in 1848. This was intended to benefit education and literature and was fixed at 6d. a lb. Various reductions were made in the scale until in 1870 it was reduced to ½d. per 2 oz., at which after a temporary increase in the post-war period it still remains. This post, owing to successive enlargements in the definition of articles admissible at the low rate, now comprises practically all kinds of commercial documents wholly or partly printed. It is not remunerative but is naturally extremely popular. Before the war the annual number was about 1,100,000,000. The increase to 1d. seriously checked the use made of it, but by 1928 it had recovered its popularity and was used to the extent of about 1,750,000,000 packets a year.

Postcards.—The next reform was not of British growth. The Austrian post office introduced the inland postcard in 1869; it won immediate success, and was adopted in England in 1870, the rate being fixed at ½d. For many years only official postcards were allowed; but the admission of private cards paid at the postcard rate, first allowed in 1894, was the origin of that notable development, the picture postcard, the numbers of which, though checked by the raising of the rate to 1d. (at which it still remains) in 1918, still represent, particularly at holiday resorts, a formidable addition to the work of the post office. In 1871 the number of postcards passing through the post was 75,000,000; in 1928 it was approximately 470,000,000.

Sample Post.—Only one of the experiments in postage rates carried out under the Rowland Hill regime has failed to establish itself permanently in the modern inland service. This is the sample post, established in 1863, with the idea of allowing a special rate to bona fide trade patterns and samples. The rate charged at the outset was 3d. for 4 oz., rising to 1s. 6d. for 24 oz., the maximum weight permitted; but after successive reductions it was brought down in 1870 to the book post rate of ½d. per 2 oz. The rule that the sample post should be restricted to bona fide samples was found in practice to be extremely difficult to enforce; and constant difficulties were experienced in securing strict application of the regulations, which was necessary to prevent the post going beyond its recognized objects and being transformed into a post for small parcels of every kind. The sample post was therefore abolished in 1871, the letter post rates being adjusted at the same time so as to reduce the postage on light packets. The sample post was, however, again revived in 1887, but gave rise to the same difficulties as before; and it was again merged in the letter post under the reduced rates conceded in 1897. Finally it had a further temporary lease of life during the war, following on the increase in the letter post rates, and was abolished for the third time in 1918. Although the sample post still survives in the international post under the terms of the Postal Union Convention it is even there a constant source of difficulties; and its history is an example of the unsoundness of the practice of making postage rates rest not on such simple and indisputable principles as weight or, in certain cases, character of contents, but on the elusive and unsatisfactory basis of the motive with which the packets are sent.

The parcel post, established in 1883, is referred to in detail later.

Registration.—The system of granting compensation for the loss of a packet in the post was a feature of the original London penny post of 1680; but the present system of registration is a comparatively modern development. A parliamentary commission in 1838 recommended a uniform system of registration at a charge of ad., liability being accepted up to £5. The reform of postage rates, however, caused the postponement of the scheme and it was not until 1841 that a general registration system came into being, and then only in an attenuated form, a fee of 1s. being charged and no responsibility being accepted in the event of loss. The service was not attractive, and little traffic was obtained; but though the fee was reduced, it was not until 1878 that the principle of compensation was adopted. The amount was originally fixed at £2, but was gradually increased, by a combination of registration with insurance and the introduction of a graduated scale of fees, until in 1906 the present system was introduced under which the minimum fee (now 3d. as compared with the pre-war 2d.) covers compensation up to £5, and the maximum fee £400. The service is very popular, some 57,000,000 registered letters and parcels being sent annually; and the percentage of losses on this total is infinitesimal.

The statistics of the growth of post office business are of considerable interest as an indication of the expansion of trade, the spread of education, and of course of the extension of postal facilities. The following table gives for each decade since the establishment of penny postage the total number of packets of all kinds sent by post and the number per head of the population.

Date	No. of postal packets of all kinds	Increase per cent	No. per head of the population
1839	82,000,000	..	3·1
1840	169,000,000	106	6·4
1850	327,000,000	93·5	13·2
1860	646,000,000	94·5	22·2
1870	877,000,000	35·7	28
1880	1,662,000,000	89·5	47·5
1890	2,620,000,000	57·6	69.4
1900	3,723,000,000	42·1	89·7
1910	5,281,000,000	41·8	116·7
1920	5,716,000,000	8·2	127
1926	*6,204,000,000	8·5	138

*Excluding the Irish Free State.

THE BRITISH RAILWAY MAIL SERVICE

Letter Mails.—The first regular railway service to be established was that between Manchester and Liverpool in 1830, and it was not long before it was recognized that this new means of locomotion would bring with it a revolution in the old methods of the conveyance of the mails. The post office authorities were not slow to recognize the necessity of obtaining adequate powers to secure the running of an efficient mail service, and the first Conveyance of Mails Act was passed in 1838. Under this act, the provisions of which still govern in essentials the relations between the post office and the railway companies, the postmaster general was given powers to call on the railway companies to convey his mails and guards in all trains, whether ordinary or special, and to provide if required the use of a whole carriage for the purpose of sorting letters. The only financial provision in the act was that the railway companies should receive "reasonable remuneration" for their services, any negotiations which could not be settled amicably being referred to arbitration.

Even at this early stage it was seen that the value of the railways lay not only in their superior speed but in the facilities they afforded for doing in a swiftly moving railway carriage the work of sorting letters which would otherwise fall on a stationary office, and so of securing a very considerable advantage in time of delivery. The first travelling post office was established between Birmingham and Liverpool in 1838. It was 16′ in length, 7′ 6″ in width, and the Railway Company protested that the running of so large and broad a vehicle would, owing to its wind resistance, delay their trains. Later in the same year another travelling post office was established between London and Preston, leaving Euston station at 8.30 P.M., a time which after 90 years is still maintained. The speeds on the earlier railways were comparatively slow. The journey from London to Birmingham occupied 5½ hours, and from London to Manchester or Liverpool 9½. These times were, however, less than half those occupied by the stage coaches, and the extension of the railways gradually drove the whole of the mail coaches off the road. The process was not a very rapid one as the last coach was not withdrawn until 1847. In spite, however, of the great improvements which they offered in the mail service the railways entailed a much heavier cost on the post office than their predecessors, and for some years after their establishment there was a constant series of disputes and difficulties between the companies and the post office on the question of payment.

At the outset the mails when not carried in a travelling post office were despatched by train exactly in the same way as by stage coach, that is, in charge of a post office guard. The system worked satisfactorily enough for the small mails of the 'thirties; but the great growth in the number of letters, which followed the introduction of penny postage soon made this method of transmission inconvenient and unnecessarily costly, and in 1848 statutory powers were obtained, under which the railway companies were obliged to convey mails by train in charge of their own guards, which is still the normal method of transmission for the great bulk of the mails sent by railway. During the next 50 or 60 years the post office was occupied in making the best use possible of the extension of the railway systems, and of the increase in the speed and the frequency of their trains, the results appearing in a constant improvement in the rapidity of postal communications and in the number of despatches and deliveries. On the financial side the great increase in the volume of the mails was, as was only natural, reflected in a gradual reduction in the relative cost of conveyance. In 1850 the annual payment to the railway companies was approximately £230,000; in 1928 it was approximately £2,000,000; but great as this increase is it is very considerably less than the increase in the same period in the number of letters handled by the post office.

Far reaching as are the statutory powers of the postmaster general with regard to the railways, in practice they are never invoked, and the details of the postal service are settled by contracts negotiated with the various railway companies. Under existing legislation any difference in regard to remuneration which cannot be settled amicably can be referred to the Railway and Canal Commissioners, but this power has not been exercised for many years. The main requirement of the post office in the contract is the running of trains at times convenient to the mail service, which cannot be altered without the consent of the postmaster general. Although separate contracts must be made with the individual companies the railway services are naturally correlated for the country as a whole, and Great Britain is now covered by an intricate network of mail trains providing complete and direct communication between the different systems, and between all parts of the country, the speed of which is equal to, or in some cases, better than that of the best passenger trains. On the west coast line to Scotland, on which, as above mentioned, the first travelling post office was established 90 years ago, there is now a special train devoted entirely to the post office, running nightly in each direction between London and Edinburgh, Glasgow and Aberdeen. This is the trunk main line mail service of Great Britain and as many as 50 post office employees are engaged in each train. A similar special train runs in each direction between London and Penzance. In all other cases the mail trains convey passengers as well as mails.

A special feature of the English mail train service is what is known as the mail bag apparatus, an efficient mechanical contrivance by which mail bags can be despatched from and received in travelling post offices while the train is travelling at full speed. This enables an extremely good service to be afforded to all places along the main lines of railway, and in sparsely populated districts, such as in the north of Scotland and parts of Wales it enables the post office to deliver correspondence at least a day earlier than would be possible by any other means.

The Parcel Post.—An international parcel post was established at the Postal Union Congress in Paris in 1878. Great Britain at that time had no such service, but the question of establishing one was immediately put in hand, and after prolonged negotiations with the railway companies the Post Office Parcels Act of 1882 was passed, establishing an inland parcel service which came into operation in the following year. The maximum weight of parcels was fixed at 7 lb., with a scale of postage varying from 3d. to 1s., according to weight. No individual contracts were made with the separate railway companies, but the post office paid to the Railway Clearing House 55% of the postage received on all parcels conveyed by railway, the distribution of the sums thus received among the railway companies being undertaken by the clearing house. This arrangement enabled the post office to maintain the principle of a flat rate of postage for the whole country in contradistinction to the railway companies' parcel tariffs which were based on zones of distance.

It soon became evident, however, that for short distances it was possible to convey parcels by road at a considerably lower cost than the payment to the railway companies provided under the act, and very shortly after the establishment of the parcel post parcel coaches were established by the post office. These road services took on a new development with the coming of the internal combustion engine. The higher speed and greater capacity of the motor van made a large extension of the coach system practicable, and at the outbreak of the World War it had reached very considerable dimensions, parcels being carried by road during the night between large towns up to a distance of 120 miles. After the war, however, fresh negotiations were entered into with the railway companies, and by the Post Office Parcels Act of 1922 it was enacted that the percentage of the postage payable to the railway companies should be reduced from 55% to 40%, the post office on its part agreeing that the railway companies should be entitled to claim a revision of their remuneration if the number of parcels conveyed otherwise than by railway exceeded 10% of the total number transmitted by post.

Since the establishment of the service, the maximum weight has been raised from 7 to 11 lb., and the postage rates have been varied from time to time. The minimum rate is now 6d. for a parcel not exceeding 2 lb., and the maximum 1s. 3d. for a parcel of 11 lb. The number of parcels posted annually is approximately 140,000,000, and the payment to the Railway Companies over £2,000,000 per annum.

The total earnings of the railway companies for letters and parcels are thus over £4,000,000 a year, and the post office is by far their greatest single customer, contributing no less than 2% of their total revenue.

The latest development of co-operation between the post office and the railways is the extension of the cash-on-delivery service to cover consignments despatched by railway as well as by post. The sender of the goods forwards to the consignee as a cash-on-delivery letter a document which entitles him to take delivery of a consignment despatched by railway. The sender's charges are paid by the consignee on receipt of the cash-on-delivery letter, the money is forwarded at once to the sender by the post office, and the consignee presents his document and receives the goods from the company.

THE BRITISH MAIL PACKET SERVICE

The first regular Government mail packet service was established by Queen Elizabeth in 1598 between Holyhead and Dublin. At that period, however, foreign communications were of greater postal importance than those with Ireland, and when James I. reaffirmed the post office monopoly in the case of foreign letters and appointed a postmaster for foreign parts, it clearly became incumbent on the post office to provide a regular means of communication with foreign countries. Witherings, who subsequently reformed the inland post, began his career by establishing efficient and regular communication with France by means of hired boatmen engaged to carry the mail between Dover and Calais. For the next 50 years the service appears to have been somewhat unsatisfactory and development slow; but in 1686 a regular service was established by Government packet between Harwich and Holland, which was followed in 1688 by a service from Falmouth to Corunna, and in 1703 by a weekly service from Falmouth to Lisbon. The growth of the British oversea possessions in the 18th century led to further developments. After an unsuccessful attempt at the beginning of the century, regular packets were put on from Falmouth to the West Indies in 1745; packets also ran to North America; and by the end of the 18th century they served a great part of the world.

Efficient as the packet service was in many respects, its history, which is known in considerable detail, is a curious commentary on 18th century administration. The packets themselves were small, being only 70 tons on the shorter services and on the ocean routes 150—vessels of the latter tonnage being, according to a report of 1788, considered fit to go to any part of the world. The crews, at any rate in peace time, were small, and the pay very low. The commander of a Falmouth packet in 1797 received the sum of 30s. a week in peace time, and £2 in time of war; the boatswain drew 7s. 6d. a week and the able seaman 7s. There was naturally every temptation to increase their incomes by such means as presented themselves, the favourite one being smuggling and, in war time, the capture of enemy ships when opportunity offered. The first practice led naturally to a good deal of trouble with the customs, in which the postmasters general supported their captains; the latter was often inevitable and was the well earned reward of a hard fight against heavy odds; occasionally it was hardly distinguishable from piracy. The management of the service, however, is a sordid history of corruption and maladministration. The cost went up rapidly towards the end of the century. The agents at the ports abused their powers by supplying defective stores, or claiming payment for provisions never supplied; by drawing the wages of non-existent hands, or the pensions of sailors long dead; by selling passes and pocketing the proceeds, and the like. Finally in 1787 the scandal became so intolerable that a parliamentary enquiry was instituted, at which it was discovered that the post office itself was also implicated, the secretary to the post office being not only a large owner of the boats (which were in many cases hired, not owned, by the Government), but also drawing $2\frac{1}{2}$ per cent on the total expenditure on packet services—a privilege which brought him altogether some £50,000.

The next important event in the history of the packets was the introduction of the steamship. Steamship communication with Ireland was established in 1816, and in 1821 a mail packet of 205 tons burden was put on this service, being followed in the next year by a steamship on the Dover–Calais route. It soon became evident, however, that mails could be carried more advantageously by private companies than by the government, and in 1831 the principle of inviting tenders for the mail service from private companies was introduced. In 1837 the Admiralty decided that the post office packets ought to be considered as forming a naval reserve of both ships and men and succeeded in having the management transferred from the post office to themselves. It was an inopportune moment, however, as the system of state-owned packets was already moribund, and being gradually displaced by the employment of private ships under contract. The Admiralty, however, retained the control of packet services for over 20 years and it was not till 1860 that it was retransferred to the post office.

In the earlier part of this period the Government definitely adopted the policy of subsidising steamship companies in order to establish regular communication on routes where ordinary traffic would not have justified the requisite expenditure, and to ensure the provision of a better type of vessel than would otherwise have been forthcoming. The first contract was made with Samuel Cunard in 1839 for a subsidy of £60,000 a year and was speedily followed by others. The subsidy policy, however, proved in practice very costly, the expenditure having by 1853, when it became the subject of a parliamentary enquiry, reached the very considerable sum of £853,000. Since that time the principle of the subsidy has gradually disappeared; its object had been fulfilled by the establishment of such far-reaching mail services as those of the Peninsular and Oriental Company, the Royal Mail Steam Packet Company and Messrs. Cunard. For the last 60 years the size and speed of mail ships has steadily increased, and the cost of the carriage of the mails diminished. At the present time even the practice of concluding regular contracts for the overseas mail service is becoming less and less frequent. The only contracts in force in 1928 were those with the White Star and Cunard companies for the Atlantic service, and with the Peninsular and Oriental Company for the service to India, Australia and the Far East. For all other destinations mails are carried by vessels running to ordinary commercial schedules, which are now so regular as to afford as satisfactory a mail service as that for which large subsidies were necessary at an earlier stage. At the time of writing (1928) the whole expenditure on the overseas packet services is £746,000.

The use of non-contract ships for providing the mail service is, however, only a return to an earlier epoch in the history of the overseas mail service. The Government packets in the 17th and 18th centuries were far from covering the whole field; for example Africa and Asia were never touched by them, and for correspondence to and from a great part of the world the only means of transport was the private ship. The post office for a long period made only a feeble attempt to secure control of this means of communication. It is true that as early as 1660 it was provided that letters brought by private ships should be handed over to the post office, and in 1711 it was enacted that fees should be paid to the captains for all letters handed over; but during the whole of the 18th century letters were accepted for private conveyance without regard to the technical monopoly of the post office, and shipowners and the proprietors of coffee-houses openly kept bags for the acceptance of letters for abroad. The post office attempted in 1799 to incorporate the ship letter system into the ordinary postal service and to insist that all letters for private ships should pass through the post office, suitable gratuities being paid to the master for their conveyance. But the measures taken were not effective, and as late as 1827 certain coffee-houses were still collecting letters in defiance of the law.

The general improvement in the postal service, and in particular the effective measures taken to establish regular mail services by private ships whenever such a course was advantageous, gradually abolished the incentive to forward letters by other means than by the post office; but by an odd survival of old practice the law still expressly permits any person to send his letters by private ship without thereby infringing the monopoly of the postmaster general.

AIR MAILS

The history of air mails in Great Britain begins in 1911, when to celebrate the coronation of King George V. an air mail service was run between Hendon and Windsor. Twenty-one trips were performed and a considerable number of picture postcards, etc., carried; but the service was very irregular and did not hold out much promise of the development which came a few years later.

The enormous development of aviation during the war inevitably caused the question of air mails to come up again for serious consideration. After the armistice an experimental service which was run between Folkestone and Cologne for the benefit of the Army of Occupation clearly demonstrated the possibilities of this means of transport; and after some negotiation between the French and British post offices a regular service between London and Paris was established in Nov. 1919. The time-table was so arranged as to admit of a letter posted in London in the morning being delivered in the afternoon in Paris, and vice versa. The letters were considered as being more analogous to telegrams than to letters, and a fee of 2s.6d. per oz. was charged in addition to the postage. Little traffic, however, was attracted; and in a few months the fee was reduced to 2d. per oz., which of course sent up materially the volume of the air mail. The establishment of *a* service to Paris was followed in 1920 by the establishment of air mails to Brussels and to Amsterdam, and in 1922 by the setting up of an air parcel post between London and Paris.

The next few years were remarkable for a considerable extension of air services all over Europe, and also in Asia and America. The most extensive service now in operation is that run by the United States post office. Starting from modest beginnings it has developed until it now includes a Government-operated trans-continental service, running continuously night and day, between New York and San Francisco, and a considerable number of other services in various parts of the country which are run under contract with the post office. The installation for the trans-continental service, with its system of continuous beacons and landing grounds, is the most complete in the world, and the service is in other respects in a unique position, as climatic conditions are unusually favourable, and the districts linked up by air are wealthy and populous. From the point of view of traffic this is the most successful air service in the world.

In 1921 an Air Mail Service was established between Egypt and 'Iraq by means of regular service flights undertaken by machines of the Royal Air Force, but in 1927 ~~ transferred to Imperial Airways. The saving of time effected was very great, as the short transit of 850 miles across the Desert cut out the long sea journey from Egypt to Bombay and from Bombay to the Persian Gulf. In March 1929, however, this service was superseded by a through Air Mail between London and Karachi by way of Italy, Greece, Egypt and 'Iraq. This is the longest regular through Air Service in existence, and the time occupied from London to Karachi is 7½ days as compared with 14½ by ordinary mail from London to Bombay. The London-Karachi service will in the immediate future be extended by the creation of air services in and across India under the auspices of the Indian Government. Another recent development of considerable postal value is the French service to Brazil and the Argentine via Morocco and Dakar.

The experience of air mail services since 1919 has been sufficient to enable certain definite conclusions to be drawn. In the first place, for short distances, such as London–Paris or London–Amsterdam, the existing means of communication are so good that the amount of traffic attracted to an air mail is and must remain exceedingly small. When, however, the services cover greater distances and the high speed of the aeroplane can thus offer a definite and tangible advantage, the possibilities of attracting traffic are considerably greater; if and when the difficulties of night flying are successfully overcome, and it is possible for letters posted in the evening in London to be delivered next morning in Berlin, Vienna, Milan, Berne, or Copenhagen, the European air mail will offer advantages which it will be impossible to ignore. In the second place, the air mail will, so far as can be foreseen, remain definitely as a luxury service. The capacity of aeroplanes, and even of the largest airship at present in contemplation, is only adequate to convey a fraction of the mails available; and the cost of air transport is very substantially in excess of that of transit by railway and steamship.

The importance of air mails from the international standpoint was recognized at an early stage by the postal administrations of the world, and provision was made to include them in the general Postal Convention signed at Madrid in 1920. The relative provisions were amplified at the later congress of Stockholm in 1924; but their rapid development has resulted in the calling of a special International Air Mail Conference in 1927, at which a definite code of regulations to be applied between the signatories was devised as a preliminary step to an expansion of the provisions of the Postal Convention. Considerable progress was made in the direction of standardizing rates of air postage, and of unifying practice generally. It is worthy of remark that in accordance with postal tradition, complete liberty of transit is established for air mails; *i.e.*, every country which establishes an air mail gives to every other country the fullest facilities for despatching its own mails by it, on the payment of certain definite and uniform charges. The result is that the latest developments in aviation are placed at the disposal of the public of all countries, and new air lines, wherever established, are available without restriction for the development of international communication.

THE BRITISH POST OFFICE AS BANKER

Savings Bank.—The idea of establishing a savings bank for the benefit of those who were not in a position to use the ordinary banking system, and of administering it through the post office, appears to have originated with Whitbread in 1807; but the project came to nothing, and was dormant for half a century until it was successfully revived by Sykes of Huddersfield, whose efforts were supported by W. E. Gladstone, then chancellor of the exchequer, and by Sir Rowland Hill. The necessary legislation was passed in 1861 and the Post Office Savings Bank came into existence in the same year. The object was to encourage thrift among the poorer classes, and deposits were therefore limited to £30 in one year or £150 in all. Deposits were handed over to the National Debt Commissioners and interest was allowed on complete pounds at the rate of £2.10s.od. per cent. All accounting was centralized in London; but any depositor might pay in or withdraw money at any office in the country at which savings bank business was transacted. To make a withdrawal, notice had to be sent to headquarters and an authority to pay was issued to the office named by the depositor.

The main outlines of the system have not been changed; but a number of detailed improvements, in the interest of depositors, have been made from time to time. In particular, the limits of deposits have gradually been raised, and £500 may now be deposited in one year, while the maximum limit has been entirely abolished. In cases of urgency money may be withdrawn at once by telegram; while any sum up to £2 may be withdrawn on demand at any office, nearly half the total number of withdrawals being effected by the latter method. The saving of small sums is encouraged by the use of "home safes," by slips to which postage stamps may be affixed, etc. The establishment of the savings bank was an immediate success, and its growth in popularity has been a proof of the foresight of its founders. In the years 1863–1868 the average number of accounts was 663,000 and the total of deposits £7,000,000; the number of savings bank offices was 3,390. In 1927 the number of accounts was over 12,000,000—one to every fourth person of the whole population—and the amount standing to the credit of depositors £283,000,000. The number of savings bank offices exceeds 14,000.

Two years after the establishment of the post office savings bank the Government passed a further act establishing a life insurance and annuity system to be run by the post office. At that time certain private insurance companies were in a doubtful financial position, and it was anticipated that a Government scheme would have a wide appeal. Though remodelled 20 years after its establishment and linked up with the machinery of the savings bank, annuity and insurance business has never exceeded a very modest total, in spite of frequent attempts to popularize it by advertisements and other propaganda. The canvassing and the direct collection of premiums which are an essential part of the procedure of the private insurance company have never been considered suitable for adoption by the State; and the doubts as to the stability of the private companies which prompted the establishment of the Government scheme have long disappeared.

A much more successful development was instituted in 1880 when facilities were given to depositors in the savings bank to purchase Government stock, up to a limit of £300. A very simple method of purchase was devised, at a low rate of commission, and dividends were credited to the purchaser's savings bank account as they fell due. In 1914 stock of the nominal value of £26,000,000 stood to the credit of post office depositors; and the machinery thus ready to hand proved of the greatest value to the Government in their appeal to all classes of the population to finance the war. In 1915, when the 4½% war loan was issued, a special post office register, managed by the post office savings bank, was formed and in subsequent loans the same procedure was followed. The post office investor now has his choice of some twenty different Government securities, and dividends are no longer restricted to payments into a savings bank account, but can be paid in cash or through a bank at the investor's option. The number of investors on the post office registers is now about 2,500,000, the nominal value of the stocks held is £190,000,000, and the annual interest payments amount to over £7,700,000.

A further simple and popular method of investment offered by the post office is the National Savings Certificate (originally known as the War Savings Certificate). This was a further outcome of the war effort to attract the savings of all classes and has successfully maintained itself since the war. The nominal value of a certificate is £1, or certain multiples of £1; the purchase price, however, is considerably less, and though there is no separate payment of interest the certificate increases in value annually up to the maximum and is repayable at any time with accumulated interest. As the interest is free from income tax it is necessary to impose a certain restriction on the issue, and the number of certificates which may be purchased by any individual is limited to 500. The terms of issue have varied from time to time, and become gradually more favourable to the exchequer; at the present time (1928) the purchase price of the £1 certificate is 16s., and the maximum value, £1. 4s., is reached in 10 years. Owing mainly to the activities of the National Savings Committee and the local Savings Associations, the investments in Savings Certificates have been on a far larger scale than those in the post office issues of war loan. In the first ten years over £598,000,000 was invested, the nominal value thus represented being nearly £766,000,000, of which £372,000,000 still remains invested. The number of investors is about eight millions, or three times the number of stockholders in the savings bank.

Money Orders.—The original establishment of the money order service was due to the desire of the postmasters general at the end of the 18th century to devise some method of preventing the frequent theft of money letters in the post. There was some doubt whether such a service could be established by the post office under its existing powers, so by a curious compromise certain officers of the London post office were allowed to set up a service on their own account, the cost of advertising it being borne by the postmaster general, who also allowed the relative advices to pass free of postage under the post office frank. The maximum value of a single order was fixed at five guineas and the commission at 6d., subsequently raised to 8d., in the pound. As the letter containing the order was a "double" letter under the regulations and thus liable to double postage the money order service was by no means cheap and the amount of business was at first not considerable. After being carried on as a private venture, with varying degrees of profit and loss to its managers, for nearly 50 years, and after being definitely condemned by a parliamentary committee, the money order service was in 1838 taken over by the Government. The rates of commission were gradually reduced, and the maximum amount of an order increased to £10. In 1871 the commission was fixed as low as 1d. on orders of 10s.; but this was unremunerative and the service began to show a substantial loss. Since 1871 a number of further modifications have been made; the maximum for a single order was raised in 1904 to f40, at which it still stands; and the raies of commission, which were raised during the war to cover increasing costs, now vary from 4d. on an order not exceeding £3 to 1s. on an order of from £30 to £40. Notwithstanding the competition of the cheaper postal order (*see* below) the money order still appeals to a large number of remitters who value the security afforded by the special feature of the money order service—the advice note which is sent to the office of payment and against which the order is checked before payment. In the year 1926–27 the number of inland money orders was 12,000,000, and the total amount remitted £71,000,000. The telegraph money order service, under which remittances may be telegraphed to any telegraph office at which money order business is transacted, on payment of the telegraph charges and a special fee, came into operation in 1889. The service is utilized to a considerable extent, as in the years 1926–27 785,000 telegraph money orders were sent to a total value of £4,000,000.

The foreign money order service, though advocated by Rowland Hill in 1843, only came into being in 1856, when arrangements were made to send home money from the British army in the East by means of money orders issued by the army post office. The system was extended the same year to Malta and Gibraltar, and in 1859 to Canada. Two years later it was decided to include all the 'colonies and by degrees the service came to include every foreign country of importance. At the present time there is practically no part of the world, in which an inland money order service is in operation, to which money cannot be remitted, either directly or indirectly, through the post office. The telegraph money order in the international service dates only from 1898 and it is not yet universal.

The financial chaos which followed the war and the rapid fluctuations of currencies led to considerable difficulties in maintaining a money order service with foreign countries and in many cases it was necessary to suspend it temporarily. The gradua! stabilization of the last few years has, however, generally permitted of its resumption and the extent of the service is now practically the same as it was before the war. The most recent statistics show that the annual number of imperial and foreign money orders is 2,880,000, representing about £9,500,000.

Postal Orders.—The comparatively high cost of the money order, if it was to cover its expenses, led the post office to consider the possibility of introducing a new method of remittance, which would dispense with the most costly feature of the money order service, the advice, and thus be available at a lower rate of commission and give less trouble to the remitter. The objections to the creation of what might be considered a paper currency for small amounts were for some time thought to be insurmountable; but finally in 1881 the postal order (originally styled postal note) was issued. Orders are issued for certain fixed denominations up to a maximum of 21s.; they can be made payable to a particular person and at a particular office, and can be crossed for payment through a bank. Their period of validity is limited to three months from the last day of the month of issue.

The simplicity, convenience and cheapness of the postal order made it an immediate success. In the first two years the number grew from 4,500,000 to 33,000,000, of the value of £13,500,000; and at the present time the number sold annually has reached the total of 142,000,000, representing remittances of £45,500,000.

The great convenience of the postal order led soon to a proposal to extend its use throughout the empire; and in 1903 the whole of the colonies and dependencies were invited to adhere to a scheme for making the postal order available for remittances not only to and from Great Britain, but between one part of the empire and another. The proposal was generally adopted; and with the exception of Australia, which for financial reasons has felt unable to adhere to it, and the partial exception of Canada, which pays but does not issue the orders, practically the whole British empire, comprising some 60 separate postal administrations, uses the postal order for its small remittances. The number of orders issued in the empire outside Great Britain is about 6,500,000 a year, of a total value of £3,760,000.

THE BRITISH POST OFFICE AND SOCIAL SERVICES

One of the most striking developments of post office activities in the last generation has been its gradual assumption of functions which have no connection whatever with its primary purpose, but have been imposed upon it because its far reaching organization has presented the only means of carrying out with reasonable economy certain social services which the State has from time to time established. This development began many years ago in the utilization of the post office for the collection of revenue in the form of licence duties, the proceeds of which are now handed over to local taxation. Dog, gun and game licences, for example, excise licences, and motor vehicle licences are obtainable from the post office, some £3,500,000 a year being thus collected.

This, however, was a comparatively small item of business. A more serious innovation was made when the Old Age Pensions Act of 1908 came into operation. It was necessary to devise some means by which pensioners could obtain payment of their pensions with the minimum of trouble and inconvenience to themselves and of cost to the State, and the obvious course was to fall back on the post office. The pensioner is provided with a bound book of orders, similar to postal orders, which show the date of payment and the amount of the pension; this is presented at the post office by him, or by his agent in case of illness, and the paid orders are retained by the post office as vouchers. The original act has been gradually modified, and the Widows', Orphans' and Old Age Contributory Pensions Act of 1925, which came into full operation in Jan. 1928, substantially enlarged the scope of pensions business. Nearly 2,000,000 pensioners are now included in the scheme. In addition to old age pensions, war pensions to the number of over 1,100,000 and the amount of £54,500,000 annually are paid by the post office. The machinery is generally similar to that employed for the old age pension.

The use of stamps, which was a part of Rowland Hill's scheme for cheap postage, has been extended in many ways never dreamed of when they were first introduced. Certain small inland revenue duties may be paid by postage stamps; but in addition the post office has long assisted the inland revenue authorities by selling such inland revenue and fee stamps and forms as are in general use; more recently income tax and entertainment duty stamps have been added. The great development, however, came with the establishment of State insurance schemes under the legislation of the early 20th century. The payment of contributions by means of adhesive stamps affixed to the relevant forms was an integral part of the new schemes, and the post office was again called in to help as being the only agency which could do what was required. The amounts of the weekly or quarterly contributions, however, are very varied, and the denominations of stamps required for National Health and Pensions Insurance and for Unemployment Insurance considerably exceed those required for purely postal business. The functions of the post office are, of course, limited to the sale of the stamps, etc., required under the insurance schemes; but the addition to both complexity and volume of its business has been considerable; the annual value of insurance stamps sold is nearly £70,000,000.

Of the convenience and economy of the system of carrying out schemes of social reform through the instrumentality of the post office there can be no doubt; but whether the system is capable of indefinite extension without interfering with the proper discharge of the functions for which the post office was intended may perhaps be questioned. Each addition to the complexity of the business—which has of course to be done not only at the large and specialized post offices in towns, but in the small village post office—increases the difficulty of securing a satisfactory standard of efficiency; and if the scope of social legislation develops in the next few years at the same rate as during the last ten or fifteen, questions of considerable difficulty may obviously arise.

Miscellaneous Services.—In addition to the general postal service placed at the disposal of the public a certain number of special facilities may be obtained by those who wish to have a more rapid or convenient method of delivery. The most important is the express delivery, which was established in 1891. There are several varieties of express delivery, the most useful perhaps of which is that by which a letter or packet may, at any time at which messengers are on duty, be despatched by special messenger to its destination on payment of a small mileage fee. This is the only postal service which is not limited to inanimate objects; dogs may be taken by the messenger, and any other live animal if enclosed in a suitable receptacle; and a stranger may use the express service to have himself conducted to his destination. A iurther service provides for the delivery, immediately on arrival, of letters or parcels received by the ordinary mail, at the request of the sender; and the same facility is given at the request of an addressee who is expecting an important letter. The number of express services performed is about 2,000,000 annually.

When a quicker transmission is desired than that afforded by ordinary mail, letters may be taken to any station and forwarded, on payment of a small railway fee in addition to the postage, by the next train to the place of destination and either kept at the station to be called for or posted in the nearest letter box. This may be combined with the express service in various ways; *e.g.*, a post office express messenger can be summoned to meet the train and convey the letter at once to its destination.

When a regular early delivery of correspondence is desired any firm or person may rent a private box at the post office, from which he or his messenger may obtain his letters and parcels on application. If, again, his postings are on so considerable a scale that the application of postage stamps becomes inconvenient and expensive, he may on certain conditions arrange to pay the postage in cash; and large users of the post may also have their correspondence or parcels collected from their premises by the post office.

Another method of avoiding the use of postage stamps is the employment of postal franking machines, which are now licensed by the post office. These machines impress the correspondence with a red franking stamp which is accepted as the equivalent of a postage stamp. Each machine is provided with a meter, which is set from time to time at the post office, postage being prepaid in cash on the number of impressions which the meter is set to register.

THE BRITISH ARMY POST OFFICE

The history of the British army post office goes back to the Napoleonic wars; and post office records contain a vivid account of the experiences of a postal official who was despatched in 1792 to supervise the postal arrangements for the British troops then in Holland. A post office staff was also sent out in 1854 to conduct the postal business of the troops in Turkey and the Crimea; but an army post office on modern lines was first established in the Egyptian campaign in 1882, and was continued and developed in the South African War.

In the reorganization of the army after the South African War the War Office adopted the sound principle of having a definite military unit (technically known as the Royal Engineers, postal section, special reserve) recruited entirely from the staff of the post office and destined to apply to conditions in the field the expert knowledge they possessed of postal organization. This unit is kept in constant touch with active service conditions, so far as possible, by carrying on the postal service for the troops on manoeuvres; and thus a trained force of some 300 men was at once available at the outbreak of war and was despatched with the British Expeditionary Force. The great expansion of the army however called for continuous increases in the personnel, and by the end of the war the strength overseas numbered nearly four thousand. Each new expedition took out its postal complement and the Dardanelles, Egypt and Palestine, Salonica, East Africa, Italy and North Russia were in turn provided with a complete army postal service.

At the outset all mails were sent in bulk to the overseas base post office, and there sorted for the various units in the field. This system was however soon abandoned, and the home depot of the army postal service, originally intended mainly for the provision of recruits for the overseas establishments, gradually developed into a large central sorting office for all the Expeditionary Forces. A system was built up under which the home depot made up a separate mail for every unit, down to the smallest, in all the overseas armies wherever they were stationed. Full and detailed information was received either from the War Office or from the army post offices overseas as to the location of each unit; each bag of the many thousands made up was suitably labelled with a code denoting the field or other post office to which it was to be forwarded; and the result was a service of remarkable expedition and completeness.

The volume of the mail handled by the army post office was enormous, and when it was at its maximum some 12,000,000 letters and a million parcels a week were sent out. In the later stages a substantial number of parcels for prisoners of war in Allied hands was forwarded through the home depot from Germany; and the whole of this traffic rose at Christmas to a level which it taxed the whole resources of the service, both in personnel and in transport, to handle successfully. The effect on the morale of the troops at the front of being in such close and constant communication with their families at home must be left to military historians to estimate. For the work at home it gradually became impossible to provide sufficient men, and at a fairly early stage recourse was had to the services of women, of whom about 1,200 were employed in London alone. Their work proved to be successful beyond all expectations; they combined genuine enthusiasm with remarkable aptitude for postal work.

The staff problem, however, was not the only one which the army post office had to meet. For traffic on so large a scale there was no adequate accommodation on post office premises; and a temporary building covering five acres was put up in Regent's park to house the parcel work alone. Even this proved scarcely sufficient and a system of decentralization was set up by which certain large provincial post offices acted as subsidiary army sorting offices and thereby relieved the London offices of a substantial part of the work. The organization of the postal system was carried out by the militarized personnel of the civil post office; its successful execution depended entirely on the provision of adequate transport. In this respect unstinted assistance was given by both naval and military authorities. A daily service was provided across the Channel to France; for more distant theatres ships of every kind which could convey mails carried their full complement; and on land the organization of both railway and road transport almost reached the level of an efficient postal service in times of peace.

THE INTERNATIONAL POSTAL SERVICE

The importance of the international service is evident from the earliest days of post office history; but the working of the service is somewhat obscure. In the 16th century, a regular service seems to have been provided between London and Calais, which was the port on which foreign communications mainly centred. The outward letters seem to have been carried to their destination by English post office messengers, while inward letters were brought by foreign messengers as far as Calais. Many of these couriers appear to have paid but scant attention to their duties, for early in the 17th century the delay in the arrival of important foreign mails was put down to the fact that the messengers minded "their own peddling traffic more than the service of the State or the merchants," and were often found "lying in tippling houses."

Witherings, as mentioned above, reorganized the foreign service; and shortly after his time (1670) a regular postal treaty was concluded between England and France. This was renewed in 1698 after the conclusion of the Peace of Ryswick. The treaty provided that the mail from London for Paris and from Paris for London was to leave twice a week, and was to be conveyed throughout with the utmost possible speed. Between Dover and Calais the English Post Office provided the mail packets in both directions; the service beyond Calais was provided by France. Letters could only be prepaid to a limited number of destinations — Paris, Rouen or Lyons; any charges for further transmission were collected from the addressee. In view apparently of the longer distances provided for by the French post office a fixed annual payment of 36,000 livres, to cover everything except these additional charges, was made by England.

This treaty, soon interrupted by further hostilities, was again renewed in 1713. The new version is interesting as containing the germ of the international system of accounting for transit mails which lasted with but slight alteration until the latter part of the 19th century. On letters for Italy, which could be franked to Turin, France was to be paid at the rate of 21 sols per single letter; on letters for Spain franked to Bayonne the payment was 19 sols, on letters for Turkey franked to Marseilles, 17 sols. Double letters were charged approximately twice, and letters weighing one ounce four times the single rate. The accounting between the two offices was based on the sum of the amounts due on the separate letters, mail by mail. The principles adopted in the 17th century show little change in the 18th, and a treaty concluded with France in 1802 shows comparatively little variation from its predecessors of over a century before.

As time went on the postal treaties required for the establishment of a gradually expanding foreign service became more and more numerous. The effect on the public of their varying and complicated provisions can in these days of simplicity scarcely be imagined; but until well into the second half of the 19th century they presented a bewildering complexity, which made it impossible for any one but an expert to be certain that the rate of postage to a particular destination was correct and that the postal regulations had been complied with. The postage depended on the sums payable to the various post offices concerned in the transit of the letters, and these were often based on their own internal rates and units of weight. The result was an extraordinary variety of rates — often differing materially for the same destination according to the route employed — and a considerable variety in the weight covered by the initial postage rate. Moreover, prepayment was in some cases compulsory, in some cases optional; but compulsory prepayment only covered conveyance up to a certain point, all charges beyond that point being collected from the addressee. The unit of weight was in a large number of cases $ o~., any letter above that weight being charged "pro rata." The lowest postage in force was that to France, which was 4d. per $\frac{1}{4}$ oz. A letter from England to Belgrade via France, weighing one ounce, cost 5s.; a half ounce letter to California via Panama cost 4s. 8d., in addition to a further charge on delivery. Even to Spain the postage was 2s. 2d. per half ounce plus a charge on delivery.

Articles other than letters were not encouraged. There was practically no case in which a newspaper could be prepaid to its destination; books were usually liable to the prohibitive letter rate, as were periodicals other than registered newspapers. For printed papers other than books, newspapers and periodicals no special rates were in force.

From the point of view of post office management also, the complexity of the service was, with the industrial development of the 19th century and the constant growth of correspondence, reaching a point at which the rapid and accurate handling of the mails became wellnigh impossible. Before a mail could be despatched it had to be classified into perhaps a dozen distinct divisions. Each section had to be separately weighed and full details entered on an elaborate waybill in accordance with the particular method of accounting in force with the country concerned. On the arrival of a mail the details given by the country of origin had to be checked and a form of receipt on the lines of the original waybill completed and returned. Almost the only advance made over the procedure in force in the 17th century was that letters were weighed in bulk instead of singly. With this procedure there was naturally considerable delay both in making up the outward mails and in releasing the inward letters for delivery. The example of a simple and uniform tariff had been set by the establishment of penny postage; but the principle which underlay Hill's scheme for obtaining uniformity, viz., that the cost of conveyance of a letter represented only a small fraction of the total cost of its treatment, was far from being applicable to the conditions of the international post.

Formation of the Postal Union. — The first step in the direction of reform was taken by the United States, which in 1862 suggested a conference for the purpose of considering the improvement and simplification of international postal relations. This met in Paris in 1863 and adopted a code of 31 articles, intended to serve as the basis of international conventions. Further progress was delayed first by the American Civil War and then by the Franco-German War. In the meantime, however, another great postal reformer, Dr. von Stephan, of the North German Postal Confederation, had devoted himself to the question of developing and expanding the somewhat meagre results of the conference of 1863, and had prepared a project for a universal postal union, based in part on the conclusions of the conference and in part on the experience of Germany, which had some years before formed a postal union including Prussia, Austria and the whole of the other German States, nearly 20 in number. The Swiss Government, at the instance of Germany, summoned a conference to meet at Berne to consider the proposal to form a general postal union.

The Congress of Berne met in September 1874 and was attended by the representatives of 22 States, including the whole of Europe, the United States and Egypt. The result of the Congress was the signature of the first International Postal Convention, which has remained from 1875 to the present time, with comparatively little modification, the foundation of the international postal service.

The fundamental principle of the union is contained in a striking article which lays down that for the purposes of postal communication the whole of the signatory countries form one single territory. The practical application of this principle lies in the doctrine of liberty of transit; every member of the union binds itself to transmit the mails entrusted to it by every other member by the best means of communication which it employs for its own letters. Thus each country has in effect the full and unrestricted use of the railway and steamship services of the whole world, and any improvement made by any member of the union is placed at the disposal of any other which desires to utilize it.

The membership of the union was at first somewhat limited, and was mainly European, although from the first the United States, Asiatic Russia and Asiatic Turkey, were included. Extensions of membership, were, however rapid. Ten years after its foundation the union included 86 postal administrations; by 1900 there were 113, and the process has steadily continued. China (1914) was the last large country to adhere; Russia fell out for a time after the revolution, but subsequently adhered anew; and at the present time there is hardly any part of the world which still remains outside. As an indication of the range of the postal service, it is of interest to note that the countries which are members of the union are responsible at the time of writing (1928) for the delivery of some forty thousand million letters a year.

The Postal Union Organization.—The organization of the union is simple, but effective. Most questions are naturally settled directly between the countries immediately concerned; but for matters in which the whole union is concerned a central office or international bureau is maintained at Berne. The bureau collects and distributes information of common interest, publishes statistical returns, a monthly journal, lists of steamship and air services, etc., and acts if required as a clearing house for the settlement of accounts. The cost of the bureau is apportioned in a ratio corresponding to their importance between the various members of the union; the annual cost in the case of an office paying the maximum quota is some £350 a year; whilst a small state pays the modest subscription of about £15.

The Postal Convention and the subordinate agreements are reviewed periodically, usually at intervals of five or six years, by a congress to which every member is invited to send delegates. Each country submits in advance any proposals which it may have to offer on any article in the agreements, and these are debated first by a special committee and afterwards by the whole congress in plenary session, all questions being decided by a simple majority. The voting system gives every metropolitan country one vote irrespective of its size or importance. The British dominions and India are considered as metropolitan countries; but votes are only allotted to colonies and dependencies by special vote of the congress, the number being subject to revision on each occasion. In cases of dispute between postal administrations the union has adopted the principle of compulsory arbitration. Serious disputes are infrequent, but when they occur the arbitration machinery has invariably been effective.

The principles adopted by the first congress in 1874, which for the first time introduced order and uniformity into the international service, were simple and well conceived.

Four Chief Principles.—The first was the uniformity of postage rates and of units of weight. The congress of Berne adopted the rate of 25 centimes per 15 grammes for letters, but permitted a certain variation within a definite maximum and minimum, and the rate of 7 centimes, with a similar variation, per 50 grammes of printed papers. In 1878, however, standard uniform rates of 25 centimes for a letter, 10 centimes for a postcard, and 5 centimes per 50 grammes for printed papers, were adopted and were retained unaltered until 1920. The only variation allowed was the addition of a surtax in cases where heavy costs for sea transport were incurred. The conditions which followed the war swept away the uniformity which had prevailed for 40 years and brought about a reversion to the original principle of a maximum and a minimum rate. At the most recent congress (1924) the old rates were reaffirmed, and the limits of variation reduced—a process which will no doubt continue until the old stability and uniformity are re-established. The only change in the units of weight has been the raising of the letter unit from 15 to 20 grammes, or to an ounce for English speaking countries.

The second basic principle is the classification of postal correspondence into three groups—letters, postcards, and printed papers (including commercial papers and samples). Definite conditions of acceptance, as well as separate rates of postage, were adopted; the delicate distinctions between what can be sent at the cheap rate and what must be charged as a letter, which are often puzzling to the public, depend on international decisions which no individual country is in a position to vary.

The third principle was the adoption of definite payments to be made by the country which despatches mails by the trains or steamships of another country for the use of those services, with the exception that no payment is made to the country of destination, the flow of correspondence in each direction being assumed to be approximately equal. Here there has been no continuity of practice. Rates for sea services in particular were at the outset extremely high; in some cases as much as 25 francs a kilogramme (representing about 2½d. a letter) was charged. The gradual cheapening of the cost of sea transport has been reflected at successive Congresses in the reduction of the scale of sea rates, while a similar though smaller reduction has been made in land rates; at the present an equitable scale is in force which varies in accordance with fixed zones of distance, and represents the lowest point which transit rates have reached in the history of the foreign post.

The fourth principle was the universal adoption of a system of registration and compensation. International registration differs from internal registration in one important particular, which often puzzles and annoys the sender of a letter. The compensation payable is a fixed amount (50 francs or £2) and is allowed only in the event of the entire loss of the registered packet and not for damage or loss of contents. This principle the union has steadily maintained from its inception.

Later Changes.—The original convention applied only to letter mails; but from an early date supplementary agreements were adopted at successive congresses for various extensions of the postal service.

In 1878 an agreement for an international money order service was signed by a considerable number of countries; and at the same time an insurance service, which provided for payment of compensation for loss or damage of letters containing documents of value (paper money, etc.) was established. This was later extended to cover insured boxes containing valuables such as gold or jewellery. The amount insured varies with the fee paid, and the maximum varies in different countries. The highest value for which a letter or box can be insured as 10,000 francs or £400.

A further considerable advance was made in 1880, when 19 countries concluded a parcel post agreement. The original agreement was limited to parcels not exceeding three kilogrammes; it prescribed a simple procedure and fixed rates of payment both for terminal and for transit countries. The scope of the service has expanded considerably since 1880. Over 70 post offices now take part in the service; it has been extended to include parcels up to 10 kg. (22 lb.); and it now provides both for an insurance and a cash-on-delivery service. The agreements above mentioned are not adopted universally throughout the union; for example, neither Great Britain nor the United States have adhered to the parcel post and money order agreements; but where separate agreements have to be concluded, they generally follow with only slight variations the principles sanctioned by the union.

From time to time other agreements, of minor importance, have been concluded between various members of the union for the extension to international traffic of certain functions performed by the post office in the internal service. These are the agreements relating to *"recouvrements"* (collection of bills, payment of coupons, etc., through the post) *"abonnements"* (collection of subscriptions to newspapers and their delivery at specially low rates) and postal cheques. The latter provides for the transfer of money between postal cheque accounts in different countries, as a supplement to the ordinary money order service.

Imperial Penny Postage.—The reduction of postage rates which followed on the establishment of the Postal Union was considerable, and it was many years before the rate to distant places was brought down to the standard level. For instance, as late as 1890 the rate on a letter to Australia or New Zealand was 6d., to India 5d., and to South Africa 4d. By degrees, however, the idea of establishing preferential postage rates on political grounds began to develop; and a decision of the postal congress of Washington in 1897 that the Postal Union Convention permitted the establishment of rates below the standard postage, coinciding with the growth of imperial sentiment in the British empire, led to the summoning of a conference to consider the possibility of imperial penny postage. The result was that in 1899 the rate of 1d. per half ounce was established to Canada, India, South Africa and the Crown Colonies generally; it was extended to New Zealand in

1901 and to Australia in 1905. A few years later (1908) the United States were included in the scheme. Throughout the various changes in letter postage brought about by the war the principle of maintaining the initial imperial letter rate at the same point as the initial Inland rate has been uniformly observed. The adoption of preferential rates has not been limited to the British empire, and a number of "restricted unions" have been established. For example, the French internal rates are applicable to all the French Colonies: Germany has reduced rates to Austria, Czechoslovakia and Hungary: and the United States has low letter and newspaper rates to Canada.

The most interesting experiment in this direction is the formation of the Pan-American Postal Union, founded at Madrid in 1920 and developed at the congress of Mexico in 1926. To this the Latin American States, the United States and Spain are parties. The main provisions of the Pan-American Convention are that the maximum rates to be charged between one member and another are the inland rates of the country of origin, and that each member conveys the transit mails of any other member free of charge. The development of this union, and the effect of its policy both on postal traffic and on the finances of the countries concerned will furnish an interesting study in postal history.

BRITISH POSTAL STAFF

The enormous expansion of post office business since 1840 has naturally resulted in a corresponding increase in the number of the staff, and brought with it its full complement of the problems which arise in modern conditions in regard to the relations between the employer and the employee.

In the 17th and 18th centuries the number of employees was insignificant; in 1763, for example, the secretary's office—the G.H.Q. of the service, which to-day has a staff of nearly 900—employed 4 clerks. At the time of the introduction of penny postage the total staff numbered 10,000, a number which of course soon increased with the growth of business. In 15 years it had more than doubled; by 1870 it had reached nearly 30,000; and the later expansion of the field of post office activities by such new developments as the telegraph service, the parcel post and the telephone service caused an even more rapid development. By 1885 the staff numbered over 90,000; twenty years later it had risen to 190,000; and in 1914 the total was 227,000, the post office being by that time the largest employer of labour in the country. At the present time, in spite of the separation of the Irish Free State, the staff still numbers 229,000.

The principal questions which arise are of course those common to all employers of labour on a large scale—the methods of appointment, the fixing of pay and conditions of employment, and the relations with the staff organizations. The majority of the post office staff consist of "established" persons, *i.e.,* employees enjoying the usual civil service conditions of permanence of employment and pension on retirement. The clerical branches are mainly staffed by the classes common to all the departments of the civil service; but employees in the "manipulative" grades in the post office have a certain proportion of clerical posts reserved for competition among themselves. Manipulative grades are generally recruited in one of two ways. Postmen are recruited to the extent of at least 50% from ex-service men; with this exception the normal entry is through the class of boy messengers, who are given facilities for continuing their education, and at the age of 16 enter for a limited competition, their future career as sorter, telegraphist, postman, or engineering workman, depending on their success in the examination.

The post office staff includes over 50,000 women, employed in various grades—clerks, writing assistants, counter clerks, telegraphists, telephonists, sorting assistants, typists, etc. The method of recruitment varies according to the work on which they are employed.

The rates of pay and conditions of service have undergone a long succession of modifications, as the result of enquiries which have been instituted periodically, through the medium of departmental committees, committees of employers of labour, etc., and select committees of the House of Commons. At the present time the established machinery is to refer all claims which cannot be settled by negotiation to the industrial court, which has been entrusted by the Government with the duty of dealing with the claims of state employees, and whose awards the Government undertakes to carry out, subject to the overriding authority of Parliament. The result of successive revisions, which have in turn benefited practically every class of the post office service, has been to place the present day employee in regard to pay, hours of duty and general conditions, in a situation which is conspicuously superior to that which prevailed a generation ago.

British Postal Trade Unions — The difficulties which Trade Unionism in outside employments has had to meet have been reflected in the history of the post office staff. Throughout the latter part of the 19th century the attempts of the staff to organize themselves for the purpose of collective representation met with but little encouragement; and discontent went so far as to produce a sporadic strike of telegraphists in 1871 and a partial strike of postmen in 1890. It was not until 1899 that the duke of Norfolk consented to receive representations from the Postmen's Federation or from any similar body; and in 1906 Sydney Buxton (now Lord Buxton) agreed to recognize any duly constituted association of post office servants and to allow the associations to employ officials outside the postal service.

The result of this recognition was the formation of a large number of associations, as owing to the variety of the work undertaken by the post office the number of grades into which the service is organized is very numerous. Of late years there has been a marked tendency to amalgamation among the various unions; but even at the present time, after all the reductions thus brought about, there are no fewer than 42 separate associations officially recognized, with an aggregate membership of 154,000.

The principal associations and their membership were in 1928 as follows:

Title	Approximate membership
Union of Post Office Workers	90,000
Post Office Engineering Union . . .	21,100
National Federation of Sub-postmasters . .	11,100
Civil Service Clerical Association . . .	5,000
Controlling Officers' Association . . .	4,400
Guild of Postal Sorters	3,400
Association of Executive officers, etc. . .	2,400
Association of Post Office Women Clerks . .	1,400
Society of Post Office Engineering Inspectors	1,200
Association of Counter Clerks and Telegraphists	660

Of late years the relations of the administration of the post office and the staff have entered on a new phase by reason of the establishment of Whitley councils in 1920. Apart from the consideration of general questions common to the post office and the rest of the civil service, which is undertaken by the national Whitley council, the post office has its own departmental councils, which meet periodically at headquarters for the discussion of questions affecting the general conditions of service. The departmental council does its most effective work by the appointment of joint committees for the purpose of considering questions which are too complicated to be discussed adequately by a large council meeting, the recommendations, if agreed by both sides, being then submitted to the departmental council for confirmation.

All matters of purely local interest are handled by the local Whitley committees, of which one exists in each head post office, and also in each sub-department of the post office. These meet much more frequently than those held at headquarters, and generally speaking they have worked with marked smoothness. The staff takes considerable interest in the discussions; disagreements are comparatively infrequent; and the substitution of personal discussion for prolonged correspondence which has resulted from the Whitley scheme has been a distinct improvement in organization. By the Trade Union Act of 1927 the post office union have been forced to sever their connection with the Trades Union Congress.

BIBLIOGRAPHY.—R. Hill, *Post Office Reform, its importance and practicability* (London, 1837); *Report of Secret Committee on the*

Post Office (1844); Lewins, *Her Majesty's Mails* (1864); Norway, *History of the Post Office Packet Service'* (1895); Joyce, *History of the Post Office* (1893); Hemmeon, *History of the British Post Office* (Cambridge, Mass., 1912); *Annual Reports* of the Postmaster General (1854–1915); Parliamentary *Reports* on the Post Office, passim; Swift, *A History of Postal Agitation* (1900); *L'Union Postale Universelle, sa fondation et son développement* (Berne, 1924); Annual *"Rapports de gestion"* of International Bureau and *"Statistiques générales"* of the Postal Union (Berne); Postal Union Convention (1924); Convention of the Pan-American Postal Union (Mexico, 1926), *Handwörterbuch des Postwesens* (Berlin, 1927); Sir G. E. P. Murray, *The Post Office* (1927); *The Post Office, an Historical Summary* (London, 1911).
(F. H. W.)

UNITED STATES POSTAL SERVICE

Early Colonial Period.—As between the villages of the same colony, special messengers were employed to carry mail, but between colonies, letters were entrusted to merchants and travellers. A proposal to the English Government to establish a post office in America was made in 1638, but the first formal step toward such an establishment was made by the General Court of Massachusetts in 1639. Provision for postal service was made in other colonies considerably later. The first advance toward an organized intercolonial service was made by the granting of a patent to Thomas Neale on Feb. 17, 1692, to establish post offices in North America. An office was established at Philadelphia and rates fixed to most of the colonies. Receipts did not cover expenses.

In 1707 the Government purchased the rights. The service grew and improved with the development of the colonies. Benjamin Franklin became deputy postmaster in 1737 and postmaster general in 1753. Under his administration and with the improvements in service it showed a substantial surplus. A packet line was established direct from England to New York in 1755 and from Falmouth to Charleston in 1768. In the approaching crisis between the colonies and the mother country, Franklin was dismissed from office in 1; 74. The service continued until taken over by the second Continental Congress.

The Continental Post.—The establishment and maintenance of postal facilities was given early attention by the Continental Congress in 1775. The establishment of a post office and the appointment of a postmaster general with office at Philadelphia was provided for. Franklin was chosen the first postmaster general. Because of the special conditions existing the Continental post office was not able to operate at a profit. A provision in the Articles of Confederation gave to Congress the sole and exclusive right to establish and regulate post offices from one State to another throughout the United States and exact such postage on papers passing throughout the same as might be necessary to pay expenses of the office.

Under the Constitution.—A distinctly new era began with the adoption of the Constitution. The postal grant in that instrument gave to Congress much wider powers. Under the express and implied powers of this brief provision a vast and most important public service has been established and developed. Post offices were established as rapidly as possible, speedy transportation of mails provided and service extended unifying the distant parts of the country.

In 1789 there were only 75 post offices; in 1928 there were 49,944. In 1790 there were only 1,875 m. of post routes; in 1928 there were 1,776,396.

Policies.—The policy in colonial times was to make a profit out of the postal business. In 1791 the post office was annexed to the Treasury department. By 1796 it was felt that the post office should become a pioneer of civilization and the means to rapid and regular communication between remote posts and the Government.

In 1823 the post office became in fact and later in law, a separate department as distinguished from a subordinate branch of the Treasury. The present policy is that the department should render good service to the public consistent with due regard for cost, and in doing so it is not necessary for the service to be always self-sustaining. Deficits have not been unusual in the history of the service. In 1927 the operating deficit was $28,914,716.05, which, however, was only 4·06% of the total cost of the service.

Post Offices.—Post offices are established in every city, town and village in the country, for the receipt and delivery of mail matter and the performance of such special services as may be provided appropriate to their size and importance. These offices, with each a postmaster, are of four classes. Postmasters of the first three classes are appointed by the President with the advice and consent of the Senate and those of the fourth class by the postmaster general. There are 1,154 first class, 3,472 second class, 11,065 third class and 34,253 fourth class offices. There are employed in offices of the first and second classes 129,074, not including postmasters, rural carriers and motor service employees.

Transportation.—The earliest methods of transportation were by horseback riders, stage-coaches and steamboats. The advent of railroads in 1834 marked the beginning of a vast change in mail transportation. In 1838 Congress declared railroads which were or might be completed post roads. The great extent of this development is shown by the fact that in 1927 mails were carried over 226,965 m. of railroad. In 1927 there were 6,350,589,586 lb. of mail transported by all methods most of which was by railroads

The earliest use of the aeroplane for carrying mails was under occasional authorizations to postmasters to dispatch mails by planes in connection with fairs and other exhibitions. In 1918 Congress having made an appropriation, an air mail route was established between New York and Washington by way of Philadelphia. In 1919 the service was established between New York and Cleveland and in 1920 the transcontinental route, New York to San Francisco, was put into operation. This provided a schedule of 32 hours and 30 minutes west-bound and 29 hours east-bound. The first through day and night service was started July 1, 1924. The department established and maintained the Government-owned air mail service over the transcontinental route until its practicability was demonstrated and then released the line to contractors for its operation. There are (1928) 20 contract air mail routes with a total mileage of 10,932 m. each way. Direct contract air mail connection is made between 98 of the more important cities in the United States. During the fiscal year 1928 there were 1,861,800 lb. of mail carried by air mail; 5,585,224 m. of service were actually flown.

Experimental transportation of the mails by 6-inch pneumatic tubes underground was inaugurated in Philadelphia in 1893. The present system consists of 26.99 m. of double lines of 8-inch tubes in New York and Brooklyn and 1·6 m. of double tubes in Boston. The larger percentage of the letters passing through the postal points connected by the system are transmitted through the tubes.

Special Services.—With a vast organization touching every locality and equipment at its disposal for postal purposes, the postal establishment has taken on various activities that can be assimilated with the general service and best performed for the public by that means. Among the principal ones are the following: A uniform system of registration for mail matter was established in 1855 to insure the greater security of valuable letters. The system has been applied to the first, second and third classes of mail matter and extended to the foreign as well as domestic mails. Domestic third and fourth class matter may be sent collect-on-delivery on the payment of a special fee; that is, the price of the article and the charges thereon will be collected from the addressee. This service was inaugurated in 1913. The money order system was established in 1864. Under this system a patron may for a specific fee purchase a domestic money order in stipulated amounts not exceeding $100. This may be paid within a limited time at any money order post office. Under separate conventions with foreign countries an exchange of money orders is provided for. This was inaugurated first with Switzerland in 1869 and Great Britain in 1871. The Parcel Post Act (1912) created markets for merchandise throughout the entire country.

Prior to 1913 fourth-class matter constituted only about 5% of the total weight of the mails. Under the new system parcel post has grown to be 60·5% in weight of the mails.

For special fees a service of "special handling" is given fourth-class matter and special delivery is given all classes of mail.

The postal savings system was inaugurated in 1911 and provides for the deposit of savings at interest with the security of the United States Government for repayment on demand. Simple interest at the rate of 2% per annum is paid. At the end of the fiscal year 1928 postal savings deposits were received at 6,679 depositories and there was remaining to the credit of depositors the sum of $151,000,000.

Mail Distribution.—The distribution of the mails for ultimate delivery, including their preparation for dispatch en route, is handled in the post offices and in the railway mail service. The post offices distribute mails for local delivery locally deposited and those received from the railway mail service. Mails for dispatch by transportation means are distributed to railway post office and air lines according to prescribed schedules.

With the carriage of the mails on the railroads a system was developed in connection therewith of handling important mails en *route* by the employment of route agents. Their duties included the assortment of the mails for the several offices and the delivery and reception of mail bags. All classes of mail are handled in accordance with their importance to the public but letters and daily newspapers are given preferred attention.

At the close of the fiscal year 1928 there were in operation 4,661 railway post office trains covering 204,974 m. of railroads; there were 13,340 closed pouch trains and 14,092 regular and acting railway postal clerks working in these railway post offices.

Delivery.—The employment of letter carriers at such offices as the postmaster general should direct for the delivery of letters upon the payment by the addressee of a fee of two cents on each letter delivered, was authorized in 1794. The delivery of newspapers under like conditions on payment of a half-cent each was authorized in 1827. What was known as a "Penny Post" was in successful operation in several of the principal cities before 1859 but was unsatisfactory because of the competition of the "private expresses." This competition was ultimately disposed of under the prohibition of the Federal Statute. Free delivery in cities as distinguished from this service was inaugurated in 1863 under the Act of that year and the service in its present form was established at nine of the largest post offices. The service has had a great growth and is maintained at 2,899 cities and employs 51,293 carriers. Village delivery service was established at certain second and third class offices in 1912 and has had a substantial development. At the present time it is in operation in 705 villages. Rural free delivery, a service by carriers to the rural inhabitants, was inaugurated as an experimental service in 1896. At the end of the fiscal year 1928 there were 44,168 rural carriers, serving approximately 7,141,792 families or 24,282,092 individuals on 44,288 rural routes. Approximately 17% of all mail originating in the country is ultimately delivered to the patrons on these routes. Service is generally daily, except Sunday.

Mail Matter.—The Act of 1792, the first after the adoption of the Constitution, recognized letters, packets and newspapers as mail matter. Magazines and pamphlets were recognized in 1799 and unbound journals of the several States in 1825. Lithographed circulars, handbills or advertisements and every other kind or description of printed or other matter were recognized as mailable in 1845. In 1851 bound books were made mailable. In 1852 the limit of weight on books was 4 pounds. In 1861 maps, engravings, photographic prints, photographic paper, letter envelopes, cards, blanks, seeds and cuttings were made mailable and the weight limit was fixed at four pounds and the Act of 1863 excepted books circulated by order of Congress from the weight limit. Mail matter was classified in 1863 and again in 1872 into three classes. The postal card was authorized in the latter year. Mail matter was again reclassified in 1879 in four classes, namely, first class, written matter; second class, periodical publications; third class, miscellaneous printed matter; and fourth class, merchandise and matter consisting of that which is not included in the other classes not in form or nature liable to injure the contents of the mail bag or harm those engaged in the postal service, and not exceeding four pounds in weight for each package. By the Parcel Post Act of Aug. 24, 1912, the scope of fourth class matter was enlarged. Congress has vested in the Post Office department a monopoly in the conveyance of letters, but this monopoly does not extend to any other class of mail matter.

During the fiscal year 1927 the number of pieces of all mail originating by classes was as follows:

	Pieces
Domestic	
First class	16,283,564,220
Second class:	
Transient	36,556,627
All other second class:	
Exempt from zone rates	649,746,746
Newspapers, dailies	2,029,942,376
Newspapers, other than dailies	923,843,450
All other publications	1,113,201,806
Total, except transient	4,716,734,378
Total, all second class	4,753,291,005
Third class	4,061,604,835
Fourth class (parcel post)	742,589,397
Penalty matter	438,590,586
Franked matter	50,487,129
Free-for-the-blind	111,949
Totaldomestic	26,330,239,121
Foreign	
Outgoing (originating):	
Miscellaneous	299,783,200
Publishers' second class	56,533,408
Total foreign	356,316,608
Grand total, all mail matter	26,686,555,729

Revenues.—The use of postage stamps was inaugurated in 1847 and it is from this source that the revenues of the service are derived mainly. From all sources they amounted to $683,121,988.66 for the fiscal year 1927. The expenses of the service are paid from the revenues and if these are insufficient the remainder is paid from the U.S. Treasury. The audited expenditures for the fiscal year 1927 were $714,577,491.79.

International Postal Service—Postage rates on international mails are regulated by the Universal Postal Convention and for the Pan American countries by the Pan American Postal Convention, to each of which the United States subscribes. Parcel post exchanges are made under separate conventions negotiated with other countries, excepting Pan American, in which case the United States subscribes to the General Parcel Post Convention.

Dead Letter Office.—Letters or parcels which cannot be delivered, from defect of address or other cause, are sent to the Division of dead letters and dead parcel post. They are carefully examined on both front and back for the name and address of the sender; if these are found, they are returned to the sender. If the sender's address is lacking, they are kept for a period, after which dead letters are destroyed, while dead parcels are sold at auction.

Staff.—The Postal Department is administered by the postmaster general, who is a member of the President's cabinet. He is assisted by four assistant postmasters general, an executive assistant, a solicitor, a comptroller, a chief inspector, a purchasing agent, and a chief clerk, in the department at Washington, under whom deputy assistants and directors and superintendents of divisions supervise the work and the clerical forces. A special assistant to the attorney general, for the post office department, in charge of matters before the Interstate Commerce Commission involving railroad mail pay, is also a part of the staff. In the field service the postmasters are in charge of the post offices and their services, including the rural delivery service. The railway mail service is supervised by the general superintendent at Washington and 15 division superintendents and their assistants and 121 chief clerks. The inspection service is supervised by the chief inspector at Washington and 15 inspectors-in-charge of divisions-

BIBLIOGRAPHY.—*American State Papers—Post Office, 1789–1833; Journal Kept by Hugh Finley, Surveyor of Post Roads on the Continent of North America, 1773–1774* (1867); Mary E. Woolley, *The Early History of the Colonial Post-Ofice* (1894); W. E. Rich, *History of the United States Post Office to the year 1829* (1924);

Fiscal year 1927	Revenues	Expenditures	Loss	Gain
1	2	3	4	5
Classes of mail:				
First class	$345,284,235.14	$262,109,805.75	..	$83,174,429.39
Second class	34,984,799 98	119,007,502.65	$84,022,702.67	..
Third class	68,594,245 32	72,909,513.56	4,315,268.24	..
Fourth class	141,399,300.84	145,878,886 60	4,479,585.76	..
Foreign	17,600,526.24	21,373,305.55	3,772,779.31	..
Penalty	..	6,263,620.66	6,263,620.66	..
Franked	..	520,691.23	520,691.23	..
Free for the blind	..	31,974.48	31,974.48	..
Total mail	607,863,107.52	628,095,300.48	20,232,192.96	..
Special services:				
Registry	12,038,365 53	20,557,170.37	8,518,804.84	..
Insurance	9,315,298 67	11,247,626.52	1,932,327.85	..
C.O.D.	6,302,334.93	9,204,658.79	2,902,323.86	..
Special delivery	9,955,833.55	10,020,307.04	64,473.49	..
Money order	17,073,618 56	25,646,950.23	8,573,331.67	..
Postal savings	1,533,904.14	931,693.21	..	602,210.93
Total special services	56,219,355.38	77,608,406.16	21,389,050.78	..
Total mail and special services	664,082,46290	705,703,706.64	41,621,243.74	..
Unassignable	17,592,223.24	5,072,152.32	..	12,520,070.92
Total related	681,674,68614	710,775,858.96	29,101,172.82	..
Unrelated	1,636,862 04	2,121,271.12	484,409.08	..
Grand total.	683,311,548.18	712,897,130.08	29,585,581.90	..

Letter Books of the Postmaster General. mss. in Post Office Department; J. D. Richardson, *Messages and Papers of the Presidents* (1896–1925); *Statutes at Large of the United States; Postal Laws and Regulations* (1825 *seq.*); Lindsay Rogers, *The Postal Power of Congress* (1916); and *Annual Reports* of the Postmaster General.

(H. S. N.)

POSTAL SERVICE OF THE BRITISH EMPIRE

In the early days of Colonial expansion the postal services established overseas were in theory and to a large extent in practice under the direct control of the Postmaster General of Great Britain. Reasons of practical convenience and the development of autonomy in the Dominions and Colonies, gradually led to the establishment of independent postal services. At the present time the British Empire comprises some 55 distinct postal administrations each responsible solely to its own Government.

Canada. — The Canadian Post Office, before the Declaration of Independence, was combined with that of the other North American Colonies, and after the separation it continued to be administered by the Post Office of Great Britain. In spite of the obvious difficulties of effective control, it was not until 1851 that it was abandoned and separate autonomous services were established in the different provinces, to be replaced by a centralized Post Office on the foundation of the Dominion in 1867. Canada in December 1928 restored the 2 cent rate on letters exchanged within the Empire which had been in abeyance since the War.

Canada has an extensive internal Money Order Service with a turnover of some $370,000,000 a year, and a considerable Savings Bank business; the Parcel Post is a relatively recent service, having been established only in 1914. A still later development is the Cash on Delivery service established in 1922.

Australia. — The history of the Australian Post Office goes back to 1810, when the first Post Office was opened in Sydney. Each State developed on its own lines, though joint action was, of course, essential in some matters of common interest. The State services were developed on the general lines of the English Postal service.

Regular sea communication with Great Britain was established in 1846, the overland route being utilized in 1850, while a regular sea service with the American Continent dates back to 1866. The high cost of transport in relation to general costs is evident from the statistics of expenditure, as no less than 28% of the total postal budget represents expenditure on the conveyance of mails. The volume of traffic is considerable; the total number of postal packets of all kinds delivered, in the last year for which statistics have been published was 1,139,000,000 or nearly 180 per head of the population. The newspaper rate is fixed at the low rate of 1d. per 10 oz.; and an unusual feature of the postal service is a specially low rate of postage for books printed in Australia, which are conveyed at one-half the rate applicable to other books; the same principle is applied also to magazines and periodicals. The aggregate length of the air routes is 3,487 miles and further considerable developments are in contemplation; the rates are moderate and the traffic is steadily increasing.

South Africa. — A regular postal service was established in South Africa immediately after the British occupation of the Cape in 1806. Regular communication was established between Cape Town and important centres by Hottentot postboys. The foot messengers were later replaced by horsed Post Orderlies; but it was not until a comparatively recent period that the development of railways made rapid local communication possible on an extensive scale.

The various States of South Africa maintained their separate Post Offices until the formation of the Union in 1910, when a centralized Postal Administration was established.

The inland letter rate is 1d. per oz., and the postcard rate ½d. For parcels of 1 lb. and over the rate is 6d. per lb.; but South Africa has introduced the interesting experiment of an agricultural parcel post, the rates on which vary from 3d. for 1½ lb. to 1s./– for 11 lb. The agricultural post includes fruit, grain, tea, poultry, meat, etc., but perishable or semi-perishable products such as butter, eggs and lard are excluded. Some 650,000 parcels annually are sent out by this service. A Cash on Delivery service has recently been introduced and though still small is increasing at a rapid rate.

The total volume of postal traffic for 1928 amounts to 309,000,000 articles of all kinds, or 40 per head of the population. The Post Office shows a small margin of profit.

South Africa, alone among the Dominions, is responsible for the whole of her sea communication with Great Britain in both directions; she also maintains the only Sea Post Office which still operates between Great Britain and any part of the Empire.

New Zealand. — The New Zealand Post Office is a comparatively modern growth, as it was not till 1854 that the first Postmaster General was appointed. In 1901 she advanced the idea of Universal Penny Postage, which was actually submitted to, though not adopted by, the Postal Union Congress of Rome in 1906. New Zealand, however, adopted Penny Postage not only within the Empire but also with every Foreign country which would accept it, even on a unilateral basis; and when she re-established the Imperial penny postage in 1923, the same measure was also extended to a number of foreign countries.

In 1905 she sanctioned the use of postal franking machines instead of postage stamps, and succeeded in 1920 in obtaining the general adoption of such machines by the Postal Union generally. In 1908 she established postal services by motor, and in 1909 introduced automatic stamp-selling machines.

The Postal business is heavy in relation to the number of the population. The number of articles of all kinds delivered in 1928 was over 244,000,000, or 181 per head.

India. — A postal service was first established in India by Clive in 1766; but it was mainly intended for official correspondence, and this principle was followed for many years during the gradual extension of British rule in India. It was not until 1837 that it was considered to be sufficiently developed to warrant the establishment of a monopoly in favour of the official post.

The Indian Post Office is governed by legislation based mainly on the English model. The area to be served is immense, and the cost of transport relatively heavy; moreover the policy of uniform rates irrespective of distance, adopted in England in 1840, was accepted in India as early as 1854, and the aim of the Government has been to fix the rates at as low a point as possible, the Post Office never having been expected to make any considerable profit. Moreover, although the population is very large, the letter-writing element is not very considerable. Although the number of letters delivered annually is about 1,300,000,000, this represents an average of only 4 letters per head per annum. Post Office work has, however, in recent years shown a steady and considerable increase, the volume having doubled in a period of about 20 years. At the present time the inland letter postage is 1 anna (1d.), the postcard rate $\frac{1}{2}$ anna, and the newspaper charge for a weight of 8 tolas (3$ oz.) is only $\frac{1}{4}$ anna. A considerable parcel post service is maintained at comparatively low rates, a parcel of 20 tolas (12 oz.) being conveyed for any distance for the low charge of 2 annas (2d.).

A Money Order Service with an annual turnover of nearly go crores of rupees (about £67,000,000) is maintained, and the value payable (Cash on Delivery) post, which has been established in India for over 50 years, is also highly developed, the annual value being over 27 crores of rupees (about £20,000,000).

POSTAL SERVICES IN OTHER COUNTRIES

France. — The establishment of a State post in France goes back to 1464, though its early history is very obscure. Improvements were made from time to time in organization, *e.g.,* by Richelieu in 1627 and Mazarin in 1643; but the system of farming, which was tried in England for a short time in the 17th century, persisted in France till the Revolution, when it was swept away and a Committee appointed to manage the postal service. Napoleon in 1804 replaced the Committee by a single Director General; and his organization has remained in general outline unchanged. Of recent years, however, the Post Office has rarely been entrusted to an independent Minister; it has usually been attached to another Ministry — Treasury, Public Works or Commerce and Industry; and its immediate chief is sometimes an under-secretary of State, sometimes a secretary-general drawn from the permanent Civil Service.

The financial conditions since the war have made the stabilization of postage rates a matter of. some difficulty; but they are now, generally speaking, fixed on the pre-war basis, having regard to the altered value of the franc. The inland letter rate begins at 50 c. (1d.) per 20 grammes; but the rate on heavy letters is relatively low; and on a letter weighing 1,500 grammes (about $3\frac{1}{2}$ lb.), the maximum weight, the charge is only 5 fr. 20, or about $10\frac{1}{2}$d. The domestic letter rates apply to the whole of the French Colonies.

The lowest postage rate is that applied to newspapers. Newspapers which have been "routed" by the publishers are accepted at the rate of $\frac{1}{2}$ centime ($\frac{1}{100}$ d.) for delivery in the department of publication and neighbouring departments or 1 centime ($\frac{1}{50}$ d.) for the whole of France and the Colonies.

At the present rates, however, the Postal service shows a considerable annual profit; in 1927 the balance of the "compte d'exploitation" amounted to nearly 300,000,000 francs.

The parcel post (colis postaux) though nominally a postal service, is operated by the Railway Companies. There is a particularly low rate (1 f. 25 for 5 kilos, or $2\frac{1}{2}$d. per 11 lb.) for the local service in Paris; and the rates for the whole of France are moderate.

One of the most recent undertakings of the French Post Office is the postal cheque system, which of late years has developed rapidly and is now a recognized feature of French finance. According to recent statistics there are about 370,000 depositors, and the annual sum paid in to postal cheque accounts is about 161,000,000,000 francs.

Germany. — Since the formation of the North German Postal Union, developed later into the Post Office of the German Empire, Germany has taken a prominent part in postal development. For the year 1927–28, the letter traffic amounted to 7,687,000,000 articles, in addition to which 309,000,000 parcels and over 2,000,000,000 newspapers and periodicals were handled in the post, the total number of postal packets thus reaching the total of 164 per head of the population. The Post Office conducts also a Money Order service with a turnover of 3,677,000,000 marks a year, an extensive Cash on Delivery service with a turnover only slightly less, and a Postal cheque service with 922,000 accounts.

The Reichspostfinanzgesetz (Imperial Post Office Finance Act) of 1924 changed the constitution of the Post Office and the service was separated from the general financial organisation and established on an independent basis analogous to that of a commercial company. The Post Office can now no longer look to the Treasury to recoup any losses.

The Administration is in the hands of a Minister, who is an Imperial official paid from Imperial funds and is responsible to Parliament for the general results of the service. The Minister is assisted by an Administrative Council of 41 members representative of the Reichstag, the Reichsrat, the Ministry of Finance, the staff of the Post Office, and of commercial interests.

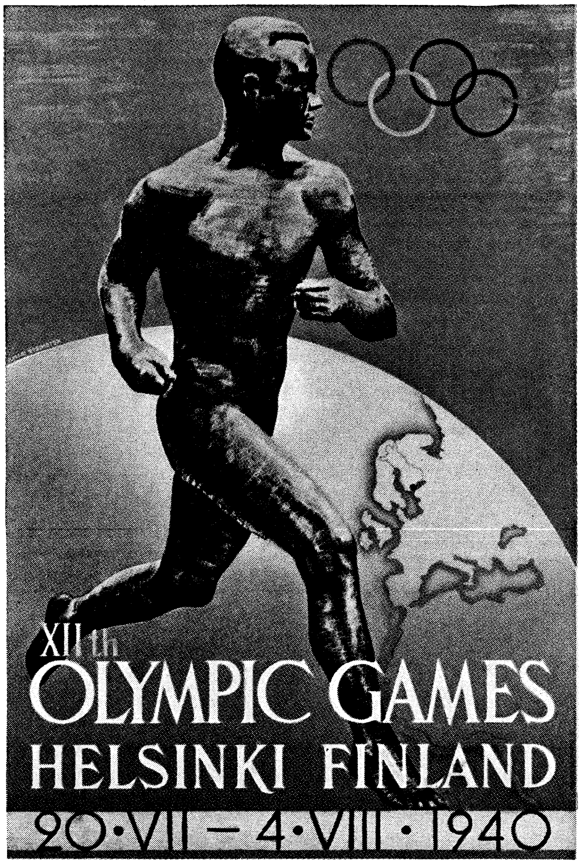
The Minister is required to consult the Council, but the decisions of the latter are not necessarily binding. It cannot increase the estimates of expenditure presented to it by the Minister without his concurrence, and the latter may also refer to the Government for decision any resolution which he judges to be inexpedient.

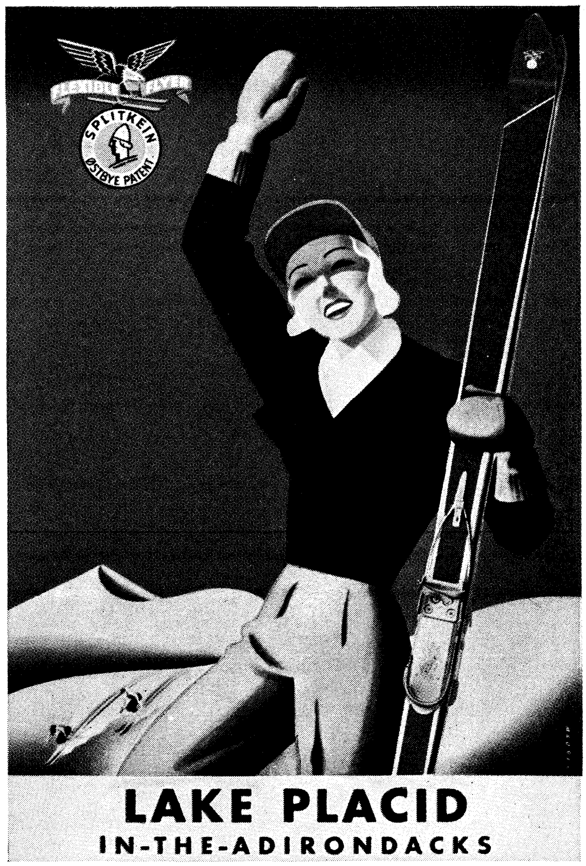
The actual powers of the Post Office Administration are, however, very considerable. For example, it fixes the estimates of expenditure, decides on all questions of borrowing for post office purposes, of redemption of debt and of the investment of the Postal Cheque Office balances, settles the rates of pay of certain classes of Post Office employees, determines whether new classes of business are to be undertaken, and, what is most important from the public point of view, fixes rates of postage and telegraph and telephone charges.

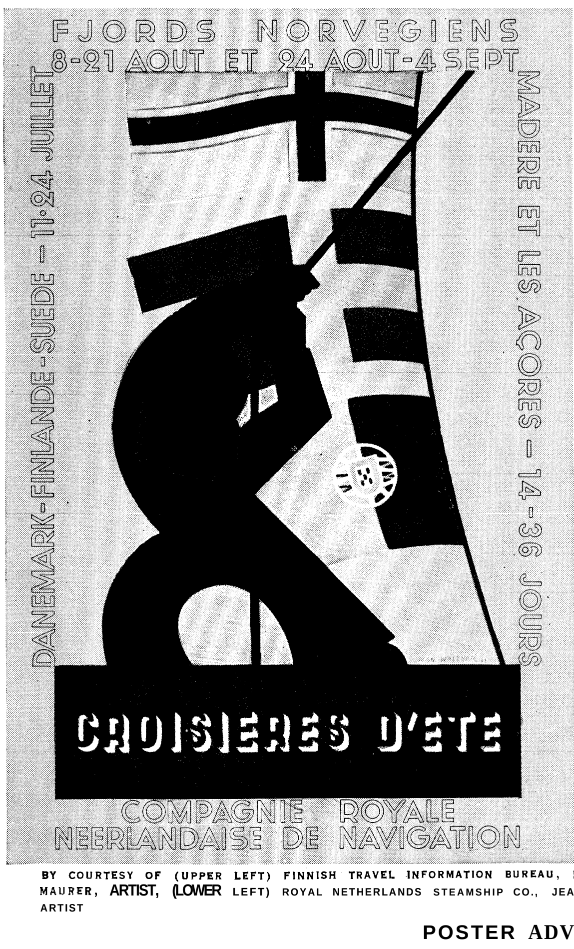
The result of this organization is a close attention to the financial results of the undertaking. While questions of organisation and administrative economies are carefully studied, the question of rates is kept under constant observation; and when it was found that the maintenance of the old rate of 10 pf. (1d.) for the letter post could not be justified, the Administration in August 1927 raised the rate by 50% (to 15 pf.) and carried out corresponding alterations in other postal rates. The postal traffic for 1927–28, however, showed an appreciable increase over the previous year, and the contribution of the Post Office to the Exchequer was 70,000,000 marks (£3,500,000) for the year.

(F. H. W.)

POSTER. A poster is a printed, written or illustrated announcement publicly exhibited.. Its usual function is to call attention to goods or service; but, to fulfil that object completely, it has not merely to arouse attention; it must provoke interest and create a desire for purchase. However attractive pictorially or textually a modern poster may be, commerce, the chief patron of poster art, finally judges a design by its value as a link in the chain of salesmanship.







BY COURTESY OF (UPPER LEFT) FINNISH TRAVEL INFORMATION BUREAU, ILMARI SYSTIMETSÄ, ARTIST, (UPPER RIGHT) S. L. ALLEN CO. AND SASCHA MAURER, ARTIST, (LOWER LEFT) ROYAL NETHERLANDS STEAMSHIP CO., JEAN WALTHER, ARTIST, (LOWER RIGHT) MEXICAN TOURIST ASSOCIATION, C. URELÁ, ARTIST

POSTER ADVERTISEMENTS

Four examples of poster design, illustrating the adaptation of art and colour printing to the uses of publicity

The poster is seldom given entire responsibility for influencing the public; rather is it regarded as a form of "reminder" advertising—an ally of the press advertisement, the creator of a favourable atmosphere. The average "commercial" poster is intended to influence two groups—the retailer, who, it is hoped will stock the advertiser's goods, and the public who will purchase them. Posters have a very wide range of duties to perform in addition to selling goods. They deliver every kind of message, to every type of "audience," in an infinite variety of styles. Actually, the poster or placard can trace its ancestry back almost to the dawn of civilization.

History.—Egyptian wall-paintings, mural decorations and inscriptions, produced over 3,000 years B.C., have been discovered by archaeologists, much of this work, together with that of the early-Babylonian, Assyrian, Greek and Roman craftsmen, displaying a precision of line and a decorative beauty which are the envy and despair of the modern poster-designer. Tablets of wood, papyrus and parchment were also used, in ancient Egypt, Greece or Rome, for the purpose of issuing announcements, while it is the lettering of the Trajan column which has inspired the finest types of poster lettering of to-day.

Later Developments.—In later days, the sign-board was adopted as a form of advertisement, the hanging sign being a picturesque feature of mediaeval architecture throughout Europe. Written handbills were an additional means of enabling the shopkeeper to bring his goods and service to the notice of the public, and vast possibilities were suddenly presented to him by the invention of printing, by Gutenberg, before 1450, and by its introduction into England by Caxton in 1476.

The first letterpress poster soon made its appearance in England; and shortly afterwards, in France, a royal proclamation was issued in poster form. During the 17th century, the general use of posters was forbidden, but in time their value to the community was recognized, official restrictions were removed, and the first pictorial posters made their appearance. These were illustrated by wood-cuts Pedlars and packmen, hucksters and showmen, strolling players and proprietors of booths, also used handbills and miniature posters, decorated by wood-cuts; and these simple, primitive illustrations have formed part of the artistic inspiration of the leading poster designers of to-day.

The wood-cut was, however, destined to be superseded by lithography (*q.v.*) as a medium for the designing and printing of posters. Invented in 1796, and developed for printing purposes by Senefelder, the new art of drawing and engraving on stone, metal plates and "transfer" papers, opened up possibilities almost as vast as those which followed the invention of the printing press.

The first lithographed posters are interesting as historical curiosities only, the earlier wood-cuts possessing infinitely more character. Lithography was seized upon as a means of producing a more elaborate, "highiy-finished" form of illustration, and it is to France that we have to turn for the earliest lithographed posters of quality.

The modem poster began with Jules Chéret, a Frenchman, born in Paris in 1836, self taught as a draughtsman. He served his apprenticeship as a lithographer in England, and when 30 years old became interested in announcements of theatrical managers and placards put out about that time urging recruiting for armies. In 1867 the world saw the first modern poster of Chéret's, an announcement of a play enacted by a young woman, then 22 years old, who was to make her name immortal—Sarah Bernhardt. The poster announced a fairy play, entitled: La Biche *au Bois.*

The first Chéret posters, with their filmy female figures seemingly floating in space and flaming colours, excited interest, held attention, and caused favourable comment. Orders for Chéret's posters came from music halls, dealers in cigarettes, drinks, toilet articles, newspapers, circuses, charity fêtes, and the streets were gladdened with merrily dancing figures. Chéret designed more than 1,000 posters, the best of which can be found in books devoted to the art.

The poster spread from France to Germany. Later it travelled across the Pyrenees to Spain, and from France to Switzerland, and over the Alps into Italy, from France to Belgium, and across the English channel to England, across the North sea to Holland, and from Germany it found its way to Austria-Hungary, the poster invasion finally reaching Russia and travelling across the Baltic sea to Norway and Sweden. From the British Isles and the Continent of Europe, the poster went to the United States, and later to Canada, thence to Australia.

In England the first to attract attention by his posters was Frederick Walker, who in 1871 made a poster for the dramatized version of The *Woman* in White. Members of the Royal academy were attracted to the newly discovered medium, and Sir John Millais exhibited "Bubbles," advertising a soap. This poster pleased England immensely. Then followed Aubrey Beardsley, with his weird posters, Walter Crane, R. Anning Bell, the "Beggarstaff Brothers" (James Pryde and William Nicholson), J. W. Simpson, Gordon Craig, Dudley Hardy, Maurice Greiffenhagen, J. Hassall, Will Owen and others.

In Germany Ludwig Hohlwein won not only a national, but an international reputation, and books of his posters are sold throughout Europe and America; his posters are so compelling that he is regarded as a master of his craft. Other German poster artists whose work reached the highest standards include Otto Fischer, Sattler, Speyer, T. T. Heine, Max Klinger, Dasio, Hofmann, Franz Stiick and L. Zumbrusch.

Leon Bakst, the Russian genius, and H. Cassiers, Belgian, have done much to bring renown to their native lands by their posters of distinction. Japan's greatest poster artist is Toyókuni.

The poster, as it is known to-day, did not exist in the United States previous to 1889, except for the theatrical and circus posters made by Matt Morgan. Posters began in the United States in the 'gos, when Louis Rhead and Will H. Bradley began to produce their decorative placards. These were used principally for the announcements of magazines and the books of publishers. Later business and commerce saw the great value of poster advertising, and enlisted the services of Maxfield Parrish, Ethel Reed, Will Carqueville, J. J. Gould, Howard Chandler Christy, J. C. Leyendecker, Frank Hazenpflug, James Montgomery Flagg, Charles Dana Gibson, and others.

On the poster panels of to-day, in the United States, may be seen the work of Harrison Fisher, Linn Ball, G. C. Beall, Norman Rockwell, Fred Stanley, William Oberhardt, Fred Mizen, Clarence F. Underwood, Karl Johnson, F. Nelson Abbott, Arthur von Frankenberg, John E. Sheridan, Harry Morse Mayers, Hadon Sundblum, John O. Brubaker, Charles E. Chambers, McClelland Barclay, Lucille P Marsh and other noted artists.

With the outbreak of the World War posters took on a new significance in all nations actively engaged in the struggle. In countries where there was not conscription, posters were most effectively used to stimulate recruiting. Before conscription in England (during the first stages of the war), more than 2,500,000 posters were posted in the British Isles alone to get men to enlist, the posters representing the work of about 100 artists. Taking a lesson from Great Britain, the Governments of the countries actively engaged in the war spoke to their nationals through the medium of the poster, appealing to the civilian population in behalf of subscriptions to the war loans, the conservation of food, aid for the organizations engaged in war work, such as hospitals, milk funds, destitute dependents, the Red Cross, the Y.M.C.A. and other activities that war entails.

Brangwyn and Spencer Pryse produced work for Britain and Belgium which was full of dignity and nobility. In France, Steinlen, Faivre, Willette, Poulbot and Fouqueray appealed to the patriotism of their countrymen. In Germany the belief in force and might was hammered into pictures by Engelhard, Louis Oppenheim, Puchinger, Otto Leonard and Wohlfeld. Austria's actions were justified or defended and her causes championed by Krafter, Arpellus, Buo and Kurthy.

Standards.—In the half century or more since the poster became a popular means of outdoor publicity, women have been predominant in many of the posters displayed. The irresistible charm of childhood illumines many posters. Birds and animals are also favourites with poster designers. But whatever is pictured on a poster, this courier of commerce must have these important features: it must be new and interesting, have attention-value, simplicity of design, brevity of text, good composition, pleasing colours, and "selling power"—the latter usually achieved through expression of a basic link of interest between the product and the public.

Great strides have been made in the development of the poster as an organized advertising medium. Modern business in America has discarded the old-fashioned and unkempt "billboard," and posters of various sizes are no longer made. Due to the Outdoor Advertising Association of America, there has come the standard structure in two sizes surrounded by a green moulding as a frame for the poster. These standard panels are found in over 16,000 cities and towns in the United States. Many of these structures are illuminated.

In Great Britain, hoardings, though not standardized, have greatly improved in character and design, under the influence of the British Poster Advertising Association. In Germany a poster hoarding is practically unknown, the design being shown on special advertising kiosks or pillars. France uses both kiosks and hoardings. *(See* PAINTING; ADVERTISING.)

BIBLIOGRAPHY.—C. M. Price, *Posters* (1913), *Poster Designs* (1922); H. C. Duce, *Poster Advertising* (1912); P. V. Bradshaw, *Art in Advertising* (1925); Alexander, Spielman, Bunner and Jaccaci, *The Modern Poster* (1895); P. Pollard, *Posters in Miniature* (1897); J. Pennell, *Liberty Loan Poster* (1918), an essay on the poster. Books containing examples of the work of distinguished poster artists include: Prof. H. K. Frenzel, *Ludwig Hohlwein* (1926); H. Furst, *Frank Brangwyn* (1924); J. Klinger, Cosl-Frey and Willrab, *Poster Art in Vienna* (1923); E. McKnight Kauffer, *The Art of the Poster* (1925). *The Poster*, the national magazine of outdoor advertising and poster art, is issued monthly in Chicago by the Outdoor Advertising Association of America.
(A. STD.; P. V. B.)

POSTE RESTANTE, a facility, generally provided at post offices, for the receipt and care of postal packets addressed to be called for. There are usually strict regulations to prevent abuse or fraud. In the United Kingdom, it is stipulated that the words "to be called for" or "Poste Restante" should appear in the address, and it is notified that the facility is intended solely for the accommodation of strangers and travellers, and that even they may not use it for more than three months. Postal packets addressed to initials, or to fictitious names, or to a Christian name without a surname, are not taken in at the Poste Restante. Postal packets may not be re-directed from one Poste Restante to another in the same town or from a private address to a Poste Restante in the same town. Re-direction from a Poste Restante is not undertaken for more than 14 days, unless a longer period, not exceeding three months, is specified on the form of application. All persons applying at a Poste Restante are required to furnish sufficient particulars to prevent mistakes and to ensure delivery to the proper person Where a ship is in question the name of the vessel should always be mentioned.

The words "General Delivery" in the United States are synonymous with the words "Poste Restante." A general delivery window is maintained at every post office in the United States and is used for handling mail bearing as a part of its address the endorsement "Transient," "To be called for," "General Delivery," or other words indicating that it is intended for a transient person, such mail to be delivered upon application and identification.

At those post offices where delivery carrier service is maintained, residents who use the general delivery window are required to furnish in writing their names and addresses and the reasons for desiring to use the general delivery instead of the carrier service. Minors are required to furnish the names of their parents or their guardians whose written consent must accompany the application.

POSTGATE, JOHN PERCIVAL (1853–1926), English classical scholar and Fellow of the British Academy, was the son of Dr. John Postgate (1820–81), the initiator of the laws against the adulteration of food. He was educated at King Edward's school, Birmingham, and Trinity college, Cambridge, where he took his degree in 1876. He was elected to a fellowship at the college, where he was classical lecturer (1884–1909). He was professor of comparative philology at London (1880–1910) and Latin professor at Liverpool university (1909–20) He was accidentally killed in Cambridge by a steam lorry on July 14, 1926.

Postgate ranks very high among Latin scholars, but some of his due reputation was lost him by his vehement methods. Of these an example is to be found in his great *Corpus Poetarum Latinorum*. He expelled the writings of Ausonius from the *Corpus* on grounds which, though stated in mellifluous Latin, amount to little more than that he thought him a bad poet. Some have seen traces of the same vehemence in certain of the emendations in his Propertius (1894) and Tibullus (1905); he was, however, undoubtedly a very eminent critic and his article on TEXTUAL CRITICISM (written for the 11th edition of the *Encyclopædia Britannica,* and substantially retained in this) is a classic upon its subject.

His greatest successes were achieved in reforming the teaching of Latin. His *New Latin Primer* (1888, last ed. 1918) and his *Sermo Latinus* (1889, 1913) became widely used because of their simple methods. In particular he took a leading part in chasing out the old Victorian pronunciation of Latin—a mass of false quantities and mispronunciations which had no relation to the established facts of ancient pronunciation He was largely responsible, not only for the adoption of the reformed scheme by the Classical Association, but for the organization and propaganda which secured its general acceptance.

Before his death Postgate had the pleasure of knowing that the old pronunciation had been practically entirely wiped out of British scholastic and learned life and, as he said, that "even a lawyer had been known to pronounce *nisi prius* without making a false quantity."

Postgate's chief works, besides those mentioned above, were editions of Catullus (1894), Virgil (1912), Phaedrus (1920) and part of Lucan (1896, 1917); *How to Pronounce Latin* (1907); *Translation and Translations* (1922); *Prosodia Latina* (1923); *Guide to the Accentuation of Greek* (1925). The *Corpus* was published in parts in 1893, 1894, 1904 and 1905. *See* S. G. Owen, *J. P. Postgate* (British Academy, 1927).

POST-IMPRESSIONISM. The essential difference between impressionism and post-impressionism is perhaps best explained by the description of the former as an objective outlook which results in the rendering of the image received on the retina, and of the latter as the mental image expressed in accordance with a subjective outlook. In other words, whilst impressionism is based on strict fidelity to natural appearances, the need of post-impressionism consists, in the main, of absolute attachment to the personal vision, and, in reality, is the expression of the matter received through the glass of impressionism to be subsequently subjected to an individual thought process. The statement which emerges from the artist as a result of this process might well be termed expressionism, were it not that this name is more exclusively reserved for the excessively brutal German contribution to the movement under consideration. Post-impressionism (a term coined on the occasion of the first exhibition of the work of Cézanne, van Gogh and Gauguin in London, in 1911) provides an alternative which, if less apt, has the merit of being safe.

Post-impressionism was as much a revolt against the naturalism of the impressionists, as impressionism was a revolt against the tyrannical academic formula. It replaced analysis by synthesis. It despised representation and gave the artist unbridled licence to amplify and distort the forms of nature, acknowledging no law but the artist's sense of fitness in arranging and organizing the contents of his picture so as to express with the greatest possible directness and intensity the material and spiritual significance of his subject—the "treeness" of the tree, as Roger Fry has it, and the "wallness" of the wall. Delivered from all restraint and rules, the post-impressionists were able to proceed by leaps and bounds on their excursions into the realms of synthesis and abstraction, to the utter bewilderment of a public which, accustomed to judging art by the degree of its verisimilitude to nature, were left floundering hopelessly when attempting to fathom the meaning of these startling artistic manifestations.

A quarter of a century was enough to secure for the initiators and leaders of post-impressionism a position among the beacon-lights of European art. Cézanne, van Gogh and Gauguin are now referred to as "the glorious triumvirate" and "the old masters of

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POST-IMPRESSIONISM AND CUBISM

1. "Nude' by Georges Braque (1881–), French painter, in his early days a follower of Picasso, and a prominent leader in Cubist research
2. "Les Baigneuses" by Paul Gauguin (1848–1903), French, one of the three leading painters in the post-impressionist movement. His revolt against impressionism took the form of a return to decorative pattern, and to the two-dimensional design characteristic of Far Eastern Art. The painting illustrated is an example of the work of Gauguin's later years, which were spent in the Marquesas Islands
3. "L'Homme à la Pipe" by Paul Cézanne (1839–1906), French painter, one of the so-called "Glorious Triumvirate" (Gauguin, Cézanne and Van Gogh) who were the initiators of post-impressionism. Cézanne's endeavour in portraiture and still life as well as in landscape painting was to make more clearly perceptible than it is in nature the sense of the third dimension, of volume and weight. In the collection of Mr. and Mrs. S. Courtauld
4. "The Yellow Chair" by Vincent Van Gogh (1853–90), a Dutch painter who derived his technique from the Impressionists but went on to more abstract and subjective methods of expression
5. "Arlequin au Violon" by Pablo Picasso (1881–), Spanish painter, famous as one of the leading exponents of Cubism. His work is characterized by abstraction of form and an aesthetic expression entirely separated from the physical appearance of objects
6. "La Jeune Fille à la poupée" by Paul Cézanne

post-impressionism." Their once despised, numerous, and by no means invariably successful paintings are in most of the galleries of modern art, and thousands of pounds are willingly paid for canvases for which the artists, during their lifetime would willingly have accepted a few hundred francs.

Cézanne.—Cézanne, who at the beginning of his career threw in his lot with the Impressionists, upon whose technique he formed his own, was among the first to realize the limitations imposed by the Impressionists' scientifically truthful rendering of colour and atmosphere. His dissatisfaction with what he considered the superficiality of impressionist productions led him to express, more basically and with greater structural firmness, the essential character of the countryside which forever offered him new vistas, new wonders for his interpretation. His endeavour, in portraiture and still life, as well as in landscape painting, was to accentuate volume and weight—to make the third dimension more clearly and immediately perceptible to the beholder's eye than it is in actual nature, where we are left to guess by experience and by memory of touch. To him is due the dictum that all forms in nature can be reduced to the cube, the cylinder and the pyramid.

Van Gogh.—Like Cézanne, van Gogh derived his technique from the impressionists; and like Cézanne, he was anything but a facile worker, his heavy hand being but an inadequate instrument for conveying his passionate aesthetic reaction to the thing seen. Of him it may truly be said that he did not paint, but rather battled with colour and essential line with a frenzy that took no count of finished execution. His pictures are executed in furiously energetic cross-hatchings of pure Prussian blue, emerald green, orange and yellow, with a daring justified only by the brilliant harmonies evolved from a palette on which he found no room for neutral tints. His brushwork can only be likened to vigorous hatchet-strokes, corresponding to the elemental force of his emotions. There was something uncanny in his power to perceive and to express the essential nature of any object or scene or person by which his aesthetic impulse was stirred. Inanimate things became somehow invested with a soul and with a life of their own—a sunflower, a wicker-chair, a cypress tree, or whatever it happened to be. He was a visionary who found a deep meaning in the humblest objects which his art invested with his own tortured spirit, and which he made eloquent of his own emotions. Van Gogh was the precursor of expressionism.

Gauguin.—The third member of the great triumvirate, Paul Gauguin, was a close friend of van Gogh, but of a less impulsive and more reflective turn of mind. Where van Gogh would shout and even shriek, Gauguin was content to talk, and his words carried more weight, for they were more considered. If Cézanne devoted his life to the search for volume, and van Gogh for material and spiritual significance, Gauguin's revolt against impressionism took the form of a return to decorative pattern, to two-dimensional design as practised by the artists of the Far East. He based his effects on abstract form and colour, not on representational truth or on over-accentuation of some particular truth. Ignoring the colour of nature, and relying, for the expression of his ideas upon his memory more than upon models, he produced first in Brittany, then in Tahiti, those splendours of harmonious decoration against which no arguments founded on convention can ever prevail. It was his belief that, before the spirit of a place could be interpreted, it needed study in all its parts during what he called a "period of incubation." Some proof of the peace Gauguin found in his retreat can be seen in the restful nature of his paintings.

Matisse.—Of the second generation of post-impressionists, Henri Matisse went farther even than Gauguin in reconciling Western art with the Chinese. He aims "at convincing us of the reality of his forms by the continuity and flow of his rhythmic line, by the logic of his space relations, and, above all by an entirely new use of colour." His is an art of extreme synthetic simplification, reducing objects almost to symbols, and disdaining any approach to make-believe of reality. It depends entirely on arabesque and is not concerned with the third dimension.

Cubism.—Cézanne had used colour in block form because, by that means. he could best express his feeling for the weight of whatever he depicted, and its relation to other things presented with it, but he kept to the accepted ideas of representation, which were discarded by his cubist followers, Picasso, Braque, Dérain and Leger, who evolved a new language from Cézanne's suggestion of space. It was a form of art that had nothing whatever to do with realism, and demanded concentration on aesthetic matters to the absolute exclusion of outside practical appearances and accepted canons of judgment. Cubism bears out Ruskin's theory that an artist may deny other truths to the end that one truth may be more apparent.

Like impressionism, the name "cubism" was first used in a derogatory sense; it was Henri Matisse who, in 1908, applied it to a painting in which the subject had received treatment of a markedly cubical character. About as far from the impressionist objective approach as anything could possibly be, cubism is really a stride—albeit a long stride, beyond the subjective outlook of the post-impressionists, in that it takes no heed of visual appearance, and renders what are thought to be essential realities in pure abstract form. Picasso, the most prominent follower of the cubist gospel, and, indeed, the creator of certain of its elements, is the exponent of scientific cubism in its purest sense. Another form of cubism, less pure, is that which is best described as physical, since its fundamentals are culled from visualized realities.

For example, in those of Picasso's works which are based on physical appearances, the objects are presented in a way at least sufficiently realistic to enable their perception by the ordinary beholder, although he may be at a loss to account for the shapes which they assume. Their recognition, incidentally, at once displaces the work from the category of cubism in its strict sense, for that entails matters of line and colour wholly unrelated to objects and figures, since the cult does not intend realism to enter into the question.

Braque stands, to some extent, as the codifier of Picasso's inventions, acting as an editor of his snipe-like movements. Thus, the products of Picasso are sobered down and reduced to a state of uncompromising logic before being handed on as standardized material.

The art of Fernand Leger is concentrated upon the mechanical age into which we are advancing. Working in the gay colours of contemporary life, he extracts excellent design from the solid strength of the mechanized world by which he finds himself enveloped.

Albert Gleizes is a devotee of two-dimensional treatment, and his attitude to a flat surface is that it has no need of the addition of a sculptural third, for the presence of such constitutes a denial of its very nature. This painter, too, does not regard painting as a form of representation, but of presentation of the spirit of the artist, and not of physical matter. Metzinger, Herbin and Lhote are others of the cubist persuasion, which has demanded, in its time, every conceivable form of liberty. Orphism, purism, synchronism, simultaneism, integralism, dadaism and numeralism, all have had their day, and now the parent bids fair to follow them into oblivion. But although cubism may prove to have been a blind alley, it has been, and still is, an invaluable discipline for artists in general and had its definite use in saving art from the rut of academic pedantry.

Futurism.—Italian futurism, initiated, heralded and extolled by the eloquent poet Marinetti, and practised by Boccioni, Severini, Carrà, Russolo, Balla, and other disciples of the founder, was really an offshoot of cubism, although the connection was not admitted in the futurist manifestos. It differs from cubism in so far as cubism is concerned with static conditions, whilst futurism is essentially dynamic. This dynamism aims at cinematographic effects, oblivious of the impossibility of creating on a flat surface the illusion of the sequence of movement. Thus, by depicting a horse with 20 legs in various positions to indicate the movement of the gallop, the futurist endeavours to express the action of the gallop, but does not get beyond the representation of a static horse with 20 legs. Any attempt to change an art of space into an art of time must needs prove abortive. The dynamic intention of the futurists also finds expression in "force-lines," that is to say in lines, radiating, swirling, wedge-shaped, to indicate either the direction of movement, or the manner in which objects would disintegrate in obedience to the force indicated by their form.

Another tenet of futurism denies the validity of the resemblance of a portrait to the sitter. To the futurist, a painting of one object covered by another in such a manner that both are visible, is a method of indicating his total disbelief in opacity, whilst a dozen people can be, at the same time, and in turn, ten, three, five in number, as well as simultaneously mobile and immobile. Paintings of a box, firmly shut but at the same time disclosing its contents, also are admissible. Pictures must be looked, not at, but through, and the spectator must feel himself to be in the midst of them.

In England, Marinetti's fiery eloquence enlisted for a time a small following, which included C. R. W. Nevinson, who adapted with great skill the futurist formula for a series of remarkable war paintings.

Vorticism.—The chief English contribution to post-impressionism was, however, the work of the short-lived group of "Vorticists" who, led by Wyndham Lewis, adopted a modified method of cubism, and included among their number William Roberts, Edward Wadsworth, and F. Etchells. In England, as in most countries, these innovators were regarded as incompetent cranks and charlatans, until their employment in connection with the Canadian war memorials and the Imperial War Museum brought them official recognition and public fame.

Expressionism. — In Germany the post-impressionist movement took root and spread with surprising rapidity. Its most abstract form is to be found in the art of the Russian-born W. Kandinsky, who has explained his outlook in a book entitled The Art of *Spiritual* Harmony. Pechstein, Marc, Nolde, Kokoschka and Corinth are the most prominent figures among the German expressionists, among whom must also be counted Marc Chagall, notwithstanding his Russian birth.

Certainly it would seem that the German activities which correspond to those of the post-impressionist painters in other European countries should be accorded some distinguishing title of their own. The term "expressionism," therefore, serves the purpose as well as any other, unless one were found which denotes a combination of truth, bestiality, creation and destruction — all expressed in a manner in which a snarling brutality obscures many finer feelings. At the same time it must be admitted that the artist to whom the expressionists owe so much, the Swiss, Ferdinand Hodler, cannot very well be held responsible for the excesses committed by his imitators or contemporaries.

Man and his relation to the world which contains him have been subjected by Hodler to every thought-process of which his clear brain is capable, and the resulting statements are models of simplicity, precision and originality. Hodler does not attempt to put the unreasoning at ease by being intimate with them, but compels them, rather by an almost holy power, to use their own imagination. Another artist, who with Hodler, Cézanne and van Gogh, left his mark upon the evolution of German expressionism, was the Norwegian, Edward Munch, whose achievement in painting leads from the subjective naturalism of the late 19th century to the post-impressionist tendencies of the present day.

In America the new art-gospel of post-impressionism or expressionism was popularized mainly by the activity of Jules Pascin (1885–1930), a Bulgarian by birth, who had been working from, 1905 onwards for *Simplicissimus* and living in France until 1914, when the World War made him seek for a new home in the United States. He is equally distinguished as an illustrator and as a painter, and his work, though always maintaining a very personal note, shows in turn the influence of Daumier, Cézanne, Degas, Renoir and Picasso. He resorted extensively to distortion for the definite purpose of forceful emphasis, and is in this respect related to the German expressionists.

Effect on Other Arts. — Post-impressionism, in its attempts at synthesis, drew on the past to as great an extent as any other movement, but, ignoring the representational tricks discovered by succeeding generations, adopted only the basic, elementary facts of the unsophisticated and consequently more sincere primitive races. Exploration has brought to light comparatively modern work, in the form of sculpture, pottery, and mat designs, by peoples who, throughout the ages, have known no art teaching or influences save those, possibly, of a conquering but equally primitive tribe. From the Congo, Bakota, Benin and other districts of lesser-known Africa, masks and figures have found their way to Europe, there to reveal to eager searchers for a means of expressing much without complication, wonders of form and rhythm which were bound to receive the investigation of serious artists. In the same way that Gauguin found stimulation in the vibrant colours of the Polynesian mat-makers, so Jacob Epstein, and to a lesser degree, Ossip Tadkine, have been helped to fuller expression by deep study of negro sculpture.

In almost everything — buildings, furniture, dress, design in the home or theatre, and especially, perhaps, in that powerful modern factor, advertising — the effect of post-impressionism and its more successful descendants is very marked, whilst the benefits accruing to sculpture and the minor arts — woodcuts, engravings, posters, wallpapers and others — have already altered the trend of public thought, and freed it to such extent as slow and inartistic officialdom will allow, from the morass of insincerity and vulgarity which had all but swallowed it up. (See IMPRESSIONISM, PAINTING.)

BIBLIOGRAPHY.—J. Meier-Graefe, *Modern Art* (1908) ; C. J. Holmes, *Notes on the Post-Impressionist Painters* (1910) ; F. T. Marinetti, *Le Futurisme* (Paris, 1911) ; Roger Fry, *Form and Design, Prefaces to Catalogues of 1st and 2nd Post-Impressionist Exhibitions*, Grafton Galleries, 1911 and 1912 ; Boccioni, *Pittura Scultura Futuriste* (Milan, 1914) ; G. Coquiot, *Cubistes, Futuristes, Passeistes* (Paris, 1914) ; W. Kandinsky, *The Art of Spiritual Harmony* (1914) ; A. J. Eddy, *Cubism and Post-Impressionism* (1915) ; W. H. Wright, *Modern P inting* (1916) ; Hermann Bahr, *Expressionismus* (Munich, 1920) ; F. Lehel, *Notre Art Dement* (Paris, 1926) ; F. Rutter, *Evolution in Modern Art* (1926) ; R. H. Wilenski, *The Modern Movement in Art* (1927) ; Jan Gordon, *Modern French Painters; A.* Gleizes and Jean Metzinger, *Cubism.* (P. G. K.)

POST-MORTEM: see AUTOPSY.

POSTULATE, in philosophy, is now generally used in the wide sense of any fundamental assumption that is indemonstrable and yet necessary if the requirements of knowledge or of practical life are to be satisfied. In this sense Kant, for example, spoke of the postulates of the practical reason; and nowadays the so-called Laws of Thought are commonly described as postulates. The usage in mathematics is, or used to be, rather different. In philosophy, too, people sometimes employed the term "axiom" rather than postulate for the Laws of Thought and similar theoretical principles, the term "axiom" being defined as "a self-evident truth." But there is no virtue in claiming self-evidence for what is recognised to be indemonstrable. See AXIOM, THOUGHT, LAWS OF, KANT.

POSTUMIA, VIA, an ancient highroad of northern Italy, constructed in 148 B.C. by the consul Spurius Postumius Albinus. It ran from the coast at Genoa through the mountains to Dertona, Placentia (the termination of the Via Aemilia Lepidi) and Cremona, just east of the point where it crossed the Po. From Cremona the road ran eastward to Bedriacum, where one branch ran left to Verona and thence to the Brenner, the other right to Mantua, Altinum and Aquileia. The military occupation of Liguria depended upon this road, and several of the more important towns owed their origin largely to it. Cremona was its central point, the distances being reckoned from it both eastwards and westwards.

POSTUMIA-GROTTE (formerly Adelsberg, Slovene *Postojina*), a town in the province of Trieste, Italy (from which it is 51 mi. E. by rail). Pop. (1936) 3,804 (town), 6,j96 (commune). It is the frontier town of Italy on the railway to Ljubljana, Graz and Vienna. A mile from the town is the entrance to the stalactite cavern of Postumia, largest in Europe. The cavern is divided into several branches. The river Piuca enters the cavern 60 ft. below its mouth. In the Sala da ballo (ballroom) grotto a great ball is annually held on Whit-Monday, when the chamber is brilliantly illuminated. A mile from the entrance, the so-called Elysian fields are reached, from which a view of over 200 yd. in length can be obtained. The finest of all, however, is the Grotta del Paradiso. These caves are now joined by a tunnel to the Grotta Vera, and with the abyss of the Piuca, which can be traversed in a boat. The stalactite formations assume fantastic shapes. The length of the passages known is nearly 14 miles. These subterranean wonders were known as far back as 1213 (the earliest names found in it date from 1250) and were probably visited by Dante, who certainly knew the lake of Circonio (Cerkniza) in which the Javornik is reflected. But the cavern remained undiscovered in modern times until 1818. The Magdalene grotto is celebrated for the extraordinary subterranean amphibian, *Proteus anguinus,* first discovered there. It is about a foot in length, lives on snails and worms and is provided with both lungs and gills.

POTASHES, the crude potassium carbonate obtained by lixiviating wood ashes and evaporating the solution to dryness, an operation at one time carried out in iron pots—hence the name from "pot" and "ashes." The term potash or caustic potash is frequently used for potassium hydroxide, whilst such a phrase as sulphate of potash is now appropriately replaced by potassium sulphate. (See POTASSIUM.)

POTASSIUM [symbol K (from *kalium*), atomic number 19, atomic weight 39·105], a metallic chemical element, belonging to the group termed the metals of the alkalis. Although never found free in nature, in combination the metal is abundantly and widely distributed. In the oceans alone there are estimated to be $1{,}141\times10^{12}$ tons of sulphate, K_2SO_4, but this inexhaustible store is not much drawn upon; and the "salt gardens" on the coast of France lost their industrial importance as potash-producers when the deposits at Stassfurt in Germany came to be worked. These deposits, in addition to common salt, include the following minerals: sylvine, KCl; carnallite, $KCl\cdot MgCl_2\cdot 6H_2O$ (transparent, deliquescent crystals, often red with diffused oxide of iron); kainite, $K_2SO_4\cdot MgSO_4\cdot MgCl_2\cdot 6H_2O$ (hard crystalline masses, permanent in the air); kieserite $MgSO_4\cdot H_2O$ (only very slowly dissolved by water); besides polyhalite,

$$MgSO_4\cdot K_2SO_4\cdot 2CaSO_4\cdot 2H_2O,$$

and anhydrite, $CaSO_4$; salt, $NaCl$, and some minor components. These potassium minerals are not confined to Stassfurt; larger quantities of sylvine and kainite are met with in the salt mines of Kalusz in the eastern Carpathian Mountains. Important deposits are being worked in Thuringia and Baden, and others occur at Wittelsheim (Alsace) and at Suria (Catalonia, Spain). There are also undeveloped resources in Chile, Peru and Brazil. The Stassfurt minerals owe their industrial importance to their solubility in water and consequent ready amenability to chemical operations. In point of absolute mass they are insignificant compared with the abundance and variety of potassiferous silicates, which occur everywhere in the earth's crust; orthoclase (potash felspar) and potash mica may be quoted as prominent examples. Such potassiferous silicates are found in almost all rocks, both as normal and as accessory components; and their disintegration furnishes the soluble potassium salts which are found in all fertile soils. These salts are sucked up by the roots of plants, and by taking part in the process of nutrition are partly converted into oxalate, tartrate, and other organic salts, which, when the plants are burned, are converted into the carbonate, K_2CO_3. The "vinasse" of beet-sugar factories, *i.e.,* the material left in the retorts after the distillation of the fermented molasses. also consists largely of potassium salts (chiefly the carbonate) and the potash is either utilized directly as a manure or in the manufacture of soft soaps, or it is refined by fractional crystallization. It is a remarkable fact that, although in a given soil the soda-content may predominate largely over the potash salts, the plants growing in the soil take up the latter: in the ashes of most land plants the potash (calculated as K_2O) forms upwards of 90% of the total alkali. The proposition holds, in its general sense, for sea plants likewise. In ocean water the ratio of soda (Na_2O) to potash (K_2O) is 100:3·23 (Dittmar); in kelp it is, on the average, 100:5·26 (Richardson). Ashes particularly rich in potash are those of burning nettles, wormwood (*Artemisia* absinthium), tansy (*Tanacetum vulgare*), fumitory (*Fumaria officinalis*) and tobacco. According to Liebig, potassium is the essential alkali of the animal body; and it may be noted that sheep excrete most of the potassium which they take from the land as sweat, one-third of the weight of raw merino consisting of potassium compounds.

Sir Humphry Davy's Experiment.—To Sir Humphry Davy belongs the merit of isolating this element from potash, which itself had previously been considered an element. On placing a piece of potash on a platinum plate, connected to the negative of a powerful electric battery, and bringing a platinum wire, connected to the positive of the battery, to the surface of the potassium a vivid action was observed: gas was evolved at the upper surface of the fused globule of potash, whilst at the lower surface, adjacent to the platinum plate, minute metallic globules were formed, some of which immediately inflamed, whilst others merely tarnished. In 1808 Gay-Lussac and Thénard obtained the metal by passing melted potash down a clay tube containing iron turnings or wire heated to whiteness, and Caradau effected the same decomposition with charcoal at a white heat. Electrolytic methods are now generally employed for the manufacture of potassium. The Castner process used for sodium (*q.v.*) is somewhat unsatisfactory for potassium, but has been rendered more suitable by various modifications. Fused potassium hydroxide is electrolysed by means of a sheet-iron anode and an iron-wire cathode, the latter being surrounded by a cylinder of magnesite in order to prevent metallic potassium diffusing into the hydroxide in which it tends to dissolve. The temperature is kept as low as possible and air is excluded. The molten hydroxide may be replaced by a readily fusible mixture of potassium chloride and fluoride. The metal, however, is not in great demand, for it is generally found that sodium (*q.v.*), which is cheaper, and, weight for weight, more reactive, will fulfil any purpose for which potassium may be desired.

Pure Potassium.—Pure potassium is a silvery white metal tinged with blue; but on exposure to air it at once forms a film of oxide, and on prolonged exposure deliquesces into a solution of hydrate and carbonate. Perfectly dry oxygen, however, has no action upon it. (See DRYNESS, CHEMICAL.) At temperatures below 0° C it is hard and brittle; at the ordinary temperature it is so soft that it can be kneaded between the fingers and cut with a blunt knife. Its specific gravity is 0·865; hence it is the lightest metal known except lithium. It fuses at 62·5° C and boils at about 760°, emitting an intensely green vapour. It may be obtained crystallized in quadratic octahedra of a greenish-blue colour, by melting in a sealed tube containing an inert gas, and inverting the tube when the metal has partially solidified. When heated in air it fuses and then takes fire, burning into a mixture of oxides. Most remarkable, and characteristic for the group it represents, is its action on water. A pellet of potassium when thrown on water at once bursts out into a violet flame and the burning metal fizzes about on the surface, its extremely high temperature precluding absolute contact with the liquid, except at the very end, when the last remnant, through loss of temperature, is wetted by the water and bursts with explosive violence. The reaction may be written $2K+2H_2O=2KOH+H_2$, and the flame is due to the combustion of the hydrogen, the violet colour being occasioned by the potassium vapour. The metal also reacts with alcohol to form potassium ethoxide, while hydrogen escapes, this time without inflammation:

$$K+C_2H_5\cdot OH=C_2H_5\cdot OK+H.$$

When the oxide-free metal is heated gently in dry ammonia it is gradually transformed into a blue liquid, which on cooling freezes into a yellowish-brown or flesh-coloured solid, potassamide, KNH_2. When heated to redness the amide is decomposed into ammonia and potassium nitride, NK_3, which is an almost black solid. Both it and the amide decompose water readily with formation of ammonia and caustic potash. The metal dissolves in liquid ammonia to give a blue solution. Potassium at temperatures from 200° to 400° C occludes hydrogen gas, the highest degree of saturation corresponding approximately to the formula K_2H, but it seems probable that KH is the only compound formed. In a vacuum or in sufficiently dilute hydrogen the compound from 200° upwards loses hydrogen, until the tension of the free gas has arrived at the maximum value characteristic of that temperature. The hydride is used for the manufacture of potassium formate which results from the action of moist carbon dioxide: $KH+CO_2=H\cdot CO_2K$.

COMPOUNDS

Oxides and Hydroxide.— Potassium forms two well-defined oxides, K_2O and K_2O_4, whilst several others, of less certain existence, have been described. The monoxide, K_2O, may be obtained by strongly heating the product or burning the metal in slightly moist air; by heating the hydroxide with the metal:

$$2KOH+2K=2K_2O+H_2;$$

or by passing pure and almost dry air over the molten metal. It forms a grey brittle mass, having a conchoidal fracture; it is very deliquescent, combining very energetically with water to form caustic potash.

Potassium hydroxide or caustic potash, KOH, formerly considered to be an oxide, may be obtained by dissolving the metal or monoxide in water, but is manufactured by double decomposition from potassium carbonate and slaked lime:

$$K_2CO_3+Ca(OH)_2=2KOH+CaCO_3,$$

or by electrolytic methods similar to those used for sodium hydroxide. (See ALKALI MANUFACTURE.) In the former case, a solution of one part of the carbonate in 12 parts of water is heated to boiling in a cast-iron vessel by means of steam-pipes and the milk of lime added in instalments until a sample of the filtered mixture no longer effervesces with an excess of acid. The mixture is then allowed to settle in the iron vessel, access of air being prevented as much as practicable, and the clear liquor is syphoned off. The liquors after concentration in iron vessels are evaporated in a silver dish, and the residual oily liquid is then poured out into a polished iron tray, or into an iron mould to produce the customary form of "sticks," and allowed to cool. The solid must be at once bottled, because it attracts the moisture and carbonic acid of the air with great avidity and deliquesces. Nickel basins are better adapted than iron basins for the preliminary concentration of potash lye. The latter begin to oxidize before the lye has come up to the traditional strength of specific gravity 1·333 when cold, while nickel is not attacked so long as the percentage of real KOH is short of 60. For the fusion of the dry hydrate nickel vessels cannot be used; in fact, even silver is perceptibly attacked as soon as all the excess of water is away; absolutely pure KOH can be produced only in gold vessels. Glass and (to a less extent) porcelain are attacked by caustic potash lye, slowly in the cold, more readily on boiling.

Solid Caustic Potash.—Solid caustic potash forms an opaque, white, stone-like mass of dense granular fracture; specific gravity 2.1. It fuses considerably below and is perceptibly volatile at a red heat. At a white heat the vapour breaks down into potassium, hydrogen and oxygen. It is extremely soluble in even cold water, and in any proportion of water on boiling. On crystallizing a solution, the hydrate $KOH\cdot 2H_2O$ is deposited; $2KOH\cdot 9H_2O$ and $2KOH\cdot 5H_2O$ have also been obtained. The solution is intensely "alkaline" to test-papers. It readily dissolves the epidermis of the skin and many other kinds of animal tissue—hence the former application of the "sticks" in surgery. A dilute potash readily emulsionizes fats, and on boiling saponifies them with formation of a soap and glycerin. All commercial caustic potash is contaminated with excess of water (over and above that in the KOH) and with potassium carbonate and chloride; sulphate, as a rule, is absent. A preparation sufficing for most purposes is obtained by digesting the commercial article in absolute alcohol, decanting and evaporating the solution to dryness and fusing in silver vessels.

The peroxide, K_2O_4, discovered by Gay-Lussac and Thénard, is obtained by heating the metal in an excess of slightly moist air or oxygen, or better by melting the metal in a flask filled with nitrogen and gradually displacing this gas by oxygen; the first formed grey film on the metal changes to a deep blue, and then the gas is rapidly absorbed, the film becoming white and afterwards yellow. It is a dark yellow powder, which fuses at a high temperature, the liquid on cooling depositing shining tabular crystals; at a white heat it loses oxygen and yields the monoxide. Exposed to moist air it loses oxygen, possibly giving the dioxide, K_2O_2; water reacts with it, evolving much heat and giving caustic potash, hydrogen peroxide and oxygen; whilst carbon monoxide gives potassium carbonate and oxygen at temperatures below 100°. A violent reaction ensues with phosphorus and sulphur, and many metals are oxidized by it, some with incandescence.

Halogen Compounds.— Potassium fluoride, KF, is a very deliquescent salt, crystallizing in cubes and having a sharp saline taste; it is formed by neutralizing potassium carbonate or hydroxide with hydrofluoric acid and concentrating in platinum vessels. It forms the acid fluoride KHF_2 when dissolved in aqueous hydrofluoric acid, a salt which at a red heat gives the normal fluoride and hydrofluoric acid. Other salts of composition $KF\cdot 2HF$ and $KF\cdot 3HF$, have been described by Moissan.

Potassium chloride, KCl, also known as muriate of potash, closely resembles ordinary salt. It is produced in immense quantities at Stassfurt from the so-called "Abraumsalze" (waste salts). When hydrogen chloride is passed into a solution of potassium chloride the salt is completely precipitated as a fine powder. If the original solution contained the chlorides of magnesium or calcium or sulphate of potassium, all impurities remain in the mother-liquor (the sulphur as $KHSO_4$), and can be removed by washing the precipitate with strong hydrochloric acid. The salt crystallizes in cubes of specific gravity 1·995; it melts at about 800° and volatilizes at a bright red heat. It is extensively employed for the preparation of other potassium salts, but the largest quantity (especially of the impure product) is used in the production of artificial manures.

Potassium bromide, KBr, may be obtained by dissolving bromine in potash, whereupon bromide and bromate are first formed, evaporating and igniting the product in order to decompose the bromate:

$$6KOH+3Br_2=5KBr+KBrO_3+3H_2O;\ 2KBrO_3=2KBr+3O_2$$

(cf. CHLORATES); but it is manufactured by acting with bromine water on iron filings and decomposing the iron bromide thus formed with potassium carbonate. In appearance it closely resembles the chloride, forming colourless cubes which readily dissolve in water and melt at 722°. It combines with bromine to form an unstable tribromide, KBr_3.

Potassium *Iodide*.—Potassium iodide, KI, is obtained by dissolving iodine in potash, the deoxidation of the iodate being facilitated by the addition of charcoal before ignition, proceeding as with the bromide. The commercial salt usually has an alkaline reaction; it may be purified by dissolving in the minimum amount of water, and neutralizing with dilute sulphuric acid; alcohol is now added to precipitate the potassium sulphate, the solution filtered and crystallized. It forms colourless cubes which are readily soluble in water, melt at 685° and yield a vapour of normal density. It is sparingly soluble in absolute alcohol. Both the iodide and bromide are used in photography. Iodine dissolves in an aqueous solution of the salt to form a dark brown liquid, which on evaporation over sulphuric acid gives black acicular crystals of the tri-iodide, KI_3. The salt is very deliquescent; it melts at 45°, and at 100° decomposes into iodine and potassium iodide. For the oxyhalogen salts see CHLORATE, CHLORINE, BROMINE and IODINE.

Carbonate of Potash, popularly known as "potashes," was originally obtained in countries where wood was cheap by lixiviating wood ashes in wooden tubs, evaporating the solution to dryness in iron pots and calcining the residue; in more recent practice the calcination is carried out in reverberatory furnaces. This product, known as "crude potashes," contains, in addition to carbonate, varying amounts of sulphate and chloride and also insoluble matter. Crude potash is used for the manufacture of glass, and, after being causticized, for the making of soft soap. For many other purposes it must be refined, which is done by treating the crude product with the minimum of cold water required to dissolve the carbonate, removing the undissolved part (which consists chiefly of sulphate), and evaporating the clear liquor to dryness in an iron pan. The purified carbonate (which still contains most of the chloride of the raw material and other impurities) is known as "pearl ashes." Most of the carbonate which occurs in commerce is made from the chloride of the Stassfurt beds by an adaptation of the "Leblanc process" for conversion of common salt into soda ash. *(See* ALKALI MANUFACTURE.)

Chemically pure carbonate of potash is best prepared by igniting pure bicarbonate in iron or (better) in silver or platinum vessels, or else by calcining pure cream of tartar. The latter operation furnishes an intimate mixture of the carbonate with charcoal, from which the carbonate is extracted by lixiviation with water and filtration. The filtrate is evaporated to dryness (in iron or platinum vessels) and the residue fully dehydrated by gentle ignition. The salt is thus obtained as a white porous mass, fusible at a red heat (838° C) into a colourless liquid, which solidifies into a white opaque mass. The dry salt is very hygroscopic; it deliquesces into an oily solution ("oleum tartari") in ordinary air. The most saturated solution contains 205 parts of the salt to 100 of water and boils at 135°. On crystallizing a solution monoclinic crystals of $2K_2CO_3{\cdot}3H_2O$ are deposited, which at 100° lose water and give a white powder of $K_2CO_3{\cdot}H_2O$; this is completely dehydrated at 130°. The carbonate, being insoluble in strong alcohol (and many other liquid organic compounds), is much used for dehydration of the corresponding aqueous preparations. The pure carbonate is constantly used in the laboratory as a basic substance generally, for the disintegration of silicates, and as a precipitant. The industrial preparation serves for the making of flint glass, of potash soap (soft soap) and of caustic potash.

Potassium bicarbonate, $KHCO_3$, is obtained when carbonic acid is passed through a cold solution of the ordinary carbonate as long as it is absorbed. Any silicate present is also converted into bicarbonate with elimination of silica, which must be filtered off. The filtrate is evaporated at a temperature not exceeding 65°; after sufficient concentration it deposits on cooling anhydrous crystals of the salt, while the potassium chloride, which may be present as an impurity, remains mostly in the mother-liquor; the rest is easily removed by repeated recrystallization. The bicarbonate forms large monoclinic prisms, permanent in the air. When the dry salt is heated to 190° it decomposes into normal carbonate, carbon dioxide and water.

Sulphur Compounds.—Potassium sulphide, K_2S, was obtained by Berzelius in pale red crystals by passing hydrogen over potassium sulphate, and by Berthier as a flesh-coloured mass by heating the sulphate with carbon. When it is prepared by treating potash with sulphuretted hydrogen and adding a second equivalent of alkali, a solution is obtained which on evaporation in a vacuum deposits crystals of $K_2S{\cdot}5H_2O$. The solution is strongly caustic. It turns yellow on exposure to air, absorbing oxygen and carbon dioxide and forming thiosulphate and potassium carbonate and liberating sulphuretted hydrogen, which decomposes into water and sulphur, the latter combining with the monosulphide to form higher salts. The solution also decomposes on boiling. The hydrosulphide, KHS, was obtained by Gay-Lussac on heating the metal in sulphuretted hydrogen, and by Berzelius on acting with sulphuretted hydrogen on potassium carbonate at a dull red heat. It forms a yellowish-white deliquescent mass, which melts on heating, and at a sufficiently high temperature it yields a dark red liquid. It is readily soluble in water, and on evaporation in a vacuum over caustic lime it deposits colourless, rhombohedra1 crystals of $2KHS{\cdot}H_2O$. The solution is more easily prepared by saturating potash solution with sulphuretted hydrogen. The solution has a bitter taste, and on exposure to the air turns yellow, but on long exposure it recovers its original colourless appearance owing to the formation of thiosulphate. *Liver of sulphur* or *hepar sulphuris,* a medicine known to the alchemists, is a mixture of various polysulphides with the sulphate and thiosulphate, in variable proportions, obtained by gently heating the carbonate with sulphur in covered vessels. It forms a liver-coloured mass. In the pharmacopoeia it is designated *potassa sulphurata.*

Potassium sulphite, K_2SO_3, is prepared by saturating a potash solution with sulphur dioxide, adding a second equivalent of potash, and crystallizing in a vacuum, when the salt separates as small deliquescent, hexagonal crystals. The salt $K_2SO_3{\cdot}H_2O$ may be obtained by crystallizing the metabisulphite, $K_2S_2O_5$ (from sulphur dioxide and a hot saturated solution of the carbonate, or from sulphur dioxide and a mixture of milk of lime and potassium sulphate) with an equivalent amount of potash. The salt $K_2SO_3{\cdot}2H_2O$ is obtained as oblique rhombic octahedra by crystallizing the solution over sulphuric acid.

Potassium sulphate, K_2SO_4, a salt known early in the 14th century, was styled in the 17th century *arcanum* or *sal duplicatum,* being regarded as a combination of an acid salt with an alkaline salt. It was obtained as a by-product in many chemical reactions, and subsequently used to be extracted from kainite, one of the Stassfurt minerals, but the process is now given up because the salt can be produced cheaply enough from the chloride by decomposing it with sulphuric acid and calcining the residue. To purify the crude product it is dissolved in hot water and the solution filtered and allowed to cool, when the bulk of the dissolved salt crystallizes out with characteristic promptitude. The very beautiful (anhydrous) crystals have the habit of a double six-sided pyramid, but really belong to the rhombic system. They are transparent, very hard and absolutely permanent in the air. They have a bitter, salty taste. The salt is soluble in water, but insoluble in caustic potash of sp.gr. 1·35, and in absolute alcohol. It fuses at 1,078°. The crude salt is used occasionally in the manufacture of glass. The acid sulphate or bisulphate, $KHSO_4$, is readily produced by fusing thirteen parts of the powdered normal salt with eight parts of sulphuric acid. It forms rhombic pyramids, which melt at 197°. It dissolves in three parts of water of 0° C. The solution behaves as if its two congeners, K_2SO_4 and H_2SO_4, were present side by side uncombined. An excess of alcohol, in fact, precipitates normal sulphate (with little bisulphate) and free acid remains in solution. Similar is the behaviour of the fused dry salt at a dull red heat; it acts on silicates, titanates, etc., as if it were sulphuric acid raised beyond its natural boiling point. Hence its frequent application in analysis as a disintegrating agent. The sulphate is also used in alum manufacture; fertilizer and medicine. For the salts of other sulphur acids, *see* SULPHUR.

Potassamide, NH_2K, discovered in 1811, is obtained as an olive green or brown mass by gently heating the metal in ammonia gas, or as a white, waxy, crystalline mass when the metal is heated in a silver boat. It decomposes in moist air, or with water, giving caustic potash and ammonia, in the latter case with considerable evolution of heat. For the nitrite, *see* NITROGEN; for the nitrate, *see* SALTPETRE; and for the cyanide, *see* PRUSSIC ACID; for other salts *see* the articles wherein the corresponding acid receives treatment.

Analysis, **etc.**—All volatile potassium compounds impart a violet coloration to the Bunsen flame, which is masked, however, if sodium be present. The emission spectrum shows two lines, $K\alpha$, a double line towards the infra-red, and $K\beta$ in the violet. The chief insoluble salts are the perchlorate, hydrogen tartrate and chloroplatinate (platinichloride); and the difference in solubility between the potassium and ammonium salts of "eikonogen" enables a separation to be effected, most other salts of these two radicals being similarly soluble. The atomic weight was determined by Stas, Richards and Stahler.

MEDICINE

Pharmacology.—Numerous salts and preparations of potassium are used in medicine; viz., *Potassii Carbonis* (salt of tartar), dose 5 to 20 gr., from which are made *(a) Potassii Bicarbonas,* dose 5 to 30 gr.; (b) *Potmsa Caustica,* a powerful caustic not used internally. From caustic potash are made: (1) *Potassii Permanganas,* dose 1 to 3 gr, used in preparing *Liquor Potassii Permanganatis,* a 1% solution, dose 2 to 4 dr., (2) *Potassii Iodidum,* dose 5 to 20 *gr.,* from which are made the *Linamentum Potassii Iodidi cum Sapone,* strength 1 in 10, and the *Unguentum Potassii Iodidi,* strength 1 in 10. (3) *Potassii Bromidum,* dose 5 to 30 gr. (4) *Liquor Potassae,* strength 27 gr. of caustic potash to the oz. *Potassii Citras,* dose 10 to 40 gr. *Potassii Acetas,* dose 10 to 60 gr. *Potassii Chloras,* dose 5 to 15 gr., from which is made a lozenge, *Trochiscus Potassii Chloratis,* each containing 3 gr. *Potassii Tartras Acidus* (cream of tartar), dose 20 to 60 gr, which has a subpreparation *Potassii Tartras,* dose 30 to 60 gr. *Potassii Nitras* (saltpetre), dose 5 to 20 gr. *Potassii Sulphas,* dose 10 to 40 gr. *Potassii Bichromas,* dose $\frac{1}{10}$ to $\frac{1}{5}$ gr.

Toxicology.—Poisoning by caustic potash may take place or poisoning by pearl ash containing caustic potash. A caustic taste in the mouth is quickly followed by burning abdominal pain, vomiting and diarrhoea, with a feeble pulse and a cold clammy skin. The treatment is washing out the stomach or giving emetics followed by vinegar or lemon juice and later oil and white of egg.

Therapeutics. — Externally: Caustic potash is a most powerful irritant and caustic; it is used with lime in making Vienna paste, which is occasionally used to destroy morbid growths. *Liquor potassae* is also used in certain skin diseases. The permanganate of potash is an irritant if used pure. Its principal action is as an antiseptic and disinfectant. If wet it oxidizes the products of decomposition. It is used in the dressing of foul ulcers. The 1% solution is an antidote for snake-bite.

Internally: Dilute solutions of potash, like other alkalis, are used to neutralize the poisonous effects of strong acids. In the stomach potassium salts neutralize the gastric acid, and hence small doses are useful in hyperchlorhydria. Potassium salts are strongly diuretic, acting directly on the renal epithelium. They are quickly excreted in the urine, rendering it alkaline and thus more able to hold uric acid in solution. They also hinder the formation of uric acid calculi. The acetate and the citrate are valuable mild diuretics in Bright's disease and in feverish conditions, and by increasing the amount of urine diminish the pathological fluids in pleuritic effusion, ascites, etc. In tubal nephritis they aid the excretion of fatty casts. The tartrate and acid tartrate are also diuretic in their action and, as well as the sulphate, are valuable hydragogue saline purgatives. Potassium nitrate is chiefly used to make nitre paper, which on burning emits fumes useful in the treatment of the asthmatic paroxysm. Lozenges of potassium chlorate are used in stomatitis, tonsilitis and pharyngitis; it can also be used in a gargle, 10 gr. to 1 fl.oz. of water. Its therapeutic action is said to be due to nascent oxygen given off; so it is local in its action. In large doses it is a dangerous poison, converting the oxyhaemoglobin of the blood into methaemoglobin. Internally the permanganate is a valuable antidote in opium poisoning. The action of potassium bromide and potassium iodide has been treated under bromine and iodine (*qq.v.*). All potassium salts if taken in large doses are cardiac depressants; they also depress the nervous system, especially the brain and spinal cord. Like all alkalis if given in quantities they increase metabolism.

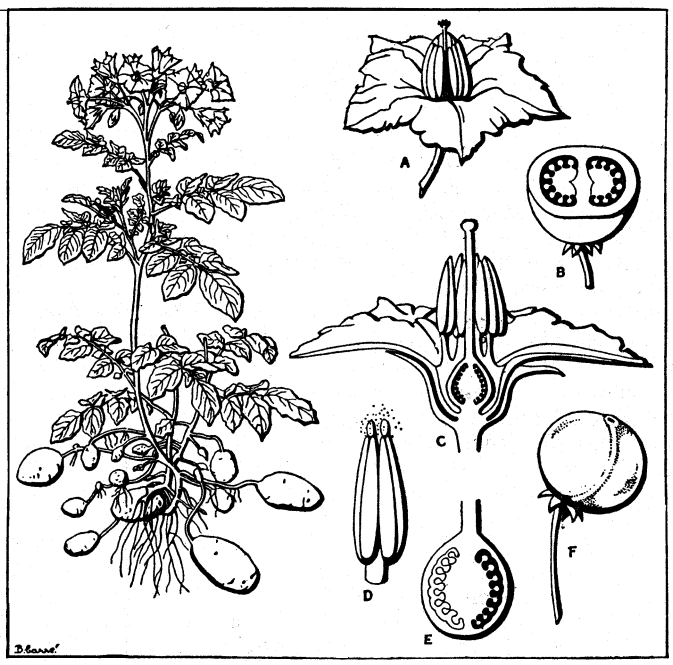
POTATO. The potato belongs botanically to the section *Tuberarium* of the genus *Solanum*, the members of which are. with few exceptions, tuber bearing. This section comprises not only the cultivated forms but many wild species, the number of which probably exceeds 100.

Formerly the species *Solanum tuberosum* was understood to comprise all cultivated varieties of the potato, but these were later assigned to 14 species. *S. tuberosum* is the most important of the group since it includes the Chilean cultivated forms as well as the commercial varieties of North America and Europe. Most of the common cultivated varieties of the Andes region belong to the species, *S. andigenum*. The 12 remaining species are grown in small local areas in the Andean countries and more or less resemble wild species in their general appearance.

Origin. — The origin of the potato is lost in antiquity, but it is known that when the Spaniards invaded South America in 1524 they found a large number of varieties and species under cultivation, the tubers of which were used as a common article of food by the natives. Where these varieties and species originated is more or less conjecture, but they seem to be native to the American continents since their relatives are still found growing wild in the elevated regions extending from the southwestern part of the United States to the southern part of South America, particularly in the higher altitudes of Bolivia and Peru and the coastal regions and nearby islands of Chile. All the species seem to require a cool climate; they are found growing in regions near the equator at high altitudes and none is known to occur under tropical conditions. If the origin of the potato is uncertain, information concerning its introduction into other countries is also shrouded in mystery. The exact history of such introductions has been lost, and the few historical stories that remain prove to have little solid foundation. Sir Walter Raleigh, for instance, is said to have brought back the potato from Virginia in 1585, yet on investigation it appears that the true potato did not reach Virginia until more than 100 years after this date. Nor could Raleigh have obtained the potato from Peru, for his ships apparently never visited that country.

Sir John Hawkins is also credited with having introduced the potato in 1565. Investigation shows that the potatoes brought back by Hawkins were the "sweet potato," *Ipomoea batatas* and not the ordinary potato, *S. tuberosum*. Claims are also made for Drake in this connection. Certainly his ships passed through the Straits of Magellan in 1578 and turned northwards looting the coast towns of Chile and Peru after which he returned to England across the Pacific and Indian oceans thereby completing his second renowned trip around the world. There is, however, no record that potatoes were brought on his ship "Pelican," and indeed it was not until 1586 that he is alleged to have introduced the potato. The Germans are exponents of the Drake story, for there stands in Offenburg, Baden a monument inscribed: "Sir Francis Drake introducer of the Potato into Europe in the year of our Lord 1580."

It is probable that the Spaniards gave the potato to Europe.



FROM BAILLON, "HISTOIRE DES PLANTES" (BONNAIRE)

POTATO (SOLANUM TUBEROSUM). SHOWING WHOLE PLANT WITH UNDERGROUND STEMS AND TUBERS (POTATOES)

A. Single flower. B. Fruit cut across to show placenta and ripening ovules. C. Longitudinal section through flower. D. Two ripe stamens opening and shedding pollen. E. Longitudinal section through ovary. F. Fruit

In the *Cronica de Peru* of Pedro Creça (Seville, 1553) the potato is mentioned under the name "battata" or "papa." Hieronymus Cardan, a monk, is supposed to have been the first to introduce it from Peru into Spain, from which country it passed into Italy, from there early in the 17th century to Austria, then to Germany, from Germany to Switzerland and finally to France.

The earliest representation of the plant is to be found in Gerard's *Herbal*, published in 1507. The plant is mentioned under the name *Papus orbiculatus* in the 1st edition of the *Catalogus* of the same author published in 1596 and again in the 2nd edition which was dedicated to Sir Walter Raleigh (1599). It is, however, in the *Herbal* that we find the first description of the potato accompanied by a woodcut sufficiently correct as to leave no doubt whatever as to the identity of the plant. In this work (p. 781) it is called "Battata virginiana sive Virginianorum et Pappus, Potatoes of Virginia."

In 1629, Parkinson, the friend and associate of Johnson, published his *Paradisus*, in which (p. 517) he gives an indifferent figure of the potato under the name of "Papas seu Battatas Virginianorum."

Little is known of the introduction of the potato into North America. It is generally believed that the English colonists of Virginia and Carolina obtained the potato from Spaniards or from other travellers. The most authentic report shows that potatoes were first grown in the United States at Londonderry, N.H., in 1719 from stock brought from Ireland. It was for this reason, no doubt, that the potato has been called the "Irish" potato. The name is still used, especially in the southern states, where it serves to distinguish the potato from the sweet potato.

Plant Characteristics. — The potato plant is a herbaceous annual, propagated by true seeds or by the tubers. The aerial stems may be erect or procumbent and have several axillary branches. Stems are round or angular, pubescent or glabrous, green or more or less purple. The first leaf on the stem is usually simple, and the later ones pinnate with three or four pairs of large, entire, petiolated leaflets and smaller ones between. The leaves are arranged on the stem in a spiral. Fibrous roots arise in groups of three just above the nodes on the underground part of the stem. They may extend to a depth of 3 or 4 ft. and nearly as far horizontally. As most of the roots are comparatively near the surface the potato does not seem adapted to culture without irrigation or frequent rainfall.

The cymose inflorescences occur in the axil of about every sixth node. The flowers of an inflorescence open progressively over a period of several days. They produce no nectar and are seldom visited by insects. The rotate corolla is five-lobed and white, yellow, purple, blue or striped, according to the variety. The five stamens are borne on the corolla tube and converge around the pistil. The large erect anthers dehisce by a terminal pore. There are two carpels forming the two-loculed ovary with a single style. The fruit, or seed ball, is a green round berry about $\frac{1}{2}$-$\frac{3}{4}$ in. in diameter and generally contains numerous seeds. The seeds are very small, kidney-shaped and smooth and are embedded in the pulp of the fruit.

The leaves on the underground part of the vertical stem are small and scalelike; in their axils lateral stems called stolons arise. These are of variable length, more or less fleshy and of typical stem structure. The tubers are swellings arising at the end of these stolons. The tuber is a shortened, thickened, underground stem, with scalelike leaves or leaf scars subtending the eyes. The eye in its entity is a leaf scar with its subtended axil which contains a lateral branch and the latter's axillary buds and undeveloped internodes. Because of short internodes, the nodes are brought close together and the buds lie in nearly the same plane. Since there are several buds on each of these shortened branches, it is possible to get several shoots from an eye. The central bud in an eye is the terminal bud of the branch and develops first upon renewal of growth. There is also a correlation between the development of different eyes on the tuber. Sprouts usually develop first from eyes at the apical or distal end of the tuber; this development is known as "apical dominance." When the vascular connection between the different eyes is severed by cutting the tuber into pieces or by notching around the eyes, apical dominance disappears and all eyes develop at about the same rate. Apical dominance within the tuber and within the individual eyes disappears when the first sprouts are destroyed or are checked in their growth.

The epidermis of the tuber sloughs off in the early stages of development and is replaced with a periderm six to ten cells thick. The periderm consists of small flat cells which become suberized during the ripening of the tuber or upon exposure to dry air. Thus a tough skin is formed which protects the tuber against

TABLE I.—Potato Area and *Output, 1937*

Country	Area in Acres (1000 Acres)	Production in Short Tons (1000 Short Tons)	Yield per Acre in Short Tons
Northern Hemisphere			
North America			
Canada	531	2,128	4.0
United States	3,174	11,827	3.7
Total	3,705	13,955	3.8
Europe			
United Kingdom	714	5,477	7.7
Ireland	326	3,032	9.3
Norway	128	949	7.4
Sweden	333	1,991	6.0
Denmark	200	1,460	7.3
Netherlands	341	2,923	8.6
Belgium	390	3,408	8.7
France	3,554	17,544	4.9
Spain	1,030(1)	5,184(1)	5.0
Italy	1,042	3,541	3.4
Switzerland	121	968	8.0
Germany	7,136	60,985	8.5
Austria	538	3,550	6.6
Czechoslovakia	1,914	13,631	7.1
Hungary	729	2,822	3.9
Yugoslavia	657	1,786	2.7
Rumania	583	2,323	4.0
Poland	7,366	44,348	6.0
Lithuania	457	2,767	6.1
Latvia	314	1,965	6.3
Estonia	188	1,087	5.8
Finland	215	1,530	7.1
Union of Soviet socialist Republics	18,303(1)	52,755(1)	2.9
Estimated European Total	46,579	236,026	
Southern Hemisphere			
Chile	126	482	3.8
Argentina	314	1,050	3.3
Bolivia	652(2)	341(2)	0.5(2)
Australia	141(1)	394(1)	
Estimated World Total	51,517	252,248	

(1) Five year average 1930–34 inclusive.
(2) Crop year 1926.

TABLE II.—*International* Trade *in* Potatoes, *1937*

Country	Exports Short Tons (1000 Short Tons)	Imports Short Tons (1000 Short Tons)
Exports Exceeding Imports		
Canada	98	8
United States	55	32
Netherlands	511	6
Italy	172	85
Poland	61	0.3
Czechoslovakia	9	8
Hungary	87	0.1
Spain	113(1)	23(1)
Portugal	19	15
Algeria	87	37
Ireland	55	0.1
Estonia	26	0
Japan	45	0
Malta	16	6
Cyprus	20	1
Netherlands Indies	1	0.6
China	5	0.2
Denmark	65	0
Norway	1	0
Yugoslavia	0.6	0.4
Imports Exceeding *Exports*		
Germany	23	157
United Kingdom	62	249
France	61	177
Belgium	95	99
Cuba	0.8	33
Austria	6	29
Switzerland	0	58
Uruguay	0	37
Brazil	0.9	1
Egypt	3	24
Finland	0	1
Sweden	0.1	7
Tunisia	1	12
Philippine Islands	0	12
Argentina	4	267
Venezuela	0	6

(1) 5 year average, 1930–34 inclusive.

bruising. It is fairly impermeable to gases. Lenticels take the place of stomata. Below the periderm is a rather dense layer of cortex which is variable in width and consists of small parenchyma cells densely filled with starch grains. The vascular bundles approach the surface of the tuber at the eyes. The pith enclosed by the vascular ring constitutes the greater portion of the tuber It may be divided into the more dense portion, the outer medulla. and the less dense portion, the inner medulla. The medullary regions consist of large parenchyma cells less densely filled with starch and other contents than is the cortex.

World Production. — Most of the accounts of the introduction of the potato into Europe and North America are without doubt legendary, but the spectacular increase of the potato as a food crop is not legendary. It is one of the miracles of agriculture and is grown in almost every important agricultural country in the world. Though it succeeds best in the cooler regions, it has made rapid development as a food crop in many other places and exceeds, in point of total production, that of any other table plant grown.

It will be noted in Table I that the countries which may be classed as cool produced the highest average yields. The average for the United States as a whole is comparatively low, although it had increased to approximately 4 tons per acre in 1942. The yields in Maine and Idaho, with cool summer climates, and in California, where the potato crop is grown for the most part in late winter and early spring, compare favourably with the highest yielding countries of Europe. A plentiful supply of irrigation water in California and Idaho also accounts to some extent for the large yields produced there. The international trade in potatoes is quite important, as indicated by Table II.

Europe as a whole exports more potatoes than it imports, as do also Canada and the United States. On the other hand, Central America, South America, Africa and Asia are deficit zones.

The demand in England and Wales is not satisfied by the home crop, and supplies are sent from both Scotland and Ireland, where production is always in excess of home needs. In most seasons the British Isles as a whole are almost self-supporting in potatoes. Imports of early kinds, however, are brought in from the Canary Isles, Spain, France and the Channel Islands in the early months when people have tired of eating "old" tubers. Commercial production of the main crop is centred in Lincolnshire, Yorkshire, Lancashire and Durham in England; Forfar, Fife and Perth in Scotland and in Counties Down and Antrim in Northern Ireland.

Potatoes are grown throughout France, though in some of the departments the soils are not well suited to culture and acreages are small. In other departments, Vienne, Rhin, Saône-et-Loire, Loire, Haute-Loire, Loire Inférieure, Maine-et-Loire and Morbihan, considerable areas are planted for commercial production. In certain specially favourable places such as St. Malo, Brittany and also in the Rhône valley, quick-growing varieties are planted to give an early supply to the markets not only of France but in normal times to England also.

Potato production in Germany is of two kinds. The crop of the west is grown mainly for table purposes, that of the east mainly for industrial purposes — though naturally much variation occurs at times. In eastern Germany there exist vast tracts of light sandy soil of little use for grass or cereal production, but by continuous and judicious manuring with fertilizers they have been rendered fertile for potatoes which are grown in large quantities and largely used for making farina or alcohol.

The late or main crop of potatoes in the United States is grown mostly in the states bordering Canada, where climate and soil are most favourable. The states leading in production are Maine, Idaho, Minnesota, New York, Michigan, Wisconsin, Pennsylvania, North Dakota, Colorado and California. Every state produces potatoes at some season, but the surplus commercial crop is grown mostly in the above named states. Colorado, California, Florida, Alabama, Louisiana, North Carolina, South Carolina. Virginia, Maryland and New Jersey ship to distant markets when the potatoes from the north are scarce. The southern states grow the crop in the winter and spring, when the temperatures are comparatively cool,

Varieties — Many hundreds of varieties of potatoes are grown in the different countries of the world. In England and America they are divided into first earlies, second earlies, mid-season or early main crop and main crop or late varieties. In England the heaviest croppers among the first earlies are Epicure, Duke of York, Sharpe's Express and Immune Ashleaf. The principal second early and main crop varieties are Ally, King George, Great Scott, King Edward, Arran Chief, Majestic and Kerr's Pink.

For many years the varieties grown commercially in the United States were mainly those which were originated by pioneer potato breeders in the 19th century. Some of these were products of hybridization, some were discovered as mutations or "sports," others originated as chance seedlings. A number of these continue to be standard varieties in certain sections of the country. Among them are the early varieties, Irish Cobbler, Triumph and Early Ohio, and the late varieties, Green Mountain, Rural New Yorker No. 2, Russet Rural, White Rose, Burbank and Russet Burbank. The National Potato Breeding program, organized cooperatively by the U. S. department of agriculture and state experiment stations, distributed to growers 16 new varieties. Among these are 4 first earlies: Earlaine, Mesaba, Warba and Red Warba; 3 second earlies: Chippewa, Pawnee and Kasota and 8 late varieties: Katahdin, Houma, Golden, Pontiac, Sebago, Sequoia, Erie and Mohawk.

Dr. William Stuart of the department of agriculture classified the American varieties into 12 groups, largely on the basis of tuber characters, season of maturity and blossom colour. Each group was named for the leading variety in it and contains all of the commercially important varieties of the respective type which it represents. The 12 groups are: Cobbler, Triumph, Early Michigan, Rose, Early Ohio, Hebron, Burbank, Green Mountain, Rural, Pearl, Peachblow and Up to Date.

Potato Soils. — The potato can be grown on almost any soil, but deep, rich sandy loams or well drained alluvial silts are most suitable. The Lancashire and a part of the Lincolnshire and Irish crop are produced in black peat. These soils produce good yields, but the tubers are dull and dark in appearance and sell at lower prices than bright skinned tubers produced in the red sandstone silts and limestone soils. One of the most ideal soils for potatoes in the United States is the Caribou loam in Aroostook county, Maine. This is a chocolate brown coloured soil abundantly supplied with small decomposing fragments of shale rock with which it is underlaid.

It has been found highly profitable to grow potatoes on the muck or peat soils that are so extensive in a number of states. The potatoes grown on such soils usually have good shape, but like those grown on the Irish peat they have a dark appearance. This difficulty is overcome by the practice of many growers of brushing or washing the tubers before they are packed for market. When this is done the potatoes often bring a premium.

Rotations. — The importance of an abundant supply of organic matter in the soil cannot be over-emphasized. A large amount of humus keeps the land in a friable condition and provides a continuous supply of available plant food. There is no general and well-defined system of crop rotation adhered to in any of the large potato growing centres. The desirability of rotating crops is well understood, but the temptation to grow a money crop as often as possible is very great so that the benefits from the practice of rotation are often sacrificed to the prospect of immediate gain. In England the position of the potato crop in the rotation varies very much in different localities, but potatoes do particularly well after old grass or a short fallow. In the United States the potato is usually grown in a rotation series of two or more crops; the one preceding is preferably a legume. Type and length of rotation depend on the kind of agriculture practised. In the Aroostook section of Maine, where the potato is the major crop, a three-year rotation of potatoes, oats and clover is standard, the clover being usually plowed under as green manure.

Sweet clover commonly precedes potatoes in the rotation in the central states and alfalfa in the western states. In most New England and middle Atlantic states timothy sod containing clover residue is plowed before potato planting. Frequently the sod residue is too scanty to be of much benefit to the potato crop.

Along the eastern seaboard potatoes are commonly grown year after year on the same soil. If little or no stable manure is available, the growers depend on rye as a winter green manure crop to maintain the soil humus supply. In the south, velvet beans, soybeans and cowpeas are used for the same purpose. Rotation is necessary in many sections where the soil reaction is nearly or quite alkaline to avoid infection of the tubers with the common scab disease. In these sections growers avoid the use of lime, and an effort is made to use commercial fertilizers that increase soil acidity. It is usually advisable to decrease the acidity of potato soils only when and to the extent necessary to promote the growth of legumes in the rotation.

Fertilization and Preparation of Land.—Stable manure is always beneficial to the potato crop, and within reason the greater the dressing the larger the crop. In practice in England not more than 20 tons per acre should be applied. Often the amount has to be cut to 10 or 12 tons; and where this is done, the deficiency should be made good by using some other material. Seaweed, for instance, is an excellent substitute and is much used by the potato growers of Scotland, Ireland, Cornwall and the Maritime Provinces of Canada. Irish growers have to use artificial fertilizers as a supplement. Most experimenters are agreed that a fertilizer containing nitrogen, phosphates and potash is desirable, but the exact proportion in which they should be mixed depends in large measure on specific soil requirements.

The following mixture per acre may be generally depended upon to produce good crops:

2 cwt. sulphate of ammonia
6 cwt super phosphate,
2 cwt. sulphate or muriate of potash

In the trials conducted at the Rothamsted experimental station in England, the nitrogen fertilizers proved over a period of years the most consistent in their action, giving every year with rare exceptions an increase of about 20 cut. of potatoes per cwt. of sulphate of ammonia used, whatever the season and whether or not farmyard manure was used. At Rothamsted there was little variation from season to season in the maximum yield of potatoes obtainable by good manuring. Their maximum was 11-13 tons per acre and usually 4 cwt. of sulphate of ammonia and 4 cwt. of sulphate of potash per acre were necessary to secure this. Economy of either ammonia or potash reduced the yield. The action on other soil would no doubt be somewhat different.

In the eastern and southern sections of the United States, chemical fertilizers make up nearly 3 of the total cost of production. In Maine and along parts of the Atlantic seaboard 1-1½ tons to the acre of a complete fertilizer is commonly applied. Westward and on heavier soils a smaller quantity of fertilizer containing less nitrogen and potash is used. In the first mentioned regions 5-8-7 or 4-8-7 analyses are recommended while on the newer and heavier soil types 4-12-4 and 5-10-5 are often used. Double-strength fertilizer in correspondingly decreased acre applications is also used. When stable manure is applied liberally, as in the dairy regions, commercial nitrogen may not be needed.

Modern planters are equipped to distribute commercial fertilizer in bands on each side of the seed piece and well mixed with the soil to avoid possible burning of the sprouts. Stable manure when used may be spread on the land by hand or with a manure spreader, either before or after the land is plowed. Some growers prefer to plow the manure under while others favour its application to the plowed land. Regardless of how or when it is applied, the best results are obtained when it is thoroughly incorporated with the soil and well decomposed before planting time.

Where potatoes follow the cereal crop, which frequently happens in England, preparation of the land should begin with an autumn cleaning followed by deep winter plowing and spring cultivation to give moderately fine tilth. In April, the ridging plow is used to throw the soil into ridges between which lie the furrows (distance between the furrows being about 27 in.) into which the potato-sets will go; before these are planted it is customary to scatter the barnyard manure and artificial fertilizers in the furrows so that they lie close to the sets.

In the United States it is generally desirable to plow the land for the potato crop in the fall, except where soil is liable to wash badly during the winter. Fall-plowed land should be disked and harrowed as early as possible in the spring and then kept friable until the crop is planted. Spring-plowed land should be disked as plowed and kept mellow. The deeper it is prepared and the more finely it is pulverized, the more suitable it is for producing large yields. It is much easier to do this before than after planting. The old adage that "a stitch in time saves nine" is quite applicable to the proper preparation of the land.

Seed.—The importance of using good seed cannot be overemphasized. but the term "good seed" needs careful definition. A potato tuber of any size when planted is capable of giving a crop. but in practice in Great Britain and parts of the U.S. it is found most economical to select seed tubers weighing approximately 2-3 oz. These can be planted whole. If large tubers are used they may be cut into seed pieces or sets. The latter is the common practice in the larger growing areas of the United States.

Good seed cannot be judged by appearance alone. It should be true to name and free from diseases, and the variety should be well adapted to the region in which it is to be grown. It is impossible even for experts to recognize varieties by examination of the tubers alone, so a record of the purity of the crop from which the seed stock was selected is the most reliable guide. Unfortunately tubers infected with virus diseases such as mosaics, leaf roll, crinkle or curly dwarf cannot be distinguished from healthy potatoes. The disease readings of the crop from which the seed was harvested is the only sure guide. If the parent crop was all of one variety, free from mosaics, leaf roll, crinkle, spindle tuber and curly dwarf, the seed selected from it has a good history and a good potential yielding capacity; if the parent crop was mixed or had much virus infection, the seed from it will be distinctly inferior, regardless of the appearance of the seed tubers.

The virus diseases are not peculiar to any country or region, but in some places and in some seasons they spread more rapidly than in others. They are spread mostly by insect vectors such as aphids or plant lice; conditions that favour insect infestations also favour the spread of these diseases. Potato crops grown in the colder districts are known usually to be freer of viruses than those of the warmer regions, and in consequence the former districts are the better areas in which to grow potatoes for seed. Consequently, growers in the southern districts of the United States buy nearly all of their seed from producers in the north and the Maritime Provinces of Canada. This is necessary because southern-grown potatoes are often seriously devitalized by heat and virus diseases.

To combat these diseases and raise the standards of potato cultivation, many countries—including the United States, Canada. the Netherlands, England, Scotland, Northern Ireland and the Irish Free State—have established systems of seed-potato-certification under which fields of potatoes are examined by inspectors and certificates given for those crops that reach certain specified standards of purity to type and freedom from diseases. The increase in the production of such seed in the United States was tremendous. In 1919 about 475,000 bu. of potatoes were certified, and in 1941 more than 17,000,000 bu. met the certification standards.

Storage is an important factor in the maintenance of good seed. At harvest time potatoes are in a dormant condition and cannot be made to sprout at once. This rest period lasts from about 6 weeks to 3 months depending on the variety and the conditions under which the tubers are stored. Tests have shown that dormancy can be maintained in some varieties for 6 to 8 months at temperatures ranging from 36° to 40° F. When kept at high temperatures the tubers sprout after a few weeks and soon become shrunken and lose vitality; each successive generation of sprouts is weaker than the preceding one. In fact, seed vigour in stored tubers can be measured to a degree by noting the character of the sprouts; if slender and originating from many eyes the seed may be adjudged weak. Long storage sprouts should not be allowed to develop. In preparing the seed for planting it is common practice to disinfect uncut seed potatoes against such tuber-borne diseases as common scab, rhizoctonia (black scurf) and blackleg. This is done at any time up to the planting date, preferably when the tubers are in a clean, dormant condition Various disinfectants and methods are used. Corrosive sublimate (mercuric chloride) and formaldehyde have been used most. Treatment of uncut rather than cut tubers is advised.

In the mercuric chloride (corrosive sublimate) treatment the standard solution is made by dissolving 1 part of mercuric chloride in 1,000 parts of water, or, 4 oz. in 30 gal. of water. Potato tubers are immersed for 30 min. to 2 hr. in this solution. Mercuric chloride goes into solution very slowly in cold water and it should therefore be dissolved in a small volume of hot nater. The solution should be prepared and used in wooden, enamel or concrete containers. The solution decreases in strength with use. To correct this, ½ oz. of the chemical should be added for every 4 bu. of potatoes treated for 2 hr. If a shorter treatment is used, the amount of chemical added should be reduced proportionately. Enough water should be added each time to bring the solution up to its original volume. Make up a fresh solution after 4 treatments. Wetting the tubers for 20-24 hr. before treatment makes the disinfection more effective.

Cold formaldehyde is not effective in controlling rhizoctonia but may be used for the control of scab. The solution is prepared by adding 1 pt. of formalin (40% commercial formaldehyde solution) to 30 gal. of water. The tubers are immersed in this solution for 2 hr.

Hot formaldehyde is not so effective as mercuric chloride but is widely used in some places. Previous to being treated it is desirable to keep the potatoes wet for 24 hr. The solution is made up by dissolving 2 pt. of formalin in 30 gal. of water heated to a temperature of 124° to 126° F. and held within these limits by steam or by means of a fire maintained beneath the tank. The tubers are then dipped for 4 min. A false bottom to the tank is necessary to keep the tubers at the bottom from becoming overheated. The solution should not be warmer than 126° F. because above this temperature injury to the sprouting of the potatoes results. Nor should it be cooler than 124° as it would then not control the disease if the tubers are dipped for only the 4-min. period. To allow for condensation water when live steam is used for heating, 0.9 pt. of formalin should be added after every 50 bu. of tubers are treated. The solution does not lose its strength on standing if it is well covered and may safely be kept thus for a few days or weeks. Covering the tubers with a canvas or burlap for an hour after treatment adds to the efficiency of this method.

It is considered by a number of experts in the United States that such seed treatments are very inefficient in the control of disease and in most cases not worthwhile. If the seed tubers are clean there is no need for treatment. If they are badly infected they should be sold for table stock. If diseased tubers must be used some of the organisms will be killed by the mercuric treatments, but very few by formaldehyde and if the treated tubers are planted in soil infested with disease organisms, the resulting crop of tubers will be diseased.

Green sprouting seed potatoes before planting in order to hasten the development of marketable tubers is a common practice in Great Britain and on the continent but is employed to a very limited extent by U.S. growers. This is essentially a germination test which results in more perfect stands of plants, less disease, increased earliness and possibly higher yields.

The questions of size of the seed piece and of planting whole rather than cut seed are still not fully answered. The superiority of whole over cut or of cut seed over whole has been demonstrated for both, and the conclusion can be drawn that no general rule can be given, but that much depends on the variety and the environmental conditions in which the crop is grown. Seed pieces should be cut large enough to ensure at least one vigorous healthy sprout. They should be blocky and as uniform in size and shape as possible especially where they are planted with a self-feeder planter. Pieces weighing less than an ounce are subject to drying out when planted in hot dry soil and may result in weak plants or missing hills. Experiments have shown that the eyes from the basal and the seed end of the tuber of most varieties are of equal value for seed.

As a rule potatoes are planted as soon after cutting as possible. This is a satisfactory method in the large producing areas of the United States if the soil at planting time is not too wet or too dry and the weather too cold. In regions where seed piece rot is a problem, whole tubers or suberized seed should be used. Suberization or corking over is best accomplished by storing the cut tubers in an atmosphere of relatively high humidity and a temperature range of from 60° to 70° F. Under these conditions a protective layer of cork cells will develop over the cut surface forming an effective barrier against disease organisms in the soil. The use of such materials as hydrated lime, gypsum and sulphur to cause rapid drying is no longer recommended.

Planting and Cultivation. — Potatoes are planted in the United States every month of the year although the bulk of the crop is planted from March 15 to June 30. The date depends on the regional climate, latitude or altitude, but it is desirable to plant at such date as will allow the period of blossoming and tuber-setting to come in relatively cool weather. In some regions subject to late blight infection, the early planted crop is most likely to escape while at the same time it may be more subject to injury by leafhoppers and flea beetles.

In England the soil is thrown into ridges with a ridging plow. The seed pieces are planted by hand in the furrows between these ridges. The distance between the furrows is about 27 in. and between the plants in the row, 10 in.–I ft. The seed pieces are covered by splitting the ridges with the ridging plow so that the soil falls into the furrows on either side. There are potato planting machines which open the furrows, place the fertilizers and sets in position and cover them as they proceed across the field. Hand planting is practised on many of the small acreages in the United States, but probably more than ¾ of the commercial acreages are planted with machines. Many of these machines plant one row at a time, but two row planters are quite common and some plant 4 rows in one operation. These planters are of two types, an automatic picker type requiring only one man to operate or an assisted feed type requiring an additional man to regulate the flow of the seed. Modern planters are equipped to distribute fertilizer in bands on each side of the seed piece and mix it with the soil to avoid possible burning of the potato sprouts. These machines can be adjusted to various distances between rows and to drop the sets at various distances apart in the row. Four inches is the depth of planting recommended, with shallower depth for heavy soils and deeper for sandy soils. The average amount of seed used is approximately 15 bu. to the acre, the range being from 8 to 30.

Cultivation for weed control is very important, as the potato plant is very sensitive to weed competition. On the other hand the plant may be seriously checked in growth and yields reduced when harsh, deep, late season cultivation results in cutting off the extensive, lateral, fibrous root system and disturbing the developing tubers between the rows. Thorough seed bed preparation and early season cultivation rather than late are therefore recommended. If late cultivation is practised it should be very shallow and just deep enough to cut off the weeds. Moisture conservation is not, as was formerly thought, a prime factor in cultivation. Shallow cultivation of heavy soils to break the crust that forms after heavy rains is desirable to provide soil aeration and permit absorption of later rains. Ridging of rows especially on heavy soils has several advantages. It affords an effective means of weed control, run-off of excess surface water, protection of the tubers from sunburn and to a degree from late blight spores and allows easier digging of the crop. Tractor or horse drawn cultivators for early cultivation and hillers or hoe ridgers are used for ridging the rows.

POTATO DISEASES AND INSECTS

Potato diseases are very numerous. They can be classed as virus, fungus, bacterial and physiological.

Virus Diseases. — The virus diseases are not due, as far as is known, to any living organism or to nutritional disturbances. They were formerly believed to be the result of degeneration brought about by continuous vegetative propagation of a variety. Thby were spoken of as "degeneration" diseases. The fallacy of this belief has been clearly demonstrated. The most troublesome virus diseases are mild mosaic, latent mosaic, rugose mosaic, leaf roll, spindle tuber and yellow dwarf.

Mild Mosaic.—The usual symptom of mild mosaic is the mottling of the leaves. The leaflets, instead of being uniformly green, show different shades of green or a slight yellowness; the leaves may also show some crinkling. In many cases the name "mild" is a misnomer, since the disease can be very severe. In such cases the plants may be dwarfed and the yield markedly reduced. Under hot, dry conditions the mosaic symptoms may not be so marked or may disappear altogether, but the yield of diseased plants is nevertheless diminished.

Latent Mosaic.—This disease is true to name in varieties like the Green Mountain and Irish Cobbler, in which it is present in 100% of the plants. No disease symptoms develop in these varieties and it is not known if the yields are reduced since no tubers can be found free from the virus and as a consequence no comparative yield tests between diseased and healthy plants can be made. In other varieties and seedlings it can hardly be considered latent since various reactions are discernible. Some varieties show mottling, others a top necrosis and in some of them the yields are severely reduced even if no symptoms are observed.

Rugose Mosaic.—This disease is considered by some to be more serious than mild mosaic and is entirely distinct from it. The mottled areas are smaller and more numerous and typically are distributed closer to the main veins. The mottling is readily masked under high-temperature conditions but the crinkling of the leaves makes identification rather certain. The veins on the underside of the lower leaves often show necrotic areas as black, pencil-like lines. Affected plants are usually stunted and die much earlier than the healthy ones. Rugose mosaic is spread readily by aphids. If infection takes place early in the season, current-season symptoms are likely to develop before the plant dies. If infection occurs late, symptoms may not appear the same season but tubers from such plants will carry the disease. Current season symptoms are characterized by a burning and discolouration of the leaf veins and leaf blades, brittleness, leaf dropping and premature death.

Leaf Roll.—This virus disease is very common in Britain, Canada, the United States and in potato growing countries generally. It is characterized by the upward rolling of the leaflets so that the midrib remains at the middle of the trough thus formed. The lower leaves usually show the symptoms first. Other symptoms are dwarfing, rigidity, leathery texture, chlorosis and reddish or purplish discolouration of the affected leaves. Net necrosis appearing in newly infected tubers is a symptom of leaf roll of certain varieties. It is a network of small brown strands of discoloured tissue extending throughout the interior of the potato tuber, the discolouration usually beginning at the stem end. As in the case of the mosaics described above, the leaf roll virus can be transmitted by aphids and possibly by other insects. Infection can also be produced by grafting together of healthy and diseased tubers or other portions of the plant. Hot dry weather often causes a curling of the leaves which can easily be mistaken for the virus leaf roll.

Spindle Tuber.—This disease is so named because of the spindle-shaped tubers produced by infected plants. Such plants are often slender, upright and smaller than healthy ones and the foliage is sometimes darker green. In Triumph, infected tubers are lighter red than the healthy tubers and have a tendency to be blocky and cylindrical in shape. Experiments have shown that this disease can be transmitted by various insects, including grasshoppers, flea beetles, tarnished plant bugs and Colorado potato beetles. To some extent the disease may be spread by contact with cut seed pieces, by the seed-cutting knife and by picker-planters.

Yellow Dwarf.—The foliage of plants with yellow dwarf takes on a yellowish-green colour, whereas the upper surface of the leaves becomes slightly rugose. Dying from the tip downward is characteristic. High temperatures and low humidity tend to hasten the death of infected plants. Brown spots in the pith of the stem are common. In warm soil, seed pieces from infected tubers often fail to germinate; others produce shoots that die before they reach the surface. Infected plants often produce small, misshapen tubers which in cross-section show small necrotic areas scattered throughout the flesh.

Experiments conducted in New York state showed that this disease is transmitted by the clover leafhopper. This insect retains the virus during the winter and infects healthy potato plants in the spring.

Fungus Diseases.—*Late* Blight. This is the most serious of the many diseases to which the potato is heir. It is found in all the potato growing countries and as a whole causes more damage to the potato than all the other diseases combined. It is caused by a parasitic fungus *Phytophthora infestans*, which seems to have been noticed in Europe about 1840 and by 1845 had become widespread. It was the cause of the Irish famine in 1846. uhen the potato crop was almost completely destroyed. It is always present in Britain but is much more severe some seasons than others.

In the United States it is most destructive in the New England and north central states. At times it is responsible for considerable loss in nearly all the eastern seaboard states even as far south as Florida and along the Pacific coast. It is seldom of any importance in the other southern and central states. Wet seasons are particularly favourable to the disease and much of the crop may be lost unless preventive measures are taken; in dry summers it may do little damage. The disease generally shows itself as purplish brown or blackish patches on the leaves, often appearing first on the leaves near the top or margin. In damp weather the undersides of the patches may show delicate white threads, the hyphae of the fungus. Under such conditions also the dark coloured patches spread rapidly, and the whole foliage may be transformed into a moist black mass. Leaves badly attacked give off an offensive odour, detectable at a considerable distance.

The minute white threads which make up the body of the fungus branch and produce large numbers of pear-shaped structures, the spores of the fungus. These spores are detached and are carried by the movement of the air to other plants, where they germinate. The resulting threads pass through the stomata1 pores of the leaf and each starts a new infected area. Under suitable conditions a new crop of spores may be produced a few hours after infection so the fungus can spread rapidly. Under favourable warm and moist weather conditions all the plants in the field may be killed in a few days. The organism also attacks the tubers, which become infected either in the soil through spores washed from the diseased tops or in harvesting through contact with blighted foliage. When late blight tuber rot first develops in the soil, it is usually brown and spreads irregularly from the surface through the flesh. The affected part may become soft partly because of an abundance of moisture but mainly because other organisms, particularly bacteria, invade the diseased areas. Under storage conditions the disease is typically a dry rot forming irregular sunken patches, which under favourable conditions may involve the whole tuber. Secondary organisms may invade the tubers in storage and cause soft rots. The disease lives over in the tubers.

Early Blight.—Early blight, also known as leaf spot and caused by Alternaria *solani*, under some conditions occurs earlier in the season than late blight but under other conditions it may occur later. The fungus attacks the potato leaves causing the development of brown spots which, as they enlarge, develop concentric rings or markings. When the spots are numerous the leaves are killed and the yield of potatoes is consequently reduced. Small. shallow, more or less circular decayed lesions are sometimes iormed on the tubers. These lesions rarely cause serious harm but they do afford entrance for soft rot organisms that complete the decay of the tubers.

Potato Scab.—This disease, often known as common scab of potato, is caused by *Actinomyces* scabies. It is particularly troublesome in sandy and gravelly soils, especially neutral or alkaline soils. It is known to exist in every potato growing section of the United States. It attacks the tubers and, when very severe, renders them unfit for market. The scab lesions are small and brownish at first but later enlarge into hard, circular, or irregular corky areas on the surface of the tubers. They may separate or run together, sometimes covering the whole potato. They vary in type from shallow to deep.

Fusaria.—A number of species of Fusarium are known to attack the potato, causing wilt and other injury to the plants and tubers. Among these are F. *oxysporum,* F. *eumartii,* F. avenaceum, F. *coeruleum* and F. trichotheciodies. Plants attacked with F. *oxysporum* may wilt rather suddenly and die in a comparatively short time, or they may show the effects slowly and succumb gradually. The first symptoms are a yellowing and drooping of the lower leaves. There may be also some curling and rolling of the leaflets and tip burning. On hot days the yellowing is preceded by a wilting of the leaves and even of the stalks. The stems of affected plants are invariably discoloured in the interior. The woody tissues of the interior of the stem are yellow to brown, often extending from the base well into the top. The tubers of wilt infected plants often show a browning of the water vessels near the stem end. F. *eumartii* produces at first a burning and bronzing or slight yellowing of the upper leaflets. In late stages the plants wilt and die. Stems of the affected plants show a brownish flecking when cut longitudinally. Tubers of such plants show a browning of the stem end and vascular discolouration. The wilt organisms are carried over from one crop to the next in the tubers or in the soil. F. avenaceum has been reported from Wisconsin as behaving very much like F. oxysporurn. Dry rots caused by F. coeruleum and F. trichotheciodies are generally referred to as storage dry rots. F. coeruleum, apparently the most common, can penetrate through an unbroken skin, but it usually enters through wounds and produces large sunken pockets or a wrinkled decay. Numerous bluish or whitish protuberances are formed on the surface of the decayed parts. The powdery dry rot caused by F. trichotheciodies is limited to situations having warm dry summers. Affected tubers shrink considerably and often develop in the interior large hollow pockets partly filled with a brick-coloured powdery mass of fungus growth.

Rhizoctonia Canker (Black Scurf).—The fungus that causes rhizoctonia or black scurf on the tubers, Corticium *solani,* ordinarily shows as small brown-black bodies closely adhering to the skin. These sclerotia, as they are called, may be as small as a pinhead or half as large as a pea. They are composed of mycelial threads and represent the resting stage of the fungus. Lesions or dead areas may develop on the underground stems and on the stolons and may so interfere with the proper functioning of the plant that the leaves roll, small tubers form in the axils of the leaves or the nodes of the stems become considerably enlarged and knobby because the starch cannot be properly transported downward. Many small potatoes and a few large knotty ones may be developed underground. This result often gives rise to the term "little potato disease."

Wart.—This disease is due to a fungus, *Synchytrium endobioticum.* It was discovered in 1896 in upper Hungary and was thought to be a new form of scab. The earliest definite record of it in England was in 1898 and in North America in 1912. It has caused serious damage in Europe, especially in certain districts of England and Ireland, but has been confined in the United States to a few small areas in limited districts of Pennsylvania, Maryland and West Virginia. The disease generally shows itself as warty outgrowths on the tubers and stolons and occasionally the stems and even the leaves. In severe cases the tuber may become a warty mass. The warty tissue of the tuber shows thick-walled sporangia which, reaching the soil, liberate free-swimming cells, zoospores. These penetrate some part of the young potato plant, usually one eye of the tuber and develop there, causing the abnormal warty tissue. In the affected tissue thinner-walled sporangia, the summer sporangia, are produced. These discharge to the exterior and liberate fresh zoospores which cause new infections, and so the process is repeated. The zoospores may unite in pairs and then after infection produce the thick-walled resting sporangia which, when they escape into the soil, are the source of infection for new crops. The fungus may live for many years even when the soil is kept in sod. The disease is easily spread by infected soil and tubers; the winter sporangia pass through the alimentary canal of animals unharmed.

Bacterial Diseases.—Blackleg.—Blackleg is caused by *Erwinia phytophthora.* It causes heavy losses in some potato growing sections under conditions favourable for its development. It may cause seed piece decay or destroy the sprout before it appears above ground. It causes also serious rotting of tubers in storage. The first symptoms are the rolling of the upper leaves of one or more shoots, compactness of the foliage and the gradual yellowing of the leaves. The plant dies as the base of the stem is rotted away by bacteria. The plant tissue in this region usually turns black, giving rise to the name blackleg. In seasons of abnormal rainfall the disease develops rapidly and involves a greater part of the stem than in dry seasons. When the disease progresses slowly aerial tubers may be formed on the stems, as in rhizoctonia canker. Tubers not severely affected if harvested and planted will very likely carry the disease over to the resulting crop. Unless conditions for the development of blackleg are favourable, however, the disease will not develop even if infected tubers are planted. It has been demonstrated in Minnesota and Maine that the seed-corn maggot is active in spreading the disease. If the fly has access to seed potatoes, eggs may be deposited. The maggots hatched from these eggs may be contaminated with the bacteria and may infect the seed pieces.

Brown Rot (Bacterial Wilt).—Brown rot is a bacterial disease resulting from infection with Phytomonas solanacearum. It is often called southern bacterial wilt. Climatic conditions limit this disease to the warmer potato growing sections of the United States. It is found in the south Atlantic and gulf coast states from Maryland to Texas and sometimes in Ohio, Illinois, West Virginia and Kentucky. The first symptom of brown rot is a slight wilting of the terminal leaves during the hottest part of the day. The plants may recover at first during the night but each successive wilting becomes more severe until finally the plants die. The vascular bundles in the stems, roots and stolons turn brown when they become stopped up with bacteria, causing the wilting and death by cutting off the plant's water supply. The brown colour is finally evident on the stem one or more inches above the soil line. When the vascular bundles are cut or broken, bacteria ooze from them as a white slimy mass. The bacteria sometimes ooze from the eyes of affected tubers, and becomemixed with dirt which upon drying sticks to the surface. Tubers left in the ground continue to decay. Other rot organisms may invade the injured tissue and assist in making it a slimy mass with a very offensive odour. Plants with their tops killed by brown rot may bear healthy as well as diseased tubers. Other plants showing no signs of disease in their tops may sometimes produce diseased tubers.

Ring Rot (Bacterial **Ring** Rot) results from infection with *Phytomonas* sepedonica. It has been known in Europe for a relatively long time but has not been prominent in the United States until recently. It is an infectious bacterial wilt and ring rot disease. It differs from brown rot in that it is not so limited by climatic conditions and has been known to occur in nearly all the potato growing states. The symptoms of this disease generally do not become evident until late in the season. Some varieties become infected without showing symptoms in the leaves. When affected tubers are present there are usually found all gradations, from sound to completely decayed tubers. Decay begins in the region near the vascular ring of the tuber; hence the name ring rot. The decayed tissue is yellowish white and of a crumbly nature and may ooze from the infected parts under pressure. Infected tubers are often invaded by other soft rot organisms causing more rapid decay. The bacteria live over winter on slightly affected tubers. In many of these tubers the disease cannot be detected, but they may contain enough bacteria to contaminate the cutting knife, the receptacle that the seed is carried in or the planter; and the disease is spread to healthy seed by contact with such infested equipment.

Physiological Diseases.—These diseases are due to unfavourable environmental conditions and are not known to be caused by any virus, fungus or bacteria. A number of physiological diseases are due to a deficiency in the soil of the elements necessary for growth. Those most often deficient are nitrogen, phosphorus, potassium and magnesium. Other abnormalities in potatoes may be due to a number of causes.

Heat and drought necrosis occurs in tubers that are allowed to lie in the hot soil after the vines begin to die. The water vessels of the affected tubers take on a golden yellow to brown discolouration. Freezing necrosis is caused by limited ice formation within the tuber. Upon thawing several kinds of internal discolouration may appear. In the ring type discolouration is limited to the vascular ring and adjacent tissue; in the net type there is more or less blackening of the vascular tissue and the fine strands that extend from the vascular tissue into the interior pith and outer tissues; in the blotchy type discolouration is characterized by irregular patches ranging from an opaque gray or blue to sooty black and may occur anywhere in the tuber.

Sunburn or greening results from exposure to light. In case of long exposure the outer tissues turn deep green and those underlying a greenish yellow or deep yellow. Greened tissue is unpalatable for most people and may be poisonous for a few.

Sunscald is caused by the development of extremely high temperatures in the tuber when exposed to sunlight. Often the tissues are killed to a considerable depth. Tubers may become watery and turn brown throughout or at least to a considerable depth, or they may have a blistered appearance externally and a metallic colour. Such areas may dry out and appear chalky and granular or hard and leathery. Most frequently, however, they are attacked by bacteria and fungi that cause a rapid decay.

Blackheart is a result of the asphyxiation of the tissue of the potato tuber. It occurs either when the temperature is too high or when the ventilation is so poor that the supply of oxygen is inadequate. The external symptoms of blackheart are moist areas on the surface which may be purplish at first but turn brown or black within a short time. The internal symptoms are a dark-grayish to purplish or inky black discolouration. Tissues cut soon after injury are of normal colour; shortly after access to air, however, they turn pink, then gray or purple and finally jet black. Generally the discolouration is restricted to the interior but may radiate to the exterior. With slight drying, affected tissues are firm and leathery; with prolonged drying, cavities result.

Insect Pests.—The common insect enemies of the potato are the Colorado potato beetle, flea beetle, leafhopper, aphid, psyllid, seed-corn maggot and wireworm.

The Colorado Potato Beetle, *Leptinotarsa* decemlineata, was unknown to the potato growers of North America prior to 1855. About that time the potato growing industry had spread west, and when it reached the section where these beetles were native they left the mild solanums on which they customarily fed and began to infest the plants. They soon spread in all directions until they were found in nearly all the potato growing regions of the United States and Canada. The adult potato beetle is about three-eighths of an inch long and yellow in colour with five black stripes running lengthwise on each wing cover and a series of black spots on the thorax. The eggs, 500–1,000 of which may be laid by one female, are yellow and are usually deposited in clusters on the under side of the potato leaflets. They hatch out in about a week. The full grown larva is a stout fleshy grub with a black head and black spots over the body. It consumes a large amount of foliage; and if many larvae are allowed to remain on the plant, they soon strip it of all its leaves. They mature in about three weeks, after which they enter the ground to pupate. Two or three generations may be produced in a season. The last generation winters underground, emerging as mature beetles early in the spring.

Flea Beetle.—The potato flea beetle, *Epitrix cucumeris,* is a small black jumping beetle, slightly over one-sixteenth of an inch in length and about one twenty-fourth of an inch in width. The antennae and legs are yellowish but the body parts including the head, wing covers and thorax are jet black. These beetles eat small holes in the leaves and when they are present in large numbers cause serious injury and reduced yields. The eggs are laid under rubbish on the ground, and the larvae attack the underground parts of the plant. In some sections, particularly in the south, the tubers at times are so seriously injured that they are inferior in market quality, if not unsalable. One or two broods are produced each season depending on the locality.

Leafhopper.—The potato leafhopper, Empoasca fabae, is a sucking insect. It causes a very destructive disease-like condition called hopperburn. This condition begins with a yellowing of the leaf around the margin and tip followed by a curling upward and rolling inward. The leaf changes from yellow to brown and becomes dry and brittle. When the hopperburn is very severe, the plant may die prematurely. The adult leafhopper is a pale green insect about one-eighth of an inch in length with wings that fold over the back. The nymphs are wingless and usually feed on the underside of the leaves from which they suck the juices. Leafhoppers pass the winter in the adult stage hidden beneath weeds or other rubbish and appear in the spring, when they deposit their eggs. In some sections of the United States this insect is very destructive, causing as much as 50% reduction in yield.

Aphids.—Several species of aphids or plant lice attack potatoes. Among these are Macrosiphum solanifolii and *Myzus persicae*. The first of these is often called the pink and green louse; the second is known as the green peach or spinach aphid. Both live on the juice which they suck from the host plant, thus depriving it of its vigour and reducing the yields. They are the common vectors that spread most of the virus diseases and these diseases are more of a problem to the growers than the aphids themselves.

Potato *psyllid*.—This pest causes a diseased condition commonly called psyllid yellows. It has also been referred to as "blight" or "purple top." The adult psyllid is very active in hot weather and has been called the jumping plant louse. The average female lays about 700 eggs. The adults appear incapable of producing psyllid yellows. As many as 1,000 have been observed on a plant with no deleterious effects. The nymphs are very destructive; as few as from three to five on a plant have been known to cause yellows. They feed for about 16 days. Psyllid injury has been reported from all states west of the Missouri river, but it is most severe in the plateau section. It has been stated that in Colorado psyllid yellows spreads more rapidly and uniformly and causes greater losses than any other disease or pest.

The first symptom of the disease consists of an upward rolling or cupping of the basal portion of the leaflets at the top of the plant. This rolling is usually accompanied by a marginal yellowing. In some varieties such as the Triumph and Irish Cobbler the upper parts may assume a distinct reddish or purplish colour. The symptoms spread from the top downward, often involving the entire plant. In some cases the nodes of the plants enlarge and the axillary buds are stimulated into growth, producing either an aerial tuber or a stocky shoot capped with a rosette of leaves. The plants often set a large number of tubers, as many as 50 being sometimes found. These tubers seldom attain marketable size and often sprout in the ground before digging time. Results of planting such tubers have not been consistent. Some lots have produced normal crops, others have resulted in weak spindly plants and still others have remained dormant. Attempts at transmitting the malady except by the feeding of the nymphs have resulted in failure.

Prevention and Control of Diseases and Insects.—Since many diseases of the potato are tuber-borne, the most important preventive measure is to secure seed stock that is as free as possible from viruses or disease producing organisms. Virus diseases in susceptible varieties are especially difficult to control. They are spread for the most part by insect vectors, and theoretically it ought to be possible to control them by eradicating the insects; but this method has not proved very satisfactory. Tubers from infected plants carry the virus but generally do not show disease symptoms; consequently they cannot be separated from healthy tubers in the storage house. On the other hand inspection of potato fields early in the growing season makes it possible to detect the diseased plants by the definite symptoms they show. If these plants are rogued out promptly and destroyed before heavy infestations of insect vectors are present, further spread of the viruses is prevented and the crop is greatly improved for seed purposes. Since the heaviest infestations usually take place late in the growing season, early harvesting is often recommended to avoid consequent heavy spread of viruses.

The knowledge of potato diseases and especially of the virus diseases grew rapidly until the production of certified seed potatoes became a specialized industry. Standards for seed certification differ slightly in various countries and among the various states of the U.S.A., but they are all sufficiently high to ensure a minimum of virus diseases and, as a result, increased yields.

In the control of late blight, prevention is perhaps as important as protection. Partly rotted tubers taken out of storage and piled or scattered on the ground may sprout early in the spring; the blight fungus carried over in these decayed tubers develops on the new sprouts and is quickly carried by the wind to the growing crops in the field. These early infections often result in heavy epiphytotics. All waste potatoes should be prevented from growing by feeding them to livestock or by burning them. Seed tubers infected with blight should be discarded; if planted they may cause a recurrence of the disease. Under wet weather conditions, however, the fungus quickly comes in from outside sources so the vines have to be protected with copper sprays or dusts. The spray or dust must be applied before the blight makes its appearance and must adhere to the plant to prevent the fungus from penetrating into the tissues. In practice Bordeaux mixture (copper sulphate combined with lime) or Burgundy mixture (copper sulphate combined with washing soda) are used as sprays. There is some experimental evidence to show that both are equally effective. Bordeaux mixture is the standard spray in most potato growing sections. The formula commonly used is 8-8-100 (8 lb. of copper sulphate, 8 lb. of hydrated lime, 100 gal. of water).

For small areas the spray can be applied by means of a knapsack machine which must be provided with a nozzle that throws a fine misty spray. The Irish growers use these knapsacks. For the first spraying 120 gal. per acre or $\frac{3}{4}$ gal. per sq.rd. is sufficient. though for subsequent spraying 160 gal. per acre or 1 gal. per sq.rd. will be needed to cover the larger amount of foliage. In England, Scotland, Germany, Canada and the United States it is customary to use horse or tractor drawn machines, each capable of spraying many rows of potatoes at one time. Power sprayers fitted with 3 nozzles per row and delivering about 120 gal. per acre at 300-400 lb. pressure are used in many commercial fields. Copper dusts, although perhaps not so effective as the Bordeaux spray, give good control if proper materials are applied correctly.

It is fortunate that early blight and hopperburn can also be controlled by copper sprays or dusts; and if arsenical poisons are added, Colorado potato beetles and flea beetles can also be held in check. Copper lime arsenate dust (20 lb. monohydrated copper sulphate plus 70 lb. fresh hydrated lime plus 10 lb. calcium arsenate) is a standard mixture for dusting potatoes. It is usually applied at the rate of 25-35 lb. per acre. Machines are used for applying the dust. It should be blown on the leaves as a very fine powder when they are somewhat moist with dew or fine rain. Arsenical compounds are highly poisonous to men and animals and must be carefully handled. A respirator should be worn by the operator while mixing such chemicals and applying them as dusts. Hands, face and clothing should be washed thoroughly after spraying and dusting operations.

For the control of the tuber-borne diseases such as common scab, rhizoctonia and blackleg see the section Seed, above.

As fusarial wilts are carried over from one crop to another in seed potatoes and in the soil, seed selection and crop rotation are the means by which these diseases can be avoided.

Potato wart is controlled most satisfactorily by the use of immune varieties, a number of which are available.

Losses due to brown rot can be greatly reduced by the use of resistant varieties such as Katahdin and Sebago. It can be controlled to some extent in sandy types of soil by an application of 800 lb. of sulphur to the acre applied in the summer, followed by 3000 lb. of limestone per acre in the fall. The treatment is not recommended on muck, peat, loam or clay types of soil.

Colorado potato beetles, leafhoppers and flea beetles, as mentioned above, can be controlled by copper sprays or dusts combined with arsenical poisons. Aphids are more difficult to control. One of the best ways to eliminate heavy infestations of these insects is by eradicating the weeds, especially the mustards upon which they multiply and from which they migrate to the potato plants. Good results are often obtained by spraying at the early stages of infestation with a mixture of $1\frac{1}{2}$ pt. of nicotine sulphate in 100 gal. of Bordeaux mixture. Another spray for aphids on potatoes can be prepared by adding 3 lb. of either derris or cube root powder and 2 qt. of soybean oil to 100 gal. of Bordeaux mixture. If Bordeaux mixture is not needed for the control of diseases and other insects, a nicotine soap solution consisting of $1\frac{1}{2}$ pt. of nicotine sulphate, 4-5 lb. of soap and 100 gal. of water may be used. Dust mixtures containing .75% of rotenone are also effective against aphids. The principal objection to spraying or dusting for aphid control is the high cost of the chemical compounds. Psyllids can be controlled to a certain degree by spraying with liquid lime-sulphur. One gallon of lime sulphur is mixed with 40 gal. of water. The sprayer used in applying this mixture should be capable of maintaining a pressure of 300 lb. and there should be three nozzles per row, the two lower ones turned upward at an angle to cover the under surface of the leaves. The success of this treatment depends upon its thoroughness and timeliness.

Control of heat and drought necrosis involves keeping the soil moist and cool and shaded, and if the soil is light and the weather hot, digging as soon as the vines begin to die.

To prevent freezing injuries, tubers should not be exposed to temperatures below 32° F. Greening of the tubers may be prevented by protecting the tubers from light.

Sunscald can be avoided by protecting the tubers from long exposure to the sun. If tubers are not exposed to temperatures of more than 95° F. and are given good ventilation they will not develop black heart.

POTATO BREEDING

The potatoes that were brought to Europe from Peru and Chile in the latter half of the 16th century had very irregularly shaped tubers, disfigured by outgrowths and extremely deep eyes. These features were characteristic of the early Peruvian varieties, and in England and on the continent these very rough deep-eyed varieties were the rule until the earlier part of the 19th century. In the hands of plant breeders the shape, colour and quality were much improved. Most of the improvements were made after 1845, when potato diseases focused attention on the crop. In that year potato blight reached Europe and became so destructive in Ireland as to cause a famine and much loss of life. This gave an impetus to the search for varieties resistant to disease. Perhaps the first and most important introduction in Great Britain was the variety Victoria, raised and introduced by William Paterson of Dundee. Victoria was a great and successful cropper and proved the parent of many other great potatoes later produced, including Champion, Up-to-Date, Great Scott and Ninetyfold. Simultaneously and for the same reasons there was great activity in the production of new varieties in the United States. Reverend C. E. Goodrich of Utica, New York, conceived the idea that the disastrous epidemics of late blight during the years 1843–47 were the result of a reduction in the vigour of the plants caused by long-continued propagation by vegetative means, and that this vigour could be restored by growing plants from true seed. While he did not succeed in the control of late blight by this means, he may be considered to have laid the foundation of potato breeding in the United States by furnishing material to be used by other breeders. The ancestry of 170 varieties can be traced back to Goodrich's Garnet Chili, a seedling of the imported Rough Purple Chili. They include several well known varieties of commerce such as Beauty of Hebron, Burbank, Early Ohio, Early Rose, Green Mountain, Prolific and Triumph. The Magnum

Bonum, a very popular potato of England and north European countries, was bred from Early Rose by J. Clark of Christchurch. Clark also grew Abundance, Epicure and Ninetyfold, varieties still of some importance.

The second wave of potato blight came in 1870 and caused much destruction of the existing varieties. Breeders concentrated on securing more resistant forms. Nicol of Arbroath then introduced the Champion, a high yielding resistant variety, which soon became largely grown throughout Scotland and Ireland and in time in most potato districts of the world.

Great credit should be given to Archibald Findlay of Scotland. however, for his success in developing many varieties, including Up-to-Date and British Queen. The Up-to-Date, especially, made both Scotland and Ireland famous for potatoes, and this variety was exported to all parts of the world. From 1907 to 1928 Donald McKelvie was active as a potato breeder; his Arran Chief, Arran Banner, Arran Comrade and Arran Consul became popular in many places. German breeders raised Richter's Imperator, the President and Paulsen's Juli, all of such merit as to justify wide cultivation. The work of C. G. Pringle of Charlotte, Vt., is worthy of mention in that it is said to represent the first systematic effort to obtain seed by controlled hybridization. His varietal contributions were the Alpha, Adirondack, Rubicund, Ruby and Snowflake.

Early in the 20th century another era in potato breeding began in Europe. The recognition and alarming spread of potato wart forced to the front the question of "immune varieties." Immunity from wart, like any other genetic character, is the end result of the interaction of genetic factors and environment. Several genetic factors are involved in the inheritance of this character. Some of them are dominant, causing immunity independent of all other immunity factors; others work together in a complementary manner and still others are cumulative in effect. With a number of dominant factors available, it was not a difficult task to produce many new varieties with immunity from wart combined with other characters of economic importance.

When potato breeding was actively taken over by the United States department of agriculture in 1910 under the direction of Dr. William Stuart, the only disease resistance sought was that against the late blight fungus. It was not until some years later that it became evident that the virus diseases were a greater menace to potato production than late blight because the viruses are transmitted from one crop to the next through tuber infection and they cannot be controlled by fungicidal application to the foliage or by seed treatment. It was soon realized that the widespread occurrence of potato virus diseases such as the various types of mosaic, leaf roll, spindle tuber, curly dwarf, yellow dwarf and streak could be controlled only by the breeding mode of attack. The first step in this direction was toward the development of varieties resistant to one of the commonest of these diseases, mild mosaic. Seedlings that showed some resistance to virus infection were selected by Dr. Charles F. Clark, who became associated with Dr. Stuart in this work. Dr. Clark crossed the resistant seedlings with one another and with other seedlings and varieties. As a result a number of new varieties with a high degree of resistance to mild mosaic, with desirable tuber characters, good habit of vine growth and relatively high yield were distributed to growers. Katahdin. Chippewa and Houma were the first of these. Katahdin has exceptionally wide adaptation. It has been grown successfully in nearly every potato growing section of the United States and in Canada, Uruguay, Argentina, south Africa and Australia.

While this work was being carried on by the department of agriculture a few of the state experiment stations, especially Minnesota and Cornell university, had undertaken potato breeding work. It was soon realized that problems and objectives in this field of endeavour cut across state lines and involved large regions of the entire country. It was therefore decided in 1928 to organize the work as a national project with all interested state experiment stations and the United States department of agriculture co-operating. Material was sent also to any foreign country requesting it. The expansion in the organization greatly increased the number of problems attacked. The so-called "economic" characters such as yield, time of maturity, depth of eye, shape of tuber and culinary quality were given primary consideration but intensive work was done also on resistance to various diseases and insect pests. Resistance was obtained to the virus diseases such as mild mosaic, latent mosaic, veinbanding, leaf roll and yellow dwarf. Immunity from late blight was found in many hybrid seedlings of the wild species, *Solanum demissum,* crossed with cultivated varieties of *S. tuberosum.* Resistance to this disease was found too in some of the cultivated varieties themselves and in a number of progenies obtained from Germany. The latter may be related to *S. demissum.* Seedling varieties, both late and early, highly resistant to common scab under a wide range of environmental conditions were produced. Varieties tolerant to Fusarium wilt also were produced. Many of the new productions were resistant, if not immune, to potato wart. Resistance to brown rot and ring rot are inherent in a number of varieties and progenies. Wide differences were found between varieties and seedlings in their reaction to injury by the insect pests, leafhoppers, flea beetles and psyllids.

Composition of the Potato.— The composition of the potato is to some extent inherent in the variety but is modified greatly by the conditions under which the plants are grown. Some of the factors that are known to result in variability even between tubers of the same variety are: the physical and chemical make-up of the soil, the kind and amount of fertilizer applied, climatic conditions, cultural methods such as depth of planting, state of maturity at harvest time and in irrigated districts the time and rate of application of water. Storage conditions, especially temperature, contribute to the variability.

Eecause of the wide variability all statistics on composition are subject to error. The average potato tuber contains 75%-80% water, 11%-20% starch (occasionally 23%-25%), 1.5%-2% of proteins and 2%-3% of fibre and mineral salts or ash. Its value, both as a food and in the manufacture of by-products, is due to its starch content. The normal potato contains only a small quantity of sugar (about 0.3%). If the tuber is analyzed in parts it is found that the dry matter usually decreases toward the centre. In one type analyzed the percentage of dry matter in the cortex, outer medulla and inner medulla respectively was 22.20, 19.41 and 14.92.

The desirable characteristic of a potato in England and America is a capacity to develop mealiness when boiled, and this depends largely on the percentage of starch in the tuber. In France, however, potatoes are rarely boiled but usually cooked in fat, hence there is a demand for a potato with a firm flesh becoming not mealy but "soapy" on boiling; such a potato is usually low in starch and high in nitrogen content. Since the culinary qualities of a potato are closely associated with its starch content the factors that cause variation in the latter will also cause variability in the former. As a result, the cooking quality of a variety may range from poor to excellent according to the conditions under which it was grown and harvested. Some varieties are more variable than others when grown under similar conditions.

BIBLIOGRAPHY.—T. P. Dykstra, "Potato Diseases and Their Control," US. *Dept. Agr. Farmers' Bul. 1881* (1941); Henry Albert Jones and Joseph Tooker Rosa, *Truck Crop Plants* (1928); E. L. LeClerg, "Potato Production in the Southern States," *U.S. Dept. Agr. Farmers' Bul. 1904* (1942); Radcliff N. Salaman, *Potato Varieties* (1926); William Stuart, *The Potato* (1937)
(H. A. J.; F. J. S.)

POTATO-LIFTER: *see* HARVESTING MACHINERY.

POTATO RACE, a contest, in which the winner is the first who collects in a basket or other receptacle a number of potatoes, usually eight, placed two yards apart along a straight line, and then crosses a line five or ten yards farther on.

POTATO SPIRIT. The use of the potato instead of grain as the source of supply of alcohol for commercial use has, during the past century, developed into an important industry, particularly in Germany where it is now a prominent feature in the organization of the agriculture of the country. In great measure it is carried on by the mutual co-operation of the farmers who supply to joint-owned distilleries the potatoes to be converted into alcohol, receiving later the spent wash and residues which are rich in nitrogenous matter and of considerable value as a cattle food. Extensive breeding of cattle is thus facilitated, resulting in a heavy production of manure useful in the cultivation of the potatoes. In 1913 there were in Germany eight million acres of land devoted to potato cultivation. Three million tons of the crop were used for the manufacture of sixty-seven million gallons of alcohol, this representing about 80% of the total alcoholic production of the country. In 1928 the industry had not recovered from the effects of the war, and in order to ensure that the supply of crops necessary for human and animal food should not be diverted to the production of alcohol, the price which might be paid for potatoes to be used for the latter purpose was restricted by the government.

The underlying principle in the production of alcohol from potatoes is the saccharification by means of malted barley or acids of the starch, of which there is usually about 20%. A little over 1 ton of potatoes produces spirit approximately equivalent to 19 gal. of alcohol.

The details of the process show considerable variation. In one method extensively adopted the potatoes, after being cooked by steam heating and reduced to a homogeneous pulp in a mill, are mixed with malt and water. After the mass has been maintained at a temperature of about 60° C. for 3–4 hr. yeast is added and fermentation takes place. Distillation is accomplished by a process of steam heating, the mass being agitated meanwhile.

In another method the potatoes after being reduced to a pulp in a rasping machine are partially drained of their natural water. Boiling water and malt are added, the mass being allowed to stand for 3–4 hr. The clear liquid and subsequent washings are fermented with yeast and the spirit distilled off in the usual manner. This method has considerable advantages over that first described, the distillation from the liquid being cleaner and the residual paste being excellent as a cattle food.

The spirit thus obtained by direct distillation is liable to act in a deleterious manner upon the animal economy. It has a strong odour and taste of fusel oil, amyl alcohol and isobutyl alcohol in particular being present in considerable proportion. This may be almost completely rectified by distillation in a patent still.

(F. G. H. T.)

POTATO WAR, the name given by the Prussians to the War of the Bavarian Succession in 1778–79 (Kartoffelkrieg). The Prussians and a Saxon contingent, commanded by Frederick the Great and his brother Prince Henry, were opposed to two Austrian armies under Loudon and Lacy. The operations consisted almost entirely of manoeuvres which had for their object the obtaining or the denial to the enemy of food supplies. The war thus acquired the name of Kartoffelkrieg. Its duration was from July 3, 1778, to the assembly of the congress of Teschen on March 10, 1779, and its total cost £4,350,000 and 20,000 men to all parties. The war may be studied from a military point as an extreme example of what Clausewitz calls "war with a restricted aim."

POTAWATOMI, a tribe of North American Indians of Algonkin stock. When first known, about 1670, they lived around Green Bay, Wis. They subsequently moved south and eventually settled in lower Michigan. They were allied with the French in their wars against the Iroquois and took part in the conspiracy of Pontiac (*q.v.*). In the American Revolutionary War they fought for England, as they also did in the War of 1812. In 1846 most of them were removed to a reservation in Kansas. Others are in Wisconsin and Oklahoma.

The name Potawatomi is properly *Potewatmik,* fire-makers, in allusion to the tribe's secession from the Ojibway and their establishment of a separate council fire.

POTCHEFSTROOM, a town in Transvaal, Union of South Africa, at 26° 30' S., 27° 40' E., altitude 4,436 ft., 88 mi. by rail S.W. of Johannesburg. Pop. (1936) 19,099, of whom 10,774 were Europeans, 7,234 natives (Bantu), 280 Asiatic and 811 coloured. The town is built on the banks of the Mooi river, 15 mi. above its junction with the Vaal. Gold occurs in the neighbourhood.

Potchefstroom was founded in Nov. 1838 by Hendrik Potgieter, and is the oldest town in, and first capital of, the Transvaal. In 1862 it was the scene of civil war between rival Boer factions. In 1880–81 the garrison camped outside the town was besieged by Boers under Commandant P. A. Cronje. The British troops, 250 in number, were confined to a fort 25 yds. square and lost more than a third of their strength in killed and wounded before they surrendered on March 21, the action having begun on Dec. 18, 1880. Charges of treachery were brought against Cronje for failing to notify the besieged that an armistice had been agreed to by the Boer leaders. Of this armistice Colonel R. W. C. Winsloe, who was in command of the British, became aware before the surrender took place. On the suggestion of Commandant General Joubert the capitulation was considered as cancelled, and a detachment of British troops reoccupied the town until the conclusion of peace. In the Anglo-Boer War of 1899–1902 Potchefstroom was occupied by the British without opposition.

Potchefstroom was developed as an educational centre. It has several high schools, a training college, a university college, the latest constituent of the University of South Africa and an agricultural school. The latter is situated on the government experimental farm.

POTEEN, called also potheen, potsheen and potyeen, the term usually applied in Ireland to any potable spirit illicitly distilled in a pot still—poit'in, pota or pot. Illicit distillation mas extensively practised in the 19th century, particularly in the inaccessible districts of the island, but it has in great measure been suppressed. The character of the substances used in preparing the wash, which is fermented preparatory to distillation (see WHISKY; RUM, etc.), varies greatly. While malt and barley chiefly are used, the spirit is often obtained by the fermentation of molasses or other saccharine matter. The method of fermentation, the type of still employed, the rate of distillation and the proportion of distillate to wash, depending as they do upon the circumstances and wish of the distiller, are also lacking in uniformity. This absence of standardization in materials and methods results in great variation in the composition of the resultant spirits. Generally they may be stated to fall into two classes, approximating to whisky when malt and barley are used, and to rum when the wash is of a more saccharine nature. The proportion of secondary ingredients almost invariably is high, however, even when compared with pot still spirits made by reputable firms. Allen, in a series of analyses presented to the Select Committee on British and Foreign Spirits, recorded 128.8 grains of amyl alcohol in poteen as compared with an average of 56 grains in eight samples of Irish whisky.

(F. G. H. T.)

POTEMKIN, GRIGORY ALEKSANDROVICH, PRINCE (1739–1791), Russian statesman, mas born at Chizheva near Smolensk. He was educated at the Moscow university and in 1755 entered the "Reiter" of the Horse Guards. His participation in the coup *d'état* of July 8, 1762, attracted the attention of the new empress, Catherine II, who made him a Kamnzerjunker and gave him a small estate. He distinguished himself in the Turkish War of 1769, and in 1771 he became Catherine's prime favourite. Catherine bestowed on him the highest honours, among others the post of commander-in-chief and governor-general of "New Russia" (Ukraine). In 1775 he was superseded in the empress's graces by Zavadovsky; but the relations between Catherine and her former lover continued to be most friendly, and his influence with her was never seriously disturbed by any of her subsequent favourites.

Potemkin's correspondence with the empress was uninterrupted. He was deeply interested in the question of the southern boundaries of Russia and consequently in the fate of the Turkish Empire. In 1776 he sketched the plan for the conquest of the Crimea which was subsequently realized; and he was busy with the so-called "Greek project," which aimed at restoring the Byzantine empire under one of Catherine's grandsons. In many of the Balkan states he had well-informed agents. After he became field marshal, in 1784, he introduced many reforms into the army, and built a fleet in the Black sea, which, though constructed of very bad materials, did excellent service in Catherine's second Turkish War (1787–92). His colonizing system was exposed to very severe criticism, yet it is impossible not to admire the results of his stupendous activity. The arsenal of Kherson, begun in

1778, the harbour of Sevastopol and the new fleet of fifteen liners and twenty-five smaller vessels, were monuments of his genius. But there was exaggeration in all he attempted. He spared neither men, money nor himself in attempting to carry out his gigantic scheme for the colonization of the south Russian steppes; but he never calculated the cost, and more than three-quarters of the design had to be abandoned when but half finished.

Catherine's famous expedition to the south in 1787 was a triumph for Potemkin, for he concealed all the weak points of his administration. On this occasion he received the title of prince of Tauris. The same year the second Turkish War began, and the founder of New Russia acted as commander-in-chief.

But the army was ill-equipped and unprepared; and Potemkin, in an hysterical fit of depression, would have resigned but for the steady encouragement of the empress. Only after Suvarov had valiantly defended Kinburn did he take heart again, and besiege and capture Ochakov and Bender. In 1790 he conducted the military operations on the Dniester and held his court at Jassy with more than Asiatic pomp. In 1791 he returned to St. Petersburg where, along with his friend Bezborodko (*q.v.*), he made vain efforts to overthrow the new favourite, Zubov. The empress grew impatient and compelled him (1791) to return to Jassy to conduct the peace negotiations as chief Russian plenipotentiary. On Oct. 5, while on his way to Nikolayev, he died in the open steppe, 40 mi. from Jassy.

Potemkin was indubitably the most extraordinary of all the Catherinian favourites. He was an able administrator, licentious, extravagant, but loyal. generous and magnanimous. Nearly all the anecdotes related of him by Helbig, in the biography contributed by him to the journal *Minerva* (1797–1800), and freely utilized by later biographers, are absolutely worthless.

See V. A. Bilbasov, *Grschichte Katharinas II.* (Berlin, 1891–1893); C. de Larivière, *Catherine la Grande d'après sa correspondance* (Paris, 1895); Anonymous, *La Cour de Catherine II. Ses collaborateurs* (St. Petersburg, 1899); A. V. Lopukhin, *Sketch of the Congress of Jassy, 1791* (Rus.; St. Petersburg, 1893); *The Papers of Prince Potemkin, 1744–1793* (Rus.; St. Petersburg, 1893–1895). (R. N. B.)

POTENTILLA, a large genus of plants of the rose family (Rosaceae, *q.v.*), comprising more than 200 species, mostly herbs, widespread in north temperate and Arctic regions, many of which are cultivated as border and rock-garden plants. Various species bear brilliantly coloured flowers and graceful foliage.

A soil of a good loamy staple, enriched with rotten dung is the most suitable. Potentillas may be increased, though not very freely, by parting them into as many pieces as there are crowns, the side growths being those which can usually be thus separated. This may be done in autumn or spring, and the plants will generally bloom the following season. The species and some of the varieties reproduce true from seed, and are readily increased by that means. Nine wild species occur in the British Isles and more than 50 in North America, many of which are called cinquefoil or five-finger.

POTENTIOMETER, an instrument, due to J. C Poggendorff, for the measurement of electromotive force and also of the difference of electric potential between two points. The term potentiometer is usually applied to an instrument for the measurement of steady or continuous potential difference between two points in terms of the potential difference of the terminals of a standard voltaic cell of some kind, such as a Clark or Weston cell but alternating current potentiometers are in use. (*See* INSTRUMENTS, ELECTRICAL.)

POTENZA (anc. *Potentia*), a town and episcopal see of Lucania, Italy, capital of the province of Potenza, 103 mi. by rail E. by S. of Naples. Pop. (1936), 18,872 (town); 25,103 (commune). Situated 2,700 ft. above sea level on an isolated hill above the Basento (anc. *Casuentus*), it is much exposed to winds and has a far more northerly climate than its position (40° 40' N.) implies, and is one of the coldest towns in Italy.

The ancient Potentia lay some 470 ft lower, by the river, at the intersection of the road leading west to the Via Popillia and northeast to the Via Appia, with the Via Herculia.

Potentia must be distinguished from Potentia in Picenum, on the Adriatic coast. In 1694 there was a severe earthquake; and the more terrible earthquake which on Dec. 16 and 17, 1857 passed through southern Italy, and in Basilicata (Lucania) alone killed 32,475 persons, laid the greater part of Potenza in ruins. It was also damaged by the earthquake of 1910. In 1860 it was the first town to rise against the Neapolitan government.

POTGIETER, EVERHARDES JOHANNES (1808–1875), Dutch prose writer and poet, was born at Zwolle, in Overyssel, on June 17, 1808. He started life in a merchant's office at Antwerp. In 1831 he made a journey to Sweden and then settled in Amsterdam. With Heije, the popular poet of Holland in those days, and Bakhuizen van den Brink, the historian, Potgieter founded *De Muzen* ("The Muses," 1834–1836), a literary review, which was, however, soon superseded by *De Gids* ("The Guide"), a monthly, which became the leading magazine of Holland In it he wrote, mostly under the initials of "W. D ——g," a great number of articles and poems. The first collected edition of his poems (1832–1868) appeared in 2 vols. (Haarlem, 1868–1875), preceded by some of his contributions to *De Gids*, in 2 vols. also (Haarlem. 1864), and followed by 3 vols. of his *Studien en Schetsen* ("Studies and Sketches." Haarlem, 1879). Potgieter's favourite master among the Dutch classics was Hooft, whose peculiarities in style and language he admired and imitated. In Holland Potgieter's influence has been very marked and beneficial; but his own style, that of ultra-purist, was at times somewhat forced, stilted and not always easily understood.

The best edition of Potgieter's works is that by his friend and executor J. C. Zimmermann (19 vols., 1885–90).

POTHIER, DOM JOSEPH (1835–1923), French musical scholar, was born at Bouzemont, near Saint Dié, Dec. 7, 1835. He became a Benedictine in 1859 and after holding various positions of authority in two French abbeys, was named abbot of a third, St. Wandrille, in 1898. In 1901, when members of religious orders were compelled by law to leave France, the monastery was temporarily located in Belgium. Shortly after he entered the Benedictine order at Solesmes, Dom Pothier was encouraged by Dom Guéranger, who had started a movement to revive the ancient plainsong, to study early church music. In 1880 Dom Pothier published *Les Mélodies grégoriennes*, which became the standard work on Gregorian chants. During the next 25 years he wrote 7 other treatises on various phases of ancient religious music and was responsible for beginning a collection of musical manuscripts at Solesmes.

Pope Pius X made him chairman (1904) of a commission which re-edited and published the musical parts of the Roman Catholic Mass. He died at Conques, Belgium, Dec. 8, 1923.

POTHIER, ROBERT JOSEPH (1699–1772), French jurist, was born at Orléans on Jan. 9, 1699. He studied law for the purpose of qualifying for the magistracy, and was appointed in 1720 judge of the presidial court of Orléans. This post he held for 52 years. He paid particular attention to the text of the Pandects, his *Pandectae Justinianae in novum ordinem digestae* (Paris and Chartres, 1748–1752) being a classic in the study of Roman law. In 1749 he was made professor of law in the university of Orléans. He wrote many learned monographs on French law, and much of his work was incorporated almost textually in the French Code Civil. He died March 2, 1772.

Of his numerous treatises the following may be especially mentioned: *Traité des obligations* (1761); *Du Contrat de vente* (1762); *Du Contrat de bail* (1764); *Du Contrat de société* (1765); *Des Contrats de prêt de consomption* (1766); *Du Contrat de depôt et de mandat* (1766); *Du Contrat de nantissement* (1767), etc. His works have several times been published in collected form (edited by Giffrein, 1820–24; by Dupin, 1823–25, and by Bugnet, 2nd ed. 11 vols. 1861–62). See Dupin, *Dissertation sur la vie et les ouvrages de Pothier* (Paris, 1825), and Frémont, *Vie de R. J. Pothier* (Orléans, 1850).

POTHOOK, a metal hook, frequently S-shaped, for suspending a pot over a fire. While one extremity is hooked to the handle of the pot, the other is caught upon an iron crane moving on a pivot over the fire. Modern cooking-ranges have obviated the necessity for this arrangement, but it is still to be seen in great numbers of country cottages and farmhouse kitchens all over England, and in small artisans' houses in the west midlands and the north. In the elementary teaching of writing, the "pothook" is a script of similar shape.

POTI, a seaport of Russia, in the Georgian S.S.R., in 42° 10′ N., 41° 38′ E., on the Rion river, on the Black sea coast, in a marshy and malarial district. Population 14,671.

During west and southwest gales the harbour is very difficult to approach.

There are berths for eight or ten large steamers and an elevator for loading manganese, the chief export from the Kvirili valley. The town is linked by rail with Baku, and there is a line northward along the coast.

The town has a saw-milling industry. The ancient Phasis, a commercial colony of the Greek city of Miletus, stood on this site. In 1578 Sultan Murad III, of Turkey, built a fortress here, destroyed during a war with Persia. In 1640 the Imeretians attacked the town. (*See* GEORGIA.) Poti was a great slave market. It was captured by the Russians in 1812 and in 1829 recaptured and annexed.

POTIOREK, OSKAR (1853–1933), Austro-Hungarian general of artillery, was born at Blieburg, Carinthia, in 1853. His career was chiefly spent on the general staff, where he held the post of chief of the section of operations, and later that of deputy to the chief of the general staff, Count Beck. After Beck's retirement he was in command of the III Corps, in 1911 army inspector and governor (*Landeschef*) in Bosnia and Hercegovina. As such, he was officially responsible for countenancing the fateful visit of the heir to the throne to Serajevo, out of which World War I ensued. In the offensive taken by Austria against Serbia in the winter of 1914, which eventually broke down after great initial success, his judgment was also found wanting. He was then relieved of his command.

POTLATCH, an Indian term, denotes the lavish feasts especially characteristic of the Tlingit, Kwakiutl, and other tribes of the northwest coast of America. The potlatch is given by one chief or clan to another, and is marked by great profusion of food and gifts, often accompanied by destruction of some of the property of the hosts, as in the breaking of highly prized copper plaques, an act which adds greatly to their fame. The keynote of such excesses is the exaggerated respect which these Indians show for wealth in use—an attitude shared by many other savage peoples and not without its cultural value. It is a matter of honour to accept any invitation to a potlatch, and to give a grander feast in return. Refusal involves loss of prestige and rank. Rivalry in feast-giving may become so intense that a man will beggar himself and relatives in the effort to win renown. But the potlatch is not a mere wasteful orgy; it maintains differences of chieftainship and rank, binds together kinship groups, and offers a medium for repayment of debts, thus serving as an institution of real importance in social and economic life.

See F. Boas, *Ethnology of the Kwakiutl,* Part I, 35th Ann. Rept. Bureau Amer. Ethnology (1914); Swanton, *Social Conditions, etc., of Tlingit Indians,* 26th Ann. Rept. *ibid.* (1905); Marcel Mauss, "Essai sur le Don," *L'Année sociologique,* n.s. I (1924).

POT-METAL. The glass employed in "stained-glass" windows is coloured in the making by tinting the glass in the melting-pot with various metallic oxides. This self-coloured glass, which may or may not be afterwards painted or decorated, is called pot-metal.

(*See* STAINED GLASS.)

POTOCKÍ, STANISLAW FELIX (1752–1805), Polish politician, son of Franciszek Salezy Potockí, palatine of Kiev, was born in 1752. Through family influence, he became grand standard-bearer of the crown at the age of twenty-two. In 1782 he was made palatine of Russia, in 1784 a lieutenant-general, and in 1789 purchased the rank of a general of artillery. Liberal, enlightened, a generous master and a professed patriot, he had awakened great hopes; but he identified the public welfare with the welfare of the individual magnates, and when elected to the Four Years' diet, schemed to divide Poland into an oligarchy of autonomous grandees exercising the supreme power in rotation (in fact a perpetual interregnum). The election of Malachowski (*q.v.*) and Kazimierz Sapieha as marshals of the diet still further alienated him from the Liberals; and he retired to Vienna whence he continued to carry on an active propaganda against the new ideas. He protested against the constitution of May 3, 1791, and after attempting fruitlessly to induce the emperor Leopold to intervene, proceeded with his friends in March 1792, to St. Petersburg, and subsequently with the connivance of the empress Catherine formed the confederation of Targowica (May 14, 1792), of which he was the marshal, or rather the dictator, directing its operations from his castle at Tulczyn. When the May constitution was overthrown, Potockí (March 1793) went on a diplomatic mission to St. Petersburg; but, finding himself duped, he settled down at Tulczyn. He wrote *On the Polish Succession* (Pol.) (Amsterdam, 1789); *Protest against the Succession to the Throne* (Pol.) (*ibid.* 1790); and other political works.

POTOMAC, a river in the east central part of the United States, having its source in the Allegheny mountains and flowing southeast into Chesapeake bay. It is formed by the union of its north and south branches, about 15 mi. S.E. of Cumberland, Md. The main stream has a length of about 450 mi. and is navigable for large vessels for 113 mi. above its mouth. From the junction of its two branches until it reaches Harper's Ferry the Potomac river separates Maryland from West Virginia. At Harper's Ferry it receives the waters of the Shenandoah river and cuts through the Blue Ridge mountains in a gorge noted for its beauty. From this point to its mouth it forms the boundary between Virginia and Maryland. The stream crosses the Blue Ridge mountains at an elevation of about 245 ft., and at Georgetown (Washington, D.C.), 62 mi. distant, it meets tidewater. Of this descent about 90 ft. occurs about 15 mi. above Washington at the Great Falls, a series of rapids about a mile long and including a cataract about 35 ft. high.

Three and a half miles above Washington are the Little Falls, which mark the head of navigation.

At Washington there are two channels, with respective depths at mean low water of 18 and 21 ft.

Large sums have been spent since 1870 on improving these channels.

A few miles below the city the river broadens into a deep tidal estuary from 2½ to 7 mi. wide; and channels 24 ft. deep and 200 ft. wide through all the shoals were secured by the project of 1899.

The Anacostia river, or "East Branch," which flows into the Potomac just south of Washington, is navigable for large vessels for about 2 mi. and for small scows and lighters as far as Bladensburg, Md., 8¾ mi. above its mouth. Improvements (begun in 1902) have produced a channel 21 ft. deep at mean low water and 380 ft. wide.

The Chesapeake and Ohio canal, from Georgetown to Cumberland, Md., follows the Potomac closely on the Maryland side.

POTOROO or **RAT KANGAROO,** any member of the diprotodont marsupial sub-family *Potoroinae* (*see* MARSUPIALIA). None of them exceeds a rabbit in size. They inhabit Australia and Tasmania, are nocturnal, and feed on leaves, roots, and bulbs, which latter they dig up with their forepaws. About ten species are known. The members of the type genus (*Potorous*) run, rather than leap, and do not use the hind feet for kicking. In the genus *Bettongia* the tail is prehensile.

POTOSÍ, a department of Bolivia occupying the southwestern angle of that republic, bounded N. by Oruro, Cochabamba and Chuquisaca, E. by the two last departments and Tarija, S. by Argentina and W. by Chile and Oruro. Pop. (1940 estimate), 649,000 the larger part Indians; area 41,297 sq.mi. The eastern part of the department is traversed north to south by the eastern branch of the Andes, locally known as the Cordillera de los Frailes and the Cordillera de Chichas. Spurs and broken ranges project eastward from these, between which are the headstreams of the Pilcomayo and Grande, the first flowing southeast to the Plata, and the second northeast to the Madeira and Amazon. The Pilcomayo itself rises in the department of Oruro, but several of its larger tributaries belong to Potosí—the San Juan, Cotagaita and Tumusla in the south, and Cachimayo in the north. The western part of the department belongs to the great Bolivian *altiplanicie,* or southern extension of the Titicaca basin. It is a barren, saline waste, almost uninhabitable. In the north, bordering on the transverse ridge of which the Cerro de Tahua (17,457 ft.) forms a part, is the depression known as the Salar de Uyuni, 12,080 ft. above sea level. Near the southern frontier is another transverse ridge, in part formed by the Sierra de Lipez and in part by apparently detached groups of high peaks; it is a waterless desert like the Puna de Atacama.

Potosi is essentially a mining department, though agriculture and grazing occupy some attention in the eastern valleys. The plateau there is rich in minerals, especially silver and copper. The Huanchaca-Pulacayo group of mines, situated on the slopes of the eastern Cordillera, about 13.600 ft. above sea level, overlooking the Salar de Uyuni, has the largest output of silver in Bolivia. Between 1873 and 1901 it yielded 4,520 tons of silver, of an estimated value of £23,200,000. Farther south are the Portugalete mines, once very productive, and near the Argentine border are the Lipez mines. East of the Cordilleras are the famous "silver mountain" of Potosi, once the richest silver mine in the world; the snow-capped peak of Chorolque (18,452 ft.), which is claimed to have the highest mine in the world, 18.000 ft. above sea level; Porco, a few miles southnest of Potosí; Guadalupe, Colquechaca and Aullagas. Besides silver most of these mines yield tin, copper, zinc, bismuth, tungsten, antimony and wolfram and are now being worked chiefly for their tin, of which Bolivia produced more than 42,000 tons in 1940. The production of minerals in these famous'centres has recently been eclipsed by the enormously rich deposits of tin at Uncia and Llallagua in the same department. The department is traversed by the Antofagasta & Bolivia railway and by a line from Uyuni to the Argentine frontier at La Quiaca. A branch line of the former also runs to Sucre via Potosi.

Besides Potosi, the capital of the department (pop. about 45,000), the principal towns are Huanchaca, Pulacayo, Uyuni (g mi. from Huanchaca, 12,100 ft. above sea level, a small town but an important railway junction and commercial centre on the waterless plain, the shipping point and supply station for an extensive mining region) and Tupiza (pop. about 8,000), a prettily situated town near the Argentine frontier, on a small branch of the San Juan river, 9,800 ft. above sea level.

POTOSÍ, a city of Bolivia, capital of the department of Potosi, 47 mi. S.W. of Sucre, or 106 mi. by the post-road. Pop. (1942, est.), 45,000. Potosi stands on a barren terrace on the northern slope of the Cerro Gordo de Potosi. 13,612 ft. above sea level, and is one of the highest towns in the world. The famous *cerro* from which its name is taken rises above the town to a height of 15,381 ft., a barren, white-capped cone, honeycombed with mining shafts.

The foundation of the city dates from 1547, two years after the first discovery of silver on the *cerro* by an Indian herder. Charles V conferred upon it the title of "villa imperial." From 1545 to 1800 the crown tax of one-fifth upon the mineral product amounted to £32,600,000, showing an acknowledged output of £163,000,000. The total output to 1864 has been estimated at more than £400,000,000, but the annual output at the beginning of the 20th century barely exceeded 400,000 oz. The town is regularly laid out with streets crossing each other at right angles. The age-begrimed buildings, many of which are unoccupied and in ruins, are commonly of adobe. A large plaza forms the conventional centre, around which are grouped various religious edifices. the government house, town hall, national college, the old "royal mint" dating from 1572, and the treasury. The city has a massive, plain cathedral, which in part dates from early colonial times, and in part from the closing years of Spanish rule. The water supply is derived from reservoirs constructed during the years of the city's greatest prosperity. Potosi, long accessible from the outside world only by rough mountain roads, now has rail connections with Rio Mulatos on the Antofagasta-Bolivia line and with Sucre. In 1611 the population of Potosi was reported to be 160,000, which probably included the whole mining district. A part of the diminution since then is explained by the fact that the great majority of the mines on the *cerro* were abandoned In recent years valuable deposits of tin have been found and many of the mines have re-opened.

POTOTAN, a municipality (with administrative centre and 64 *barrios* or districts) of the province of Iloilo, island of Panay, Philippine Islands, on the Jaluar river, and located along the railway, about 17 mi. N.E. of Iloilo, the provincial capital. Pop. (1939) 33,020; 15,871 were males and 7 were whites. The chief agricultural products are sugar, maize (corn), palay (rice), tobacco and abaci (Manila hemp). Cattle, carabao and horses are bred for local use and for export. Panay-Bisayan is the vernacular. Of the inhabitants aged 6 to 19 inclusive, 41.7% in 1939 attended school, while 51.8% 10 years old and over was literate.

POTSDAM, a town in Germany, the administrative capital of the Prussian province of Brandenburg and formerly one of the residences of the German emperor, on the river Havel, 16 mi. S.W. of Berlin, on the main line of railway to Magdeburg. Pop. (1939) 136,167. It is connected with the capital by two local lines and by a steamboat service through the chain of lakes formed by the river. Potsdam, originally Poztupimi, a Slavonic fishing-village, is first mentioned in 993. A town in the 14th century, it was unimportant until the great elector built a palace there between 1660 and 1682; and even at the close of his reign it only contained 3,000 inhabitants. The elector Frederick William I greatly enlarged Potsdam, and his stiff military tastes are reflected in the monotonous uniformity of the streets. Frederick the Great continued his father's work, and was the real creator of the splendour of the town.

The palace, a large quadrangular building of the 17th century, is chiefly interesting for the numerous relics it contains of Frederick the Great. It also contains reminiscences of Voltaire, who resided here for several years. The principal churches are the Nikolaikirche; the Church of the Holy Ghost, built in 1728; and the Friedenskirche, or Church of Peace, erected in 1845–50, to which is attached a mausoleum. Among other conspicuous buildings are the military establishments; the town hall; and the Brandenburg gate. Potsdam has manufactures of chemicals, furniture, chocolate, soap, tobacco and surgical and musical instruments. Market-gardening affords occupation to many of the inhabitants, and the cultivation of winter violets is a specialty. The Havel is well stocked with fish. To the south of the town lies the observatory.

POTSDAM, a village of St. Lawrence county, New York, U.S.A., on the Raquette river, Federal highway 11 and the New York Central railroad, 30 mi. E. of Ogdensburg. Pop. in 1930, 4,136; 1940, 4,821. It is the seat of the Clarkson College of Technology (1896), a state normal school (1869) with which is incorporated the former Crane Normal Institute of Music, and is the centre of a large dairy industry and of several electric power developments. Settlement here began in 1803 and the village was incorporated in 1831. It gives its name to deposits of a reddish sandstone studied here first by Emmons in 1838–42.

POTT, PEWCIVALL (1714–1788), English surgeon, was born in London on Jan. 6, 1714. He became assistant surgeon at St. Bartholomew's in 1744 and was full surgeon from 1749 till 1787. He died in London on Dec. 22, 1788. The first surgeon of his day in England, excelling even his pupil, John Hunter, he introduced various important innovations in procedure, doing much to abolish the extensive use of escharotics and the actual cautery that was prevalent when he began his career. A particular form of fracture of the ankle which he sustained through a fall from his horse in 1756 is still described as Pott's fracture. and his book, *Some Few Remarks upon Fractures and Dislocations,* published in 1768 and translated into French and Italian, had a far-reaching influence in Great Britain and France. "Pott's disease" is a spinal affection of which he gave an excellent clinical description in his *Remarks on that Kind of Palsy of the Lower Limbs which is frequently Found to Accompany a Curvature of the Spine* (1779).

There are several editions of his collected works; that published by Sir James Earle in 1790 contains a sketch of his life.

POTTER, ALONZO (1800–1865), American bishop of the Protestant Episcopal Church, was born at Beekman (now La Grange), N.Y., on July 6, 1800. He graduated in 1818 at Union college, where he became tutor and then professor of mathematics after a brief period spent in studying theology at Philadelphia. He was rector of St. Paul's, Boston, from 1826 to 1831, when he returned to Union as professor of philosophy and political economy, becoming vice president of the college in 1838. He was consecrated bishop of Pennsylvania on Sept. 23, 1845, and died on board ship in San Francisco harbour on July 4, 1865. By his publication with G. B. Emerson of The *School* and the Schoolmaster (1842) and by lectures Potter did much to extend and better public school education. He was particularly interested in work for young men and in temperance reform. As a legislator in the church he was wise and progressive. He established the Philadelphia Divinity school (1861), and laboured for the "Hospital of the Protestant Episcopal Church in Philadelphia."

See M. A. De Wolfe Howe, *Memoirs of the Life and Services of the Rt. Rev. Alonzo Potter, D.D.* (1870).

His brother, HORATIO POTTER (1802–1887), was born in Beekman, N.Y.. Feb. 9, 1802. He graduated at Union college in 1826 and was successively rector in Maine, professor of mathematics and natural philosophy at Washington (now Triniiy) college at Hartford, Conn., rector in Albany and after 1854 provincial bishop of New York. Failing health put an end to his active service in 1883, when his nephew, H. C. Potter (*q.v.*), became his assistant. He died in New York city Jan. 2, 1887.

POTTER, HENRY CODMAN (1834–1908), American Protestant Episcopal bishop, the son of Bishop Alonzo Potter, was born in Schenectady, N.Y., on May 25, 1834. In October 1883 he was consecrated assistant to his uncle, Horatio Potter, bishop of New York, whom he succeeded in 1887. He died in Cooperstown, N.Y., on July 21, 1908. During his administration the corner-stone of the cathedral of St. John the Divine was laid (Dec. 27, 1892). As rector of Grace church he worked to make it an "institutional church" with clubs for working men and girls, day nurseries and kindergartens. He won fame on the centennial of Washington's inauguration by his address on the dangers and corruptions of the spoils system.

See Harriette A. Keyser, *Bishop Potter, the People's Friend* (1910), and the official biography by George Hodges (1915).

POTTER, PAUL (1625–1654), Dutch animal painter, was born at Enkhuizen, Holland. He was instructed in art by his father, Peter Potter, a landscape and figure painter of some merit, and by Nicolas Moeyaert, of Amsterdam. Other masters and influences are mentioned by various writers, but more than any other of his contemporaries he learnt through direct study from nature. In 1646 he went to Delft, where he became a member of the gild of St. Luke. At the age of twenty he settled at the Hague, and there married in 1650. He was patronized by Maurice, prince of Orange, for whom he painted the life-size picture of the "Young Bull," now one of the most celebrated works in the gallery of the Hague. In 1653 he was induced by Burgomaster Tulp of Amsterdam to remove to that city. He died Jan. 15, 1654.

His paintings are generally small; early in life, however, he attempted, but with ill success, to work on a monumental scale, as in the "Bear Hunt" at the Rijks Museum and the "Boar Hunt" of the Carstanjen collection, Berlin. Even the famous "Equestrian Portrait of Tulp" formerly in the Six collection, Amsterdam, is awkward and stiff and hard in handling. His animals are accurately designed, and the landscape backgrounds are introduced with spirit and appropriateness. His colour is clear and transparent, his execution firm and finished without being laboured. His view of nature is purely objective and unemotional; he painted with the greatest directness and simplicity the things he saw before him, and his paintings of horses and cattle are so individualized that they become faithful portraits of the animals. The best among his small portraits of horses are in the Louvre and in the Schwerin Gallery; and certain of his studies are the most brilliant of all.

The earliest dated picture of importance is "Abraham Entering Into Canaan" (1642), at the Germanic Museum in Nuremberg, in which he makes the Scriptural subject an excuse for painting the patriarch's herds, just as in his "Orpheus" of 1650 (Rijks Museum, Amsterdam) he makes similar use of the Greek myth. Among his finest works on a small scale are a cattle piece (1653) in the Duc d'Arenberg's collection, and a similar, though earlier, picture in the Munich Pinakothek. Hofstede de Groot enumerates 177 works by Potter. He worked with feverish application, as though he were aware of the short span of life that was granted him. He executed a series of some twenty etchings, mainly of animals, which are simple and direct in method and handling.

Potter's works have been engraved by Bartolozzi, Danckerts, Visscher, Le Bas and others. There are two of his paintings at the National Gallery, three in Buckingham Palace and a few in the duke of Westminster's collection. On the continent of Europe the most numerous and representative examples are to be found at the Rijks Museum in Amsterdam, the Hermitage in Leningrad and the Dresden Gallery. (P. G. K.)

See *Paulus Potter, sa vie et ses oeuvres,* by *T.* van Westrheene (the Hague, 1867); *Eaux-fortes de Paul Potter, by* Georges Gratet Duplessis; and an old but interesting volume, *Paul Potter, peintre de l'école hollandaise,* by *C. L.* F. Lecarpentier (Rouen, 1818); Hofstede de Groot, *Catalogue of Dutch Painters* (1912).

POTTERIES, THE, a name applied to a district of north Staffordshire, the principal seat of the china and earthenware industry in England. It lies in the upper part of the Trent basin. For a distance of 9 m. from south-east to north-west, and about 3 m. from north-east to south-west, the district resembles one great town, but the chief centres are, Burslem, Hanley, Longton, Stoke-on-Trent, Fenton and Tunstall. These towns were amalgamated in 1910 as one municipal borough under the name of Stoke-on-Trent, which was raised to the dignity of a city in 1925. Newcastle-under-Lyme, though not sharing in the staple industry, may also be reckoned in the district. In 1769 Josiah Wedgwood founded pottery works at Etruria, now in the parliamentary division of Hanley. The Wedgwoods and the Mintons are the two most famous family names connected with the china industry of the district. Coal and coarse clay are the only local natural products used in the industry, the finer clay and other ingredients being brought from Cornwall and elsewhere. Ironstone is raised, and many new industries have been established in the district.

POTTERY AND PORCELAIN. The word "pottery" (Fr. *poterie*) in its widest sense includes all objects fashioned from clay and then hardened by fire; the word "porcelain" should only be applied to certain well marked varieties of pottery. Pottery is dependent on two important natural properties of that great and wide-spread group of rocky or earthy substances known as clays, viz., the property of plasticity and the property of being converted when fired into one of the most indestructible of ordinary things.

"Ceramics" or "Keramics" (Gr. κεραμος, earthenware) is a general term for the study of the art of pottery. It is adopted for this purpose both in French (ceramique) and in German (Keramik).

INTRODUCTION

The primitive races took such clay as they found on the surface of the ground, or by some river-bed, and, spreading it our on a stone slab, picking out the rocky fragments, then beating it with the hands, with stones or boards, or even treading it with their feet, proceeded to fashion it into such shapes as need or fancy dictated. Fired in an open fire, such pottery may be buff. drab, brown or red—and those from imperfect firing become smoked, gray or black. For ages tools and methods remained of the simplest—the fingers for shaping or building up vessels, a piece of mat or basket-work for giving initial support to a larger vase—until some original genius of the tribe found that by starting to build up his pot on the flattened side of a boulder he could turn his support so as to bring every part in succession under his hand, and thus the potter's wheel was invented.

At first this simple hand-made pottery was hardened by drying in the sun, but the increasing use of fire soon brought out the fact that a baked clay vessel became as hard as stone. Different districts produced different colours of clay, and thus colour decoration arose. On this substructure all the pottery of the last 4,000 years has been built, for behind all Egyptian, Greek or

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DECORATED POTTERY OF ANCIENT GREECE AND ITALY

1. Attic ***oenochoe*** or jug, with a moulded design representing a sacrifice. 4th cent. B.C.
2. Roman (Arretine) ***krater*** or mixing bowl, bearing a design of the Seasons. 1st cent. B.C.
3. Attic black-figure ***amphora*** or two-handled jar, signed by the potter Exekias, showing Achilles slaying Penthesileia. 6th cent. B.C.
4. Attic red-figure ***krater*** attributed to the painter Myson, showing Heracles and Apollo struggling for the Delphic Tripod. 5th cent. B.C.

Chinese pottery we find the same primitive foundations.

In subsequent articles on this subject we find that the Egyptians evolved schemes of glowing colour—brilliant glazes fired on objects, shaped in sand held together with a little clay, or actually carved from rocks or stone; the Greeks produced their marbles of plastic form, and then turned the plastic clay into imitations of metal forms; the Romans spread some knowledge of the craft over all the empire, but with its fall pottery was forgotten along with its greater achievement. Egypt and the Near East continued the splendours of their glorious past, and glazed and painted pottery was still made by traditional methods. Many interesting kinds of decorated pottery were made at Old Cairo, Alexandria, Damascus, in Syria, Anatolia and elsewhere (on which the later Moslem potters founded their glorious works).

Meantime, in the farther East, the Chinese—the greatest race of potters the world has ever seen—were quietly gathering strength, until from their glazed, hard-fired pottery there emerged the marvellous, white translucent porcelain, one of the wonders of the mediaeval world.

With the dawn of the 15th century, the state of affairs was practically this; In European countries proper, we find rudely fashioned and decorated wares in which we can trace the slow development of a native craft from the superposition of Roman methods on the primitive work of the peoples. The vessels were mostly intended for use and not for show; were clumsily fashioned of any local clay, and if glazed at all then only with coarse lead-glazes, coloured yellow or green; in no case above the level of workmanship of the travelling brick- or tile-maker. The finest expression of this native style is to be found in the Gothic tile pavements of France, Germany and England.

As early as the 12th century the superior artistic pottery of the Moslem nations had already attracted the notice of Europeans as an article of luxury for the wealthy; and we may well believe the traditional accounts that Saracen potters were brought into Italy, France and Burgundy to introduce the practice of their art, while Italian potters certainly penetrated into the workshops of eastern Spain and elsewhere and gathered new ideas.

During the 15th and 16th centuries, Chinese porcelain also began to find its way into Europe, and by the whiteness of its substance and its marvellous translucence excited the attention of the Italian majolists and alchemists. The first European imitation of this famous oriental porcelain of which we have indubitable record was made at Florence (1575–85) by alchemists or potters working under the patronage, and, it is said, with the active collaboration of Francesco de' Medici. This Florentine porcelain was the first of those distinctively European wares, made in avowed imitation of the Chinese, which form a connecting link between pottery and glass, for they may be considered either as pottery rendered translucent or as glass rendered opaque by shaping and firing a mixture containing a large percentage of glass with a very little clay.

During the 18th century not only was there a very large trade in imported Chinese and Japanese porcelain, but there was a great development of porcelain manufacture in Europe.

The 19th century witnessed a great and steady growth in the output of porcelain and pottery of all kinds in Europe and the United States. Mechanical methods were largely called in to supplement or replace what had hitherto remained almost pure handicraft. The English methods of preparing and mixing the materials of the body and glaze, and the English device of replacing painted decoration by machine printing, to a large extent carried the day, with a great gain to the mechanical aspects of the work and in many cases with an entire extinction of its artistic spirit.

The 20th century opened with a wider outlook among the potters of Europe and America. In every country men were striving once again to bring back to their world-old craft something of artistic taste and skill.

TECHNIQUE

All pottery, whether of ancient or modern times, is made by the simplest method. The clay, dug from the earth's surface, is prepared by beating and kneading with the hands, feet or simple mallets of stone or wood. Care is taken that all stones and hard particles are picked out. In ancient pottery, the clay, well tempered with water, was almost invariably used without any additional material. From this pure clay, vessels were shaped by scooping aut or cutting a solid lump or ball, by building up piece by piece or by squeezing cakes of clay on to some natural object or prepared mould or form. The potter's wheel, though very ancient, was a comparatively late invention, arrived at independently by many races of men. In its simplest form it was a heavy disk pivoted in a central point to be set going by the hand, as the workman squatted on the ground. About the Christian era, and in Egypt apparently, a much larger disk, which the potter could rotate with his foot, was introduced; this gave the potter an opportunity to use both hands in the manipulation of the clay. In the 17th century the wheel was spun by means of a cord working over a pulley, and in the 19th century the steam driven wheel was introduced.

The rotating process completed, the piece is removed from the wheel and set aside to dry. When it is about leather-hard, it may be recentred carefully on the wheel (the old practicej, or placed in a horizontal lathe (16th century) and turned down to the exact shape and polished to an even, smooth surface. Many Greek vases have obviously been "thrown" in separate sections. So too with the Chinese; many of their forms have been made in two or three portions, subsequently joined together and finished on the outside as one piece. (See TERRA-COTTA.)

Firing.—The type of kiln used by the potters of ancient Egypt or Greece have not entirely vanished from present day use; it is only in the civilized countries of the modern world that they have been replaced by improved and perfected devices. The potters of certain sections of the Near East and of Japan remain content with the crudest and most primitive types of kilns. With the organization of the pottery as a factory industry in the 18th century, improved kilns were introduced, and the type of kiln now used in civilized countries is a verticle furnace from 10 to 22 ft. in diameter and of similar height, capable, therefore, of containing at one firing a quantity of pottery that would have formed the output of a mediaeval potter for a year. Gas-fired kilns and ovens are now being used or experimented with in every country, and their perfection, which cannot be far distant, will improve the most vital of the potters' processes both in certainty and economy.

Glazes.—We can only consider as glazes those definite superficial layers of molten material which have been fired on the clay substance. Glazes are as varied as the various kinds of pottery, and it must never be forgotten that each kind of pottery is at its best with its appropriate glaze. The most important types of glaze are (1) alkaline glazes, *e.g.,* Egyptian, Syrian, Persian, etc., the oldest and most uncertain; (2) lead glazes, the most widespread in its use and the best for all ordinary purposes; (3) felspathic glazes, the glazes of hard-fired porcelains, generally unsuited to any other material; (4) salt-glaze, produced by vapours of common salt, the special glaze of stone-wares.

Colours.—The primitive potters of ancient and modern times have all striven to decorate their wares with colour. The simplest, and therefore the earliest, colour decoration was carried out in natural earths and clays. The clays are so varied in composition that they fire to every shade of colour from white to grey, cream, buff, red, brown or even to a bronze which is almost black. One clay daubed or painted upon another formed the primitive palette of the potter, especially before the invention of glaze. When glaze was used these natural clays were changed in tint, and native earths, other than clays, containing iron, manganese and cobalt, were gradually discovered and used. It is also surprising to note that some of the very earliest glazes were coloured glasses containing copper or iron (the green, turquoise and yellow glazes of the ancient Egyptians and Assyrians). Marvellous work was wrought in these few materials, but the era of the finest pottery-colour dawns with the Persian, Syrian and Egyptian work that preceded the Crusades. By this time the art of glazing pottery with a clear soda-lime glaze had been thoroughly learnt. Vases, tiles, etc., shaped in good plastic clay, were covered with a white, highly siliceous coating fit to receive glazes of this type, and giving the best possible ground for the painted colours then known. The colours already spoken of were either clay colours or what are known as "under glaze" colours, because they were painted on the pottery before the glaze was fired.

The earliest glazes of the Egyptians appear not to have been white, but were coloured throughout their substance, and this use of coloured glazes as apart from painted colour was developed along with the painted decoration by the later Egyptian, Syrian and Persian potters. Green, yellow and brown glazes were almost the only artistic productions of the mediaeval European potters' kilns, and their use everywhere preceded the introduction of painted pottery.

With the exceedingly refractory felspathic glazes of Chinese porcelain very few underglaze colours could be used; and the prevalence of blue and white among the early specimens of Chinese porcelains is due to the fact that cobalt was almost the only substance known to the potters of the Ming dynasty which would endure the high temperature needed to melt their glazes. Consequently the Chinese were driven to invent the method of painting in coloured fusible glasses on the already fired glaze. They adopted for this purpose the coloured enamels used on metal; hence the common term "enamel decoration," which is so generally applied to painting in those colours which are attached to the already fired glaze by refiring at a lower temperature. With the introduction of this many-coloured Chinese porcelain into Europe the same practice was eagerly followed by our European potters, and a new palette of colours and fresh styles of decoration soon arose amongst us.

It must be pointed out that the colour possibilities in any method of pottery decoration are largely dependent on the temperature at which the colour needs to be fired. The clay colours are naturally more limited in range than the under-glaze colours, and these in their turn than the on-glaze colours.

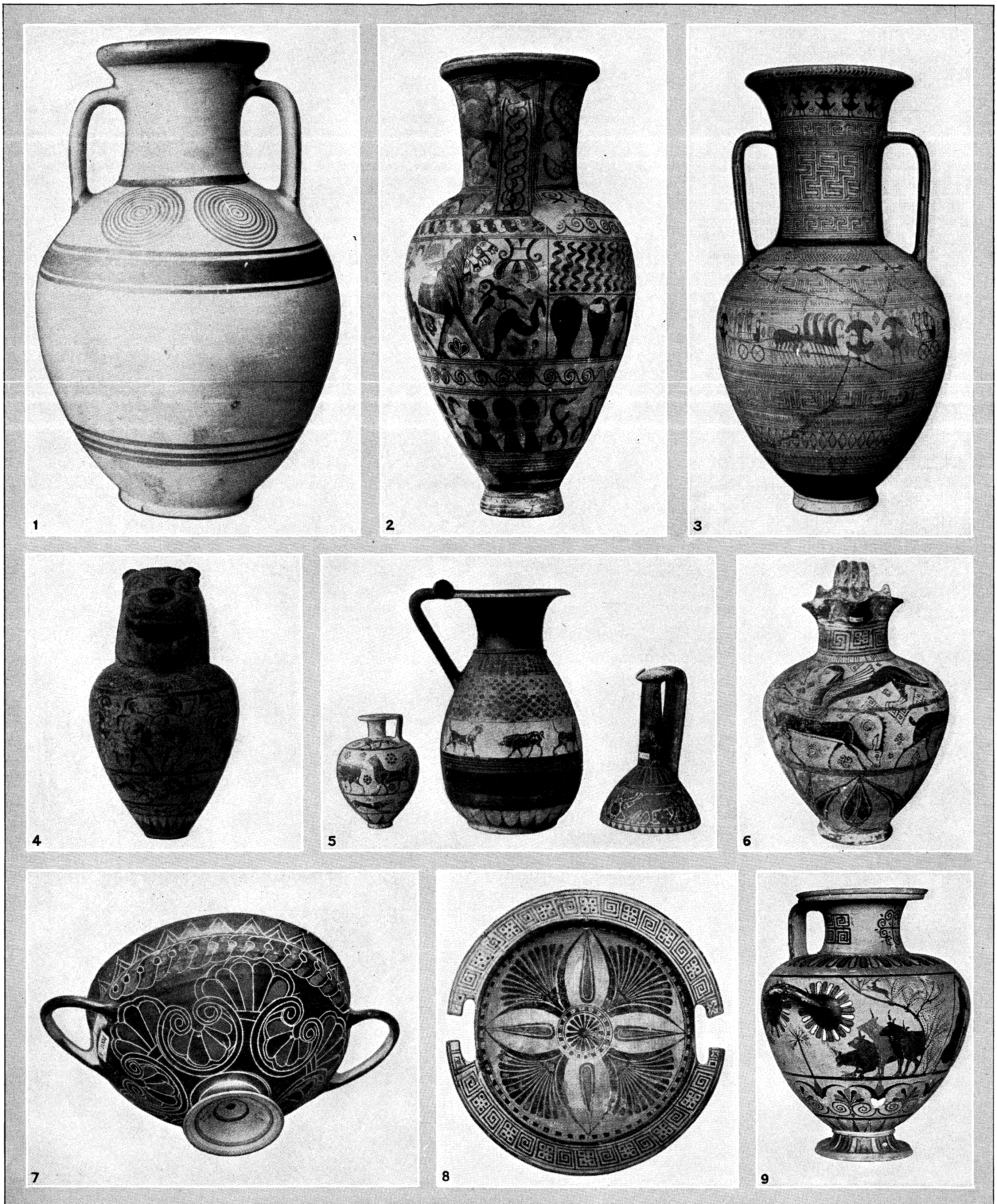
Metals.—The noble metals, such as gold, platinum and silver, have been largely used since the early years of the 18th century as adjuncts to pottery decoration, especially on the fine white earthenwares and porcelains of the last two centuries. At first the gold was applied with a kind of japanner's size and was not fired to the glaze, but for the last 150 years or so the metals have generally been fired to the surface of the glaze like enamel colours, by mixing the metal with a small proportion of flux or fusible ground glass. There can scarcely be a doubt that the ancient lustres of Persia, Syria and Spain were believed to be a form of gilding, though their decorative effect was much more beautiful than gilding has ever been. The early Chinese and Japanese gilding appears, like the European, to have been "sized" or water-gilt, not fired; and it seems probable that the use of "fired" gold was taught to the Oriental by the European in the 18th century. To-day "liquid" gold is exported to China and Japan from Europe for the use of the potter. (For Egyptian pottery, *see* EGYPT: ***Archaeology and Art,*** section ***Ceramics;*** for ***Primitive Far Eastern*** and ***Near Eastern Pottery, see*** those sections. ***See*** also BABYLONIA AND ASSYRIA: ARCHAEOLOGY, and POTTERY, PRIMITIVE.) (X.)

GREEK POTTERY

The pottery of ancient Greece, prehistoric and historical, is distinguished from all other fictile wares of the same ages by its free development of naturalistic painted decoration. The ceramic painter's art was so far separated from the potter's in the classical period, that each could put his signature to his own portion of the work, and there can be little doubt that the best Minoan pottery was equally the joint product of the two craftsmen. This uniformity in Prehellenic and Hellenic ceramics can hardly be fortuitous. Though Late Minoan (Mycenaean) vase-painting contains no visible element of design that was adopted by the Geometric artists, the technique of potter and painter passed intact across the apparent gap in culture that separates the Aegean ages of Bronze and Iron, and the subsequent revival of naturalistic ornament in the Archaic Greek period shows that something more than mere mechanical skill had been inherited.

Prehistoric Origins.—The technique in which the masterpieces of classical vase-painting were executed was first perfected in Minoan Crete, but its invention was not Cretan. Painted pottery was made in prehistoric Mesopotamia and Egypt long before its appearance in Aegean lands. Pre-Sumerian ware bears decoration fired on pale clay in a dark medium of ferruginous earth fused with an alkaline flux, and one variety of Egyptian predynastic pottery has dull white pigment similarly fired on a dark ferruginous wash. Both processes were applied in Early Minoan pottery; the latter was brilliantly exploited in the polychrome Middle Minoan style (Kamares ware), but the former finally prevailed, because of its greater freedom, in the Late Minoan age. ***(See*** ARCHAEOLOGY; ***Crete.)*** At the close of the M.M. period, when Cretan arts were transplanted to the Greek mainland, the colonial (Mycenaean) fabric of Minoan pottery displaced the inferior and largely hand-made native wares, Helladic, Cycladic and Thessalian, which formerly marked the various cultural regions. ***(See*** ARCHAEOLOGY; ***Greece.)*** By the end of the Mycenaean age the pottery of the whole Aegean area was uniform, except on its northern and eastern borders, where Danubian and Anatolian influences were preponderant. This latest Mycenaean ware preserves the forms and fabric of the best Minoan models, but its ornament is atrophied. Shells, octopods and seaweed have degenerated into rows of wavy lines, lily and papyrus flowers appear as groups of parallel curves or chevrons, and the rich designs of linked and running spirals give way to bands of single coils. But the clay is finely worked, the pots accurately turned, the firing hard and even, the glaze dense and lustrous. Two Mycenaean fabrics can certainly be distinguished. The more numerous class has a warm yellow clay surface and its black glaze fires red. The smaller group is made of exceedingly smooth pale greenish clay, and painted with brown-fired glaze, which tends to flake away from the close texture of the surface. The latter belongs to the Argolid, and was made from the same white clay that produced the later Protocorinthian and Corinthian wares.

The Geometric **Style.**—The next historical phase in Greece was the transition from bronze to iron, about 1000 B.C., a cultural change that involved the violent downfall of the Mycenaean polity. Arts were generally submerged, but the pottery can be identified. It is called Submycenaean or Protogeometric, as its elements appear to attach themselves to the old Minoan or the new Hellenic system. The technique is still Minoan and is often brilliant, but many of the pot-shapes are modified and the decorative patterns assume a new character. The surviving Mycenaean motives are resolved into their simplest linear elements, and these tend to combine again in rigid geometric schemes. Another tendency was to abandon painted patterns and cover the whole pot with black glaze. In this potent fallow the new principles of Hellenic art were laid, and the so-called Geometric style sprang rapid and luxuriant. In its mature phase a Geometric vase is covered with narrow horizontal bands of minute and crowded ornament, rows of repeated figures, triangles, lozenges, circles, continuous or panelled bands of zig-zags, chequers and, chiefly characteristic, the maeander. This last motive, always drawn in double outline filled with hatching, is probably the key to the origin of the style. It appears at the same period in Italy, in the pottery and bronze work of the Villanova culture, and since there is no evidence of intercourse between the two countries at this date, must have been introduced into both from a common northern source. Its first occurrence in Greece is in isolated bands or panels reserved on necks or bodies of black-glazed pots, a rudimentary form of decoration which was as universal as the former Mycenaean style. Subsequent developments were local, and many styles have been identified in mainland Greece, the Aegean islands and the coast of Asia Minor. The most elaborate is that of Athens, called Dipylon ware after the cemetery at the city-gate, where the largest vases have been found. These are huge sepulchral jars which sometimes bear among the geometric patterns broader bands or longer panels filled with pictures of funerals, a corpse surrounded by mourners, and processions of chariots, human and animal figures being drawn



ANCIENT GREEK POTTERY

1. Sub-Mycenaean Amphora (storing vessel). Height 17"
2. Proto-Attic Amphora, combat of Heracies and Nessos. Height 3'7"
3. Dipylon Geometric Amphora. Height 30"
4. The Macmilian Lekythos (oil bottle). Proto-Corinthian. Height 2¾"
5. Proto-Corinthian and Corinthian Group. Height, central figure, 10½"
6. Rhodian Oenochöe (wine jug). Height 13"
7. Rhodian skyphos (drinking cup). Diameter 5"
8. Rhodian pinax (plate)
9. Caeretan Hydria (water jar). Height 18". In the Louvre

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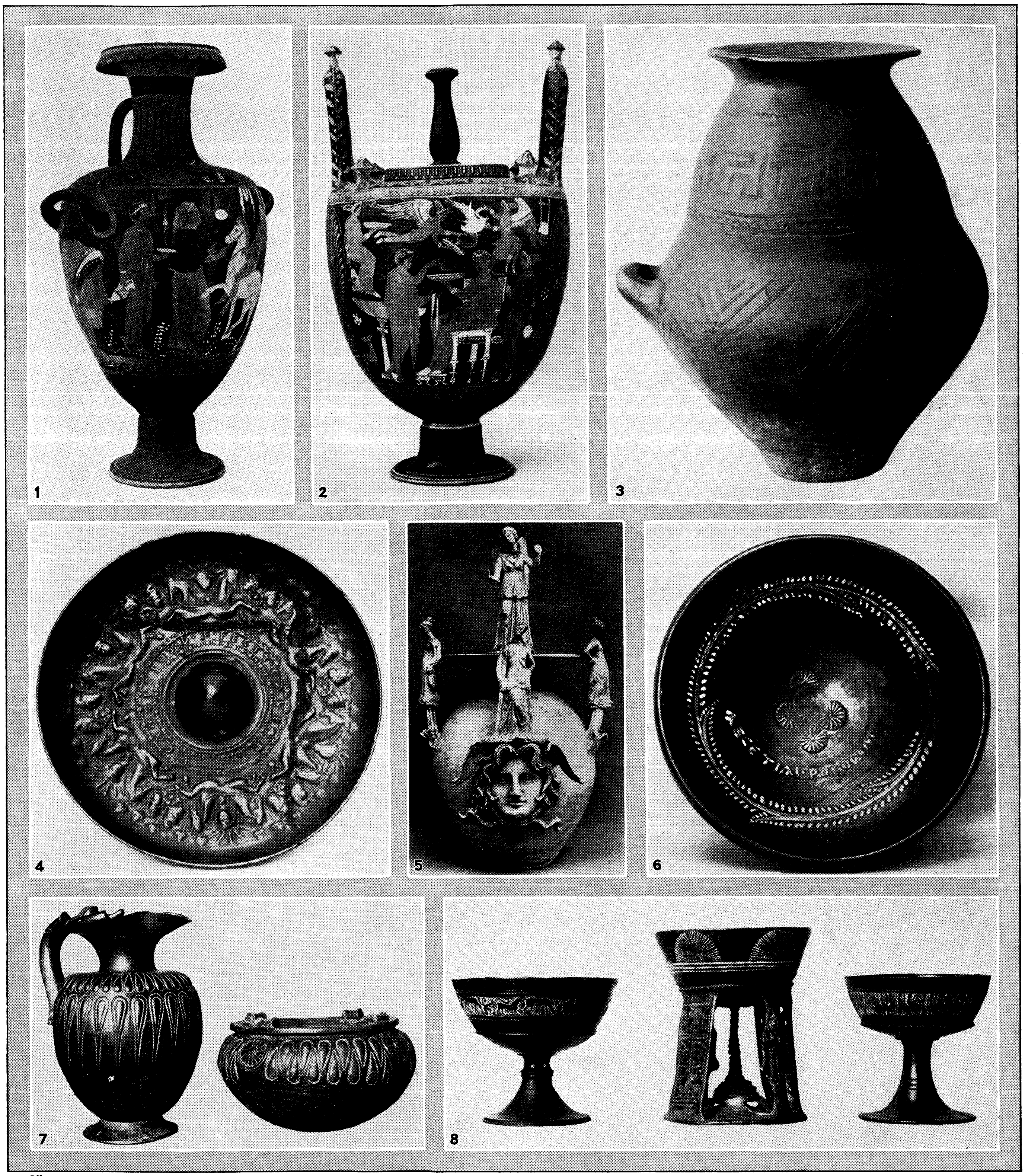
ANCIENT GREEK POTTERY

1. Chalcidian black-figure krater (vase for mixing wine and water). Height 18″
2. Attic black-figure hydria (water jar). Height 18″
3. Attic kylix (drinking cup), miniature style. Height 5½″
4. Eye **kylix.** Height 5″
5. Attic red-figure **kotylē** (drinking cup), signed by Hieron. Height 8¼″
6. Attic red-figure **lekythos** (oil bottle). Height 10″
7. Attic lekythos. Height 8″
8. Megarian bowl. Height 3½″
9. Vase of red Samian ware. Height 6¼″



ANCIENT ITALIAN POTTERY

1. Campanian hydria (water jar)
2. Apulian vase
3. Villanova cinerary urn. Height 15"
4. Calene (Campanian) bowl, with potter's signature. Diameter 7"
5. Canosa (Apulian) vase
6. Gnathia (Apulian) bowl with Latin inscription. Diameter 5½"
7. Etruscan bucchero jug and bowl. Height, jug, 16"; bowl 8"
8. Etruscan bucchero cups. Height, central figure, 7½"

ANCIENT ROMAN POTTERY

1. Arretine mould and stamp. Height 4¾″
2. Bowl of *terra sigillata*. Gaulish fabric. Diam. 9″
3. Bowl of *terra sigillata*. Gaulish fabric. Diam 5½″
4. Jar with *barbotine* and moulded ornament. Height 7½″
5. Arretine saucer with potter's stamp. Diam. 4½″
6. British castor ware. Height 6″
7. Black Rhenish ware. Height 5″
8. Lead-glazed ware. Height, central figure, 7″

schematically in black silhouette. These subjects are the first expression of Hellenic delight in representation, which quickly dominated decorative art and ultimately destroyed it. The live subject, human and animal, was also utilized in the Geometric style as a decorative unit, in bands of soldiers carrying shields and spears, of grazing horses, deer and goats, running dogs and birds. The birds belong, like the maeander, to primary sources of the style, but the grazing and running quadrupeds are a later feature, and are probably the first signs of oriental influence.

Oriental Influences.—The political changes that destroyed the Mycenaean power had also interrupted Aegean relations with Asia and Egypt, but when contact was restored, about the 10th century, the new Greek world became doubly linked with the ancient foreign civilizations, by its colonies on the coast of Asia Minor as well as by its own and Phoenician commerce. The effects of oriental contact are visible in all Greek arts after the 9th century. The actual commodities that served Greek vase-painters for models have not been identified, and if, as is possible, they were textiles, cannot have survived. They seem to have been brightly coloured, for touches of red and white paint enliven the black figures in all the orientalizing styles. But accurate drawing and incised contours suggest metal prototypes, and some bronze and silver bowls and cups engraved in the same manner have been found in Greece and Italy. (See BRONZE.) Oriental motives in the late Geometric style, besides the bands of animals, are cable-pattern (guilloche), palmettes in bands or panels, and base-rays. The latter are derived from the petals of a flower-calix; originally Egyptian, they are a common feature of Asiatic pottery, and particularly of late Hittite vases. These novelties broke up the conventional Geometric art, and the succeeding local wares bear very little resemblance to one another.

Protocorinthian, etc.—The principal early orientalizing styles are Protocorinthian, Protoattic, Island (Melian), and Ionian (Rhodian). They belong broadly to the 7th century. The true Protocorinthian fabric was located in the Argolid, where a very precise and simple geometric style had been established. Precision is the distinguishing feature of Protocorinthian ware, and is accentuated by the miniature forms of nearly all existing vases. They are made of the smooth pale yellow clay which distinguishes the local Mycenaean fabric, and which invites fine craftsmanship by its plasticity. Conical cups (skyphoi) and pointed oval scent-bottles (lekythoi) are typical forms. Their earliest subgeometric ornament of simple linear patterns was soon displaced by bands of animals, particularly running dogs, palmettes and lotus, cables and rays, all of which were in turn subordinated to a main frieze containing human or monstrous figures, sphinxes, chimaeras, centaurs and the like. The background in the figure-friezes is filled with detached ornaments, in this style typically the dot-rosette, a device which belongs properly to metal reliefs, where it is simply executed with a round-nosed punch. The influence of metal-work is also visible in the sharpness of this style and in its use of engraving to define outlines and inner markings of the silhouettes. The colour is enriched with patches of dull red and white, as if inlaid on the black-glaze figures, for details such as manes, throats and bellies of animals, armour, clothes and hair of men. Masterpieces of the Protocorinthian style are the Chigi vase in the Villa Gierlia at Rome, a large jug with an amazingly elaborate battle-piece and hunting-scenes in three friezes, and two small scent-bottles, with fancifully modelled tops and hardly less elaborate hunts and battles on their bodies, in Berlin and London (the Macmillan lekythos). A purely decorative Protocorinthian scheme consists of scales or tongues closely incised on a black-glazed surface and painted alternately white and red, together with thin bands and dot-rosettes in the same bright colours. Large and small vases are entirely or partially covered with these ornaments. This fabric was largely exported, particularly to Italy, where it was more or less successfully imitated by Greek and Etruscan potters. Another Protocorinthian group consists of little vases moulded in natural forms, squatting men, busts and heads, animals, birds and shells. They were largely copied from Egyptian faience figures, and in their turn influenced the Egyptian vase-shapes. Large quantities of these Egyptian blue-glazed wares were exported from the Greek settlement of Naucratis, and some were evidently made there, or in some Greek colony in Asia, for the style of many pieces is more Greek than Egyptian, and one found in Rhodes bears a Greek inscription. The same shapes, particularly heads in helmets, were made in ordinary Greek pottery in Rhodes, and other plastically decorated fabrics from the same island are made of black ware like the Etruscan bucchero nero. Large storage-jars, with plastic patterns worked in relief or impressed in friezes with engraved cylinders, are also represented on Ionian sites. Protoattic pottery exhibits the same developments as Protocorinthian, but in a very different style. Vases and their painted decoration are large and vigorous, their fabric rather coarse, in red clay. Various stages of development are called by names of places where typical examples have been found, Phaleron and Vourva. They illustrate the intrusion and refinement of the Oriental repertory, from the animal-frieze with its close array of filling-ornaments to the isolation of human subjects in a clear field. The Island style is as bold as the Attic; it affects heavy spiral ornaments, gay colours, and ambitious narrative-subjects. Crete was a main channel of the new influence, but its pottery is not yet adequately represented. A typical Island form is a large high-necked bowl with a tall conical foot. Some examples, usually attributed to Melos, are painted over a white slip.

Ionian.—In this technical peculiarity they resemble the fabrics of Ionia, where the white slip was universal. This is a pipe-clay wash laid on the rough body of the vase to make a ground for painting. It is rare in Geometric fabrics, and seems to have come in with Oriental decoration; it was probably an ancient Anatolian invention, for it occurs in Hittite, Syrian, and Cypriote wares, and its immediate source may have been Lydia. The many fabrics of early Ionian style are generally represented by Rhodian vases. These are mostly jugs with rays or lotus-wreaths on foot and shoulder, and animal-friezes on the body, done on the white ground in large black-glaze figures with dull red patches. Among the filling-ornaments are looped semicircles (roundels) attached to the borders of the frieze. Human subjects are rare, the most prominent animal-figures are sphinxes, and the characteristic motive is a band of grazing goats. Large plates are a frequent shape, painted with lotus designs, or with concentric panel-friezes containing heads of goats and birds. A very similar fabric, mostly found in the Ionian city of Naucratis in Egypt, has been called Milesian, but may have been made locally. Clazomenae is chiefly represented by large painted sarcophagi. The red and white ornament on black, which was used in Protocorinthian ware, appears also on Rhodian vases, though not quite in the same forms. Red and white bands stand alone, or separate the floral and animal friezes, and the same colours are used for drawing lotus wreaths, or for filling tongues or lotus and palmette-petals, or even animals outlined by incision on the black ground. A fabric resembling the Ionian, but apparently belonging to mainland Greece, is the so-called Cyrenaic, which, since the discovery of a complete stylistic series in Spartan temple-deposits, has been known rather as Laconian. The excavation of Cyrene should decide the question of its origin. It is a white-slipped ware with bold decorative painting, large black and white chequers and step-patterns and solid rays in its subgeometric form, pomegranates and lotus-buds formally disposed between animal-friezes in its orientalizing phase Its early shapes are somewhat fantastic; a typical drinking-cup (*lakaina*) has a low convex body, from which two long loop-handles spring, and a tall concave lip or neck. A mature work is the famous *kylix* in the Bibliothèque Nationale of Paris. with a picture of Ring Arcesilas of Cyrene supervising in oriental state the lading of a ship. It is this scene that caused the fabric first to be attributed to Cyrene.

The Black-figure Style.—Towards the end of the 7th century the local fabrics, which had diverged so widely in their orientalizing phases, tended to come together again, perhaps under Athenian influence, in the Black-figure style. The expansive interest in human form and human Iife enlarged the fields in which these subjects were accommodated; animal and floral friezes were reduced in width and relegated to the less conspicuous positions on the pots. In the mature style of the 6th century ornamental animals hardly occur at all, and floral patterns are only used for borders or bands and panels in which narrative-pictures are displayed. But the new pictorial style retained the technique of the old ornament. The figures are drawn in black silhouette on the clay ground, and inner details are indicated by incision and by colour. The same dull red and white pigments were laid on the black glaze or on the clay in place of it. Both were decoratively applied without consideration of reality to produce a colour-pattern, but white was specially used for faces and limbs of women. White slip disappears as a mark of locality, but occurs on special occasions in several fabrics. The normal surface has the same colour as the body of the clay, light yellow in Corinthian, light red in Attic and most other wares. The natural colour of Attic clay was enriched with red ochre (*miltos*) and this substance had such industrial importance that its supply was strictly controlled by the Athenian Government. Corinthian ware in its latest development tried to imitate the Attic colour with a red wash. The history of Greek pottery in the 6th century is the continuous progress of the Athenian fabric towards its ultimate monopoly. At the beginning of the century there were numerous other black-figure wares, Protocorinthian and Corinthian, Laconian (or Cyrenaic), Boeotian, Chalcidian, and Ionian, but hardly any of these survived beyond its elementary stages. The passing of Protocorinthian into Corinthian was accompanied by such a fundamental change of content that the process is obscured, and it is sometimes supposed that the Corinthian potteries displaced those of some neighbouring city, perhaps Sicyon, which had produced the Protocorinthian ware. But though the output was increased and the style changed, the fabric remained constant, and most of the old forms continue to appear with the new decoration. The change took place at the end of the 7th century, and was evidently due to new Oriental models, 'perhaps textiles instead of metal work. Globular and baggy oval bottles (aryballoi and *alabastra*) came into fashion, with large figures, often monstrous or grotesque, painted in a loose style which is the antithesis of Protocorinthian precision. Backgrounds that had been sparsely studded with neat dot-rosettes are now filled up with irregular patches. This is the common ware that was distributed east and west by Corinthian trade. Besides it is a pictorial style which omits the filling-ornament. There is a splendid series of large Corinthian bowls (*krateres*) bearing scenes from life and legend, with single subsidiary bands of animals or horsemen. In their free use of colour, their technique of outline-drawing, and their deep designs of overlapping figures, these vase-pictures 'probably give a better idea of monumental painting than any other surviving documents. Chalcidian pottery stands very close to metal work in its angular vase-shapes and sharp figures. The evidence by which the various fabrics are assigned to their localities lies in the forms of the letters in which the names of gods and heroes are inscribed beside their figures. Ionian black-figure designs are lively in colour and in action; the Clazomenian fabric, like the Laconian, retains its subgeometric subsidiary bands. Ionian wares were largely imitated in Etruria, and some of them may have been made there by immigrant craftsmen. Such are the Caeretan *Hydriai*, a brilliantly decorated series of water-jars found at Cervetri (Caere). Their free floral patterns connect them with the Fikellura vases (so-called after a Rhodian site), an odd old-fashioned group that keeps the white slip technique and is shy of narrative-pictures. One of the last Ionian inventions, the *eye-kylix* (a cup mainly decorated with two large pairs of eyes), mas adopted by Attic potters. A related Attic series (*Kleinmeister* kylikes) has miniature figures, often single, in an upper band, and below these, or sometimes alone, a line of minute writing, a drinking posy, a love-name or an artist's signature.

Signatures.—The practice of signing vases began in the 7th century; a Protocorinthian lekythos and a (perhaps Argive) krater with the names of their potters, Pyrrhos and Aristonothos, are the earliest examples. Timonidas, Chares and Milonidas are the only known Corinthian painters; there are four or five Boeotians, and the rest are Attic. Names are always accompanied by the words *made* (ἐποίησε) or *painted* (ἔγραψε), sometimes by both. The former is taken to be the potter's signature, but the term is not explicit, and may apply to the owner of the factory, to the manipulator of the clay, or to the maker and decorator. But double signatures indicate that the functions of potter and painter were generally separate: "Ergotimos made me, Klitias painted me" on the François vase; and one man occasionally claims both honours: "Exekias painted and made me." More than 100 Attic masters are known by name. Many were manifestly foreign, and some were slaves from the unpromising regions of Thrace and Scythia. One of the great black-figure potters bears an Egyptian name, Amasis; his work reveals Ionian affinities and shows that the Athenian monopoly was partly achieved by attracting foreign craftsmen to the city. Mature Attic pottery incorporates the best qualities of the fabrics which it superseded, technical excellence accomplished draughtsmanship and a large repertory of pot-shapes and decorative schemes.

Vase Shapes.—In archaeological usage the numerous shapes are denoted by ancient names which do not always rest on ancient authority, but they are accepted as a convenient means of classification. Important forms are two-handled storage-jars (*amphora*, *pelike*, stamnos), mixing-bowls (krater, in variety), water-pots (*hydria*, *kalpis*), jugs (oinochoe, *olpe*, *prochoos*), drinking-cups (*kylix*, *kantharos*, kotyle, *phiale*, skyphos), and oil-bottles (*alabastron*, *aryballos*, askos, lekythos). All were copied from metal models. Greek pottery was never a free art; its forms and decoration were inspired, controlled, and finally destroyed by progress in the arts of painting and metallurgy. After the middle of the 6th century, when technical perfection had been achieved, Attic decorators set themselves to perfect their draughtsmanship and power of expression, and the interest of painted pottery after that time is largely as a document in the history of drawing. The finest early black-figure work is the François vase in Florence, a monumental krater signed by Klitias and Ergotimos. It is covered with bands of lively narrative, the Calydonian boar-hunt, the funeral games of Patroclos, the marriage of Peleus and Thetis, the death of Troilos, and the battle of Pygmies and cranes. Among many later masterpieces is an amphora in the Vatican made and painted by Exekias, with a single panel-picture on each side. One picture shows Achilles and Aias playing draughts. The group is a stock subject reproduced by several painters, an excerpt, doubtless, from a monumental picture of the siege of Troy. The intentness of the poses and the elaboration of incised detail represent the last possible achievement of this style.

The Red-figure Style—The innovation was made before the end of the 6th century, about 520 B.C. Some masters, notably Andocides and Pamphaios, produced vases in both styles, and even combined the two on one vase. In the new process the background was blacked and the figures reserved on the red clay; inner markings, details of limbs and features were drawn in thin lines of black glaze, hair and clothing were occasionally done with a diluted brown or yellow wash of the same medium. The glaze has not been successfully reproduced by modern experiment, but analysis shows that it was composed of ferruginous earth with an alkaline flux. It was applied to the pot after the clay was dried, and before firing. The design was lightly sketched with a point, then drawn in outline and detail, apparently with a pen. The background was blacked in, and certain contours of the figures accentuated with relief lines of thick glaze. Touches of colour, red and gold, were very rarely added, and pot and glaze were fired together in a single operation. The new drawing had unlimited freedom and made rapid progress in truth and expression, but its decorative qualities were slight. The formality of archaic art and the restraint of early classical drawing preserved the decorative value of the figures to some extent, but after the middle of the 5th century, when the problems of representation had been solved, this character was lost, and facile drawing admitted weak design.

Attic Masters; Love-names.—Epiktetos, Euphronios, Euthymides, Brygos, Hieron, Douris, are a few names of the great archaic-masters; Sotades, Polygnotos, Meidias, of the free style. Some of these signed as potters, some as painters, and there are anonymous painters, no less capable and far more numerous,

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ITALIAN MAIOLICA

1. Plate of Italian maiolica, painted with a hunting scene, by Nicola **Pellipario.** Early 16th century
2. Drug-vase or *albarello,* painted with Gothic foliage; height 8⅛". Italian maiolica, late 15th century
3. Drug-vase, painted with bust of a youth and monogram TB.; Italian maiolica Faenza. Early 16th century

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EUROPEAN POTTERIES

1. Bowl with lion supports, *sgraffito* ware. Italian, late 15th century. In the Louvre
2. Side view of bowl shown in fig. 1
3. Dish with rampant lion, Hispano-Moresque ware; diameter 10″
4. Tray, Rouen faience; length 14⅞″, width 9¾″
5. Dish, Frankfort faience; diameter 13½″
6. Tureen, Strasbourg faience; height 19″
7. Jug, Raeren (near Aachen, Germany) stoneware
8. Dish, Palissy ware, second half 16th century; length 11″, width 7⅝″. From the Salting Collection

whose style can be recognized in their work. Recent research has gone far towards identifying all the hands in Attic red-figure drawing. Where the artist is not known by name, he is called after the potter for whom he worked (the Brygos painter, Meidias painter), after one of his vases or the collection in which it is preserved (the Villa Giulia painter, the painter of the Bowdoin Box) or a notable subject (the Pan painter), or after other persons named on his vases (the Panaitios painter). These, the so-called love-names, refer to popular idols of their day. When known to history they are youths of noble family, and the form of inscription *Panaitios* is handsome (Παναίτιος καλός) indicates that their fame rested on their good looks. The duration of this popularity was therefore not very long, and the use of historical names, Glaukon, Leagros, Miltiades, is valuable evidence for the dates of the vases. The character of red-figure subjects changes with the style. Archaic artists favoured heroic deeds and genial life, exploits of Herakles and Theseus, battles with Amazons and Centaurs, athletic contests and drinking-bouts. The early free style suited contemplative subjects, boys leaving home for the wars, religious and musical ceremonies. In the late free or florid style the scene is largely filled with idle women clad in voluptuous robes and trifling with winged love-gods.

Late Attic and Italian **Fabrics.**—In the early 4th century an attempt was made to revive this dull field again with colours, white generally for flesh of one or two figures in a group, blue, green, red and gold for drapery and jewels. Gold was often laid on details modelled in relief. These vases have been largely found in North Africa and South Russia, and take their name from the Crimean town of Kertch. They represent the last phase of pictorial painted pottery in Greece. The art survived, however, and even flourished for at least another hundred years in South Italy, where it was first established at the end of the 5th century. Another Attic fabric, the white-slipped ware which was regularly used for funeral *lekythoi* and occasionally for kylikes and other shapes in black-figure and outline-drawing, also came to a natural end in the 4th century, but was not involved in the same artistic decadence, since its decoration had proceeded on the broader lines of painting. These little vases, oil-bottles made for offerings to the dead, generally bear pictures of the tomb with boys and maidens bringing gifts. Clothes and mourning-sashes are painted in bright colours, and free brush-work dominates the designs. But painted patterns did not entirely disappear with pictorial subjects.

Hellenistic Relief-wares. — There was always a large class of black-glazed vases which had no other painting, but were sometimes fluted or impressed with slight ornaments in close imitation of metal. These were further adorned in the 4th and 3rd centuries with wreaths and necklaces drawn or engraved, or modelled and painted white or gilt, and occasionally with moulded figures like bronze plaques in relief. This style seems to have been universal in Hellenistic Greece, and was also produced extensively in Apulia and Campania (Gnathia and Capua wares). Another Hellenistic fabric, usually black-glazed, has purely plastic decoration, being exactly copied or even cast from contemporary bronze and silver vessels ornamented with reliefs. One group of bowls is called, for no good reason, Megarian or Homeric; it may be the Samian ware mentioned by Pliny, and is certainly the prototype of the Roman pottery wrongly called by that name. Bowls have decorative foliate patterns, or bear mythological and heroic scenes, often accompanied by written descriptions or verses quoted from the plays or poems which they illustrate. Another type, called Calene *phiale*, and mostly made in Italy, is a shallow bowl with a central medallion or interior border-frieze in relief. Two examples in the British Museum, with a frieze of chariots, are replicas of a silver bowl in the same collection. (See SILVERSMITHS' AND GOLDSMITHS'-WORK.) Some Hellenistic wares preserved the old tradition of black painted ornament on a light clay ground or slip. Their designs are mostly wreaths and garlands, and their fabrics seem to be located in the East, particularly at Alexandria in Egypt (Hadra vases). Alexandria and Tarsus were the first centres of manufacture of Greek pottery glazed in modern fashion. Blue and green faience was the speciality of Egyptian potteries. It had been imitated by the archaic Greeks and appears with Greek designs again in the Hellenistic age. But the new glaze is quite different, and was probably an Asiatic invention. It is a thick vitreous substance made with a metallic flux, in colours ranging from brown through yellow and green to blue, and was usually laid over lamps and similar small vessels moulded in relief or entirely modelled in natural forms. But at this point Greek plastic pottery finally merges with Italian. The art of the Mediterranean world in the 2nd century B.C. was Hellenistic, industry was cosmopolitan, and it is not always possible to know in which country the fabrics were located.

ANCIENT ITALIAN POTTERY

North and south Italy were separate cultural provinces in prehistoric times. The south, with Sicily, produced some elaborately painted pottery, which may be related to the Neolithic wares of mainland Greece, and some incised with rectilinear patterns like those on the earliest fabrics of Troy and Crete. But there is no evidence of contact between the Aegean and Italian areas before the Late Mycenaean age (c. 1300 B.c.), and the mutual resemblances in the pottery are equally referable to the universal similarity of primitive abstract decoration. In any case this south Italian art lived and died in isolation. Contemporary pottery of the north and central regions was of much coarser type, seldom decorated at all and never painted. But the Bronze age (*Terremare*) fabrics, though inferior in quality, had a plastic character that influenced the southern shapes and developed through the Villanova style into classical Etruscan ware. It was probably not fortuitous that the Hellenistic relief styles were largely established in Italy, and that the pottery of the Roman empire bore plastic decoration.

Prehistoric Origins. — The decorative elements in Terremare pottery are knobs and ribs on the bodies and fantastic modelling of handles, which often end in horns and crescents. The same elements, which had Danubian affinities, persisted in early Iron age (*Villanova*) fabrics, and the Geometric style in which the other Villanova ornament was designed also reflects the influence of central European art. The similarity of this Villanova Geometric to the contemporary Dipylon Geometric style of Greece has sometimes been referred to Greek influence in Italy, but there is no other trace of contact at this time (c. 900 B.C.), and it is probable that the same style penetrated both peninsulas from the north. In each case the new designs found an effective medium ready for their expression. Greek Geometric pottery was painted in the old Minoan technique, the Italian patterns were engraved or stamped or modelled in soft clay. The characteristic maeander, which the Greeks painted in a hatched band, appears in Italy in a band of parallel incisions. The Italian style, like the technique, is far more primitive than the Hellenic. Villanova pottery is not wheel-made; its clay is coarse, red or brown in body with a darker surface which at its best is polished black. This type of pottery is known in Italian archaeology as impasto. The surface colouring was probably done by fumigation. The fabric is thick and clumsy and the shapes are composed of the simple globular and conical forms that belong to elementary metalwork. A typical cinerary urn has a tall biconical body with a single horizontal handle on its wide middle. Its mouth is often covered with a shallow one-handled bowl. The natural development of such pottery was towards closer imitation of metal in refinement of fabric and accuracy of form, but the process was disturbed by the intrusion of foreign influences from Greece and Asia. This contact, which began in the 8th century, coincided with the first settlements of Greeks in Italy and with the rise of Etruscan civilization.

Etruscan **Bucchero.**—The native Etruscan pottery is called in Italian bucchero nero, or simply bucchero. The clay is fine and coloured black throughout its substance, probably by chemical reduction in the kiln or by previous staining. The fabric is generally heavy, since most of the vases were made in moulds and the wheel was rarely used. There are, however, some very fine, thin pieces. Besides the simple developments from Villanova forms, among which the arched band-handle is conspicuous, are copies of Greek and oriental models, *oinochoai, kantharoi, kylikes,* enriched with various kinds of moulded ornament, engraved, impressed or modelled. The three processes were often applied to one pot. Linear designs were drawn freehand with a graver or a wheel; they consist of animal and human subjects, floral ornaments, palmette and lotus and simple geometric figures, zig-zags, hatched triangles, linked arcs and spiral coils. Common patterns are fan-shaped groups of dots or dashes impressed with toothed wheels. Small decorative units like rosettes and stars were applied with separate stamps, and continuous patterns such as cables (*guilloche*) were done with engraved wheels. Elaborate friezes in relief were similarly executed with cylinders like Babylonian seal-stones engraved with real and monstrous animals and scenes of hunts, races, banquets and funerals. They were applied to all kinds of vases, but are particularly common on the body of the characteristic Etruscan *kylix* or *calix,* a cylindrical cup on a heavy stem which was a Phoenician form, and perhaps originally Hittite. Some ivory examples carved with similar reliefs were among the foreign articles in the Barberini tomb at Praeneste. Many of these cups are supported by three or four modelled struts, in addition to or instead of the central stem, set between the edges of base and body. They are in the form of human figures or flat strips decorated in relief or openwork. Plastic ornament was also applied to these and other vessels in large reliefs, usually of single animal figures on the bodies, rows of masks on rims, and heads standing free on handles. Bodies were also ribbed and fluted and moulded with gadroons, tongues and petals.

Greek Influences.—Though the foreign influence in this modification of Etruscan pottery may have been Asiatic and derived through Phoenician channels, Greek models introduced the innovation of painted patterns in ferruginous glaze. Greek artistic influence was doubly strong in Italy because the workmen were imported together with their works, either as colonists in the Greek settlements of the south or as adventurers in Etruscan cities. There was, for instance, a considerable manufacture of Protocorinthian ware at Cumae (Naples), founded from Chalcis about 750 B.C., and the local Greek fabric can only be distinguished from imported originals by a slight difference in the clay. But some other pieces found at Cumae reveal their provincial origin in coarser forms and decoration, and still more debased versions found on Etruscan sites are evidently the work of Italian potters. The Greeks rediscovered Italy at the end of their Geometric period and the first Etruscan ware painted in the Greek method bears simple rectilinear patterns, not often closely copied from Greek designs, in dull black glaze on light clay. At the same time, and perhaps earlier, there was painted decoration in Etruscan and Latin pottery done in dull white on the dark *impasto* and *bucckero* surfaces. A fabric of red *bucchero* connected with Falerii frequently bears white linear patterns. Greek and oriental subjects, bands of animals and lotus, were also painted in the same medium, and black *bucchero* was perhaps more often finished with polychrome ornament than the present condition of the vases indicates, for these colours were badly fixed and are very fugitive. Protocorinthian and Corinthian pottery were more skilfully copied and to such an extent that the Italian versions of these styles are now as plentiful as Greek originals, particularly jugs with subgeometric patterns, *lekythoi* and *alabastra* with polychrome imbricated decoration and those with bands of running dogs. In the black-figure period (6th century) Greek influence was so intense that it is not possible to decide whether some groups, Caeretan *hydriai* and Pontic *amphorae* were made in Italy, Ionia or Greece. But ordinary Italian products are easily detected by their inferior style and fabric. As Greek art progressed, Etruscan fell behind, and there can be no confusion between the two fabrics in the red-figure style, though most of the existing Attic vases have been found in Etruria. For this reason they were thought on first discovery to be Etruscan, and the false name still lingers in popular usage. It has also been supposed that Attic vases were made chiefly for the Etruscan market, but the fact is that their better preservation in Italy is due to the Etruscan practice of burying them as funeral furniture in chamber tombs.

South Italian Red-figure.—Between the later Attic originals and their Etruscan imitations stand the great series of red-figure vases made in the Greek cities of south Italy, which are derivative rather than imitative, and contain many Italian elements. They had a vigorous life for a hundred years after the disappearance of the true Greek industry. Painted pottery had been made by the natives of south Italy since the 8th or 7th century, at first without any traces of Hellenic influence, in fantastic shapes, large *askoi* and strongly curved and carinated cups with horned handles, elaborately ornamented with geometric patterns (Peucetian ware), and in the 5th century with Greek floral motives in place of the rectilinear designs (Messapian). Some of their peculiar shapes were ultimately incorporated in the red-figure fabrics, but the new style at first was wholly Greek, and its earliest examples are not easily distinguished from Attic vases; they may, indeed, be the work of Athenian artists living in Italy. But in the 4th century definite local styles were formed, differing from Attic in certain vase-shapes, colours of clay and paint, types of subjects and styles of drawing. The recognized south Italian fabrics are Lucanian, Campanian and Apulian, with a special group attributed to Paestum. They differ from one another in some technical and stylistic details, but all are marked by dull brownish clays, extravagant shapes and florid ornament. The simplest style is Lucanian, which probably represents an early phase of the industry. Mature Campanian and Apulian are gaily and profusely ornamented, but the effort is generally limited to one face of the pot, the reverse side being filled with dull conventional figures. Some large vases bear mythological scenes, but ordinary pieces have commonplace subjects of youths and maidens lounging in exaggerated elegance and a close atmosphere of ribbons, flowers, pet animals and domestic furniture. The filling of the backgrounds approaches that of the Greek orientalizing styles. Border patterns, palmettes, waves and foliate wreaths are bold and large. Subsidiary colours, white, yellow, red, were freely applied in dots, lines and washes. Men's costume often reflects Italian fashions, particularly on Campanian vases, a very short tunic with broad belt, and feathered helmets and triangular breastplates for soldiers, presumably the Samnite armour. Dress, pose and gesture of the figures have a histrionic extravagance which seems actually to have been taken from the stage. An important class of subjects consists of theatrical scenes, particularly from the tragedies of Euripides. Burlesques of tragic and heroic legends are also depicted. These were the local *phlyakes,* the kind of farce that the Tarentines were attending in the theatre when they saw the Roman fleet entering their harbour, in 302 B.C. The stage and scenery are often illustrated in these pictures. Only three artists are known in the Italian schools, and two of them, Assteas and Python, belong to the Paestum group. Both painted theatrical scenes. A *krater* by Pythoa shows Alcmena on the funeral pyre, Antenor and Amphitryon setting light to it, and in the upper background, by a characteristic and perhaps theatrical convention of perspective, half-figures of rain-nymphs pouring water out of pitchers on the fire at the behest of Zeus. The most imposing Apulian vases are great sepulchral *amphorae, hydriai* and *krateres.* They bear pictures of elaborate funeral monuments, done in white paint, gabled tombstones or shrines with reliefs or statues of the dead, to whom mourners (in red-figure) bring gifts. Another florid south Italian class of pottery has free plastic ornament; large globular *askoi,* a native shape, have gorgon-masks and fronts of horses on their bodies, large statuettes of women, cupids and winged goddesses standing on rims and handles, all brightly painted in blue and red.

Hellenistic Relief-wares.—These Graeco-Italian fabrics were succeeded, in the 3rd century, by Hellenistic pottery imitating metal, black glazed ware painted with white, yellow and red necklaces and garlands or moulded in relief. The first class takes the name from Gnathia (Egnazia) in Apulia, where much of it has been found. There was certainly an Italian fabric in this style, for several pieces bear Latin legends, mostly dedications to deities such as *Aecetiai pocolom* (*Aequitiae poculum,* the cup of Justice) painted with the foliate decoration. Some of the contemporary relief wares were also made in Italy. Moulded signa-

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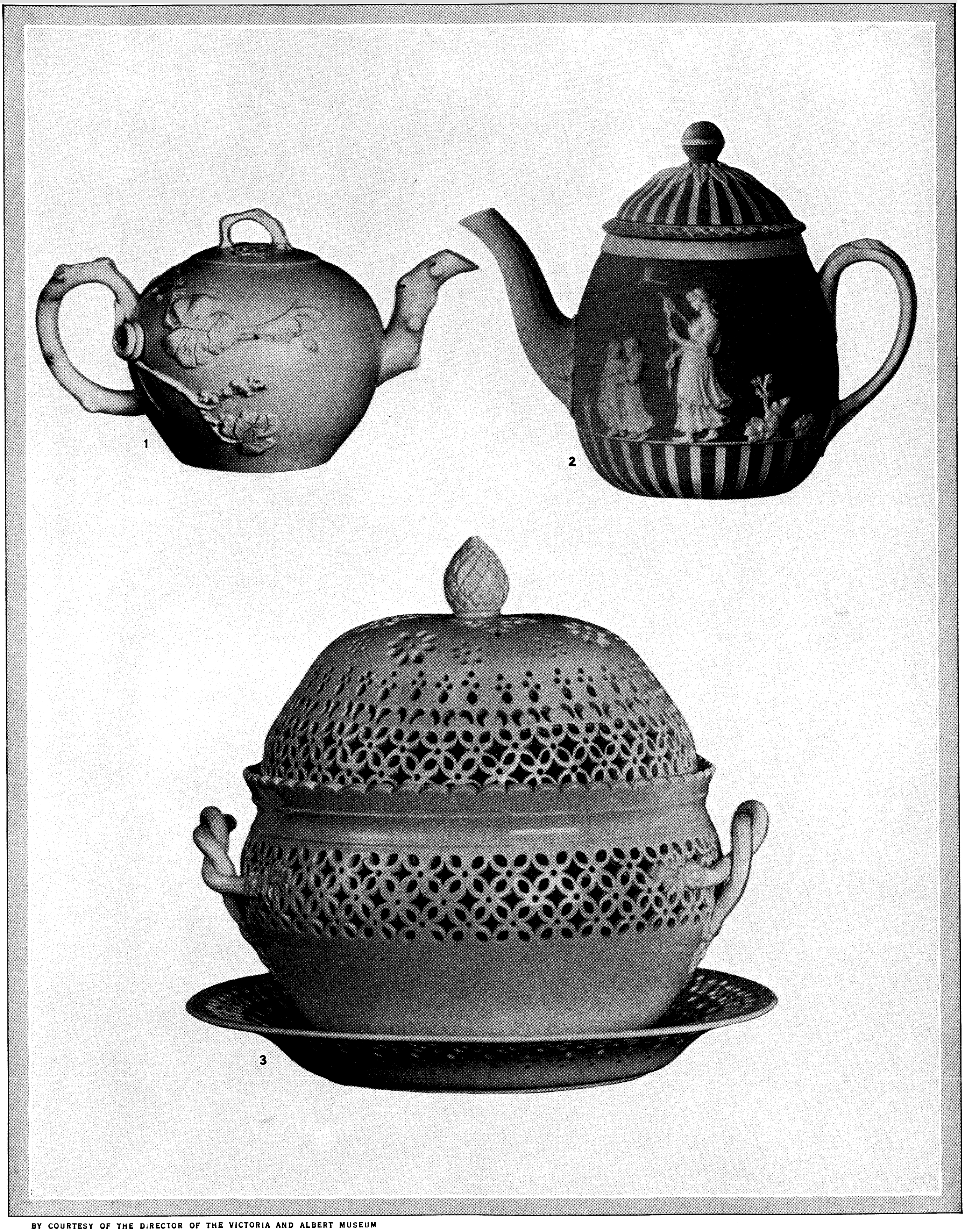
EUROPEAN POTTERY

1. Plate of Delft earthenware, with polychrome design of Chinese flowers and birds. Early 18th century
2. Jug with figures in relief, earthenware. Nuremberg, Preuning factory. 16th century
3. Vase with flowers in white and yellow on a blue ground. Nevers faience. 17th century



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EXAMPLES OF ENGLISH POTTERY

1. Teapot, Staffordshire salt-glazed stoneware. Height 4⅛″
2. Teapot, Wedgwood's lilac jasper ware. Height 6⅜″
3. Chestnut basket, Leeds ware. Height 8⅝″. W. 9½″

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18TH CENTURY GERMAN, AUSTRIAN, FRENCH AND ITALIAN POTTERY

1. Frankenthal figure, after a model by Konrad Link (1732–1802), in the classical manner
2. Sèvres *biscuit* group, after a model by Étienne Maurice Falconet (1716–91)
3. Nymphenburg figure, after a model by Franz Anton Bustelli
4. Vienna teapot, painting in black
5. Doccia cup and saucer
6. Meissen coffee pot, with "German flower" design

POTTERY AND PORCELAIN

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ENGLISH PORCELAIN

1. Chelsea (red anchor) Rgure of a carpenter; height 7¾″
2. **Derby** cup and saucer painted by **Boreman;** height 2½″, diameter 5⅜″ respectively
3. Bow figure of a cook; height 6½″
4. Worcester vase, blue ground; height 6″
5. Chelsea (gold anchor) vase with mazarine blue ground; height about 5″
6. Worcester mug (Frank Lloyd Collection); height 5″

tures on several bowls fix their place of origin at Cales in Campania and their maker's nationality as Roman: L. *Canoleios* L. *F. fecit Calenos.* A similar fabric assigned to Bolsena in Etruria is unglazed, and may have been gilt or silvered.

Roman Pottery.—It was also in Etruria, at Arezzo (Arretium), that the first Italian fabric was established of the fine red pottery, variously called Arretine or Samian or *terra sigillata,* which became the standard ware throughout the Roman world for several centuries. *Terra sigillata* is the modern archaeological name for the whole class. Samian is a misnomer; it may perhaps be applied to some Greek fabrics, but means nothing definite. Pliny says that the reputation formerly held by Samian table pottery had passed in his day to Arretium and other places in Italy, Spain and Asia Minor. There is no trace of a Spanish fabric in the existing material, but examples of Asiatic origin have been found at Laodicea, Pergamon, Myrina and elsewhere. It is a purely Hellenistic type of pottery, whether made in Italy or Greece.

Arretine.—Arretine is the name of the Italian fabric, which was not made solely at Arezzo. Provincial Roman varieties, mostly Gaulish, are nanied from their places of manufacture, La Graufesenque, Lezoux, etc. All this pottery is made of bright red clay and, when ornamented, moulded with reliefs (*sigilla*). Some early (2nd century B.C.) products of Arezzo are black glazed, but they hardly enter into the series. The vases are generally small, for table use, and very rarely have handles; they are mostly bowls, cups and saucers of shallow cylindrical and globular forms. Their lustre was produced with a thin alkaline glaze, which gives an extraordinary depth and richness to the colour of the clay. The earliest decoration was copied from the embossed silverware which was originally a speciality of Alexandria and Antioch. *(See* SILVERSMITHS' AND GOLDSMITHS' WORK.) The bodies are completely covered with floral and foliate designs, masks and decorative furniture, human and animal figures, allegorical and mythological scenes, processions, sacrifices, battles, hunts, dances, feasts and similar episodes of social life The vases, or their decorated bodies, were cast complete in clay moulds, which were prepared mechanically by means of separate stamps, for the component elements of the design. The final artistic effect was therefore dependent on the potters' manipulative skill. The potters' signatures were stamped into the moulds, sometimes appearing in relief on small tablets among the ornamental figures, sometimes in sunk spaces, rectangular, round or fancifully shaped as footprints, wreaths or stars on rims or bases, inside or outside the vessels. Plain wares are ordinarily stamped inside the base. The names of Arretine potters begin about 100 B.C. They represent owners of factories, whose names are sometimes given in the formal Roman manner, sometimes greatly abbreviated and in monogram, and the actual potters, slaves, who often have foreign names. The master potter Marcus Perennius signed M. *Perenni,* M. *Peren, M. Pere, M. Per,* and *M. Pe.* Seventeen slave names occur on his vases, sometimes in conjunction with the master's, sometimes alone. Bargates and Tigranes are the best known; the latter signed *Tigran, Tigra and Tigr.* Aulus Titius signed *A. Titi. Figvl(ina) Arret(ina).* The factory of Rasinius was directed by Lucius of that family in the Augustan period and by Gaius Rasinius Pisanus in the Flavian, by which time the Arretine potteries were turning out replicas of Gaulish work. The large numbers of names and the many varieties of vase shapes and types of ornament that were produced during the long life of this pottery, have been very accurately recorded, and the pottery has become a valuable archaeological index for determining the dates of other Roman objects, buildings and sites, with which it is found in excavation.

Gaulish Terra **Sigillata.**—The Italian fabric came to an end about A.D. 100, being displaced in Italy and the provinces by *terra sigillata* made in France Italy still produced its own coarse pottery for ordinary domestic use, unglazed and undecorated vessels, which formed the bulk of ancient pottery at all periods. The new Gaulish ware was precisely the same as Arretine in fabric, and at least as good in technical quality; its colour is even superior, a darker and brighter red, and its paste is usually harder than the Arretine. But the decoration is inferior, the ornament is in very low relief, and designs and figures are generally small and mean. It is found all over the Roman world, but most abundantly in central France. Finds of moulds and kilns have fixed the localities of the two principal fabrics at La Graufesenque (Aveyron) and Lezoux (Puy-de-Dôme), in the ancient Rutenian and Arvernian territories. The Gaulish fabrics began before the middle of the 1st century A.D. and ended about the middle of the 3rd, but ornamented vases were probably not cast from moulds after the middle of the and century. The names are often Gaulish, and even Roman names are spelt in Gaulish fashion, *Tornos* for *Turnus.* It is a strange fact that native elements do not appear in the designs. The forms were at first identical with Arretine or derivative, and there was the same distinction of shapes for ornamented and plain wares. The commonest type of ornamented vase was a carinated bowl with a band of design on each plane *(Form* 29). It was succeeded in popularity about A.D. 150 by a bowl cylindrical in form, which in its turn gave place to a type of hemispherical shape (*Form* 37). The commonest plain red vessels are very wide and shallow cylindrical and conicai bowls or flat saucers. The earliest ornament consists of purely decorative motives, wreaths and scrolls. with a few animals incorporated in the foliate designs. These bands are continuous, but the figure-subjects, which began about A.D. 75, are broken up in panels, medallions and arcades, and a free style of figure composition was not reached until the 2nd century. It is characteristic of Lezoux bowls. The figures are minute and were generally taken from well-known Hellenistic sculptural types. There are a few mythological groups. **A** purely Roman subject, the gladiatorial duel, is very frequent. In the free style hunters chasing animals are popular subjects.

Barbotine and Lead-glaze.—A technical innovation of the 2nd century was relief applied in *barbotine,* slip clay laid on by piping. It seems to have been a German invention, since it appears first on native Rhenish pottery of the 1st century. Its early use in *terra sigillata* was for small foliate patterns on the rims of flat bowls and dishes, but in the 3rd century it began to replace moulded work on bowls of the standard Roman shape. Another Teutonic element in the Roman fabrics of this date is a globular jar with narrow neck *(olla),* which could not be cast entire. Its ornament was therefore made in separate plaques or medallions and affixed to the pot; scrolls in *barbotine* form a setting for these reliefs, which are largely topical in subject, portraits of emperors, gladiatorial contests and theatrical scenes, often accompanied by explanatory inscriptions. These were made in Provence and also at Lezoux, where they were the last products of the Roman industry. The Gaulish output was not large in Roman times and its forms were trifling, small vases and lamps and toys ornamented with reliefs or modelled in the shapes of animals and common objects. But in the Eastern empire the process was generally used for Byzantine pottery. It was adopted by the conquering nations after the fall of Rome, and became the medium of ceramic decoration in mediaeval Europe. • (E. J. F.)

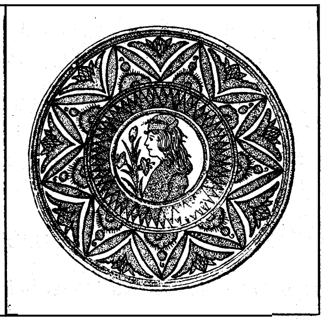
BIBLIOGRAPHY.—H. B. Walters, *History of Ancient Pottery* (1905, bibl.); **E.** Pfuhl, *Malerei und Zeichnung der Griechen* (1923, bibl.), and an abridged version translated by J. D. Beazley (1926); **A.** Furtwangler and K. Reichhold, *Griechische Vasenmalerei* (1904), accurate large scale drawings; W. Riezler, *Weissgrundige Attische Lekythen* (1914), photographic reproductions; G. M. A. Richter, *The Craft* of *Athenian Pottery* (1923); *F.* Courby, *Les Vases Grecs à Reliefs* (1922); *F.* Oswald and T. D. Pryce, *Terra Sigillata* (1920, bibl.)

EUROPEAN POTTERY
TO END OF 18TH CENTURY

Byzantine.—The Eastern Empire with its capital at Constantinople was the channel through which, after the downfall of Roman civilisation in the West, the art and culture of the East was communicated to Europe, and the artistic ancestry of later European pottery is to be sought, in part, in this quarter. Evidence is scanty, however, as to the nature of Byzantine pottery, owing to the cessation of the pre-Christian custom of burying earthenware and other vessels in the tombs of the dead. What little we know is derived from finds of potsherds in excavations at Constantinople and a few sites in Greece, Cyprus, the Crimea and elsewhere. These are of two main types, both of red-bodied earthenware with a surface coating of transparent lead glaze. The decoration in one type is in relief, produced with impressions of a wooden stamp; in the other it is of the kind known as *sgraffito*, engraved with a pointed tool through a coating of white slip. The fragments are mostly those of bowls and deep dishes; the ornamental motives include human figures, animals and birds of symbolic import, simple leaf designs, interlacements, monograms and the Greek cross. The glaze is generally yellow; a bright copper-green is also found.

Hispano-Moresque Ware.—The chronology of the Byzantine wares discussed above is difficult to establish, but it is probable that they date from the two or three centuries immediately preceding the Turkish conquest of Constantinople in 1456. Pottery of artistic quality was known long before this date in Spain, fragments with painted decoration akin to that of the contemporary wares of Mesopotamia and Egypt having been found on the site of Medina az-Zahra, the palace of the Caliphs near Cordova, destroyed in the 11th century. References are found in writers of the 12th century and later to the "golden pottery" of Calatayud (in Aragon) and of the Kingdom of Granada; this phrase undoubtedly means the tin-enamelled earthenwares painted in metallic lustre colours, derived from silver and copper, which are the most famous of the Hispano-Moresque wares, although no surviving specimens are known which can be referred to a date earlier than the 14th century. To this period belong the celebrated vase in the Alhambra, with its decoration of confronted gazelles, arabesques and inscriptions, in golden lustre with touches of blue, and the similar vases scattered in various museums. A bowl of similar style, at Berlin, which is marked with the name of Malaga, suggests that that city rather than Granada was the place of origin of this Andalusian class of lustred pottery. In later times the manufacture passed to the kingdom of VALENCIA, whence in the 15th century such wares were shipped to places so far distant as Leeuwarden, London, the Crimea and Cairo. The chief Valencian pottery centre in the 14th century was Paterna, where quantities of enamelled ware have been found with human figures, animals and foliage designs of pronouncedly Gothic character painted in manganese-purple and green. In the neighbouring town of Manises, on the domain of the Buyl family, lustred pottery was made which the writings of Eximenes show to have been already famous for its beauty in 1383. In the earlier Manises wares we find designs of strongly Oriental character, comprising the Islamic "tree of life," palm-motives and Arabic inscriptions (generally the word *alafia,* "blessing," repeated in formalized characters). Early in the 15th century we find bold heraldic animals in blue against lustred spirals, and from about 1450, especially in wares made with heraldic designs for export to Italy, beautiful diapers of vine-leaves and small flowers In the 16th century renaissance foliage makes its appearance, and in the decadent 17th century wares a crowded ornament of birds and leaves in a fiery copper lustre. Fine blue-and-white wares were made at Teruel (Aragon). At Seville and Toledo especially were produced polychrome-enamelled tiles, at first cut so as to form geometrical and other designs in enamel pigments, which are kept within the outlines, first by painting these in manganese mixed with a greasy medium (de cuerda seca), and afterwards (from about 1510) by moulding the outlines in slight relief (de cuenca). Earthenware dishes with bold animal designs executed by the cuerda seca technique were made at Toledo. Mention must be made also of the great amphora-shaped wine-jars, well-heads and fonts with stamped or incised ornament, sometimes covered with a green enamel, which were made at Triana (Seville) and elsewhere in southern Spain in the 14th and 15th centuries.

Italian **Maiolica.**—The Italian wares of the early Renaissance period represent the highest achievement of the potter's art in Europe. They are mostly of the type known as maiolica, that is, earthenware coated with an opaque tin glaze or enamel as a recipient for painted decoration. The name was first used in Italy in the 15th century of the lustred Valencian wares imported in Majorcan trading ships and mistakenly supposed to have been made in Majorca; it was afterwards extended to Italian imitations of them and finally to unlustred earthenware with a tin enamel. Such wares have been found at Orvieto, Faenza, Siena and elsewhere. dating from the 14th and 15th centuries, with designs of animals, birds, foliage and heraldry of Gothic style in manganese-purple and green, recalling those of the Spanish wares of Paterna. By the end of the 15th century the palette was extended to five principal colours or more, but the designs retained their purely decorative character. After 1500 a change to pictorialism came about, with a further range of colouring, dishes and vases being at last treated merely as recipients for subject-paintings (*istoriati*); later in the century the arabesaues of Raphael and his school based on ancient Roman wall-paintings began to influence maiolica design, and in the 17th century decoration of this type found a rival in monochrome blue painting in emulation of Chinese porcelain and the Dutch wares of the time, heralding the downfall of the art of maiolica in competition with English earthenware in the 18th century. A great part of the output of the maiolica-potters, in the form of large dishes, wall-panels and vases, was intended from the outset for decoration only; dishes with appropriate designs were a favourite form of gift as love-tokens or to celebrate betrothals and weddings. The "useful" wares include plates, jugs and large pitchers, and especially drug-pots for the equipment of feudal or monastic pharmacies, either with a handle and short spout or of the waisted cylindrical shape known as *albarello.* Pavement-tiles were also an important part of the output of certain workshops. From about 1500 onwards the influence of contemporary graphic art becomes increasingly apparent in the decoration of maiolica. Woodcuts in devotional and other books and the engravings on copper of German as well as Italian masters provided the painters with motifs.



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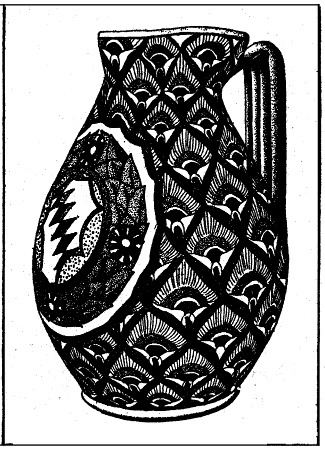
DERUTA MAIOLICA DISH

Early in the 15th century, under the lordship of the Manfredi, Faenza became an important centre of the craft; the city soon rose to such predominance that its name was adopted in French and other languages for enamelled earthenware in general. Floor-tiles, dated 1487, of great beauty, powerful design and colouring, in the church of San Petronio, Bologna, are shown by inscriptions on them to have been made at Faenza in the workshop of the Betini family. The leading Faventine workshop from about 1500 was the Casa Pirota; the dishes and drug-vases there made display a great wealth and variety of ornament based on early Renaissance motives—cupids, masks, dolphins, cornucopias and the like, generally in reserve on a blue ground. One class of wares is painted in dark blue and white on an enamel stained lavender-blue. A great master of the craft, identified by the signature on the back of a dish painted with Christ amongst the Doctors as Ieronimo da Forli, is believed to have lived at Faenza; he adapted compositions of Dürer and others in paintings displaying all the resources of the art in unexcelled beauty of harmonious colour ("The Resurrection," Victoria and Albert Museum, London; "Martyrdom of St. Sebastian," Florence; "Death of the Virgin," British Museum).



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CAFFAGGIOLO MAIOLICA JUG

It seems that maiolica was not made at Florence, but potteries

BY COURTESY OF (1-4, 6) THE DIRECTOR OF THE VICTORIA AND ALBERT MUSEUM, (5) ALFRED E. HUTTON

EUROPEAN PORCELAINS OF THE 18TH CENTURY

1. Mennecy group. H. 9½″. French, middle of 18th century
2. Capo-di-Monte figure. H. 5″. Italian,
3. St. Cloud jug. H. 5½″. French, about 1730
4. Bow mug. H. 6½″. English, about 1765

lection). Diam. 8½″. English, about 1755

6. Chantilly pot. H. 6⅞″. French, about

1

2

3

4

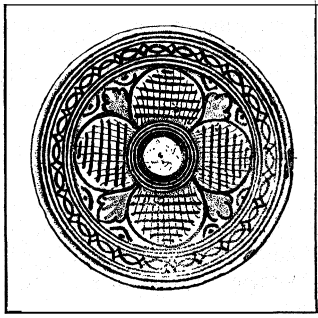
5

6

EUROPEAN PORCELAIN

1. Spanish group, *buen retiro,* height 7⅜″. 2. Meissen cup, height 1¾″, and saucer 4⅞″ in diameter. 3. Höchst figure, modelled by Melchior; height 7″. 4. Chantilly inkstand, figure of a Chinaman; height 7½″. 5. Sèvres porcelain vase, *gros bleu,* and green ground, height about 15″. 6. Meissen group by Kaendler; Scaramouch and Columbine; height 7″

existed in its neighbourhood at Montelupo and Caffaggiolo. To the former perhaps belong the noble 15th century wares, especially two-handled nearly globular drug-pots, painted in a thick blackish blue and purple with animals, birds and human figures amongst foliage which from its type has won for these wares the appellation "oak-leaf jars"; in the 17th century this place produced dishes with crude figures of musketeers. A pottery attached to a castle of the Medici, Caffaggiolo, was the source of some of the most sumptuous maiolica ever made, great dishes, bowls and pitchers with the arms of the Medici and of the two popes of that family, triumphs in the manner of Mantegna, and subjects after Florentine artists. Hardly less splendid are the wares of Siena, particularly of one Maestro Benedetto; they excel in vigorous ornamental designs of early Renaissance character, in a palette dominated by a rich orange-yellow. Conspicuous among them are the drug-vases with an oval panel on one side formed by a ribboned wreath of fruit and foliage and traversed by a wide band bearing the name of the intended contents. The typical Sienese painting is seen also in the heraldic and grotesque designs of the pavement-tiles of the Petrucci Palace, Siena, now scattered in various museums. The Sienese wares were imitated at Deruta, near Perugia, which was, however, better known for its lustred wares (the earliest with a date, a relief of St. Sebastian in the Victoria and Albert Museum, is of 1501); these are painted in blue outline and shading, filled in with a pale lemon—or straw-yellow lustre. They take the form especially of two-handled vases and goblets and heavy wide-rimmed dishes, often painted with a lady's bust accompanied by a moralising adage or with figures influenced by Perugino.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ANTWERP MAIOLICA DISH

A large share of the production of maiolica in the 16th century belongs to the duchy of Urbino. Castel Durante (now called Urbania) made wares predominantly decorated with fancifully-conceived arrangements of weapons, musical instruments and the like combined in trophies with grotesque masks, dolphins and cornucopias. One Zoua (*i.e.,* Giovanni) Maria employed such themes as borders to enclose figure-subjects of exquisite delicacy. Castel Durante was also the birth-place of Nicola Pellipario, the greatest of maiolica-painters, who migrated to Urbino and there adopted the name Fontana; he brought narrative (*istoriato*) painting to an unsurpassed pitch of perfection in several services of plates with mythological and other subjects, particularly one with the arms and devices of Isabella d'Este and another now in the Museo Civico, Venice. He freely adapted motives from engravings, including the woodcuts of an edition of Ovid's *Metamorphoses* published at Venice in 1497. Nicola's style was followed, in progressive deterioration, by his grandson, Orazio Fontana, and others of his family, and by Francesco Xanto and Alfonso Patanazzi, all of whom owned or painted at potteries at Urbino itself. In these, about 1550, a new and pleasing style of ornament was adopted, of airy and fanciful arabesques in the manner of Raphael scattered over a creamy white ground; about the same time also Urbino began to produce imposing snake-handled urns, fountains, wine-cisterns, salt-cellars and inkstands (the latter often in the form of a group of figures) in shapes largely borrowed from bronze or silver. Pictorial wares similar to those of Urbino were made about 1560 in the workshop of the Lanfranchi family at Pesaro. The maiolica of *Gubbio,* made by Maestro Giorgio Andreoli and his successors, is famous for its lustre painting, in golden yellow and especially in a rich ruby colour; at first this artist followed the style of the Deruta lustred wares, but about 1518 he began to produce designs of his own, including grotesques and trophies like those of Castel Durante, figures of *putti* within symmetrical border-ornament, and pictorial subjects based on engravings, chiefly after Raphael. Resides making pottery for his own decoration, he added lustre enrichments to already-painted wares sent from Urbino, Castel Durante and Faenza for the purpose.

There were several maiolica factories at Venice. In some of these pictorial wares were made like those of Urbino, but generally of indifferent quality. One Maestro Lodovico produced about 1530–50 a distinctive class of wares strongly influenced by the Near Eastern pottery and Chinese porcelain then beginning to be imported by Venetian traders; they are painted solely or chiefly in blue on an enamel stained to a pale greyish-blue. The 17th century Venetian maiolica displays a fondness for architectural subjects and occasionally ornament in high relief imitating contemporary *repoussé* silver.

The potteries of the Ligurian coast between Genoa and Savona came into prominence in the 17th century with their blue-and-white maiolica sometimes directly copied from Chinese porcelain; at the same time close imitations of Turkish earthenware were being made at Candiana near Padua. From about 1670 onwards the potteries of Castelli, in the Abruzzi, and its neighbourhood produced wares with polychrome painting in subdued colouring of figure-subjects and landscapes.

Italy is remarkable not only for its maiolica but also for a distinctive kind of lead-glazed earthenware with decoration incised through a coating of white slip (*sgraffito*). The glaze is generally of a deep buff tone, giving a dark brown colour to the red body where revealed by the engraving of the decoration, which is often heightened by touches of green and purple laid on with a brush before the application of the glaze. The technique, derived through the Byzantine dominions from the Islamic East, attained artistic importance in Italy towards the end of the 15th century. Recent investigations have shown that although it was practised at several other places north of the Apennines, the wares in which it is displayed at its best were made under the patronage of the Bentivoglio family at Bologna. Sgraffito ware was made at Bologna until the 17th century.

French Faience.—Pottery found in excavations at various places in Provence, and at Agen, and tiles from the church of Brioude, prove that tin-enamelled earthenware, with painting in manganese-purple and green, was made in Southern France as early as the late 14th century. Maiolica of a more developed type was made in the 16th century at Lyons by Italian potters from Florence and Faenza; to them are attributed certain wares with pictorial subjects in the Urbino style and French inscriptions, and tiles from the church of Brou. About 1540–60 Masseot Abaquesne was making maiolica and tiles painted with purely French renaissance designs at Rouen. Some rare examples with heraldic decoration are believed to be the work of Antoine Sigalon of Nfmes.

In 1578 a pottery for this kind of earthenware (called in French faience) was set up at Nevers by three brothers named Conrade, from Albissola near Genoa, and continued in the hands of their descendants. In the 17th century, under Chinese influences, polychrome gave way to blue-and-white painting, with manganese for the outlines, though classical themes continued for a time in favour. Soon after, subjects adapted from late Ming Chinese porcelain became the fashion.

A privilege for making faience at Rouen was accorded in 1644 to Nicolas Poirel, who was succeeded by Edme Poterat and his son, and in the reign of Louis XIV. the city became a thriving centre of the faience industry, noteworthy for the large dimensions of many of its wares—dishes, wall-cisterns, and life-size busts on pedestals. A distinctive style of decoration was introduced characterised by wide borders and radial arrangements of palmettes, scrolls and festoons somewhat resembling lace; in the motives of this graceful *lambrequin* decoration Chinese elements are blended with those of the classical baroque. The painting is carried out in blue, either alone or combined with red or ochre-yellow. About 1730, in the pottery of Guillibaud and others, a change came about in favour of a more varied polychrome palette; motives borrowed from the Far East assert themselves, together with the asymmetrical scrollwork. shells and cornucopias of the rococo, and towards the end of the century the enamel-painted flowers of contemporary porcelain were imitated. The faience industry at Rouen as elsewhere was killed by competition with imported English wares.

At Moustiers in Provence faience began to be made shortly before 1700 by members of the Clérissy family. Among their early productions are dishes of exceptionally large diameter with hunting-subjects after engravings by Tempesta and wares, especially oblong trays, with airy baroque designs in the manner of Bérain; these were at first in blue, afterwards polychrome. In 1738 Joseph Olerys, a Moustiers potter who had spent some years at Alcora in Spain, introduced a new floral style in colours with sprays resembling potato-blossoms, and grotesque figures borrowed from the engravings of Callot. About 1677 one of the Clérissys of Moustiers moved to Marseilles and there made faience, similar to that of his native town, in the suburb of St. Jean-du-Désert. Several factories were at work at Marseilles during the 18th century; chief among them were those of Veuve Perrin, Joseph Robert and Honré Savy.

In Lorraine flourishing faience-factories were carried on at Strasbourg and Niderviller, both conspicuous for the fine quality of their overglaze enamel painting. The Strasbourg pottery, in the hands of the Hannong family, came to an end in 1774 after some half century of existence. Its earliest wares were blue-and-white in the manner of Rouen. Its later table wares in good rococo shapes based on silversmith's work show quasi-naturalistic flower-painting skilfully rendered in fresh colours dominated by a strong crimson, which exercised a great influence on the work of other French faience factories. That founded by Baron Beyerlé in 1754 at Niderviller and transferred in 1774 to the Comte de Custine made similar enamel-painted faience, including admirable figures, mostly of children or peasants, from models by the sculptors Cyfflé and Lemire.

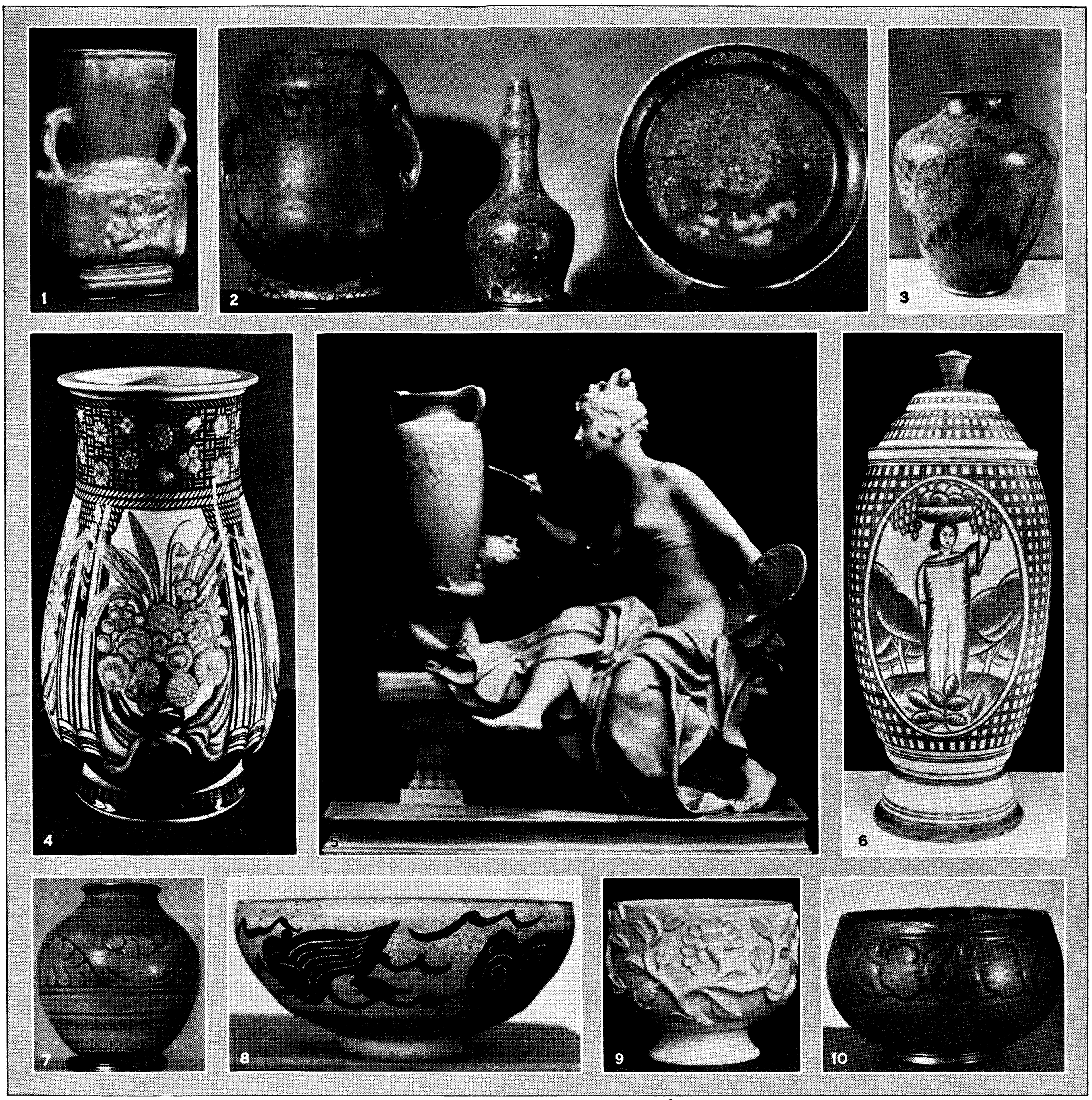
Faience of artistic quality was made at many other French towns in the 18th century. Sceaux near Paris produced both porcelain and enamel-painted faience hardly inferior to porcelain. Aprey is known for gaily-coloured wares of a more homely kind. In Paris, at Lille and Rennes the formal style of Rouen was followed. St. Omer and St. Amand-les-Eaux in French Flanders, and Montpellier in Languedoc also had faience-factories.

Faience of Northern Europe, Spain and Portugal. — Early in the 16th century an Italian potter from Castel Durante, Guido di Savino, was settled at Antwerp, and from this time may be dated the beginning of maiolica-production in the Netherlands. The Antwerp wares, which included pavement-tiles, show the influence of the Faenza potteries in simple floral and linear motives, but soon took on the distinctive characteristics of Netherlandish renaissance design. About 1560–70 maiolica-potters from Antwerp carried their art as Protestant refugees to Holland and England. Rotterdam and Haarlem became centres of production of earthenware and wall-tiles with animal, flower and fruit motives in strong colouring, and large tilework pictures with figure-subjects. Towards 1650 Delft came to the fore and for more than a century continued with its numerous potteries, known by their signs (the Peacock, the Star, etc.), as a thriving centre of industry exporting its wares all over the civilized world. Aelbrecht de Keizer is the earliest Delft potter whose productions are known, if the initials AK on certain blue-and-white pieces are rightly identified as his; the designs on these are borrowed from the contemporary Chinese porcelain then being imported in quantities by the Dutch East India Company. About 1600 we find plates and panels charmingly painted in blue with Dutch or Italian landscapes, by Frederick van Fritjtom. Samuel van Eenhoorn developed the Chinese fashion in a broad highly decorative manner of his own. To Adrianus Koek are owing the imposing blue-and-white hyacinth-vases made to the order of Queen Mary for the adornment of Hampton Court Palace; their ornament is borrowed from the French baroque designer, Daniel Marot. Other potters adopted Biblical subjects or scenes from Dutch life of the time (often in series continued through a set of plates or dishes) for the decoration of their wares. About 1700 close imitations of Chinese porcelain of the reign of K'ang Hsi, both blue-and-white and five-colour, were made, especially by Lambertus van Eenhoorn and Louwijs Fictoor, whose monograms are indistinguishable; notable amongst them are chimney-piece sets of large covered jars and vases, often reeded (so-called *cachemire* ornament). The wares produced became ever more varied, including statuettes and even model violins. Before 1700 muffle pigments and gilding were introduced by Rochus Hoppesteyn, in vases with classical figure-subjects, and by Adriaen Pijnacker, in imitations of Japanese polychrome porcelain dominated by a vivid red. Coloured enamel grounds were also occasionally used, notably a fine black in imitation of lacquer. As the 18th century advanced the wares became more commercial in character; the Delft potteries declined, only ten surviving till 1794. Somewhat rustic wares in the Delft style continued to be made till recent times at Makkum and elsewhere in Friesland.

BY COURTESY OF THE VICTORIA AND ALBERT MUSEUM
BRISTOL DELFT DISH, TULIP DESIGN

In Spain the adoption of the renaissance and Italian influences resulted during the 16th century in the production of enamelled earthenware entirely different in character from Hispano-Moresque ware. The settlement of an Italian tile-painter, Nicoloso Pisano, in Seville about 1503 brought about a widespread employment of maiolica tile-pictures for wall-decoration. At the same time Talavera and the neighbouring Puente del Arzobispo became the leading centre of pottery production. They produced, alongside wares in which Netherlandish renaissance ornament can be recognised, others of a strongly native character painted with animated hunting and battle scenes or with large busts or animals amongst loose foliated scrolls, in blue alone or in a limited range of colours dominated by a strong copper-green. From Talavera, potters went out to Mexico and there founded a vigorous industry. The foundation of a faience factory by the Count of Aranda in 1727 at Alcora led to the decline of Talavera. The faience mostly painted in blue and purple made in the 17th century at Lisbon, in which freely-handled Chinese themes are blended with renaissance motives has decorative value.

It is recorded that about 1567 Jasper Andries and Jacob Sanson fled from Antwerp to England to escape religious persecution and set up potteries at Norwich, whence in 1570 they moved to London. Their productions have not been identified, but it is likely that they resembled the maiolica at that time made in the Netherlands, and it is possible that certain jugs with mottled blue, purple and orange colouring over a tin enamel, generally found with silver mounts, were made by them. The earliest piece of maiolica of certain English origin is dated 1601; we may note here that at a later stage such wares were known as "delft," after the chief Dutch centre of production from about 1650 onwards. After 1625 dated pieces made at Lambeth and elsewhere near London become plentiful, chiefly dishes and small mugs with decoration painted either in blue in crude imitation of contemporary Chinese porcelain or with coloured designs of fruit and flowers or arabesques in imitation of Dutch and Italian wares. Wine-bottles painted with the name of the intended contents were also made in quantity. Towards 16jo figure-subjects, mostly scriptural (especially the Fall) become plentiful. Imitations of the "Persian" blue ware of Nevers were also made. From London the maiolica industry was carried to Brislington, near Bristol, where in 1682 we find working one Edward Ward, who in 1683 established a pottery at Temple Back, Bristol. He was succeeded at Brislington in 1697 by Thomas Frank. Other leading Bristol potters of the 18th century were Richard Frank, and Joseph Flower. John Bowen and Michael Edkins were painters employed by several of the potters. The earliest recorded date on Brislington-Bristol ware is 1652. The early designs include tulip and other flower designs in the Dutch manner, Chinese subjects and portraits of sovereigns or celebrities of the day. After 1700 Chinese motives take the lead, but adapted in a free and original manner. Landscapes of a local character with figures, in blue, were also in favour. The third great centre of delft production in England was Liverpool, which in the 18th cenmry exported



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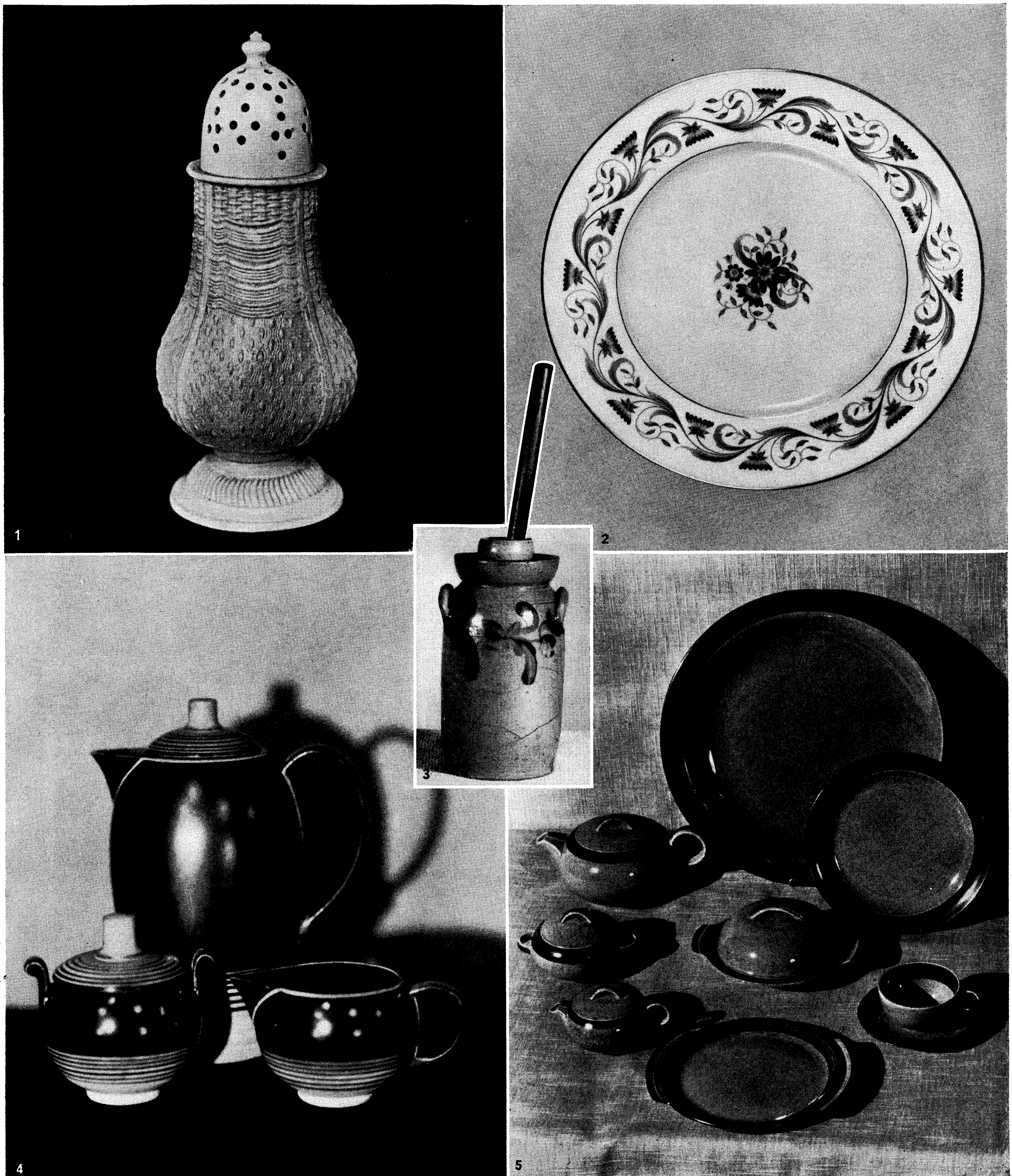
MODERN EUROPEAN POTTERY

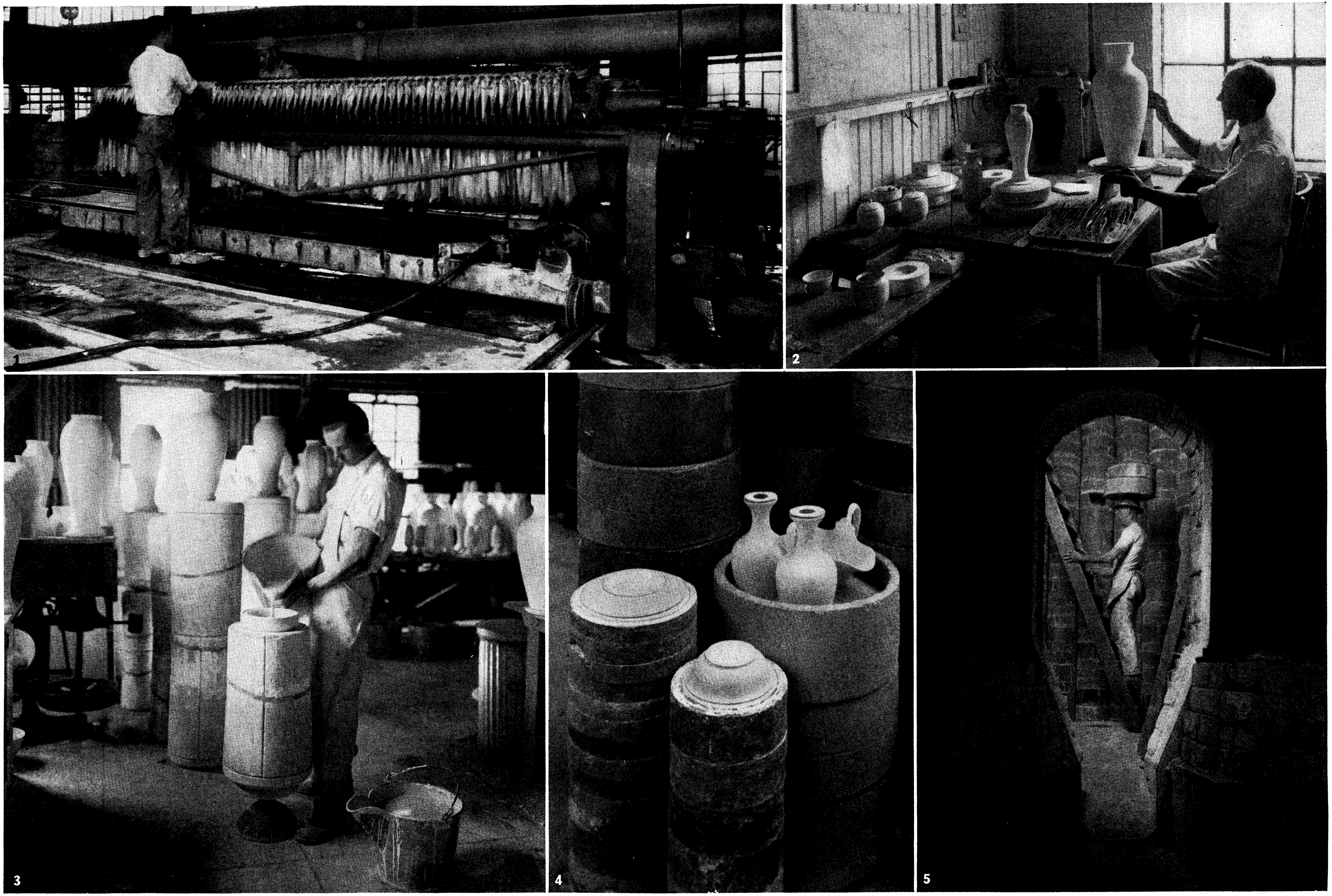
1. Grès (kaolinic stoneware), about **1925,** by W. Kage
2. Grits, about **1900,** by Ernest Chaplet
3. Grits by M. Pihan
4. Vase (*forme Aubert*) underglaze dscoration, designed by Guy Loe, made by M. Walter, on silica porcelain
5. "La Peinture" by Chéret, in white biscuit
6. Vase (*forme Rapin*) in faience, designed by M. Patou, made by M. Walter
7. Grits by Emile Lenobie. French
8. Fire Elementals by W. Staite Murray, **1926.** Stoneware bowl with ivory glaze and sepia brushwork. English
9. Porcelain, about **1925,** by W. Kage
10. Grits by Auguste Dclaherche. French



BY COURTESY OF (1) THE HALLIDAY HISTORIC PHOTOGRAPH CO., (2) LENOX, INC., (3) THE NEW YORK HISTORICAL SOCIETY, (4) SEBRING POTTERY COMPANY, (5) AMERICAN LIMOGES CHINA COMPANY

EARLY AMERICAN POTTERY AND MODERN U.S. INDUSTRIAL WARE

1. Salt glare saltcellar, an example of U.S. colonial pottery from the Mary H. Northend collection
2. Service plate of fine china, designed by Frank G. Holmes
3. Stoneware pottery churn made about 1800 in New York city by Clarkson Crollus, Sr. (1773–1843)
4. "Metropolitan" shape designed by Belle Caldwell, New York city
5. "Manhattan" shape designed by Viktor Schreckengost

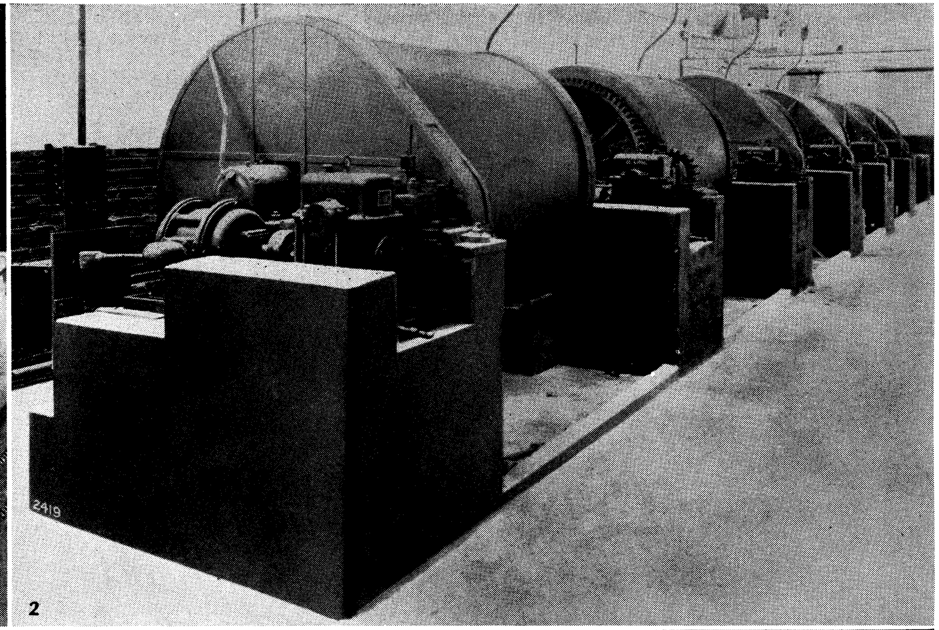


BY COURTESY OF (1) WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, (2-5) LENOX, INC.

INITIAL STAGES IN THE MANUFACTURE OF PORCELAIN

1. A **filter** press preparing the clay
2. The first step in the manufacture of a vase—making the model in plaster or clay
3. A mould is made from the model, then the piece is cast from "slip"—a mixture of ground clay and water poured into the **revolving** mould
4. After the ware is removed from the mould, dried and cleaned, **it** is placed in rough clay **"saggars"** and given its first firing, which hardens and transforms it from slip into porcelain. In this "biscuit fire" the ware shrinks one-sixth in size
5. "Placing" a periodic kiln for the **first** fire

1



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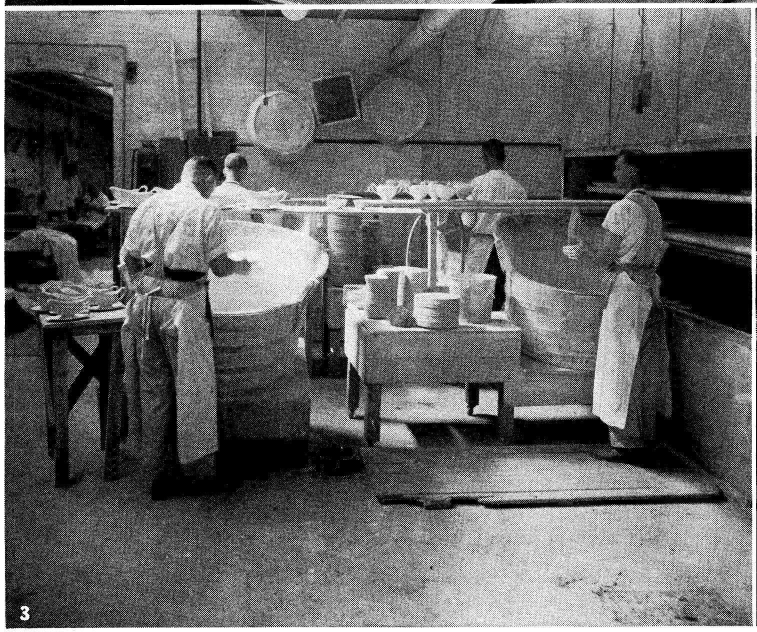

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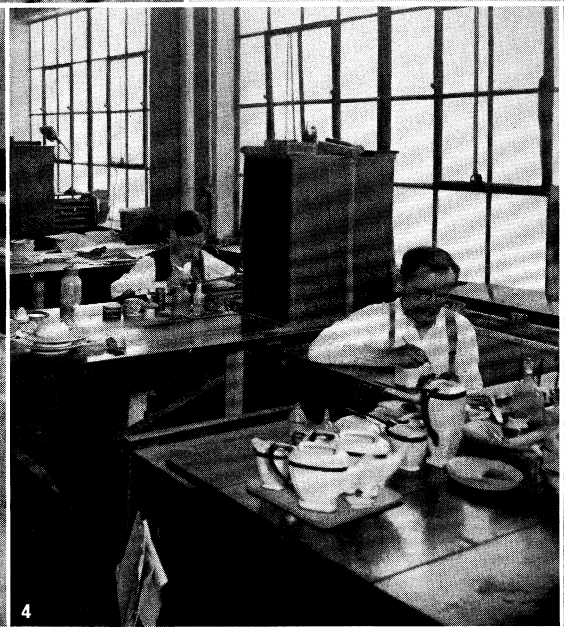

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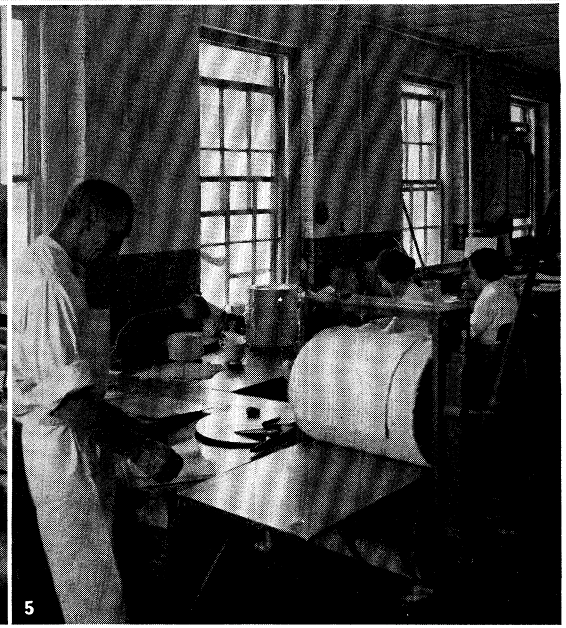

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BY COURTESY OF (1, 2) CERAMIC INDUSTRY, (3-5) LENOX, INC.

LATER STEPS IN PORCELAIN MANUFACTURE

1. Car stacked with ware ready to enter a continuous or tunnel kiln. This type of kiln is used in large factories

2. Ball mills which grind the glazes

3. After the first firing, the ware is dipped in the glazing mixture. It is then returned to a kiln, where heat melts the glaze and forms a hard, transparent coating

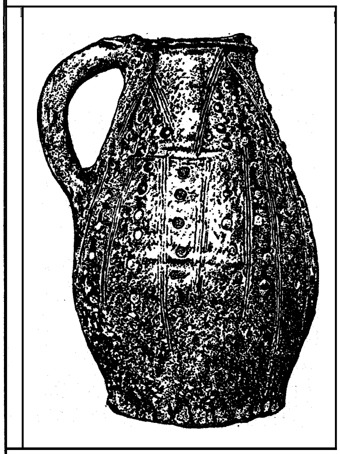
4. Decorating chinaware with raised gold, applied by brush

5. Printing designs by transfer on china. After decoration, the ware is fired again before undergoing final inspection such wares in quantity to America. Shaw, Pennington and Barnes were the leading potters. Their wares show less individuality than those of Bristol. Notable among them are the punch-bowls made for skippers with polychrome paintings of their vessels; a speciality of Liverpool were the delft tiles with transfer prints in black or red executed by Sadler and Green. Delft was also made at Wincanton, Dublin and Glasgow.

Tin-enamelled earthenware was made by German potters from 1620 onwards. They learnt the art of maiolica in Venice, amongst them Augustin Hirsvogel of Nuremberg; he is believed to have been the maker of the owl shaped jugs made apparently for presentation purposes. The earliest known date on German maiolica is 1526. These early wares were painted in blue, with imitations of venetian designs, or with figure-subjects derived from contemporary German engravings. Maiolica-painting was applied to the decoration of tilework stoves in the Tyrol, in Austria and especially at Winterthur in Switzerland, where from 1590 to 1740, approximately, a flourishing maiolica industry was carried on by the Pfau family and others. About 1618 the majolica technique was introduced by Lorenz Speckner in the potteries of Kreussen, in Bavaria (of special note are his drug-pots boldly painted with spirals in blue), and about the same time blue-and-white wares, especially narrow-necked pear-shaped jugs, showing Chinese influences, were made at Hamburg. The settlement of two Dutch potters at Hanau in 1661, and the establishment of a factory at Frankfort-on-the-Main in 1666 mark the beginning of a second phase, under Dutch influences, in which the Chinese fashions of the day determined the styles of decoration. Frankfort is notable for large dishes and jars with bold adaptations of late Ming motives in a remarkably clean vivid blue. Faience-factories at Nuremberg, Bayreuth, Ansbach, Dresden, Berlin, Potsdam and elsewhere are witnesses to the spread of these wares in cheap imitation of blue-and-white and five-colour porcelain. Potsdam was the first place to attempt to simulate Chinese "powdered blue" on faience. Tankards with baroque panelled designs or somewhat crude polychrome renderings of Chinese landscapes were made extensively at Erfurt and minor factories in Thuringia. In the 17th century glass-enamellers such as Johann Schaper and Abraham Helmhack of Nuremberg took to decorating in their own homes (as "*Hausmaler*") faience obtained "in the white" from the factories. Their paintings of landscape or scriptural and other figure-subjects in black monochrome (*schwarzlot*) or bright polychrome are often of extraordinary fineness of execution. From their work arose the adoption of overglaze enamel-painting in the potteries themselves. This prepared the way for the third phase, the spread of French influences from Strasbourg and Marseilles, seen in coloured naturalistic floral decoration and French rococo forms for the wares. Disseminators of this technique were Johann Eberhardt, Ludwig Ehrenreich and Johann Tännich; the latter, trained under Hannong at Strasbourg, worked afterwards in several factories, notably at Kiel and Mosbach. From Germany the manufacture of faience spread to Scandinavia; flourishing factories at Copenhagen, Sleswick, Rörstrand near Stockholm and Herreboe in Norway produced chiefly blue-and-white wares showing Dutch and Chinese influences; large tea-trays, sometimes used as table-tops, and punch-bowls in the form of a bishop's mitre are conspicuous amongst their output. At the Marieberg factory, Stockholm, founded in 1758, the enamel-painted faience of Strasbourg was successfully imitated. Hollitsch in Hungary also produced enamel-painted faience of good quality closely resembling that of Strasbourg.

Mediaeval Pottery of North-west Europe.—The mediaeval pottery of western Europe is unpretentious and often crude in technique, but shows at the same time great virility and dignity of form. Glaze had passed entirely out of use in the Dark Ages. On later wares, when present, it is a soft galena glaze, sometimes stained brown with iron or green with copper. Decoration is effected by scratching with a point, or by impression with cut stamps or the application of reliefs such as overlapping scales or strips of clay pressed on with the potter's thumb, or rough floral and heraldic ornaments shaped in moulds; painting with red, brown and white clay pigments is the exception, but clays of various colour are often combined in relief decorations. Vessels such as aquamaniles, in rude human or animal form, and jugs modelled into human features, are not unusual. These characteristics are common to France, Germany and England.

In France the revival of glaze began in the 13th century, when Savignies, in the neighbourhood of Beauvais, began to become an important centre of production, of which in the 15th and 16th centuries the bluish-glazed wares with applied heraldic and floral ornament enjoyed some esteem; from the 14th century La-Chapelle-des-Pots near Saintes, was another important centre. Fine earthenware with inscriptions in Gothic characters and floral designs, made after the Italian manner by the *sgraffito* technique and including Italian shapes such as the *albarello* jar, appear towards 1500, and shortly after polychrome lead-glazed wares began to be made. Ornamental earthenware finials for gables were produced, especially in Normandy, from late mediaeval times onward.



BY COURTESY OF THE YORKSHIRE MUSEUM
MEDIAEVAL ENGLISH JUG

Remains of mediaeval potter's kilns have been found in England at Nottingham, Lincoln and Cheam, and community of characteristics amongst vessels dug up at Oxford indicate local production; the same is true of York, and simple pottery must have been made at many other places. The earliest remaining wares, certain tall slender jugs of light buff earthenware, with a double swell in their profile, are attributed to the 13th century. In the 14th century forms tend to become more squat, glaze and applied or incised decorations appear. Greater refinement of shape is seen in green-glazed jugs of the 15th century, and under the Tudors elaborate moulded heraldic reliefs are found. In Germany the hard-fired semi-vitrified ware known as stoneware was first made, from the 14th century onwards. The earliest specimens are slender jugs, strongly wheel-marked, in a creamy-white body, made at Siegburg near Bonn. Drinking-vessels of great elaboration, often double-walled, the outer wall being pierced with Gothic tracery, were made of a hard brown ware in the 15th century at Dreihausen, Hesse. Floor-tiles form a great part of the output of mediaeval kilns, and were made wherever great churches were being built. Those of France and England have glazed bichromatic inlaid decoration, the German tiles, mostly unglazed, showing stamped or moulded designs. Tile-work was used in Germany for architectural details also, and especially for stoves.

French and German Lead-glazed Earthenware.—With the arrival of the renaissance in France pottery rose in that country to a higher level of general esteem, and two highly specialized experimental developments took place. One of these passed without lasting influence on ceramic history, that of the famous so-called Henri II. ware; the place of its production was for long a mystery but it is now known to have been made at St. Porchaire in Poitou, approximately from 1525 to 1560. It is of a fine whitish clay, with a cream-coloured glaze, and decorated with designs built up from impressions of metal stamps like those of a book-binder and inlaid in the manner of *niello* with darker clays; in the later examples touches of blue, green and purple pigment are added. The early forms are imitations of metalwork; later, salt-cellars, standing cups and ewers were built up like architecture in miniature with applied reliefs and statuettes and inlays imitating tile pavements. Devices of François I. and Henri II. and the crescents of Diane de Poitiers appear on many of the pieces.

Of greater significance was the work of Bernard Palissy (*q.v.*). After years of experiment he made coloured lead glazes, blue, green, purple and brown, of an excellence never attained before. His earlier wares were decorated with casts from the smaller fauna and flora of the district of Saintes. Later he adopted reliefs of figure subjects or formal designs. He was succeeded by two sons and by several potters who early in the 17th century made wares in his manner, including statuettes after bronze originals, at Avon and Fontainebleau, and at Manerbe (Calvados). Earthenware with a rich dark brown lead glaze, in forms copied from metalwork, was made towards 1600 at Avignon.

Contemporaneously with Palissy various potters in south Germany were making polychrome earthenware of a similar type, but combining a white tin enamel with coloured lead glazes. This technique was employed specially in the production of stove-tiles, which from about 1550 onwards were commonly decorated with figure-subjects of biblical or allegorical reference, reflecting the all-pervading religious pre-occupations of the time, rendered in relief under a renaissance arched recess. Potters known as Hafner, who worked in this manner, were settled at Nuremberg (Paul Preuning and others) and also at Salzburg and elsewhere in Austria. Besides stoves they made jugs with applied reliefs (sometimes including figures in the round in a recessed niche) and bright-coloured glazes. An analogous ware, made from about 1550 at Neisse in Silesia, is characterised by designs rendered by means of deeply-incised outlines separating the coloured glazes and enamels. In the 17th century the wares of the Hafner in Central Europe fell to the level of peasant pottery, which, however, has often great aesthetic value.

German and Flemish Stoneware.— Artistic stoneware began to be made at Cologne about 1540. It is characterised by the ferruginous brown stain of its salt glaze. Its commonest form is that of a round-bellied jug with a bearded man's mask applied on the front of the narrow neck, a form which under the name *Bartmann* or "greybeard" became common in most stoneware potteries. Small applied medallions resembling the Roman coins frequently dug up in the city and its neighbourhood, and coiled branches with small oak leaves and acorns, are also frequent motives of decoration. About 1566 one of the Cologne workshops was removed to Frechen, where the manufacture especially of greybeards for Rhenish wine, exported in quantity to England and elsewhere, lasted into the 18th century. At Siegburg the mediaeval white stoneware took on a renaissance dress about 1550; the place was famous for its tall slightly-tapering tankards (Schnellen) with heraldic and figure reliefs in three adjacent vertical panels, the finest being the work of the Kniitgen family. Raeren, near Aix-la-Chapelle, was also a centre of the industry; its wares are deep brown-glazed, and (at a later stage) grey ware with cobalt-blue colouring in places. The characteristic productions are jugs, often of large dimensions, with elaborate mouldings and reliefs which generally take the form of a frieze, either continuous or broken into arcading, round the belly and sometimes also the neck. Jan Emens and Baldem Mennicken were the most gifted of the Raeren potters. Soon after 1600 the potteries of Siegburg (sacked by the Swedes in 1632) and Raeren declined, and many of the potters migrated to the Westerwald district near Coblentz, where at Grenzhausen and Hohr the industry lasted till it was superseded by earthenware of the English type late in the 18th century. The Westerwald stoneware is grey in body, and its relief decorations, in which figure subjects tended to give place to formal floral motives, are picked out with colouring in cobalt blue and occasionally also in manganese purple. Stoneware, mostly inferior imitations of the Rhenish, was made in the 17th and 18th centuries at Bouffoualx and elsewhere in the south Netherlands. Kreussen in Bavaria produced in the 17th century a chocolate-brown stoneware with reliefs (of the Apostles, Electors of the Empire, etc.) painted in the vivid colours of the contemporary enamelled glass. Altenburg in Saxony and Bunzlau in Silesia also made relief-decorated stoneware.

BY COURTESY OF THE DIRECTOR OF THE VICTORIA AND ALBERT MUSEUM
JUG, OF COLOGNE STONEWARE

English Stoneware and Lead-glazed Earthenware.— The importation of German stoneware in the 17th century led to various attempts to imitate it in England. The most conspicuous was that of John Dwight, an Oxford scientist, who set up a pottery at Fulham about 1670 in which he made not only bottles and mugs in stoneware of various colours but also statuettes, modelled by an unknown artist (perhaps the sculptor, Grinling Gibbons), in white or dark brown clay with a thin coating of salt-glaze; these famous works, including busts of Prince Rupert and others and figures of classical deities, are amongst the most remarkable achievements in the history of plastic art. Stoneware of good quality, with a lustrous brown glaze, decorated with stamped, incised and moulded designs, often dated, was made at Nottingham from about 1695 onwards by John Morley and others of that family. Similar ware was made later at Chesterfield and Swinton. Another experimenter in stoneware was Francis Place, who worked about 168; at York. Dwight had competitors also in the brothers Elers, two Dutch silversmiths who made teapots in a fine red-bodied ware, imitating Chinese boccaro ware, at Bradwell Wood near Newcastle-under-Lyme; their work was of great importance in its revolutionary effect on the output of the North Staffordshire potteries.

Mediaeval traditions in the production of coarse red earthenware with decoration in white "slip" (that is, clay diluted to a creamy consistency) were followed throughout the 17th and 18th centuries in many small potteries throughout England. Wrotham in Kent produced "tygs" (drinking-vessels with several handles) and posset-pots with neatly applied pads of clay stamped with initials or floral devices, animals and birds. At Bethersden near Ashford the inlay technique of the mediaeval tiles was adopted for pottery. By working with a comb the different coloured clays in a semi-liquid state on the surface of the wares, marbled and feather patterns of real distinction were often produced. No attempt at lightness and refinement of shape was made in the district until the advent of the brothers Elers, which stimulated the local potters to improve their technique. Soon after 1700, in response to the demand newly created by the introduction of tea-drinking, John Astbury was making tea-services, with small stamped reliefs in white on a red ground, and similar wares in a harder fired drab stoneware, from which about 1720, by the introduction of ground flints into the body, the Staffordshire white salt-glaze ware was evolved. A further advance came with the introduction of the process of casting the wares in plaster moulds with relief designs. About 1750 "marbled" wares were made by mixing clays of different colours, also "tortoiseshell" ware with mottled glazes, and tea-services in the form of cauliflowers and pineapples coloured after nature; such wares were produced especially by Thomas Whieldon, who in 1753 took into partnership a young potter destined later to revolutionise the industry. This was Josiah Wedgwood (*q.v.*). His new productions were "black basaltes" ware, an improvement on the black unglazed stoneware of the district, and jasper ware, a fine stoneware stained with blue, green, lilac and other colours and generally decorated with applied cameo reliefs in white. For shapes and decoration he drew upon the recently-published repertories of Greek vases, conforming entirely to the neo-classical taste of the period. He engaged John Flaxman and other sculptors to provide him with designs. An important part of his output were small medallions with portraits or other reliefs, made for mounting in furniture or as jewellery. For decorating his Queen's ware he introduced transfer printing, sending it at first to Liverpool to be printed by Sadler and Green. Wedgwood had many competitors who produced imitations of most of his wares; in Staffordshire, Adams, Neale, Turner and Palmer were the most important. Cream-coloured ware of good quality was made from about 1770 onwards at Leeds and elsewhere in Yorkshire; pierced decoration is its most characteristic feature. Earthenware figures emulating those of the porcelain factories were made at Burslem from about 1765 onwards by Ralph Wood, his son Ralph, and his grandson Enoch, and by many other Staffordshire potters. The earliest, painted in coloured glazes in the manner of Palissy ware, are mostly from models by a French artist, John Voyez, who generally copied the figures of Cyfflé of Niderviller; they have considerable artistic merit Lead-glazed earthenware of good quality was also made in the late 18th century at Liverpool, Bristol, Swansea, Newcastle-on-Tyne and Sunderland, A variety made in many places is the so-called silver lustre ware, coated with platinum, in imitation of silver plate. After 1800 the English earthenwares were rapidly degraded. (B. RA.)

EUROPEAN PORCELAIN TO END OF 18TH CENTURY

From the time of its first appearance in Europe, at the latest in the 15th century, Chinese porcelain was regarded by potters as in the highest degree worthy of imitation. Admiration for its whiteness led to the use of a white enamel or slip-covering on the earthenwares of Italy and other countries, whilst its translucency and vitrified texture misled the potters into supposing that a substance of the nature of common glass entered into its composition. Attempts to imitate it in this way were made in small manufactories at several places—as at the glass-making centre of Venice and elsewhere in Italy, more particularly at Florence, where a factory was started under the patronage of Francesco de' Medici, not later than 1581. Medici porcelain was decorated, as a rule in a soft blue only, with motives drawn from Italian maiolica in combination with Chinese elements imitated from wares of the type made for export to Persia. The manufacture is supposed to have been continued at Pisa; later and not dissimilar porcelain is to be attributed to Candiana near Padua. No settled manufacture was, however, in existence before the latter part of the 17th century. Edme Poterat of Rouen and his son Louis were granted a privilege in 1673, whilst another factory founded in 1677 at St. Cloud near Paris had by the end of the century grown to considerable size. These artificial porcelains, fired at a low temperature and made translucent with the aid of a previously fired glassy mixture or frit, were of the type now known as soft-paste (*pâte tendre*). They remained the characteristic porcelains of France for nearly a hundred years, and somewhat similar compositions were widely used in England, Italy and Spain during the 18th century.

Meanwhile in Germany the insight of Tschirnhausen and Bottger (see below) had perceived that porcelain of Chinese type could be made only with potters' materials, and by experiments with the fusing of clays were discovered, first, a hard red stoneware, and in 1709 true, that is, hard-paste, porcelain, which is essentially a high-fired mixture of the fusible and non-fusible silicates of alumina, called by the Chinese *petuntse* and kaolin, and in English china-stone and china-clay. From the manufacture founded at Meissen upon Bottger's discovery sprang others making hard-paste at Vienna and other places in Germany, at Venice, St. Petersburg and elsewhere Hard-paste began to be made at Sèvres in 1769 but did not entirely displace the *pâte tendre* until the beginning of the 19th century In England hard-paste was independently rediscovered before 1768, but it was used in a single manufacture only and was superseded towards the end of the 18th century by a universally-adopted hybrid composition in which china-clay was partially replaced by the ashes of calcined bones, an ingredient which had for some time previously been used in a characteristic type of English soft-paste.

STAFFORDSHIRE SLIP WARE: DECORATION MADE WITH WHITE CLAY DILUTED TO CREAMY CONSISTENCY

France.—The rare porcelain attributed to the Poterats of Kouen resembles in decoration the blue-painted faience of the same city, and similar painting in *Louis Quatorze* style is characteristic also of much of the St. Cloud porcelain. Jugs, cups and saucers, pomade-pots and other small objects, as well as flower-pots of considerable size, were the chief productions of St. Cloud: they were as a rule tastefully and substantially potted with a fine feeling for the qualities of a rather yellowish but pleasant-toned material. Plum-sprays amongst other motives in relief were sometimes copied from blanc de *Chine*, for which this French porcelain has often been mistaken. Fluting and scale-pattern were also favourite decorations Painting in turquoise-blue, red, yellow and green was inspired by Japanese Kakiemon porcelain. Boldly modelled figures inclining to the grotesque were done. St. Cloud (which was founded by Pierre Chicaneau in 1677) came to an end in 1768. Very similar porcelain, as a rule indistinguishable from the St Cloud, was made in Paris at a factory in the Rue de la Ville-l'Evêque and at Lille.

Porcelain of distinctive character was made at Chantilly, where a factory was founded in 1725 by Louis-Henri of Bourbon, duc de Condé Here for the first twenty years or so the material was singular in being covered with a glaze made opaque with oxide of tin At its best Chantilly is of a beautiful creamy white colour. "Kakiemon" patterns were freely copied in designs of great charm. The Meissen styles of flower-painting (q *v.*) and the formal "Indian" and naturalistic "German" flowers were adapted in the French taste, as were some of the figure-models of the same factory. In the later Chantilly, coloured grounds were imitated from Sitvres and the tin-glaze was given up; slight decoration in underglaze blue was favoured for cheaper wares. The factory ceased to make soft-paste about the end of the century.

The factory at Mennecy-Villeroy, near Paris, was a continuation of one in the Rue de Charonne in Paris, founded in 1735 by François Barbin, who removed his establishment to Mennecy in 1748 to place it under the patronage of Louis François de Neufville, duc de Villeroy. The earliest of Barbin's productions were in Rouen-St. Cloud style, but later a great variety of small objects was made and enamelled in colours of a singular freshness, amongst which a purplish rose-pink is prominent. At its best, Mennecy porcelain is of unsurpassed quality, mellow in tone and texture and of a warm white colour. Some charming figures were made. The factory was removed in 1773 to Bourg-la-Reine and ceased to make porcelain about 1790.

The beauty of material characteristic of the French soft-pastes was achieved in the highest degree in the productions of the royal factory at Vincennes, which was removed to Sbvres, between Paris and Versailles, in 1756. This factory was established in 1738, under the patronage of Orry de Fulvy, by two workmen named Dubois, who, however, failed to produce porcelain. A workman named Gravant eventually succeeded, in 1745, and a company was formed with a subvention from Louis XV., who finally in 1759 took over the factory, which enjoyed certain exclusive privileges (such as the use of gilding) amounting to a monopoly. The Royal proprietorship ended, with the Revolution, in 1793, but the establishment has continued under State control to the present day. The Vincennes productions at first consisted chiefly of porcelain flowers in imitation of those of Meissen, intended for mounting in ormolu. Meissen styles of painting were copied in this early period, though the forms, largely in rococo style, were designed by the court-goldsmith Duplessis. Jean-Jacques Bachelier supervised the painting and gilding, whilst the chemist Hellot was in charge of the technical side. Painting in panels reserved on a coloured or diapered ground enriched with gilding, soon became the characteristic Sèvres decoration, and the succession of the ground colours is the chief feature in the chronology of the great period of 40 years from 1749 onwards. The dark gros bleu, probably imitating Chinese powdered-blue, was introduced in 1749 and abandoned in favour of the brighter bleu de roi about 1756. Turquoise-blue (*bleu céleste*), yellow (*jaune jonquille*) and green grounds made their appearance in 1752, 1753 and 1756, The rose *Pompadour* (miscalled in England rose *du* Bamy), invented by Chrouet, appeared in 1757 and went out of fashion in seven years. The favourite painting in monochrome (*en camaieu*) was at first generally in crimson, later in blue. Particulars of many of the painters and the marks used by them may be found in several books of reference. Late in the period, about 1780, an enameller named Cotteau invented the so-called jewelled decoration in which drops of coloured enamel were fused over gilding. Glazed and coloured figures were made in the early years of the factory in rivalry with Meissen, but about 1751 Bachelier introduced *biscuit* or unglazed porcelain as a medium for novel work for which the painter Boucher made designs to be executed by Blondeau and others. The sculptors Falconet and la Rue in the earlier period, and Pajou and Boizot in the later, created many models for execution in Skvres biscuit. The influence of Boucher is apparent throughout in the painting and modelling, whilst the so-called *Louis* Seize neo-classical style began to replace the rococo soon after the transfer to Skvres in 1756. For technical skill and perfection, and for delicacy and taste (if not for more vital qualities) Skvres porcelain is unsurpassed. Soft-paste at all times has the merit of absorbing enamel-colours into its easily-fusible glaze, and this is nowhere more evident than on Siivres china.

Though soft-paste was the medium of the finest Skvres productions, hard-paste was made occasionally (from kaolin found after long search at St. Yrieix near Limoges) as early as 1769 and finally superseded the other altogether in 1804, when the newly appointed director Brongniart gave up the manufacture of the more costly material with a view to repairing the financial distress of the factory, caused by the Revolution. Hard-paste became the medium of a style marked by a severe and even pompous classicism, shared also by a number of other factories which had sprung up in the latter part of the 18th century in Paris and the neighbourhood, largely under the patronage of members of the Royal family. Rue Thiroux, La Courtille, Rue de Bondy ("Manufacture d'Angoulême") and Rue Popincourt (Nast's factory) were the chief. Other French factories making hard-paste and equally concerned to imitate Siivres, were at Lille, Étiolles, La Seynie, Boissette, Limoges and Valenciennes.

Hard-paste of distinctive character was made at the faience factories of Strasbourg and Niderviller and of Joseph Robert at Marseilles. The first-named was closed at the instance of Vincennes in 1753 and Paul Hannong, its proprietor, crossed the frontier to found the Frankenthal factory.

Some soft-paste of fine quality was made also at Sceaux, Orleans, Arras and St. Amand-les-Eaux, whilst at Tournai (which was part of France in the 18th century) soft-paste was used for wares inspired as much by Meissen as by Sèvres.

Germany. — The discovery of hard-paste by Johann Friedrich Bottger was the result of experiments into the vitrification by heat of clays and rocks, conducted by him in association with Ehrenfried Walther Tschirnhausen, with whom he had been concerned in the establishment of a faience factory at Dresden. Like almost all scientists of the time, Bottger believed in the possibility of transmuting base metals into gold, and he was kept, virtually a prisoner, in the service of Augustus the Strong, King of Saxony, who hoped to benefit by the exclusive property of his alchemist's secrets. The first important product of Bottger's labours was a hard red stoneware, comparable with the so-called buccaro of Yi-hsing in China. First produced in 1708, it was quickly developed into a medium capable, by cutting and polishing, of expressing much of the baroque taste of the time. Silvering and gilding and a black glaze, invented by Bottger, were sometimes added to it. Imitations were made at Plaue-an-der-Havel, and at Bayreuth. The first glazed white porcelain was produced by Bottger alone in 1709; its regular manufacture did not begin until four years later. The earliest specimens inclined to a smoky tone, and the decoration (for which Irminger, a goldsmith, was responsible) of applied acanthus leaves, masks and rich mouldings, was similar to that of the red ware.

In 1710 the manufacture was removed to the Albrechtsberg at Meissen, but the making of the white porcelain was not fully mastered until 1715. Though without adequate financial support, Bottger succeeded in the four years before his death in 1719 in perfecting his material and in inventing a wide range of enamel colours, including a rare pale-violet lustre-colour almost peculiar to the factory and much used in the subsequent period.

In 1720 the painter Johann Gregor Heroldt was appointed director, and in the next 20 years introduced many new decorations — chinoisen'es in gold and colours, landscape- and figure-subjects, as well as adaptations of Japanese and Chinese flowers (*indianische Blumen*) and other designs. Purple and red monochromes were used in a novel style. About 1740 Heroldt introduced the naturalistic deutsche Blumen. Though underglaze blue was never thoroughly mastered, many new colours were compounded for use as grounds, often richly gilt in *baroque* style with panelled decoration. Almost every ground colour used elsewhere later on was employed at Meissen under Heroldt.

The appointment as modeller of Johann Joachim Kaendler in 1731 marked the beginning of a period of great development in the plastic decoration. The king had constantly pressed for colossal figures in porcelain which Kaendler's predecessor, Gottlob Kirchner, had failed to produce to his satisfaction. Kaendler succeeded with these so far as the natural unfitness of the medium would allow; and then proceeded to create a succession of new forms for table-ware — plates, tureens, sweetmeat-stands, candelabra, etc.—with modelled ornament, as well as a range of highly individual small figures. It was the court custom to group wax or sugar models on the dinner-tables, and Kaendler, helped by Friedrich Elias Meyer, Johann Friedrich Eberlein and Peter Reinicke, created many porcelain figures for use in the same way. Some subjects were novel in being drawn from contemporary life, embodying a satirical or witty commentary. Kaendler was the first to understand the potentialities of glaze and colour in the make-up of the porcelain figure, which in his hands was never merely monumental sculpture reduced in scale. French rococo was not without influence on Kaendler's style after about 1740, but he remained essentially a baroque sculptor, and continued to work for the factory until his death in 1775.

Meissen remained the premier porcelain factory in Europe until the Seven Years' War, which broke out in 1756, when Frederick the Great virtually sacked the place. Technically excellent work was done under the direction of Count Marcolini (1774–1813), but the former position was never regained. Skvres fashions were copied, and an artist actually from Sèvres, Michel-Victor Acier, made many characteristic models in the sentimental style, whilst an academic sculptor, Christoph Jiichtzer, made biscuit figures in the classical manner.

Following the fashion set in Saxony, many other German princes sought to establish or patronise china-factories, and by 1760 no fewer than eight had come into existence in this way. Broadly, Meissen styles prevailed until about 1760, when Sbvres fashions and the neo-classical began to predominate. The dependence upon Meissen and Skvres, however, was very much less than a superficial view would indicate.

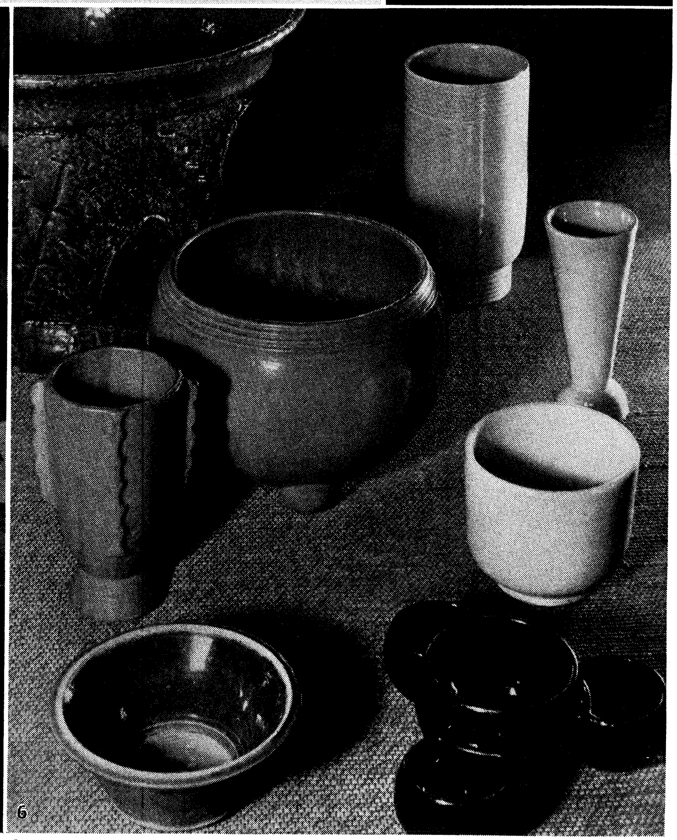
In 1718 a runaway Meissen workman, Christoph Konrad Hunger, enabled Claude du Paquier to start a factory at Vienna, which was in 1744 sold to the state. Much of du Paquier's china was decorated by independent enamellers (Hausmaler) ; the factory's own styles were remarkable for the frequent use of a black (Schwarzlot) and other monochromes in rich baroque designs. Mayerhofer became director in 1751. Vienna figures of the period about 1760 have a very distinct and airy charm. In 1784 a prosperous period began under the directorship of Konrad von Sorgenthal. A modeller Anton Grassi (who had previously made some lively enamelled figures) began to use biscuit with success, whilst in the last decade of the century was made the porcelain with elaborate miniature pictures in the style of oil paintings, with rich gilding and coloured grounds which was formerly considered the best, and still is the most famous, Vienna work.

At Berlin, a wool manufacturer Wilhelm Kaspar Wegely made porcelain of fine quality, including figures, from 1752 to 1757. A few years later, a financier named Gotzkowsky started a factory which in 1763 was taken over by Frederick the Great. Berlin table-wares tend to favour simple colouring with a special fondness for pink diaper (*Mosäik*) borders. Some good figures were made by Friedrich Elias Meyer (brought from Meissen in the Seven Years' War), his brother, Christoph, and others.

With the help of one Lowenfinck from Meissen, porcelain was





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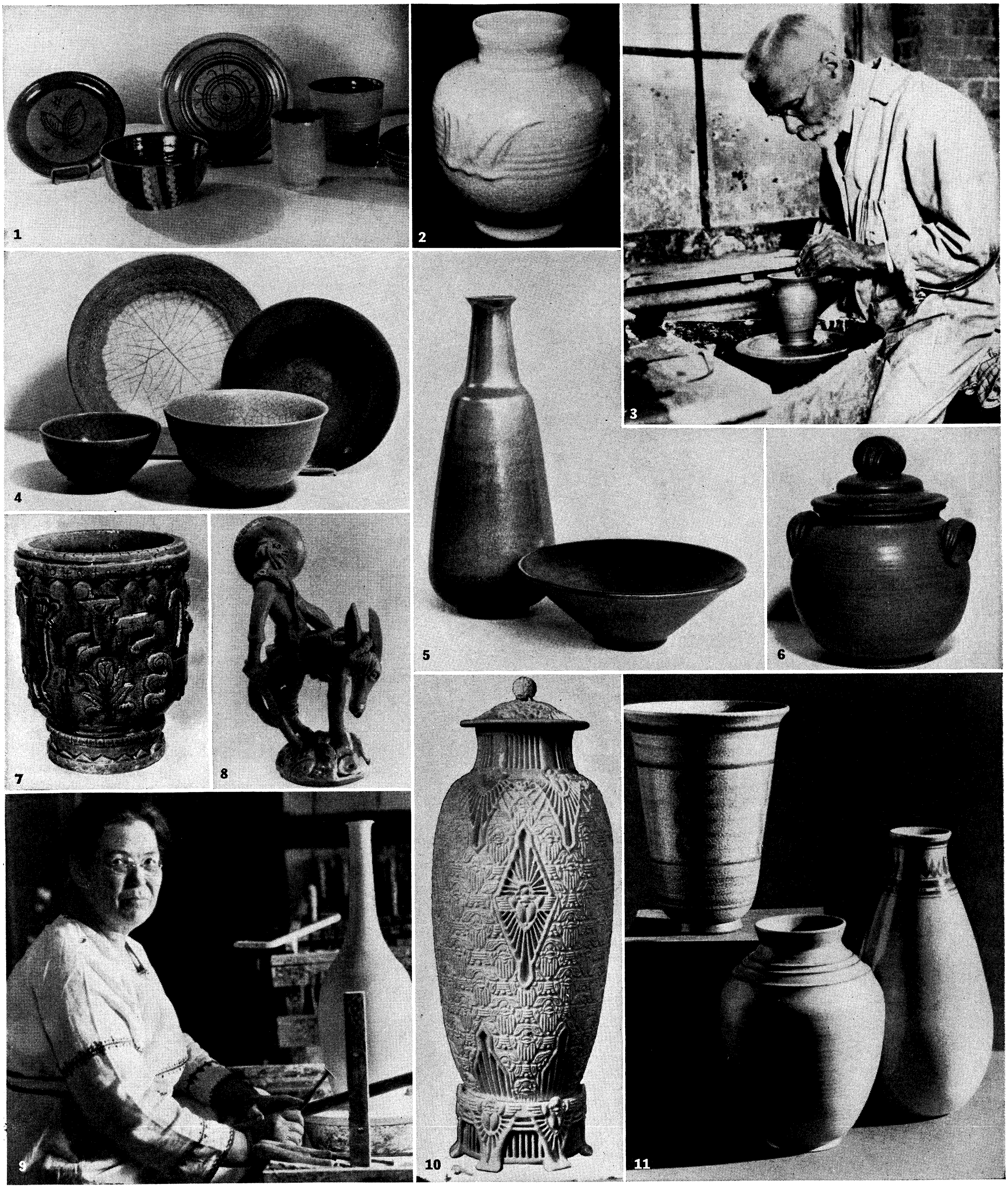
WARE MADE BY CRAFTSMEN OR DESIGNERS USING THE TOOLS AND METHODS OF INDUSTRY

1. Tea set designed and made by Ramsey Wieland
2. Pottery vase made by Jane Curtis, using the casting method
3. Plate and bowl made by Elizabeth Simmons on jigger machine and decorated with coloured slip
4. "Kangaroo," by Mario Ubaldi; ceramic bisque with slip decoration
5. Student making a plate on a jigger machine at the School of the Art Institute of Chicago
6. Bowls and vases by Myrtle Meritt French

POTTERY AND PORCELAIN



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WARE THROWN ON POTTER'S WHEEL OR MODELLED BY AMERICAN CRAFTSMEN

1. Pottery by Peggy Beck. The plate was made on the jigger machine; other pieces were thrown on the potter's wheel
2. Crackle-glazed stoneware jar by Marion L. Fosdick
3. Charles Fergus Binns (1857-1934) throwing at the potter's wheel
4. Group of bowls by Glen Lukens
5. Stoneware vase and bowl by Charles F. Binns
6. Salt-glaze jar by Arthur Baggs
7. Vase by Ramsey Wieland
8. Turquoise-glazed ceramic sculpture modelled by Miguel Juarez
9. Adelaide Alsop Robineau (1865-1929) in her workshop at Syracuse, New York
10. Scarab vase by Adelaide Alsop Robineau — white porcelain with excised carving
11. Vases by Edgar Littlefield

made at a faience-factory at Hochst as early as 1746, under the patronage of the Elector of Mainz, but not in any quantity until 1760. Very lively figures in Meissen rococo styles preceded those made by Johann Peter Melchior (appointed 1767), upon which the factory's fame chiefly rests. Melchior's very personal style shares the same inspiration as the contemporary Sèvres models: he showed an equal mastery in the treatment of the nude, in figures of children, and in portrait busts and plaques. All have the smooth, not glossy surface and soft colouring that are characteristic of Hochst.

The factory at Furstenberg in Brunswick was established in 1753 by Duke Charles I. with the help of Johann Benckgraff of Hochst. A feature of the early porcelain was the use of elaborate moulded patterns designed to disguise the imperfections of the material. In the last twenty years of the 18th century biscuit was used for a series of portrait medallions in white on blue.

The Bavarian state factory, founded in 1747 at Neudeck, and transferred in 1761 to Nymphenburg, is chiefly famous for its figures, for which Franz Anton Bustelli (*fl.* 1754–63) made models which are perhaps the finest plastic expression of rococo. The same qualities, however, distinguish the delicately painted table-wares and vases of the factory. Bustelli was followed by Auliczek, who in turn gave place in 1797 to the Höchst and Frankenthal modeller J. P. Melchior.

The Frankenthal factory was founded by Paul Hannong of Strasbourg in 1755 under the patronage of the Elector Palatine. The early figures modelled by J. W. Lanz, their subjects chiefly drawn from contemporary life, are amongst the best produced in Germany, whilst the classical models of Konrad Link (made 1762–66) share the largeness of style of the best later work of Kaendler. Other able modellers were J. G. Luck, and Karl Gottlieb Luck, and in 1779 J. P. Melchior came to Frankenthal from Hochst.

Though the porcelain of Ludwigsburg is seldom free from imperfections and generally grey in tone, it was the medium of some excellent figures, for which amongst others the sculptor J. C. W. Beyer (1764–67) made some models combining rococo character with the classical style. The factory was founded in 1756 and taken over in 1758 by Charles Eugene, Duke of Wurttemberg.

Amongst the minor German factories founded in 1756 by the Prince-Bishop of Fulda has a deserved reputation for high quality both in the modelling of figures and the painting of table-wares. Another factory, started in 1758 at Ansbach and transferred four years later to Bruckberg, closely followed Meissen models. Others of some importance were at Ottweiler in Nassau-Saarbrucken (founded 1763), Cassel in Hesse (founded 1766), Pfalz-Zweibrücken (founded 1767), Baden-Baden and Kelsterbach. In the forest region of Thuringia, many private factories sprang up soon after 1760 making cheap useful wares, as well as imitations (often definitely fraudulent) of the better Meissen china. Very good porcelain, however, was made at Kloster-Veilsdorf, Gotha, Ilmenau and Vqlkstedt. The rather crude figures of Limbach sometimes have an attractive simplicity. Porcelain was also made at Gera. Gross-Breitenbach and Rauenstein.

In the earlier days of Meissen and Vienna no serious attempt was made to prevent undecorated porcelain from reaching the hands of independent enamellers, though eventually the Meissen factory adopted the plan of cancelling its mark (by a cut in the paste) on all defective pieces sold in the white. Amongst many excellent *Hausmaler* may be mentioned J. Aufenwerth of Augsburg and J. F. Metsch of Bayreuth; Preussler, Ignaz Bottengruber and his pupils H. G. von Bressler and C. F. von Wolfsburg, all of Breslau, who specialized in monochrome painting, chiefly in red and in black, in which last also Jacob Helchis decorated Vienna porcelain in a distinctive manner. The wandering arcanist C. K. Hunger of Meissen, Vienna and Venice, practised a style of painting in thick gold, and about the middle of the century, F. Mayer of Pressnitz worked in several styles, and Canon Busch of Hildesheim made original engravings on porcelain with a diamond-point and coloured them with black.

Switzerland. — In Switzerland, porcelain was made at a factory at Schoren near Zurich, founded in 1763. Though smoky in tone and painted in subdued colours, Zürich china has a very distinct charm and delicacy. Another Swiss factory at Nyon made hard porcelain in French style in the late 18th century.

Belgium and Holland. — Hard-paste factories of no great importance were in existence in the 18th century at Weesp (afterwards transferred to Oude Loosdrecht and Oude Amstel) and The Hague, where, however, Tournai and other porcelain was sometimes decorated and marked. Paris styles were followed at Etterbeek near Brussels.

Denmark and Sweden. — At Copenhagen as at Marieberg (Stockholm) soft-paste was made at first. At the former from about 1760 Louis Fournier from Vincennes made wares in French style until hard-paste began to be made about 1772: in this last a series of Norwegian peasant-figures is noteworthy. At Marieberg, Pierre Berthevin from Mennecy made soft-paste from 1766 to 1769, and a hybrid porcelain was used for the next twenty years.

Russia. — Hard porcelain in German style was made in Russia as early as 1745, but was scarcely an established manufacture until the time of Catherine II. (1762–96). Amongst the little that is distinctive in the Imperial porcelain from the St. Petersburg factory a series of figures of Russian folk-types may be mentioned. Other factories included one conducted by an Englishman, Gardner, at Verbilki and Tver near Moscow.

Italy. — Venice shares with Meissen and Vienna the distinction of a porcelain factory established in the first quarter of the 18th century, in the period of the baroque style. Two brothers, Francesco and Giuseppe Vezzi, founded their factory in 1720 with the aid of the Meissen and Vienna workman Hunger. It ceased to exist soon after the death of the first-named in 1740. The Vezzi porcelain resembles Meissen in its technique of painting, in which iron-red plays a prominent part, but a certain Italian fantasy and irresponsibility distinguishes it. Another Venetian factory seems to have been in operation from 1758 to 1763 under one Hewilcke of Dresden, but little is known of it, and that founded by Geminiano Cozzi in 1765 made most of the porcelain for which Venice is celebrated. Meissen was again much imitated, but the fantastic Italian rococo and a freshness of colour mark much of the Cozzi china, which was a kind of soft-paste. The existing Doccia factory was founded about 1735 by the Marchese Carlo Ginori, with the help of a chemist from Vienna, Karl Wendelin Anreiter. Its earliest work included some distinctive baroque decoration, and later on in the 18th century some highly dramatic groups were made. Factories at Nove, Vinovo near Turin, and Treviso produced more or less original work, whilst at Capo-di-Monte near Naples, a celebrated factory was in operation from 1743 until 1759, when its patron Charles, king of Naples, succeeded to the Spanish throne and the establishment was transferred to Buen Retiro. Typical Capo-di-Monte china is a glassy soft-paste, extravagantly decorated with reliefs, often of figure-subjects; it was much imitated at the Naples factory which was in a sense its successor (1771–1821), and at Doccia and elsewhere in the 19th century.

Spain and Portugal. — The Madrid or Buen Retiro porcelain (1759–1808) was of various quality but included some of the most beautifully modelled and coloured figures ever made in Europe. For these the modeller Giuseppe Gricci was probably responsible. Amongst many styles of painting on vases and table-wares there is much that is of a minute but significant delicacy. The manufacture was revived at La Moncloa from 1817 to 1849. Porcelain was also made at the count of Aranda's faience-factory at Alcora from 1774, and at Vista Alegre in Portugal from 1790.

England. — No certain English porcelain is known of earlier date than the so-called "goat and bee" jugs, made of a soft paste resembling milk-white glass and incised with the name of the Chelsea factory, the date 1745 and a triangle. This "triangle-period" of the Chelsea factory is believed to have ended about 1750, when Nicholas Sprimont apparently displaced Charles Gouyn as manager. Chelsea china of the next eight years is the finest ever made in England. Of a smooth soft-paste capable of giving the most delicate quality to enamel-painting, Chelsea is more often original than any other English porcelain, though its styles were largely inspired by Meissen. The figures in particular are unsurpassed for beauty of modelling. The mark of an anchor, at first in relief, later painted in red, belongs to this period, 1750–58, which ended with the death of the proprietor, Sir Everard Fawkener. In the subsequent period, when Sprimont was proprietor as well as manager, the rococo style (at the time outmoded at Sttvres) survived for ten years in extravagant forms of great interest. Coloured grounds, including a dark "mazarine" blue and a rich broken crimson were inspired by Siivres, as were figure-subjects, *chinoiseries,* and other styles of painting. Profuse gilding of fine quality, richly brocaded costumes and *bocages* or backgrounds of flowers and foliage were characteristic of the boldly modelled figures, some of which were at one time erroneously attributed to the sculptor Roubiliac. The beautiful Chelsea toys — scent-bottles, seals, bonbonnittres and the like — were made from about 1750 onwards and even continued to be done at the factory after its sale in 1770 to William Duesbury, the proprietor of the Derby factory. This had been in existence since 1750 and had made figures and other porcelain in Chelsea styles, but of comparatively little merit. The productions of the period 1770–1784 (when the Chelsea works were closed) are often known as Chelsea-Derby china. The pseudo-classical vases and the figures (including some in biscuit) in the fashionable sentimental Sèvres styles are of less importance than the table-wares which are the chief title to fame of the Derby factory. Later porcelain in the same excellent tradition was painted by artists whose names are known, such as Zachariah Boreman and William Billingsley. Derby declined after the succession to the management of Robert Bloor in 1811, and came to an end in 1848.

The Bow factory was perhaps in existence in 1744, but its productions before 1750 have not been certainly identified. From 1749 (when a distinctive bone-ash paste was adopted) to about 1760 its productions were largely inspired by, and often close copies of Meissen, but rank next to Chelsea for delicacy of modelling, and have the attraction of a beautiful ivory-toned material and clean strong colouring. Later Bow, which was marked with an anchor and a dagger, shows a distinct falling off in these respects. Lowestoft was an offshoot of Bow and largely imitated the productions of other factories, as well as Chinese models, in soft-paste. At Longton Hall in Staffordshire from about 1750 to 1760 William Littler made excellent figures and other wares of a soft porcelain in which are apparent some of the attractive qualities of the more rustic Staffordshire earthenware. A rich blue enamel used as a ground, and a fondness for dishes and vessels in the form of folded leaves were characteristic of Longton Hall. At Lowdin's factory at Bristol, transferred to Worcester in 1752, soapstone (steatite) was used in the paste, and Chinese, Japanese and Meissen motives were employed with an attractive simplicity. Amongst the best Worcester china, made between 1755 and 1765, may be singled out the beautiful armorial mugs. Transfer-printing was adopted very largely as a mode of decoration at Worcester. About 1768, painters from Chelsea were engaged, and a showy style with rich gilding and coloured grounds, including a distinctive "scale-blue," became the fashion of the day. The painting of highly-coloured "exotic birds" was inspired by Chelsea. The later "Flight" and "Flight and Barr" periods of Worcester (which succeeded the so-called Dr. Wall period, 1751–83) show a marked decline in taste. Some Liverpool factories and that at Caughley (the "Salopian" factory), making porcelain from about 1760 to 1772 respectively, may be regarded as offshoots of Worcester. At Plymouth, William Cookworthy had discovered the secret of hard-paste before 1768 (when he took out a patent), and made figures and useful ware employing Chinese, rococo and classical motives. His factory was transferred to Bristol in 1770, and sold in 1773 to Richard Champion, who made much handsome table-ware as well as figures in the classical style. The Plymouth and Bristol china often fails in effect on account of its comparatively hard glaze, into which the colours have not fused. Champion sold his patent in 1782 to a Staffordshire syndicate who continued to make hard-paste in "cottage style" at the New Hall factory until about 1810. Meanwhile a hybrid porcelain made of hard-paste materials in combination with bone-ash had been introduced before the end of the century by Spode and others. The history of this china, like that of a beautiful but unpractical soft-paste made by William Billingsley, at first at Pinxton (1796) and afterwards at Nantgarw and Swansea (1814–17), belongs to the 19th century.

Bibliography.—*General.* E. Hannover (ed. B. Rackham), *Pottery and Porcelain, A Handbook for Collectors.* Volume III. (European Porcelain) (London, 1924) (Comprehensive and up-to-date, and includes a very full bibliography: the following list includes some standard books together with some published since the date of the bibliography in Hannover).

France. X. de Chavagnac and E. Grollier, *Histoire des Manufactures françaises de porcelaines* (Paris, 1906).

Germany. Max Sauerlandt, *Deutsche Porzellan-Figuren des 18 Jahrhunderts* (Cologne, 1923). *Meissen:* E. Zimmermann *Meissner Porzellan* (Leipzig, 1926). *Hausmalerei:* G. E. Pazaurek, *Deutsche Fayence- und Porzellan-Hausmalerei* (Leipzig, 1925).

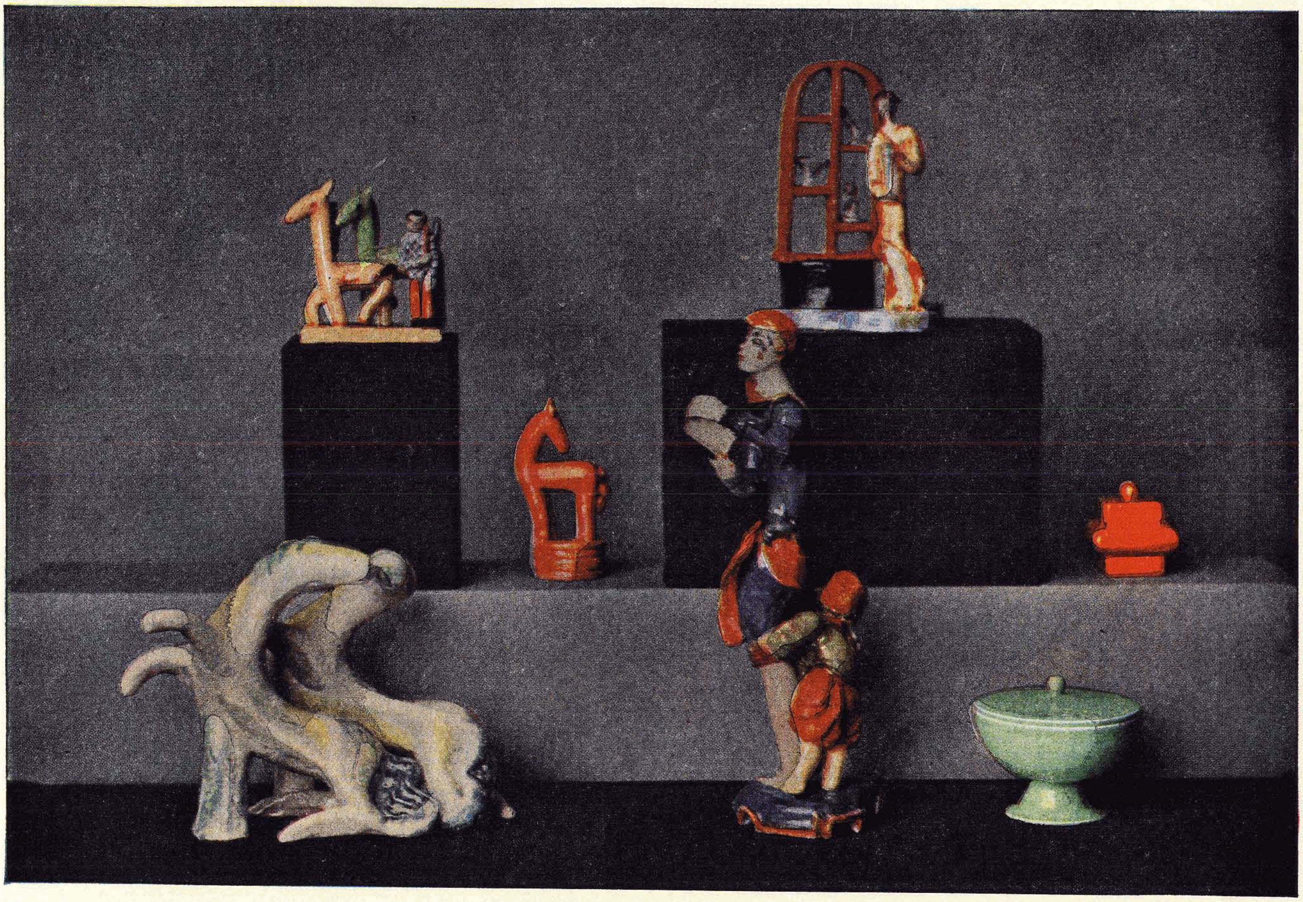
England and Wales. W. B. Honey, *Old English Porcelain, A Handbook for Collectors* (London, 1928). *Chelsea:* W. King, *Chelsea Porcelain* (London, 1922). *Worcester:* R. L. Hobson, *Worcester Porcelain* (London, 1910).

NINETEENTH CENTURY EUROPEAN POTTERY AND PORCELAIN

The period of the Napoleonic Wars marks a definite break with the older traditions of craftsmanship: European civilization emerged impoverished and found the Industrial Revolution complete. In the more pretentious wares, the Empire style was a pompous and frigid continuation of the neo-classical, and the "revived rococo" of 1820–50 was one of the first of the series of revivals that make up the greater part of the "styles" of the century. Some of the older factories, such as Meissen and Vienna, were even content to reproduce their former inventions, whilst the Great Exhibition of 1851 saw a general attempt to outdo in "exquisiteness" the most costly Sèvres productions of the 18th century. At Sttvres itself work of a high order of technical accomplishment was done under the management of Brongniart, who remained director until his death in 1847. In England the porcelain made by the Spodes and their successors Copeland's, of Stoke-on-Trent, by Minton's of the same place, and at Coalport and Swinton (Rockingham factory) was often very creditable technically but artistically of little account.

Amongst the cheaper types of pottery, the cream-coloured earthenware of Staffordshire commanded at the beginning of the century a world-market which it retained for a long time despite Continental rivals perforce driven to make the so-called *faïence anglaise.* In France the English method of transfer-printed decoration was also adopted, notably at Creil and Montereau, and the development of the deposits of kaolin in the neighbourhood of Limoges led to a rapid growth of the pottery industry in that part of the country. In Italy, some distinguished and fanciful painting was done on cream-ware by the firm of Giustiniani of Naples.

After the Great Exhibition, manufacturers began to be aware of "Art," and pottery inspired by Renaissance models — by maiolica, "Palissy ware" and Limoges enamels — made its appearance. The Paris Exhibition of 1867 introduced a fashion for Japanese naturalism and asymmetry, and some European porcelain was even made (as at Worcester) in imitation of the degraded "export Satsuma" of the period. The collecting of Turkish and Syrian pottery (called at the time "Rhodian" and "Persian") brought a vogue for designs in the same style, from which issued the work of William de Morgan who at a later stage began to make ruby-lustred wares inspired by Italian maiolica; he was also in a sense the representative in pottery of the Morris movement towards handicraft as against industrial machine-work. In France Théodore Deck made similar essays towards the rich colour of the "Damascus" wares; and indeed the most noteworthy pottery of the last forty years of the century was the work of individual artists striving to emulate the great achievements of past times. In particular, Chinese single-coloured and flambe' glazes inspired the high-fired stonewares and porcelain of Chaplet, Lachenal, Delaherche and Dalpayrat in France, and of Mr. Bernard Moore in England. Mr. William Burton developed some distinctive single-coloured glazes and lustre-pigments for Pilkingtons of Manchester, and similar lustred effects were



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MODERN AUSTRIAN AND FRENCH POTTERY

Upper Group: Left to right, Back row: Group by Kitty Rix; Animal (original) by Kitty Rix; Figure by Erna Kopriva; Jar by Josef Hoffmann. Front row: Animal group (original) by Mathilde Flögl; Figure group by Vally Wieselthier: Jar by Josef Hoffmann. All pieces are burnt and afterwards glazed in various colours. Lower Group: Left to right, Carriès (*Grès*, about 1890); Augusta Delaherche (*Grès*, 1901); Chaplet (Porcelain grand *feu*, about 1900)

also obtained by Zéolnay of Pecs (Fiinfkirchen) in Hungary, and by the Massiers of Golfe Juan in France. The so-called Arts and Crafts movement in England, by drawing attention to the virtues of peasant art, brought a sentimental fashion for simpler lead-glazed decorative wares; at Florence the Montelupo style was revived, whilst more or less exact copies of Hispano-Moresque and later Italian maiolica were made by Cantagalli and also by various other potters.

At the older porcelain factories in the latter part of the century some innovations of importance included the crystalline glazes and subdued green, grey, mauve and blue underglaze colours introduced at the Royal Copenhagen factory, and used for delicately painted vases and figures of Danish peasants and animals, modelled by some able sculptors. Similar work was and is being done by Bing and Grondahl of the same city, by Heubach of Lichte in Thuringia, and by the Meissen and Rorstrand (Stockholm) factories. A mode of impasto decoration, known as *pâte sur pâte,* in which successive layers of white or coloured slip were applied to a dark ground, was skilfully practised at Sbvres by several artists, notably by Taxile Doat, and was brought to England by M. L. Solon, who worked for Minton's of Stoke-on-Trent. This was perhaps the foremost English factory, where Léon Arnoux was director, and the well-known sculptor, A. Carrier-Belleuse (afterwards at Sèvres) a principal modeller. At Wedgwood's another French artist, Emile Lessore (who had also been at Minton's), developed a delicate and individual manner of painting on cream-coloured earthenware.

Salt-glazed stoneware was revived in national styles by Villeroy and Boch of Mettlach, and by Doulton's of Lambeth, one of whose modellers, R. W. Martin, with his brothers Edwin and Walter, employed the material for grotesque figures and vases which have the merit of attractive colour in their sombre browns and greens, and show, moreover, a true feeling for pottery technique. Equally attractive work in stoneware was done by the French sculptor, Jean Carribs, and by E. Bigot of Paris. In Germany, Max Lauger of Karlsruhe developed an interesting style of decoration modelled in slip under coloured glazes. At the national factories of Berlin and Sbvres, highly accomplished work was done in many styles, with the support of up-to-date scientific knowledge, and the Paris Exhibition of 1900 marked the culmination of what may be called the eclectic period of European ceramic art. (W. B. Ho.)

BIBLIOGRAPHY.—General: E. Hannover, *Pottery and Porcelain, I.* "Europe and the Near East" (London, 1925), a thorough illustrated survey, with full classified bibliography. Italy: O. von Falke, *Majolika* (2nd ed., Berlin, 1907), the most authoritative monograph. Netherlands: B. Rackham, *Early Netherlands Maiolica* (London, 1927). Germany: *A.* Stoehr, *Deutsche Fayencen und deutsches Steingut* (Berlin, 1920); O. Riesebieter, *Die deutsche Fayencen des 17 und 18 Jahrhunderts* (Leipzig, 1922). France: M. J. Ballot, "La Céramique française," *Documents d'art, Musée du Louvre* (Paris, 1924). Spain: P. Paramó, *La cerámica antigua de Talavera* (Madrid, 1919); M. Escrivá de Romani, conde de Casal, *Historia de la cerámica de Alcora* (Madrid, 1919). England: B. Rackham and H. Read, *English Pottery* (London, 1924).

MODERN CONTINENTAL

At the end of the 19th century the movement in the domain of the applied arts, with which the names of Ruskin, William Morris, Walter Crane and their fellow-artists are connected, wrought a great change. At first this tendency scrupulously supported the preservation of the methods of handicraft, and strongly opposed manufactured articles. But the same principles with which it originated, and which were indeed identical with those out of which the applied arts had developed in all previous periods, gained ground in the meantime, and the possibility of having artistic articles for practical use came once more within the purview of increasingly larger groups. Gradually also there came into being a desire to bring them within the reach of the many by changing the expensive handmade articles for manufactured goods, but such production was to be led by artists. But in proportion as these ideas became more general, a reaction set in against their excessive rationalistic elements. Consequently, after the beginning of the 20th century taste inclined towards the ornamental, the lively, the richly coloured, though the basic principle that the shape and appearance of the object should be determined by the requirements of material, technique and purpose was not neglected.

Artists, sensitive to shape and colour, could be satisfied with the ceramic production, for working the soft clay on a potter's wheel allows scope for the most individual expression. So far as the continent of Europe was concerned, there were two centres whence the above described development sprang: France and Denmark, or, more strictly speaking Copenhagen. An important development in Holland has exerted little influence outside its own boundaries, and similarly in Germany, while both have undoubtedlv orofited from French and Danish artists.

MODERN CERAMIC TECHNIQUES

By ceramics is meant all production of which the final result is baked clay in different grades of hardness and purity.

Porcelain. — The composition of European hard porcelain has remained about the same since the 18th century. The ingredients consist of the plastic material, kaolin, and the non-plastic quartz and felspar, which, in the process of working, is used as a diluting element, and in firing, as a cement. The kaolin is principally found in Germany, but always mixed with another soil. It has to be purified by washing. The quartz and felspar must be cleaned. The fragments of iron, in particular, have to be removed, as they are dangerous to the product. By mixing these ingredients the plastic material is obtained. This is made homogeneous by a mechanical method, and it frequently lies unmoved for some months in a special cellar in order to be moulded once again. Then the shaping can begin. It is not usual to shape this fine material by hand, but moulds are used which have been made of plaster after the models fashioned out by artists. The plastic material is pressed into these moulds or poured out in them as a pulp. In the latter case the plaster absorbs so much liquid that a sheath is formed alongside the inside of the mould, out of which the superfluous pulp can be poured. Shaping is followed by drying. After that there is the controlling and the removing of the casting seam and other unevenness. If the object consists of more than one part these are joined together. They are then put in the kiln in sagars or clay boxes so that the heat is more evenly distributed over the piece, and heated to about 950 degrees. The porcelain has then become hard and water-tight but dull. This is therefore followed by glazing. The objects are dipped into a liquid consisting of the same ingredients as the material, but in which felspar and quartz predominate. The objects which have been glazed in this way must then be fired in a heat of 1,370°–1,458°, again in sagars. This heating lasts from 20 to 30 hours, and is followed by a gradual cooling which takes three days. A full kiln never produces everything perfect, the many dangers in the firing—for example all objects shrink about one-sixth of their volume—result in articles being spoiled by exploding, warping, etc.

The porcelain is then ready to be painted with dyes, with which a very lightly fusible glass-powder has been mixed. In order to make these melt together with the glazing and become durable the painted objects are heated in an enamelling-furnace to a heat of 700°–800°. This heat must be reached quickly and the cooling takes place equally rapidly in order to keep the colours bright. The old porcelain bakers painted on the so-called biscuit-ware, *i.e.,* after the first baking and before the glazing, but they could only make use of very few colours at this stage — really only cobalt blue, as most other colours could not endure the heat of the second firing. Modern ceramic technique, however, has considerably extended this process of painting before the glazing. Since Copenhagen's success with it, it has been more generally used and imitated. In these cases the paint is put on the material in a different way, viz., as a liquid with a brush or squirt and then engraved in order to increase the plastic impression of depth. After that the objects are glazed. In a high temperature the colours under the glazing mix with the material, except in the case of cobalt blue, which mixes with the glaze. This process has the technical advantage of making the colours durable, but on the other hand it has a disadvantage in the artistic sense, in that the covering colour reduces the lustre of the porcelain itself by breaking the rays of light which cause the minute crystals in the porcelain to glitter. This is not the case with painting after glazing. Another way of ornamenting, which, however, has the same artistic disadvantage, is to coat with coloured glaze, which is applied in one colour. By adding metals the glazing can be made what is known as "streaming"; or, by choosing a glazing compound, the coefficient of expansion of which is smaller than that of the material, irregular fissures or artificial crackles can be obtained with the cooling.

Grès.—Grès has many qualities in common with porcelain, but it is grey or ash-coloured and not translucent. The material needs less working in order to purify it. As this clay is already fairly hard after being dried in the open air the first firing can be omitted and the ornamenting begun at once. After being painted the objects can be put in the furnace without sagars and may be baked at a temperature of 1,190°. Throwing salt in the furnace causes an evaporation which brings a glaze on the objects. The colour is then ash-like, or, with a higher temperature, red-brown. The modern ceramist, however, prefers a superior kind of grks, which is more carefully washed, has the colour of ivory, and to which kaolin can be added (French grès kaoliné). The painting takes place as with the ordinary grès before the glazing, after which it is baked and is coated with lead glazing. The grbs can also be coated with an engobe-like pulp glaze.

Earthenware. — In England, at the end of the 18th century, this imitation and rival of porcelain was invented. In the course of the 19th century it obtained a prominent place in ceramic production, especially for domestic use. It consists of a plastic clay, freed as much as possible from iron and white-burning, but with which some quartz and felspar are mixed. Sometimes some kaolin also is added. The washing must be done very carefully. The exact shape is obtained by the moulding of the liquefied clay. Both during the first and second firing the objects are placed in sagars. Between the two firings the painting and the glazing take place. The ornamenting can also be done by coating the whole object with a pulp glaze.

Maiolica.—This is the name of a kind of porous pottery which after the drying and firing is coated with a tin glazing, either by immersion or squirting. On this non-transparent coating decoration is painted with dyes consisting of metallic oxides—a work that requires great skill, as retouching is impossible. During the process of baking the colours mix with the glaze. The effect is sometimes improved by coating the colours with a second glaze, this time a transparent lead glaze. So-called lustres can also be obtained by means of metallic reductions.

Pottery. — Pottery is the earliest ceramic production of mankind. For this a slightly calcareous potter's clay is used, which when baked becomes a red or yellow shard that still has to be glazed to render it water-tight. Decoration can be done in different ways—for instance by putting on ornaments of clay in a different colour (bnrbotine ddcor), or by painting them. The whole object can also be coated with another kind of clay and the décor in the original reproduced by scratching away the outer coating. It can also be engraved (*graffite* ddcor). In all these cases a transparent lead glaze is applied. By a combination of the different techniques all kinds of variety are possible and usual.

Historical Survey. — Interest in this fine old handicraft was revived in the period beginning with the Great Exhibition in London in 1851. Museums of industrial art were opened, and applied-art schools followed the lead, by the imitation of old models. Imitation led to a revival and improvement of old techniques and this was fostered by chemical science which in these years grew more and more important. People grew tired of imitation, however, and inspiration was sought elsewhere. It was found in the closer acquaintance with Japanese ceramic art at the Paris exhibition in 1867 and more especially in that of 1878. This inspiration took effect in two directions. First, it showed the possibility of another attitude towards nature and the reproduction of nature, and so pointed out a new way to porcelain; a new way to which Denmark was to lead a few years later. Secondly, it demonstrated the splendid ceramic qualities of the old Japanese grbs. From this originated the new ceramic art of the French. This is the starting point of the history of modern ceramics.

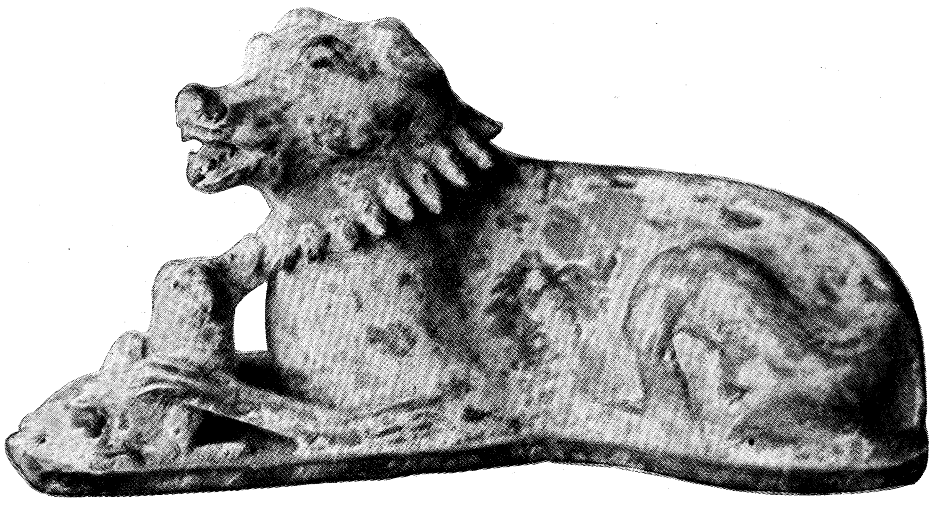
FRANCE

The revival of French ceramic art was initiated by Ernest Chaplet, who was born at Sèvres in 1835 and whose work became world famous 20 years before Jean Carriès, the sculptor, became a ceramist, under the influence of the exhibition of 1878. Chaplet entered the Skvres factory in 1848, and at the exhibition of 1855 he produced work of his own. Afterwards he worked at Laurin's at Bourg la Reine, where he reapplied the old barbotine technique. For it he used very white earth mixed with colour-oxides, which he painted on ordinary potter's earth. The success he had with this at the exhibition of 1878 did not last. In 1875 he became manager of the ceramic factory of Haviland in Paris, which factory he took over in 1885, and in 1887 he went to Choisy-le-Roi, where he lived and worked until his death in 1909. His great merit is the application of "flammés"—colour glazes without real figure ornamentation that cover his grbs and sometimes his porcelain, copper-red, white, violet and blue in all varieties and combinations. First Japanese grbs, and later the monochromatic Chinese porcelains inspired him, but his own work retains an independent quality. His trade mark is the rosary (*chapelet*). By the time that Chaplet reached the high-water mark of his fame Carries had already achieved success. Jean Carriès was born in 1855. As a sculptor, with strong leanings to the decorative, he sought for picturesque effects. Deeply influenced by the charm of the Japanese work exhibited in 1878, he decided to devote himself to ceramic art, and to use grbs as his material. Far from Paris, in St. Amand-en-Puisaye and Montriveau, in the neighbourhood of Nevers, where he found his material, he began to experiment in a furnace of his own, and in the exhibition of 1889 he showed the results which won universal admiration. The Japanese influence is strong, especially in his vases and bowls that are ornamented with streaming glazes. But his work has a character of its own, and he avoids what he considers the too great brightness of the Japanese glazes, and so obtains a better harmony between the colours of the glazes and the clay.

Besides numerous vases and bowls, simple and with no ornamentation other than the glaze, Carriès created a great number of plastic works such as masks, heads, figures of animals, etc., which please not only by their construction, their exquisite colour and beautiful surface, but also by their subtle characterization. His last work was a monumental hall which the Princess de Scey-Montbeliard had made in her hotel in the Avenue St. Martin. But he did not live to see it completed. He was ill when the work began, and on July 1, 1894, he died. His friend, the architect G. Hoentschel, who made china after the same method as Carries, gave a large collection of the latter's work to Paris (Musée du Petit Palais). Another disciple was Paul Jeanneny (1861–1920), who took over Carries' atelier in St. Amand. Neither he nor Hoentschel has done any plastic work. Jeanneny's work is even more closely connected with Japanese ceramics than is the work of the others.

In the meantime Chaplet had started a school, and the most prominent of the artists, who with their master formed the group of "L'Art du Feu," was Auguste Delaherche, who, when Chaplet went to live at Choisy-le-Roi, took over his furnace at Vaugirard in 1887. At first he worked with streaming glazes, and sometimes combined these with designs in relief. But gradually he simplified his methods. In the museum at Sbvres there is an early dish of his with a motif of oak leaves; but his later work is remarkable only for the dull glow of his warm-coloured émails, strong and deep, dark and velvety.' Other disciples of Chaplet are: Adrien Dalpayrat, born at Limoges, who collaborated first with Voisin-Delacroix and later with Mlle. Lesbros. His work can be recognized by the deeply coloured blue, blood-red or yellow opaque glazing, reminiscent of oil painting. Technically his workshop was very highly developed; sometimes he made vases several yards high in blue and red spotted grbs.

Edmond Lachenal was much more under Japanese influence. For ornamentation, especially in his dull green glazed pots, he used naturalistic branches and flowers or blossoms, brought out in relief, and tinged with white or rose red. By giving his works an acid bath he succeeded in making the surface peculiarly velvety

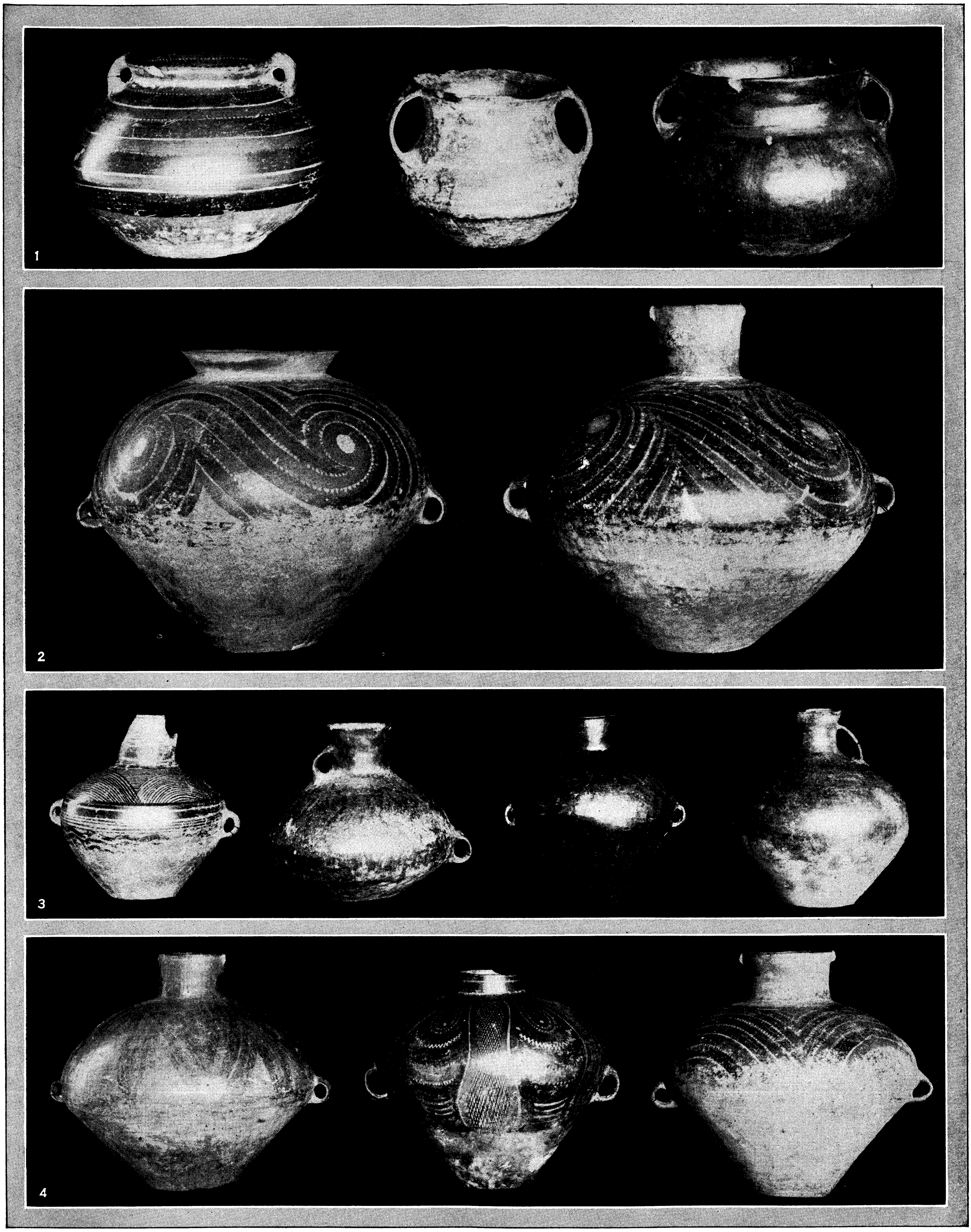


TOP, DELOS CHAPPELL COLLECTION; BOTTOM, WARREN E. COX COLLECTION

CHINESE EARLY POTTERY SCULPTURE

Top: Pottery horse of the T'ang dynasty (A.D. 618–907) decorated with rare blue glaze and touches of red paint on the saddle. It represents the Bactrian horse, a type introduced into China by the Mongols

Bottom: Pottery dog with puppy, pre-T'ang, an excellent example of vigorous primitive modelling, showing remnants of red and white paint on dark grey biscuit (unglazed surface)



EARLY POTTERY FROM THE PROVINCE OF KANSU, NORTH CHINA

Illustrations of 12 pottery vessels of a very early period (probably 3000 B.C.) discovered in the province of Kansu, North China, by J. G. Andersson, while excavating old sites. The pottery is generally red with black ornaments, clearly of the same family of design as the aeneolithic pottery found on many sites in the Near East

—*émail velouté*. Albert Dammouse considered the material more, and his work at the Sèvres factory has a character entirely its own. For the decorating of his rather simple forms he used plant motifs, and often those of mosses and seaweeds. In so-called *pâte-décor,* the glaze and the pâte material are applied side by bide or one over the other, as in enamel painting. Dammouse avoided bright colours and tried to get dark, deep harmonic tinges. In connection with this the Englishman Taxile Doat might also be mentioned. He worked at the Sèvres factory and produced *pâte-décor* Especially remarkable are his grès articles on the surface of which have been affixed small porcelain insets with heads of animals. Alexandre Bigot, who has carried out designs for Henri van der Velden, and J. C. and M. Cazin (father and son), attained fame with their richly coloured running-glazes. They are inferior, however, to some of the younger artists, who in closer association with Chaplet and Delaherche, raised, with the help of the latter, French grks to a height not reached by the older artists. First among these are Emile Lenoble and Emile Decoeur. Lenoble, Chaplet's son-in-law, not only took over Chaplet's furnaces, but also inherited his preference for grès. But his work is quite different. Except in some of his Japanese-like products with a half coating of brown-black glaze, he specialized in engobes, in which he knew how to produce simple but very strong straight-lined ornaments by erasing. The colours of his engobes are of a blackish brown, grey, deep blue, green, orange-red, and white, and always of a quiet tone that harmonizes with the simplicity of the grey clay material. Decoeur is finer and more complicated with his dim, delicate glazes, occasionally bright, but generally dull, in which colour is more important than with Lenoble. Other ornament is lacking in his work or is reduced to a minimum, such as a few simple lines, a small cufic motif in relief, or a margin of leaves reminiscent of Chinese celadons. His bowls and pots are covered with a soft brown-yellow, a delicate green or blue glaze, usually rather thick and applied in a somewhat streaming manner. For softness of surface, his work equals the very best old Chinese and Japanese wares. Raoul Lachenal, the son of Edmond Lachenal, follows after Decoeur, and sometimes his work is equally good. Henri Simmen does the same, but he often imitates Japanese examples too servilely. Jean Mayodon decorates his work with figures like those on antique and Persian examples; *e.g.,* slender, leaping deer. René Buthaud has another technique—his decoration' is of large flat human figures and a strong relief produced by deep incisions.

Of the artists who work in earthenware André Methey must be particularly mentioned. He is the greatest lover of colour and the greatest decorator, an artist who seeks inspiration not in Chinese or Japanese work, but in the rich ceramic production of ancient Persia whose metallic lustres he tries to equal. He is at his best when he builds up his décors from rhythmical repetition of very simple motifs taken from nature. Etienne Avenard follows his example. Félix Massoul uses in his work much heavier colours, his décor is more geometric and not so delicate as Methey's. Finally, the very simple but always fine forms and décors of Jean Besnard are not without merit.

While French ceramic artists were following new paths and bringing French work into world-wide prominence the development of the porcelain factory at Skvres—the former glory of France—was negligible save in one respect, that of technique. At the Great Exhibition of 1851, Sèvres created a very bad impression. In 1852 Regnault was made director. An improvement resulted, but only in so far as the art director Dieterlé (till 1856) and after him Nicolle tried to make very clever imitations of the 18th century examples, instead of the dull repetition of the old traditions. Under L. Robert who was in charge from 1872 the old post of "directeur des travaux d'art" was reinstituted, and Carrier-Belleuse was appointed to it; new men were engaged, amongst others the young Rodin from 1880-82. But, in spite of these efforts and the experiments of the able and resourceful T. Deck a new ceramic art was not born. After Deck's death in 1891 the factory was reorganized, and in 1896, in anticipation of the Paris Exhibition of 1900, an extensive working scheme was drawn up as the basis for more modern and artistic development.

By a decree of Oct. 1, 1926, greater independence was granted to this factory.

Outside the Sèvres factory the only names worthy of note are those of Taxile Doat who has already been mentioned, and Camille Naudot, who about 1900 did some fine work in porcelain tendre. Haviland, in Limoges, worked at painting-before-glazing and also tried to produce artistic earthenware, but without producing anything special. A group of artists in Glatigny, near Versailles, who called themselves after this place, produced porcelains with streaming glazes reminiscent of grès. Their example was followed by Pillivuyt in Paris. The first to attempt to make artistic stoneware of this kind in France was G. de Feure. In general, however, few good things have been produced. There were several tea and dinner sets at the exhibition of 1925, designed by decorative artists, but they seldom had a cachet of their own. Good work was done by Robert Bonfils, Maurice Dufresne, Suzanne Lalique and, probably the best of all, Marcel Goupy.

GERMANY

In connection with the revival of the German ceramic industry in the 20th century two names may be mentioned here, Th. Schmuz-Baudisz and Max Lauger. Both were attracted to the ceramic industry by knowledge of the so-called peasant pottery. and both learned the industry in its simplest forms from potters in Bavaria or the Black Forest. In this way it was impressed on them that the first thing a ceramist should know is that the shape and decoration of any object must depend very largely on the nature and composition of the material and on the technique of firing.

Max Läuger, who worked at Karlsruhe, decorated his vases and jugs, which were simple in shape and of a deep and even colour, with motifs from nature applied in clay of a different colour. His work resembles the *barbotine décor*. Working for a factory in Kandern he also designed, with the technical expert C. Mayer, architectonically applied earthenware, a great number oi tiles, tile-tableaux, and mural coverings. Later, he worked in maiolica for the Majolica Manufaktur at Rarlsruhe, and produced articles decorated in strong colours. These have greatly influenced younger artists, such as Ludwig Koenig and Georg Schrimpf, who, however, are inclined to an affected naïveté. Th. Schmuz-Baudisz was a painter at Munich, who after 1896 devoted himself to ceramics. He began to shape his objects himself and decorated them with motifs of flora and fauna which he cut out in the engobes that covered his pots. His decorations are much more strongly stylized than those of Lauger. In 1902 he became director of the Staatliche Porzellan Manufaktur at Berlin. The work of Elisabeth Schmidt-Pecht must also be mentioned; it is simple in decoration and form. In the meantime the porcelain factories took some interest in modern work. The Berlin factory, although strongly dependent on the taste of the court, had already, under Dr. Seger, about 1884, made experiments with copper-oxide glazes, and had even obtained good results in red and blue on the so-called flammés and running-glazes. The plastic articles, however, remained of little importance in spite of some successful products by Franz Metzner. But when Schmuz-Baudisz, who had started making domestic porcelain with simple decorations at the factory of Swaine and Company in Hiittensteinach, moved to the factory at Berlin, the example of Copenhagen was soon followed and painting-before-glazing was applied. Of the artists, Adolf Flad and Max Dürschke must be mentioned. Schmuz-Baudisz, who set himself the task of designing landscapes in colour on large porcelain tiles, attempted a difficult technique which was not always justifiable from an artistic point of view. For many years the plastic work at Berlin could not free itself from the influence of the court. Since that time, however, Hermann Hubatsch has made clever statuettes, and in animal pieces Anton Pachegger (1917) and Edmund Otto have done sensitive work. But a great deal has not been accomplished, and in this respect Berlin is just as unimportant as Meissen for the same period, in that, although technically very clever, it produced nothing really important until 1918.

In 1918 Max Adolf Pfeiffer was made director; he brought new life into the factory and made a great improvement especially in plastic work, to which some of the younger artists, for instance E. P. Borner, Max Esser and Paul Scheurich have contributed. More important than Meissen and Berlin in modern ceramics has been Nymphenburg in Bavaria. In 1888 Albert Bauml became director, and he soon attached some young artists to his establishment who, so far as plastic work is concerned, have obtained astonishing results. Jozef Wackerle was especially prominent here. He made beautiful types of peasant pottery, and also humorous groups from 18th century life. He fully mastered the possibilities of porcelain, and made some clever models in maiolica. For some years Wackerle worked at Berlin. Theodor Karner has done animal pieces which are in the first rank; of his disciples W. Neuhäuser must be mentioned.

Among other important factories may be mentioned the Schwarzburger Werkstatten fur Porzellankunst at Unterweissbach, later combined with those at Volkstedt, of which M. A. Pfeiffer was director. He knew how to escape the influence of Copenhagen and sought to produce original work. Jozef Wackerle first worked here and also Ernst Barlach, who with his figures of Russian peasants introduced an entirely new style. Moritz Pfeiffer's table decoration "Hunting scene" also deserves mention. Besides these, good plastic models have been made by Hugo Meisch and by Arthur Storch, while Hans Poelzig has succeeded in making porcelain subservient to modern interior decoration.

Andreas at Leipzig has attempted to make expressionist porcelain pieces, but so far the fine qualities of porcelain have not been adapted to this method of expression. Maiolica offers a better field, and is better adapted to painting. The somewhat affectedly naïve products of L. Koenig and G. Schrimpf have already been mentioned. They work at the Majolica Manufaktur at Karlsruhe, where other younger artists are also engaged. Another and smaller workshop is that of the women ceramists J. Biehler and M. Goossen at Nymphenburg. They have made good reliefs and also free pieces. Two other Munich workers deserve mention, Georg Kemper, who produces miniature pieces, sensitive in form and colour, of *putti* and such like; while Königsbauer attempts a close resemblance to mediaeval forms with his double-surfaced sided jugs of which the outer one is open-worked. Something like this is also found in the maiolica work of Otto Müller who was inspired by Chinese examples, and in the pottery of Kurt Feuerriegel who is more inspired by 16th century models, though both of them, especially the former, produce work with a character of their own. The same can be said of Auguste Papendieck who works independently in the neighbourhoed of Bremen, and who, in her monochrome, slightly glazed vases, aims at great simplicity and pure technique.

Finally some important progressive features can be seen in the cievelopment of stoneware. The domestic pottery of the firm of Villeroy and Boch, who have factories in various places, is frequently meritorious work. In particular their Dresden factory has obtained good results. J. Kühne and Jean Beck design forms and decors. The Wachtersbacher Steingutfabrik at Schlierbach has had as art directors Chr. Neureuther and, after his death, Ed. Schweitzer. Good plastics have been made by Ernst Riegel.

AUSTRIA

During the 19th century there was no artistic ceramic work to speak of in Austria. The revival dates from the first years of the 20th century. Following an exhibition of simple and brightly coloured ceramics at the Viennese Secession in 1902, Bertold Löffler began his attempts to create something new with ordinary red clay, and was joined soon after by Michael Powolny, the most important person in Austrian ceramics. They established a workshop, the Wiener Keramik, where Powolny's pieces of ordinary clay, fired and brightly glazed, were produced. In 1907 there followed the collaboration with the Wiener Werkstatte, where Josef Hoffmann sought and found new possibilities for the entire industrial art. On the ceramic side he was helped by Kolo Moser (d. 1918). The Werkbund exhibition of 1912 showed not only the *putti* and other figures wreathed and surrounded by flowers, but also the ceramics in black and white under-glaze which has become a special Viennese type and has been imitated endlessly. In the same year the Wiener Keramik collaborated with the Gmundener Keramische Werkstätte, where, under the directorship of Franz and Emile Schleisz, peasant pottery developed into an artistic product. An important side of this industry was practised by Powolny, who made work for interior decoration and tiles for stoves at Gmunden. One of the most prolific designers is Otto Prutscher. Meanwhile, Powolny has a number of disciples at the Wiener Kunstgewerbeschule, who work at the Wiener Werkstatte or in small studios of their own. The Wiener Porzellan Manufaktur has come under the influence of the revival in earthenware Multi-coloured decors by Franz Zulow cover its products. In general, however, lively and dainty as the whole of Austrian ceramic production may be, it is always in danger of becoming affected.

HOLLAND

In the 19th century the famous ceramic traditions of the early maiolica and Delft ware, with its cream pâte, had completely disappeared. That which had taste imported from elsewhere flourished. In the last quarter of the century there was a revival. J. Thooft in 1876 bought the last remaining Delft factory, De Porceleyne Fles, and, together with Ad. Lecomte, he applied himself to the revival of Dutch artistic pottery. Unfortunately at first this usually consisted of an imitation of old Delft ware,—blue and, later on, coloured; but shortly after, in 1884 at The Hague, the German ceramist W. Von Gudenberg together with the decorative artist Th. Colenbrander, began to make more original work in the Rozenburg factory. Colenbrander's designs were novel and distinguished, his décors sometimes under Japanese influence, but usually completely his own, were in rich colours and usually had phantasies of plant motifs. There are amongst these bright and slightly too brilliantly glazed pieces of faience hints of futuristic compositions, but they are purer from a decorative point of view. Production of this kind at the Rozenburg factory lasted only until 1889 when Colenbrander left it. It was not revived until 1916, when the vogue was for rather heavy, darkly painted faience. A peculiar product was a kind of very thin pseudo-porcelain, in pale colours, shaped and painted in Jugend style. Japanese influence can be recognized in the ornament. The material, as thin as paper, has not been generally used. Meanwhile the De Porceleyne Fles found two clever artists in L. Senf and E. L. F. Bodart who made various experiments, including dark brown earthenware with running glazes and graffite ornaments, and glass-covered faience with painting inspired by Persian colour and décor. Gold and silver lustre ware has also been successful.

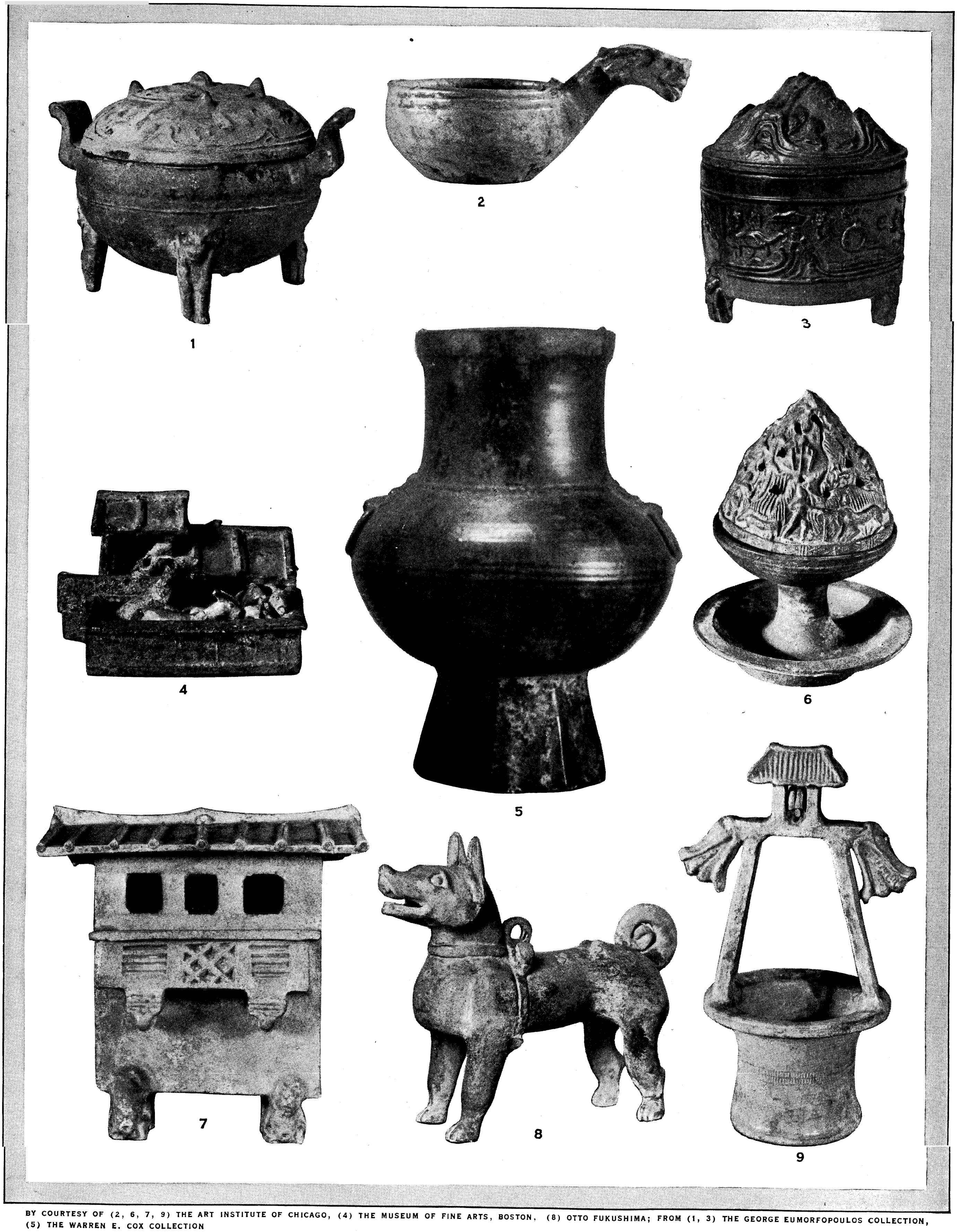
A third tendency became apparent, the influence of the English movement in industrial art inspired by Morris and Crane. On the one hand this was seen in the workshops when first at Amstelhoek and later at Distel an attempt was made to produce beautiful domestic ware with simple materials and old ceramic techniques. On the other hand an independent potter, W. C. Brouwer, turned original shapes on a potter's wheel, which, coated with selfmade glazes, were simple but elegant objects. Very little plastic work was done, but the sculptor J. Mendes Da Costa made very delicate and typical small groups of Jewish women and animals in lead-glazed grbs.

An important figure in the 20th century was C. J. Lanooy, who, as an independent ceramist, imitated the grès flambés of the French, and produced very original and most beautifully coloured pieces. His glazes in which metallic oxides play an important part, are frequently very fortunate discoveries. B. Nienhuys, for a long time a teacher at Hagen, Westphalia, and later at the industrial school at Amsterdam, has a fine feeling for harmonious colouring, and his pots and vases certainly have good and original shapes. Th. Nieuwenhuys and C. Lion Cachet, who as decorative artists occupied themselves with many forms of art, designed faience for the Distel which is deserving of attention. About 1912 Colenbrander, for a short time, made faience covered with dull glazes on which his peculiar decors, principally in blue and brown, were painted. Again, about 1925, in his old age, he designed underglaze décors on the faience of the Arnhem factory Ram. At the same time the factory of Eskaf produced beautiful domestic ware with white streaming glazes, sometimes decorated in black in a

FROM THE GEORGE EUHORFOPOULOS COLLECTION

T'ANG VASE

Covered vase, pottery with coloured glazes. T'ang dynasty (A.D. 618–907). Height 10.15"
The blue glaze is exceedingly rare in this period, though some exceptional specimens are found



BY COURTESY OF (2, 6, 7, 9) THE ART INSTITUTE OF CHICAGO, (4) THE MUSEUM OF FINE ARTS, BOSTON, (8) OTTO FUKUSHIMA; FROM (1, 3) THE GEORGE EUMORFOPOULOS COLLECTION, (5) THE WARREN E. COX COLLECTION

CHINESE MORTUARY POTTERY, HAN DYNASTY (206 B.C. TO A.D. 220)

1. Covered bowl in imitation of bronze form. 2. Ladle. 3. Hill jar decorated in relief with mythological animals, ring handles, and with usual mountain cover surrounded by waves. 4. Barnyard with goats, and man playing piccolo just in front of the little gable. 5. Example of the rare octagonal base type of wine jar with unusual strength. 6. Hill censer modelled in low relief. 7. Pavilion. Height 20¼ inches. 8. Pottery dog vigorously modelled. 9. Well-head. Height 14¾ inches

plastic manner, and also miniature plastics, both by H. Krop. At the factory of Z. Holland at Gouda, domestic ware of good shape and colour was made by C. De Lorm. Brouwer still continues his work and also frequently designs ware for interior decoration. Besides those of Senf and Bodart and their disciples the De Porceleyne Fles produces very good tiles, usually in monochrome, but also in fine colours. Generally speaking, Dutch faience—no porcelain or grès is produced—has a distinct character of its own.

(H. E. VAN GE.)

SCANDINAVIA

Interest in ceramics in Scandinavia was renewed with unusual vigour about the end of the 19th century. This movement, particularly in Denmark, may be attributed to Philip Schou, for some time the manager of the Royal Porcelain works. The white underglaze porcelain, introduced at the end of the 19th century by Arnold Krog, by virtue of its plastic qualities and the depth and perspective it can give to a picture, demands decorations taken from nature and everyday life. The decorations and the more severe ornamental lines which in other ceramic art attain such beauty of perfection, are out of place here; but a sentiment from the air, from the water, from bird, animal or plant life, is reproduced by this underglaze porcelain as by nothing else. This school, which is thus of a national character, is bound up with a great development in sculpture, especially of animals portrayed as they are in life, and of figures, which also reproduce Danish atmospheres, whether taken from life or literature, as for example, Hans Andersen's fairy tales. Another type, the fluted porcelain, which in English-speaking countries is called "the blue Danish pattern," is akin to the underglaze porcelain. The pattern originally came irom China, but in course of time has become entirely Danish and has undergone an interesting development. All the models, even the plainest, are the work of the best and most artistic designers and thus the whole set is stamped with a refinement which makes it probably the most popular dinner-service in the world at the present moment.

It is interesting to note that the first great novelty which appeared after underglaze porcelain had made its mark was its direct antithesis—the overglaze. It is interesting also to see how three different artists solved the problem of creating modern overglaze porcelain and its sculpture. Henning, imaginative, artistically great, with a cosmopolitan stimulus, conjures up romance by blending the cultures of East and West in beautiful, rather voluptuous figures; whereas Carl Martin Hansen takes his themes from the almost forgotten national dresses of men, women and children in the various parts of his native country; and A. Malinowski seeks the ideal of his art in white porcelain, only very discreetly and very slightly decorated with a little sepia and gold.

Biscuit, a peculiar material, was at one time, particularly towards the close of the 18th century, admired over the whole world, And then the taste for it died away, probably because the ceramic importance of the material was not sufficiently appreciated. Compare old Sèvres with modern Sèvres, old Wedgwood with modern Wedgwood, and the difference will be seen—and this difference is not due solely to age, for all porcelain changes slightly with age; it is presumably due to the failure to recognize the importance of the question of material. Even when biscuit was introduced in the reproduction of the works of Thorvaldsen, this recognition was lacking, and it was only after more than 20 years of research and experiment that the Royal Porcelain works in Denmark discovered a faintly cream-coloured biscuit—amber against the light—which artists, particularly Malinowski, have endeavoured to mould to their work.

Only three principal colours can be used on underglaze porcelain, blue, green and a reddish tone, and painters have therefore had recourse to overglaze technique where every colour is available, especially gold. However, after numerous experiments with white and grey porcelain, and with stoneware, etc., our artists have found in greyish crackled porcelain a background for painting that inspires them to break new ground. In this porcelain the artist works with vigour, and his decorations possess at the same time a sweetness, a charm, a freshness and a freedom made possible by the employment of this new material, and it is an interesting fact that to attain their effects the artists are not content with crackled porcelain; they wart the crackled large or small, square or round, according to the motifs they have created; and the potter knows how to satisfy these demands. A closer collaboration between technique and art scarcely exists.

Of late years unusual interest has been taken in celadon, that remarkable old Chinese porcelain which was discovered through iron having become mixed in the glaze, the effect being that the glaze became green when the porcelain was baked in a certain way. The material is not easy to work with; it requires its own artistic treatment, its own particular shapes, a very special glazing and a special glaze. The material gives opportunity for line effects, architectural effects and reliefs. Often it assumes a jade-like character and is in the closest harmony with the old Chinese culture.

Almost simultaneously with the renaissance of overglaze technique, work was started upon stoneware, a ceramic material that is between porcelain and faience. Porcelain is a siliceous, translucent material; stoneware is a siliceous, opaque material; faience is a porous material. It is interesting to see the strange and unexpected effects which appear gradually as one studies the material more and more. There are the coloured glazes, the fine surface aptly termed *peau* de *vierge* in France; Jais Nielsen's strong, turquoise-blue glazes, which make one think of the ceramic wonders of Persia and Samarcand, and Kyhn's splendid animals.

From the beginning of the 20th century the Copenhagen Faience works has endeavoured to create a modern style of faience of high artistic merit. It must be remembered that present-day faience is generally different from faiences which delighted the world in mediaeval times. The fine collections of Italian and French and Moorish faience all have tin glazes. These tin glazes are less used in modern faience; for technical reasons potters have turned to a lead glaze or a hydric borate glaze, and attention has principally been devoted to finding an artistic expression for a product of this kind. Here, too, the work is under the glaze where, in contrast to porcelain, one can employ the whole of the colour scale. The designs produced under the leadership of Joachim are gay and lively, rich and glowing, and characteristically Danish. The ground colour resembles that of English faience; but it will not be denied that the artistic treatment of faience in this modem material is much more difficult than tin faience and porcelain, because the glaze is a clearer and lighter glass than the glaze upon porcelain and tin faience, and it has required great trouble to obtain the proper harmony between body, colour and glaze. Joachim has attained great heights with this remarkable faience. The simplicity of decoration and colour, and the definite glaze shades are a constant source of pleasure.

There is in Denmark another very important pottery, Bing and Gröndahl's Porcelain works, which were established in 1853. The same desire which seized Philip Schou to ennoble the material on the basis of Danish artistic culture also animated Harald Bing, who was manager at that time. He engaged the artist, Peitro Krohn, whose finest work is, perhaps, the beautiful heron set, in which he has created something extremely decorative by means of a combination of underglaze and gold. In 1900, at the exhibition in Paris, it entered upon entirely new paths. Later on Bing and Gröndahl attached such artists to their establishment as Kai Nielsen, whose Venus seems to be a symbol of complete harmony between art and material. In 1925, at the exhibition at Paris, Jean Gauguin exhibited a number of works in stoneware with chamotte, in which he proved himself a very gifted artist. By various chemical means, he created peculiar and beautiful works which, in stoneware, may to some extent correspond to biscuit in porcelain. Jean Gauguin's latest works, in faience with tin glaze, demonstrate the fresh and bold imagination of the artist in a sculptural sense.

A beautiful and peculiar art which has arisen in Denmark is the manufacture of earthenware, particularly at Kähler's works at Nastved, where two generations have succeeded in showing novel and interesting results in refined glazed earthenware. The material itself is ordinary clay from the fields near the factory. The work lies in the baking, the painting and the glaze, in which much is done with lustres—the red copper lustres ranking higher, in some ways, than both Clément Massier's from Golfe de Juan and the Hungarian lustres from Fiinfkirchen. The factory has extended the colour range of these lustre glazes and has some grey lustres which, in the hands of the painter Tirslund, have attained the finest effects.

On the island of Bornholm there is a small factory Hjort's pottery. It is, perhaps, not very well known outside of Denmark, but Hjort's stoneware is of excellent quality, even though the output is limited. He turns out small vases and figures with coloured glazes, with a charm characteristic of his own touch. His glazes excel by their great thickness. And finally, we must not neglect to name the artist, Hansen-Jacobsen, who has dreamed of creating ceramic wonders and so often realized his dreams.

Sweden has worked on different lines. Whereas Denmark has, perhaps, devoted herself principally to the free ceramic art, Sweden has had a background for her ceramic development that might well be envied by other countries. Sweden has always possessed a great folk-art which has produced distinguished work, especially in her textile wares, her wood-carving and her iron. and this art has influenced the great factories, such as Gustafsberg, Rorstrand and Gafle, in their production of characteristic dinner-sets which are in the closest possible harmony with Swedish home-life. There is no doubt that this art is very desirable and peculiar to Sweden, and that the highest ceramic ideal lies in raising the artistic level of such dinner-sets, where the scope of the artist is so much more limited than in free art.

Norway, in the two factories, Porsgrund and Egernsund, the one porcelain and the other faience, has repeatedly been on the verge of creating something national and unique, but has unfortunately abandoned it uncompleted.

The factory, "Arabia," in Finland, has attempted to achieve the same end, but stern necessity has doubtless confined its production within the boundaries set by the economic life of the country. (F. Da.)

ENGLAND

English cream-coloured earthenware still retains much of the market it gained by its excellent quality in the latter part of the 18th century, and modern taste has reverted to slight graceful patterns not at all unlike those on Wedgwood's early "Queen's ware." Some noteworthy private decorators have contributed to this. Alfred and Louise Powell have painted some interesting designs on Wedgwood pottery, and latterly on wares of their own making. Dora Billington's fancifully decorated table-wares should also be mentioned here, amongst the work of a small group of people whose efforts, though slight in themselves, are significant as determining the styles eventually adopted by the manufacturers. Standing apart from all other "useful wares" are the charming and original things designed by John and Truda Adams and made by Carter, Stabler and Adams of Poole: a novel and pleasant half-glossy surface and distinctive clean colour are amongst their good qualities.

The decorative styles first inspired, late in the 19th century, by the Chinese *flambé* and other glazes have been continued by (amongst others) W. Moorcroft of Stoke-on-Trent, Doulton's of Burslem, IV. Howson Taylor (Ruskin Pottery, Smethwick), Bernard Moore and Pilkington's of Manchester. The last-named have continued their work in lustre-painting, and in 1928 introduced some very pleasant grey glazes, with effective slight designs in black by Gwladys Rodgers. The later work of the Martin brothers in salt-glazed stoneware showed a praiseworthy advance in simplicity. Doulton's Lambeth stoneware with coloured glazes has been used for statuary by Gilbert Bayes in a manner practised also with success by Mr. and Mrs. Harold Stabler. Perhaps the best and certainly the most promising work in glazed pottery-sculpture has been done by John Skeaping. Interesting figures on a smaller scale, inspired by 18th century china, have been made by Charles Vyse and Gwendolen Parnell.

Amongst the studio-potters, W. Staite Murray's genius has produced much work superficially resembling the early Chinese but highly personal in its low-toned glazes and austerely beautiful forms and decorations. Of equal importance is the fine work in stoneware of Bernard Leach, also inspired by Far Eastern models. The art of Reginald Wells is less simple and direct, stressing colour rather than form, but capable of charming effects. Amongst the other artist-potters, Frances Richards has produced some interesting glazes on stoneware and three other women, Nora Braden, K. Pleydell-Bouverie and Sylvia Fox-Strangways, deserve mention for original work. Mr. Leach and his pupil, Michael Cardew, have revived with success the interesting English slip-ware technique, but high-fired stoneware is likely to be the most fruitful medium in this branch of the potter's art. (W. B. Ho.)

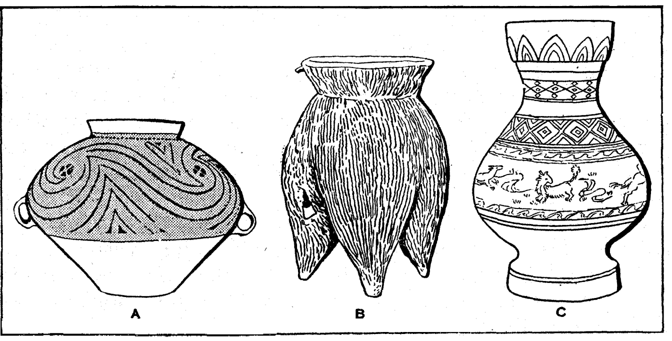
Other Countries.—There has been no important development in ceramics in countries other than those dealt with above. Neither Spain nor Italy has produced more than imitations of the oid Spanish-Mauresque and Italian styles; Czechoslovakia and Switzerland are endeavouring to produce a distinctive native pottery, but with no very remarkable results.

Bibliography.—R. Borrmann, *Moderne Keramik,* 1902; O. Pelka, *Keremik der Neuzeit,* 1924; René Jean, *Les Arts de la Terre,* 1911; Lucien Magne, *Décor de la Terre,* 1913; *L'Exposition Internat. des Arts Décoratifs,* 1925, ed. "Beaux Arts"; *L'Art Décoratif Français 1918–1925,* ed. A. Lévy; Arsène Alexandre, *Jean Carriès imagier et potier,* 1898; G Migeon, *Préface à l'Exposition de l'oeuvre céramique du potier E. Chaplet,* 1910; A. Hayden, *Chats on Royal Copenhagen Porcelain,* 1918; J. F. Blacker, XIX. *Century English Ceramic Art;* L. W. Rochowansky, *Wiener Keramik,* 1923; H. E. Van Gelder, *Ned. Pottenbakkerskunst,* 1927; Arthur Hayden, *Royal Copenhagen Porcelain,* 1911; Emil Hannover, *Pottery and Porcelain,* vols. ii. and iii., 1925 (ed. by Bernard Rackham); Gustaf Munthe, *Udstillingen i Goteborg, Svenska Slojsforeningens Tidsskrift,* 1927 (French translation in *La Renaissance,* Feb. 1, 1927); Gabriel Mourey, Art. in *Art et Décoration,* June 1, 1925; Victor P. Christensen, Arts. in *Connoisseur,* Nov. 1922, August 1923; Erik Wettergren, *The Modern Decorative Arts of Sweden* (1928).

NEAR AND FAR EAST

CHINA

The supreme excellence of Chinese pottery in mediaeval and later times gives an unusual zest to the enquiry into the first phases of Chinese ceramic history; and we welcome the new light recently shed on them by Prof. J. G. Andersson's discoveries in Honan and Kansu which reveal the existence of two distinct kinds of pottery in pre-dynastic times. The Andersson finds have been provisionally divided into six periods; and the earliest and, oddly enough, the most artistic of his pottery can hardly be later in time than 3000 B.C. It consists both of funerary wares and pottery for general use, made by hand (helped perhaps by a slow wheel) of



(A AND B) FROM ANDREWS, "MEMOIRS OF THE GEOLOGICAL SURVEY OF CHINA" (C) BY COURTESY OF THE BRITISH MUSEUM

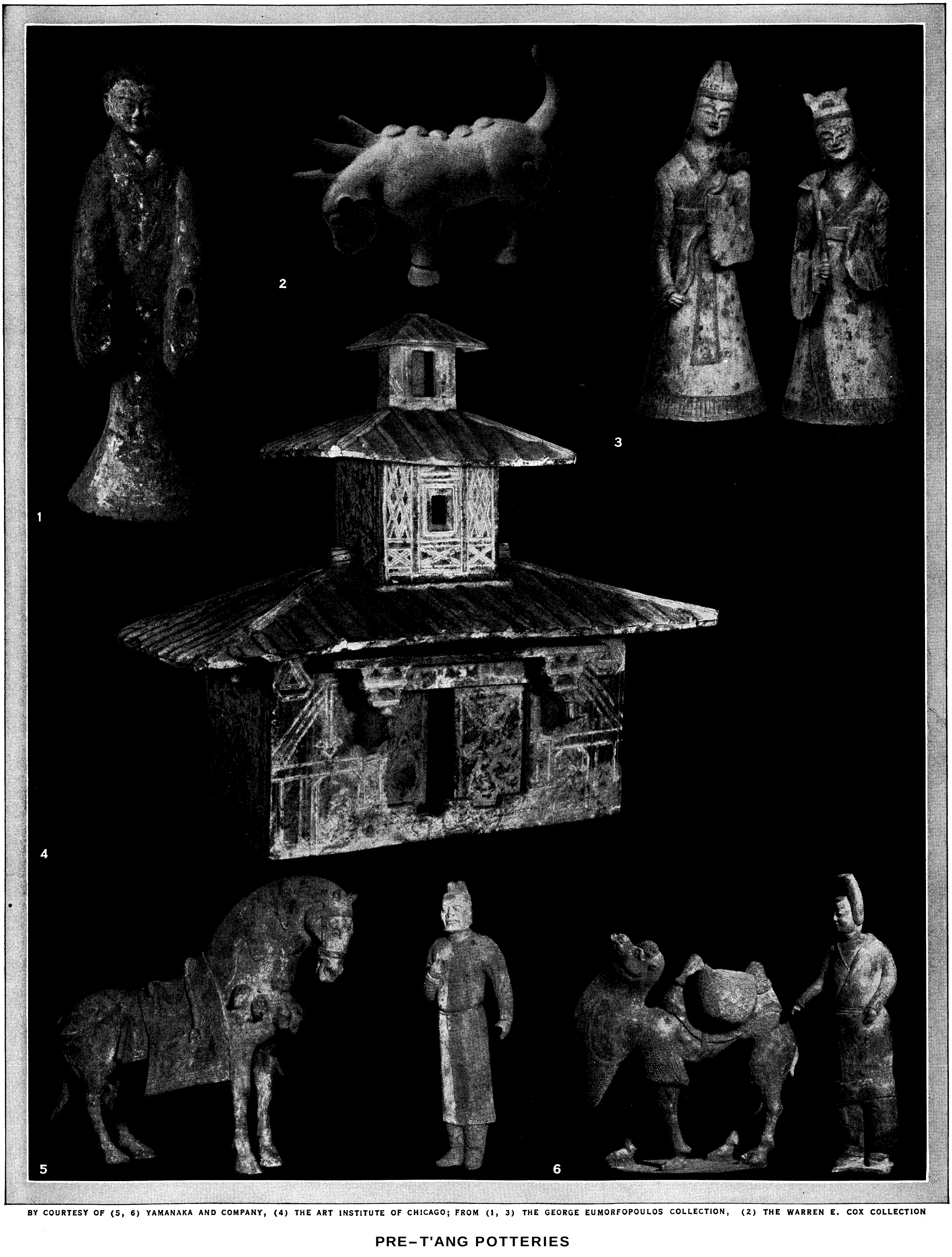
EARLY CHINESE POTTERY. (A) NEOLITHIC POTTERY FROM KANSU. (B) NEOLITHIC MAT-MARKED POTTERY FROM HONAN, (C) PAINTED POTTERY OF THE 4TH CENTURY B.C.

finely levigated, thin and strongly baked buff and red clays, shaped in pleasing, and often quite imposing, forms and decorated with elegant painted designs in red, black, purple and white clays which have been submitted to the fire of the kiln. This painted ware, which is superior in technique to any of the pre-Han pottery of dynastic times so far known, has interesting, if superficial, resemblances to the painted pottery found at Anau, Susa and other western Asiatic sites of late neolithic date.

Alongside this painted ware Andersson found another type of pottery, a coarser, grey earthenware made without the wheel and often impressed on the exterior with markings which suggest that

PORCELAIN OF THE SUNG PERIOD

1. Vase, Ju type, Sung period (A.D. 960–1279) or Yüan period (1280–1368). Height 7½″
2. Ewer, Ju type, Sung or Yüan period. Diameter 5¾″
3. Bulb-bowl, Lung-ch'üan celadon, Sung period, Diameter 11¼″



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PRE-T'ANG POTTERIES

1. Figure with long robe folded in front, spreading below to form a hollow base; holes for hands. Grey pottery with dressing of white slip and remains of pigment: hair painted black. Ht. 28.5". Six dynasties (A.D. 220-618). 2. Mythological animal resembling prehistoric triceratops, possibly suggested by discoveries of fossils in the Mongolian desert. 3. Figure of a lady, with double peaked cap, holding a lotus, with bird-shaped flower. Hard grey pottery, wash of white slip, pigmentation in red and black. Ht. 30.75". Companion figure, with crown-like head-dress. Ht. 33.75". Northern Wei (A.D. 386-636). 4. House with sliding doors. 5 and 6. Men with Bactrian horse and camel, animals introduced into China by the Mongols

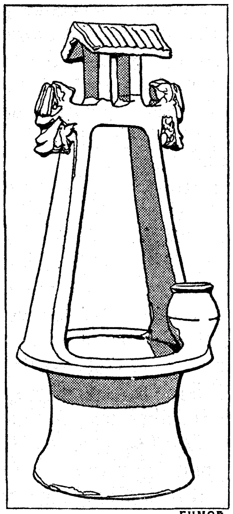
FROM THE COLLECTION OF POTTERY AND PORCELAIN PREPARED ESPECIALLY BY THE TOKYO IMPERIAL HOUSEHOLD MUSEUM

JAPANESE POTTERY

1. Square dish designed by Ogata Kenzan, one of the most famous potters of Japan, and painted by his brother, Ogata Korin (*c.* 1657–1716). Given to the Imperial Household Museum by the Dowager Empress Shoken
2. Water jar used in the tea ceremony (*q.v.*), by Nomura Ninsei, one of Japan's greatest ceramists. He worked chiefly at Awata in Kyoto and produced beautiful examples of jewelled faience. 17th century
3. Octagonal bowl by Sakrida Kakiemon, noted for his enamelled porcelain. Height, 13.6 cm. 17th century
4. Teapot used in *Sen-cha,* or steeped tea, by Aokj Mokubei, a celebrated Kiyomizu artist. 17th century
5. Incense case of Iga ware, used in the tea ceremony (*Chan-no-yu*). The incense often consists of small chips of wood or ground-up wood burnt in the charcoal fire which heats the water for making the tea

the wet clay had been wrapped in matting or some coarse textile. This mat-marked pottery evidently had a long life, for it was still made in Chou and Han times.

The next important discovery belongs to the Yin dynasty (1765–1122 B.C.). On the site of the Yin tombs near An-yang in Honan were found pieces of a white pottery, and of carved ivory and bone. The pottery, doubtless made of kaolinic earth, has been carved like the ivory and bone with the conventional designs and angular fret patterns which are usually associated with pre-Han bronzes. Complete vessels of this kind of carved white ware must have had a striking appearance, if indeed the fragments ever formed part of pottery vessels and were not, as has been suggested, moulds for the use of the bronze maker.



BY COURTESY OF GEORGE EUMORFOPOULOS, ESQ.

HAN WELL-JAR From the George Eumorfopoulos Collection

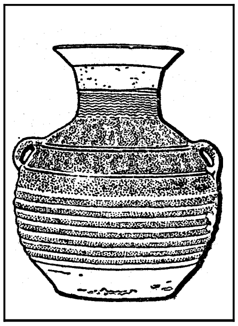
For the rest all the pre-Han pottery which we know is funeral ware of a rough and not very interesting type, and generally following the fornis of the more precious bronze vessels for which it was doubtless a substitute. It is frequently '.mat-marked," and much of it is roughly coloured with unfired pigments.

The Han Dynasty (206 B.C.–A.D. 220).—The Han pottery, though our knowledge of it is still confined to the funeral wares recovered from tombs, shows a considerable advance in ceramic technique. Many of the Han vessels, such as the wine vases, are of elegant form, and they are ornamented with artistic designs in a variety of ways, by painting with unfired pigments, by stamping. by the appiication of reliefs which have been separately formed in moulds, and by incising.

Glaze is now used, apparently for the first time, a transparent lead glaze of yellowish tone which is coloured green with copper oxide and variegated by the use of liquid clays or slips of different colours. The underlying body of the glazed ware is usually red and this showing through the transparent glaze gives a brown or reddish brown surface, when the glaze has not been coloured green by the use of copper.

Probably this lead glaze was introduced from western Asia, where it was in use in late Roman times; for the Chinese were in touch with the Roman empire in the Han dynasty.

Many of the pottery objects recovered from Han tombs are of deep archaeological interest, for they include, besides the household and ritual vessels, models of the buildings, implements, livestock and even human beings, which had belonged to the household of the deceased. Further it is noteworthy that the potters who supplied this funeral furniture evinced much artistic skill in the way in which they conventionalized their models. Thus the granary tower and the well-head are transformed into picturesque objects and even the model of the kitchen stove is not devoid of ornamental qualities.



BY COURTESY OF THE BRITISH MUSEUM

PROTO-PORCELAIN VASE (3RD OR 4TH CENTURY)

Han to T'ang (A.D. 220–618).—To the interval between Han and T'ang belongs a considerable group of figures and other beings. Animals are in many ways the most attractive of all the Chinese grave goods. Some of them are little later in date than the Ran dynasty; but they evidently range over a long period, for whole sets of figurines of this class in the Toronto museum are known to have been found in tombs of the Liang dynasty (A.D. 502–557).

There are, besides, wine jars, vases, incense burners and toilet boxes of the 3rd and 4th centuries which are finely painted in unfired pigments with a style and execution not unworthy of the paintings on silk. The Han lead glaze continued in use, and it is by no means easy to differentiate the glazed pottery of the Han and of the immediately succeeding periods. There are, however, certain flask-shaped bottles with green and brown lead glaze over well moulded reliefs which, though certainly post-Han, are probably earlier than the T'ang dynasty. Some of them are remarkable for their Western types of ornament, such as dancing and piping figures, which would be at home in a Herculaneum frieze, surrounded by vine scrolls. Similar designs are seen on late Hellenistic pottery; and this doubtless was the source from which the Chinese potters drew their inspiration.

There is yet another kind of glazed ware which belongs to this interval, and which is apparently of purely Chinese origin. It is a kaolinic stoneware of hard grey body with a high-fired glaze of greenish brown tint. Specimens of this ware analyzed by H. W. Nichols of Chicago were pronounced to be a kind of proto-porcelain. In other words they are believed to contain the elements of porcelain, though in an unperfected state. Dr. M. Nakao holds that the glaze of this ware is a wood-ash glaze evolved from the accidental gloss which often forms on pottery fired to a high temperature in a wood-fed furnace, as in the case of the Early Korean pottery (see p. 369). It is practically certain that this kaolinic pottery with its glaze of feldspar and wood ashes forms a stage in the evolution of true porcelain which we know the Chinese to have discovered by the T'ang dynasty. Indeed it is highly probable that porcelain was evolved from this material at some period in the interval between Han and T'ang. It may be added that the colour of the glaze was probably due to iron impurities in the clay, and that this glaze is the beginning of the celadon green glazes which owe their colour to iron.

The T'ang Dynasty (618–907).—In the great T'ang dynasty the Chinese empire reached its widest expansion, and China was without doubt the greatest and most civilized power in the world. It mas an age of splendour for all the arts, and the potter's art was in no way behind the rest. Oddly enough. Chinese ceramic literature has little to tell us of the T'ang potters. But Chinese ceramic literature is a comparatively modern growth and the secrets of T'ang pottery, only recently laid bare, were known in Europe almost as early as in China.

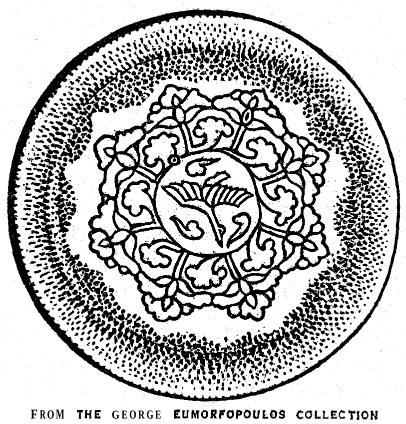
It was in fact largely due to the excavations msde by European railway engineers that the contents of many T'ang tombs came to light, and what we know of T'ang pottery, as in the case of the earlier wares, is practically limited to the sepulchral wares. Naturally these do not show the T'ang potters in the most favourable light, but they enable us to see the great progress which had been made in ceramic technique and to realize the artistic capabilities of T'ang craftsmen. They make it clear too that Western influences were active in China in this enlightened age, for we frequently find the traces of late Hellenistic, Sassanian and Persian art in the forms and designs of the pottery of this period.

FROM THE GEORGE EUMORFOPOULOS COLLECTION

FLASK OF BUFF STONEWARE WITH BROWN GLAZE, T'ANG PERIOD OR EARLIER

Of the T'ang funeral pottery the figures of human beings, birds and animals are modelled in a lively and spirited fashion, especially those of horses and camels, dancing girls and musicians. They are usually of a white or pinkish white clay. soft where lightly fired but some occasionally are baked to considerable hardness. Some of them are unglazed and tricked out with red, black and blue pigments. Others are covered aith a thin transparent lead glaze of faint yellowish tint, while on the more elabsrate this glaze is coloured nith washes, streaks or mottling of green, amber yellow or blue. The flesh parts of the glazed figures are commonly left without glaze, and in this case they are painted with the pigments mentioned above. Besides the figures, vases, ewers, bowls, cups and dishes of various kinds are found in the tombs; and among them are amphora-shaped jars of strikingly Hellenistic form and ewers of Sassanian type with a bird's head below the lip, a form common again in Persian pottery of a slightly later date.

The glazes used on the figures appear also on these vessels. sometimes in monochrome, more often in mottled colours, but they rarely cover the whole exterior of the vessel, stopping as a rule in a wavy line short of the base. The base of the T'ang vase is usually flat and shaved at the edge.

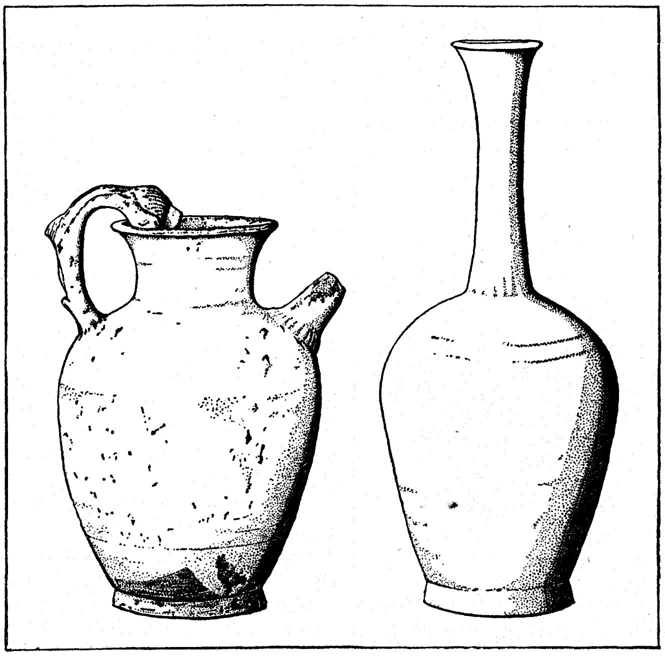


FROM THE GEORGE EUMORFOPOULOS COLLECTION
DISH OF THE T'ANG DYNASTY

The decoration of T'ang pottery is chiefly effected by moulding in relief, by applying reliefs which have been stamped out separately, by carving the surface or by incising it with a pointed instrument.

Painting with a brush was also used not only for the application of pigments on unglazed wares, but in rare instances for decorating in black under a green glaze.

The T'ang pottery so far discussed shows a considerable advance on its predecessors in the use of coloured lead glazes; but it is also apparent that great strides were now made with the harder, feldspathic glazes which were fired at a much higher temperature. The important excavations on the 9th century site of Samarra on the Tigris (*see* F. Sarre, *Die Keramik von Samarra,*



FROM THE GEORGE EUMORFOPOULOS COLLECTION
LEFT. PORCELAIN EWER WITH WHITE GLAZE. T'ANG PERIOD: RIGHT. WHITE PORCELAIN BOTTLE WITH UNGLAZED BASE. T'ANG PERIOD

1925, and also below under Persian pottery) revealed quite a number of fragments of porcellanous stoneware and even true porcelain of Chinese make. From them we gather that these advanced ceramic products were not only made, but had actually become articles of overseas trade in the T'ang dynasty. They include a semi-porcelain with closely crackled, yellowish white glaze or with green and mottled glazes, or again with the sea-green glaze which we distinguish by the name of celadon; besides pure porcelain with white or ivory glaze. Other high-fired T'ang glazes are a chocolate brown, verging on black, a watery green and a brown splashed with frothy grey.

But the progress of the T'ang potter is not to be measured by improved technique alone. The beauty of the vase-forms which he threw on the wheel places him in the front rank of potters, and his incised and moulded ornaments prove him to have been a true ceramic artist.

In the half century which intervened between the T'ang and Sung dynasties ceramic history records the manufacture of two interesting wares, both of which are still a puzzle to the student. One is the celebrated Ch'ai ware which was reputed to have been "thin as paper, resonant as a musical stone and blue as the sky seen between the clouds after rain." This was an imperial ware made for a few years only in the neighbourhood of K'ai-fêng Fu in Honan; and apparently no complete specimen of it remained above ground even in the 16th century. The traditional description of it suggests a kind of porcelain, and modern opinion holds that it probably belonged to the *ying ch'ing* class of ware which will be described presently. But this is only a theory and, it must be added, a theory which is by no means universally accepted.

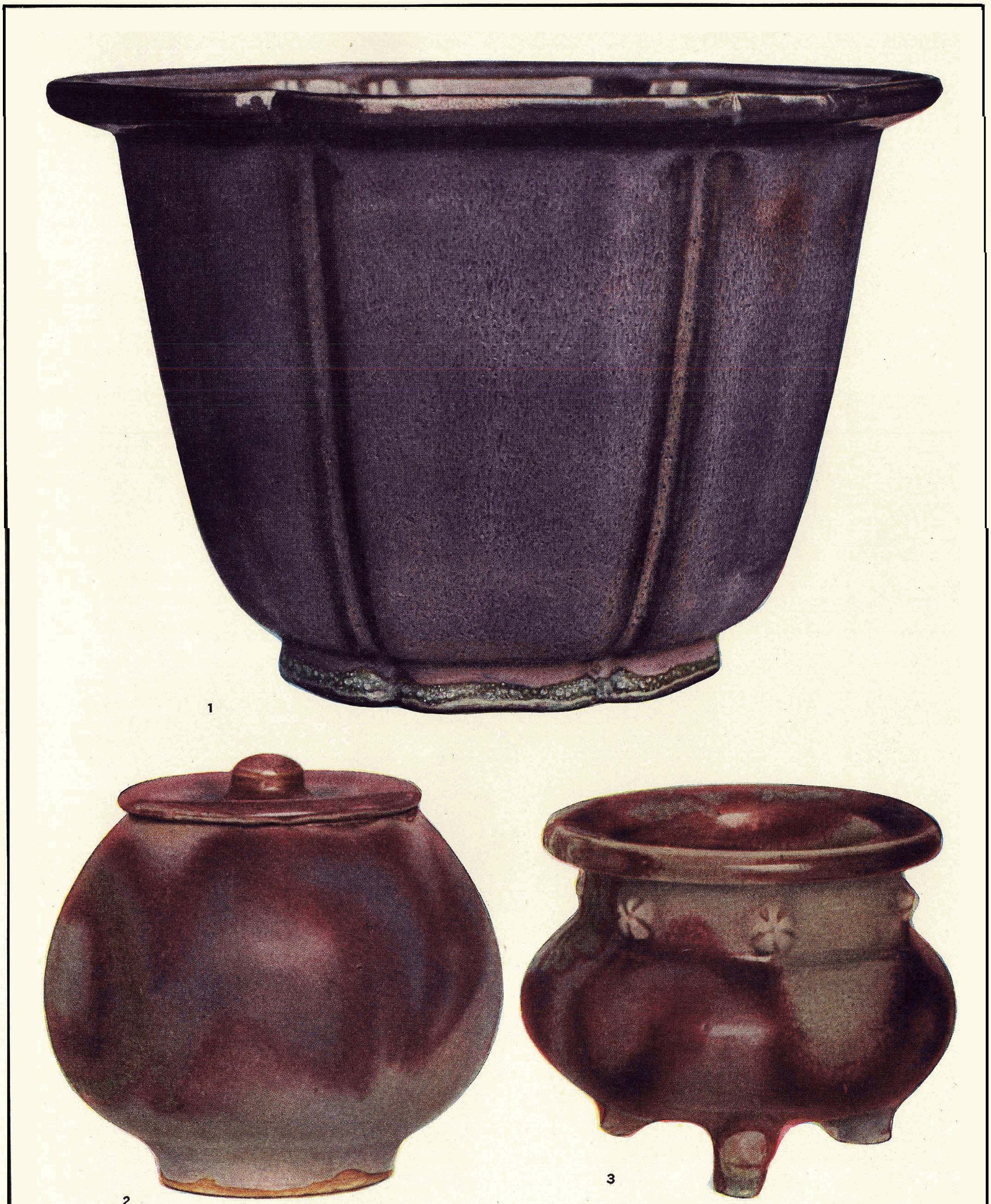
The other is the *pi sê* (secret colour) ware made at Yueh Chou, the modern Shao-hsing Fu in Chekiang, for the princely house of Chien. It is generally agreed that this was a porcelain or semi-porcelain with grey green glaze of the celadon type.

The Sung Dynasty (960–1279).—The Sung dynasty was another Augustan age of Chinese art, and ceramic writers in after years described the Sung porcelains in reverential terms as the classic wares of China. Collectors treasured them with loving care, so that not a few have survived above the ground and we are not dependent entirely on excavated funeral goods for our estimate of the Sung potter's skill. Something too is recorded of the history of the more noted Sung factories, and slender as is the information given it has enabled the modern student to attempt a reasoned, though not yet assured, classification of the principal types, namely the Ju, Kuan, Ko, Ting, Lung-ch'uan, Chun, Chien and Tz'ŭ Chou, with a few subsidiary wares in addition.

The Imperial Ju ware was made at Ju Chou, near K'ai-fêng Fu in Honan, for a brief period at the beginning of the 12th century; but we gather that it belongs to a type of ware which was made at several potteries, *e.g.,* in the districts of T'ang Têng and Yao on the north of the Yellow river—besides at Ju Chou itself. The Ju Chou ware, however, excelled the rest and doubtless the imperial works were manned by picked Ju Chou potters. The Chinese descriptions of the Imperial Ju ware, which was already extremely scarce in the 16th century, leave us in some doubt as to its exact nature, but the most plausible theory is that it was of the *ying ch'ing* type. The term *ying* ch'ing, which means misty blue or green (the colour word *ch'ing* connoting both blue and green), is applied by the Chinese to-day to a soft-looking, bubbly porcelain glaze, white in colour but with a faint tinge of blue or greenish blue which sometimes develops a definite blue tint.

This tinge of colour has been traced to the presence of a minute quantity of iron in the ware. The *ying* ch'ing porcelain is a relatively low-fired ware and the body has a somewhat granular texture. It varies much in quality, from a coarse material with impure, pearly grey glaze to an exquisite eggshrll porcelain thin and translucent and of a deliciously soft and melting quality. The best specimens are skilfully potted and of elegant shape, and the decoration, if any, is carved in low relief, incised with a fine point or pressed out in moulds. It is surmised that some of the finer *ying ch'ing* porcelain may have been made at the Imperial Ju Chou factory, while the rest comes from the numerous private factories working with more or less skill on the same lines. It must however be understood that the identification of this ware with the famous Ju porcelain is not yet proved.

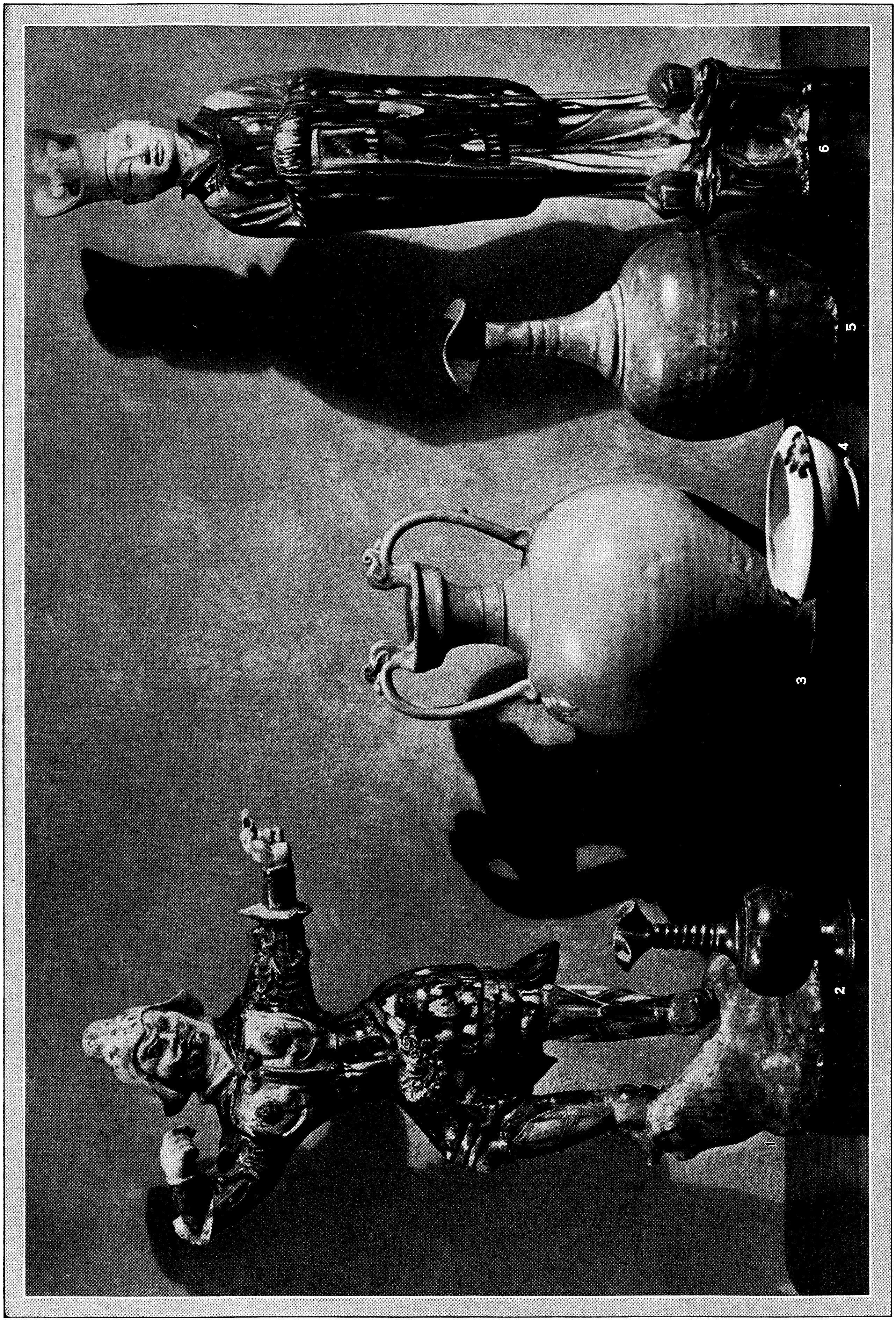
Another type which is still problematical is the Kuan. The name itself leaves room for various interpretations, and the description of it in Chinese works, like most Chinese descriptions, is full of ambiguities. Kuan means imperial, and Kuan ware may be nothing more than imperial ware of whatever kind. But Chinese writers evidently intended the Kuan wares of the Sung dynasty to be distinctive types. They describe first of all a Kuan ware



FROM THE GEORGE EUMORFOPOULOS COLLECTION

CHINESE PORCELAINS OF THE SUNG DYNASTY (A.D. 960–1279)

1. Flower pot, Chun ware, 7·4″ high
2. Water pot, Chun ware of Kuan type, 3·6″
3. Incense bowl, Chün ware of Kuan type, 3·2″ high



FROM THE WARREN E. COX COLLECTION

GROUP OF T'ANG GLAZED POTTERY INCLUDING TWO MORTUARY FIGURES

1. Mortuary figure representing the God of War
2. A "wood-grain" vase made of two coloured intermingled clays and covered with brown glaze
3. Pale green glazed vase showing Greek influence
4. Bulb bowl decorated with cream, yellow and brown glazes
5. Pitcher-like vase, suggested Near Eastern influences, covered with olive green glaze
6. Mortuary figure representing a court dignitary

made in the neighbourhood of the capital, K'ai-fêng Fu, for a short time before 1127, when the Sung court was driven south of the Yangtze by the Kin Tartars. The ideniification of this northern Kuan is extremely uncertain, though there are reasons for thinking that it had the opalescent, blue-grey type of glaze which was developed to its full on the Chün Chou ware (see p. 364). The southern Kuan, made after 1127 in the precincts of the imperial palace at Hang-chou, whither the Sung court had been transferred, so closely resembled the Ko ware, that many Chinese writers do not attempt to discriminate between the Ko and Kuan.

FROM THE GEORGE EUMORFOPOULOS COLLECTION

TZ'U CHOU VASE, YUAN DYNASTY

A band of lotus scroll with one of foliage below, ornaments this buff grey vase which has a black finish

The Ko ware is described in some detail in Chinese books. It got its name from the elder of two potter brothers Chang who lived in the Lung-ch'üan district in Chekiang in the Southern Sung period, being in fact the ware of the "elder brother" (*ko*). It is evident, however, that the term Ko ware was not confined to any individual's work, but passed into general use as a generic term for a group of wares made over a long period at various places. Like the Hang Chou Kuan, the Sung Ko ware was made of a dark-coloured clay (we are told by one writer that this clay was actually brought from Hang Chou to the Lung-ch'uan district), and for this reason it has a dark brown edge on the unglazed foot-rim and a brown mouth-rim where the glaze is thin enough to allow the body material to show through it. The glaze itself was crackled, sometimes in a wide network of cracks, sometimes in a close pattern of small crackle which was likened to fish roe. The crackle was further emphasized by staining it with red or black. The colours of the Ko glaze are described as *fên* ch'ing, *hui sê*, mi *sê* which may be rendered grey green, ash colour and millet colour or yellowish, and less intelligibly as tan *pai* which was probably something of the *ying ch'ing* colour.

Well accredited specimens in Western collections have a blackish body material which gives the traditional "brown mouth and iron foot," a thick opaque glaze, lustrous and fat, with crackle stained red or black, and of bluish grey, greenish grey or buff grey colours, which tally well with the Chinese descriptions. We read of Ko mare made in the Yuan and even the early Ming periods; and in later times the term Ko glaze was current for all the grey and buff crackled glazes which figure so largely in the Chinese potter's output.

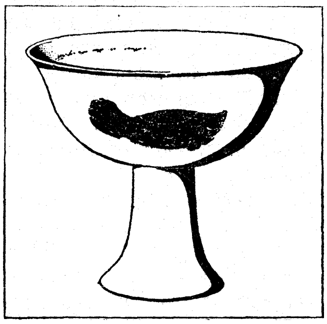
The crackle affected by the Chinese potter from the Sung dynasty onwards was deliberately sought by definite processes and was eventually got under perfect control, so that large or small crackle could be produced at will. It is unlikely that the earlier processes were very reliable, such as the plunging of the ware while still warm into cold water; but the Chinese eventually discovered that the mixing of a certain kind of stone (apparently pegmatite) with the glaze disturbed the relationship of body and glaze sufficiently to ensure crackle, and they learnt to prepare a crackle glaze which was applied in single, double or treble doses according to the size of the crackle desired.

Lung-ch'üan Celadon.—The Lung-ch'uan district in Chekiang, the home of the original Ko ware, had long been noted for a beautiful ware which is familiar to us under the name of celadon.

It is a porcelain or semi-porcelain of greyish white body with a thick translucent glaze varying from greyish and bluish green to sea-green and grass-green.

The most precious of the Lung-ch'iian celadons has a delicate bluish grey or greenish grey glaze over a finely potted porcelain body which is almost white. Such was the ware reputed to have been made by the younger Chang at the village of Liu-t'ien in the Southern Sung period; and collectors distinguish it by the Japanese name kinuta, after a famous vase in shape of a mallet (*kinuta*), which is preserved in a Japanese temple. Nothing could be more subtly beautiful than this soft, misty bluish grey porcelain.

It is not known how far back the industry of Lung-ch'iian dates; but the fragments of celadon found on the 9th century site of Samarra, in Mesopotamia, may well have been made there On the other hsnd we are told that the kilns were transferred to the neighbouring Ch'u-chou at the beginning of the Ming period and that they flourished there till the end of that dynasty. The output must have been large, and it formed from the earliest time an important item of Chinese export trade. Fragments of celadon are found in the ruins of ancient cities all over the Near East, and we know from actual records that celadon was imported into Egypt and carried thence along the Mediterranean coasts as far as Morocco. Fragments too have been found on the coastal sites of East Africa as far south as Zanzibar. India and the East Indies had their share of the trade, and a few pieces of celadon found their way even to western Europe in the middle ages. This justly celebrated ware, the export celadon, was a stoutly built greyish porcelain with a beautiful sea-green glaze of considerable thickness but transparent enough to allow the carved, moulded or incised designs to show through clearly.



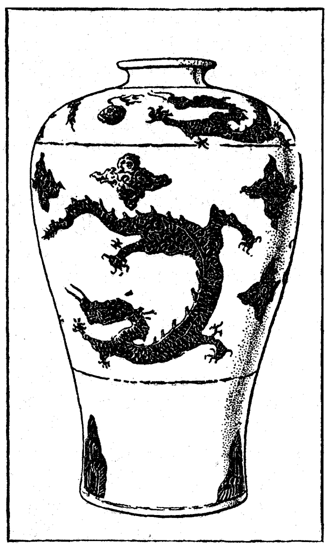
FROM THE GEORGE EUMORFOPOULOS COLLECTION

HSÜAN TÊ PORCELAIN STEM-CUP

One of the three crimson red fishes painted on the outside, is shown

Besides the carved and incised designs which are of great beauty, reliefs moulded or applied were effectively used. Sometimes these reliefs—floral medallions, fishes and even figure subjects—were left uncovered by the glaze, and in this case they invariably took on a red or reddish brown colour as a result of exposure to the fire in the kiln.

This browning, caused by the presence of iron in the clay, is in all parts of the ware which were unprotected by the glaze, such as the base-rims and the large unglazed ring which is often seen on the bottoms of dishes. It was thought at one time that the presence of this ring was a sign of Ming origin, but it is very doubtful if this rule holds good; and the distinction between Ming, Yuan and Sung celadons, no easy matter, must depend on an appreciation of style and finish. Much help in this delicate task of connoisseurship can be obtained from a study of the other Sung wares, especially the Ting porcelain (see below) with its carved and engraved floral designs which closely resemble those used on the celadons. In the hands of the Sung artists these designs had a freshness and spontaneity which is dulled by repetition on the Ming wares. A special type of celadon is variegated by patches of reddish brown derived from iron. This is known as "spotted celadon," the *tobi seiji* of the Japanese.



BY COURTESY OF THE BRITISH MUSEUM

PORCELAIN VASE WITH DRAGONS

Other Celadons.—Though the industry in Chekiang is said to have died out in the 17th century, it was not to be expected that such a beautiful glaze as the sea-green celadon would be allowed to disappear. It was in fact made with slight variations in many other pottery centres. At Ching-tê Chên it was used over the white porcelain body for which that place is noted, and the Ching-tê Chên celadons have the ordinary white glaze, and sometimes a reign-mark in blue, on their bases. A celadon glaze was used on the Kwangtung stoneware; and there are many specimens with glaze of celadon type but so different in body from the typical Chekiang ware that we must perforce look to some other centre ior their origin. If we consult the Chinese books we get little help in this quest. It is true that they speak of a certain T'ung ware, made near K'ai-fêng Fu in Honan, as if it were of the celadon class. Rut the identification of the T'ung is quite conjectmal. In the absence of definite indications, we have adopted the term "northern celadon" for one large and important group. It comprises bowls, small dishes, vases, incense burners, etc. with a dry buff grey stoneware body and an olive green celadon glaze. The decoration is carved, incised or moulded, often with much skill and taste; and it closely resembles that of the *ying ch'ing,* or Ju type of porcelain, a fact which suggests a Honan origin for the ware.

This northern origin, however, is not accepted by all authorities. Dr. Nakao, for instance, holds that it is only a variety of the Chekiang celadons, in spite of the very obvious difference between it and the usual Lung-ch'üan types, and he is probably right in supposing that the art of celadon manufacture was introduced into southern Korea from Chekiang, the most accessible Chinese ceramic centre. And it must be admitted that the resemblance between the so-called northern celadon and the Korean (see p. 369) is remarkably close.

A stoneware of celadon type but with a pale and watery glaze was made at Sawankhalok in Siam as early as the 14th century; and in more recent times good celadon wares, scarcely distinguishable from the Lung-ch'iian, have been made in several parts of Japan. And it may be added that the imported celadon wares were freely imitated in Persia and Egypt; but these imitations, made with the soft Near-Eastern pottery, are easily recognizable for what they are.

Ting Ware.—Another of the classic Sung types is the ivory white porcelain made at Ting Chou in southern Chihli. It is a singularly pure and beautiful ware with a flour-white body, slightly translucent, and a glaze of cream or ivory tint, which, however, tends to run in tears or drops on the outside of the bowls and dishes. A peculiarity of the ware, which it shares with the *ying ch'ing,* or Ju type, is that the mouth-rims of bowls and dishes are often unglazed while the base is covered with glaze, thus reversing the usual conditions. The rough rims of such vessels are generally concealed by a band of silver or copper. The Ting ware was exquisitely decorated with carved or incised designs, largely floral, and in some cases, especially in the later periods, the more mechanical method of pressing out the designs in moulds was used with good effect.

Besides the fine ivory white Ting ware there are several varieties. One is known as t'u (earthy) Ting because it has a more opaque and earthy-looking body. This kind has a soft, cream white glaze which is usually covered uith faint crackle. Chinese writers also speak of Ting wares with black, red and brown or purple glazes. The two first are probably glazes of the Honan *temmoku* type (see p. 365); but the purple Ting has so far eluded recognition. There is also mention of a painted Ting ware, which must have resembled the painted stoneware of Tz'ŭ Chou (see p. 365).

The beauty of the white Ting porcelain encouraged, while its simplicity abetted, numerous imitations, some of which are admitted by Chinese writers to be practically indistinguishable from the original. There was, for instance, the Southern Ting, made by Ting Chou potters who moved south with the Sung court in 1127 and who seem to have settled in the neighbourhood of Ching-tê Chên. Then there were the famous imitations made by P'êng Chün-pao at Ho Chou in Shansi; and the Ssŭ Chou and Su Chou wares of Anhwei which were bought for Ting ware in the Sung dynasty "by persons who liked a bargain." There are the white wares of Hsiian Chou, and those made at the "white earth village" near Hsiao Hsien in northern Kiangsu. There were the cream white wares made at Tz'ŭ Chou which were regarded as equal to Ting; and we know of a singularly pleasing stoneware with grey or light buff body covered with a wash of white slip and a beautiful waxen white glaze closely crackled and recalling the finer *t'u* Ting wares. Much of this ware has been excavated on the site of the submerged town of Kuluhsien (destroyed by flood in 1108); and many of the specimens have been made additionally attractive by pinkish grey stains acquired during burial.

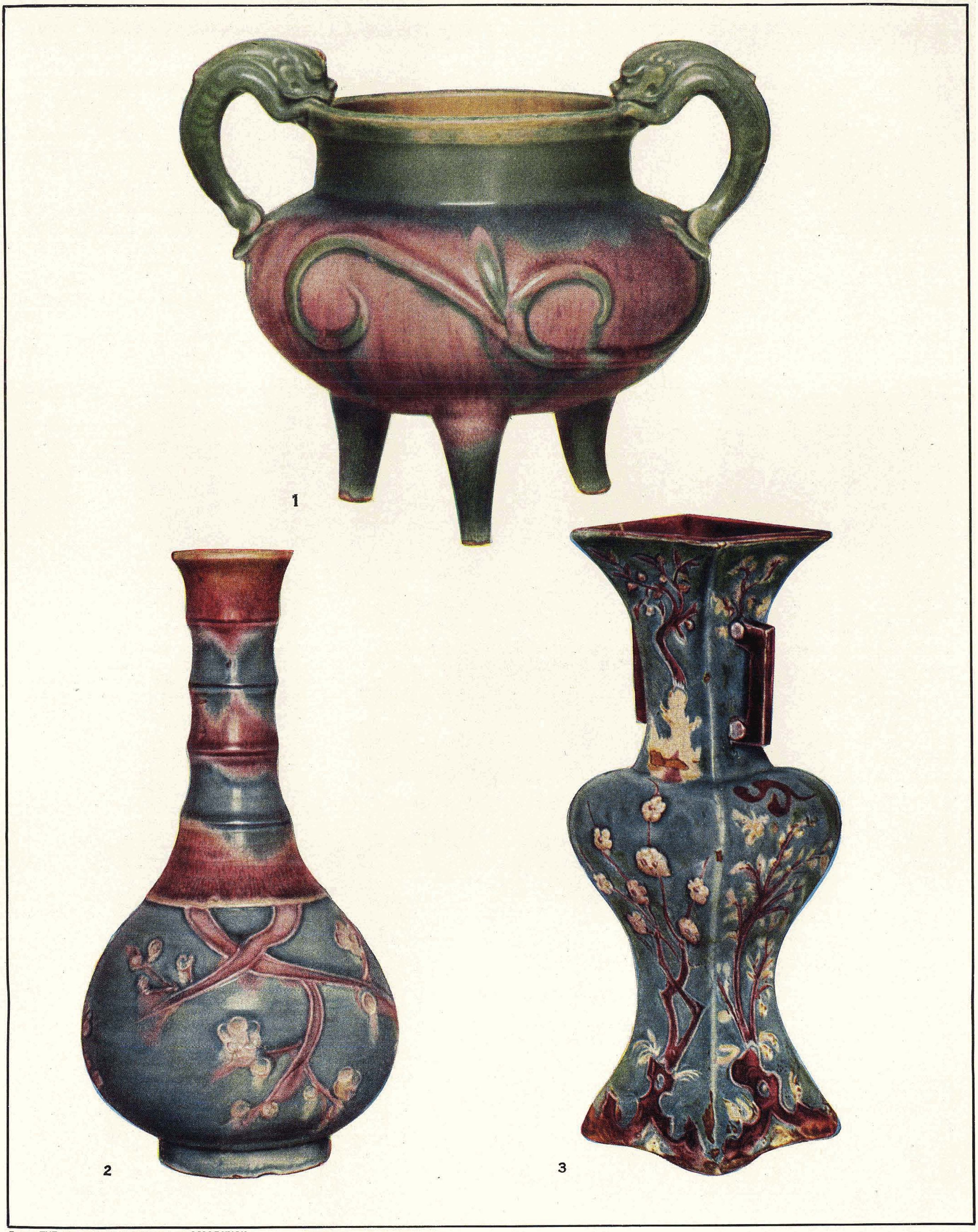
The Ting Chou factories themselves, though their fame died down after the Sung period, continued in operation, and Ting ware is mentioned in court records as late as the middle of the 16th century. About this time too a celebrated potter at Ching-tê Chên, Chou Tan-ch'iian, made himself a name by his wonderful imitations of Sung Ting vessels; and we gather that he had many followers who kept up the traditions of his work at Ching-tê Chên long after his death.

Chun Ware.—Yet another celebrated ware was the Chun, which was made at Chun Chou in the K'ai-fêng Fu district of Honan. It was in fact, like the white Ting and the green celadon, one of key wares of the Sung dynasty. According to Dr. Nakao it is the type of ware which would naturally result from the firing of a kaolinic body and feldspathic glaze coloured by copper in the oxidizing flame of the typical round kiln of northern China.

The finer Chün wares have a grey porcellanous body and a thick opalescent glaze full of bubbles and minute pin-holes (caused by the bursting of bubbles), and displaying a wonderful variety of colours which are due in part to the protean changes of copper oxide in an oxidizing flame, in part to a trace of iron which is present in the body material, and in part to the play of light in a highly opalescent glaze. Copper under the conditions prevailing in the Chun Chou kilns was capable of producing a range of colour from blue to blood red, and the Chün glazes display endless combinations of these colours suffusing a basically grey glaze. Thus we have in the extremes an even lavender grey and an almost uniform purplish red, and between these a variety of splashed, streaked and mottled effects of blue, grey, purple and crushed strawberry red. Again the interior of shallow dishes is often frosted over with an opaque, greenish grey; and the Chün glaze is apt to break into irregular V-shaped lines known as earthworm marks, which the Chinese connoisseurs regard as a sign of genuine Sung make. The Chun ware is strong and heavy, and the finer specimens consist mainly of flow-er-pots and shallow bowls which could serve as stands for the flower-pots or alternatively as bulb-bowls. This class of Chun ware has a wash of brown glaze on the base and a ring of "spur" marks formed by the pointed stilts on which the vessel rested in the kiln. It is moreover usually incised with a series number which ranges from one to ten and apparently indicates the size. No. 1 being the largest. An "outsize" is indicated by addition of the character *ta* which means *large.*

It is known that the Chün factories continued active through the Sung and Yuan dynasties and as late as the 16th century. In fact we are not informed when their activity ended. Consequently there is much difficulty in distinguishing the Sung and later Chun wares: and the tendency is to call the finer specimens Sung and the coarser Yüan, too little regard being paid to the fact that much of the ware must be as late as Ming. All that can be said for certain is that the heyday of the Chün factories was in the Sung and that their reputation faded after the Yuan dynasty.

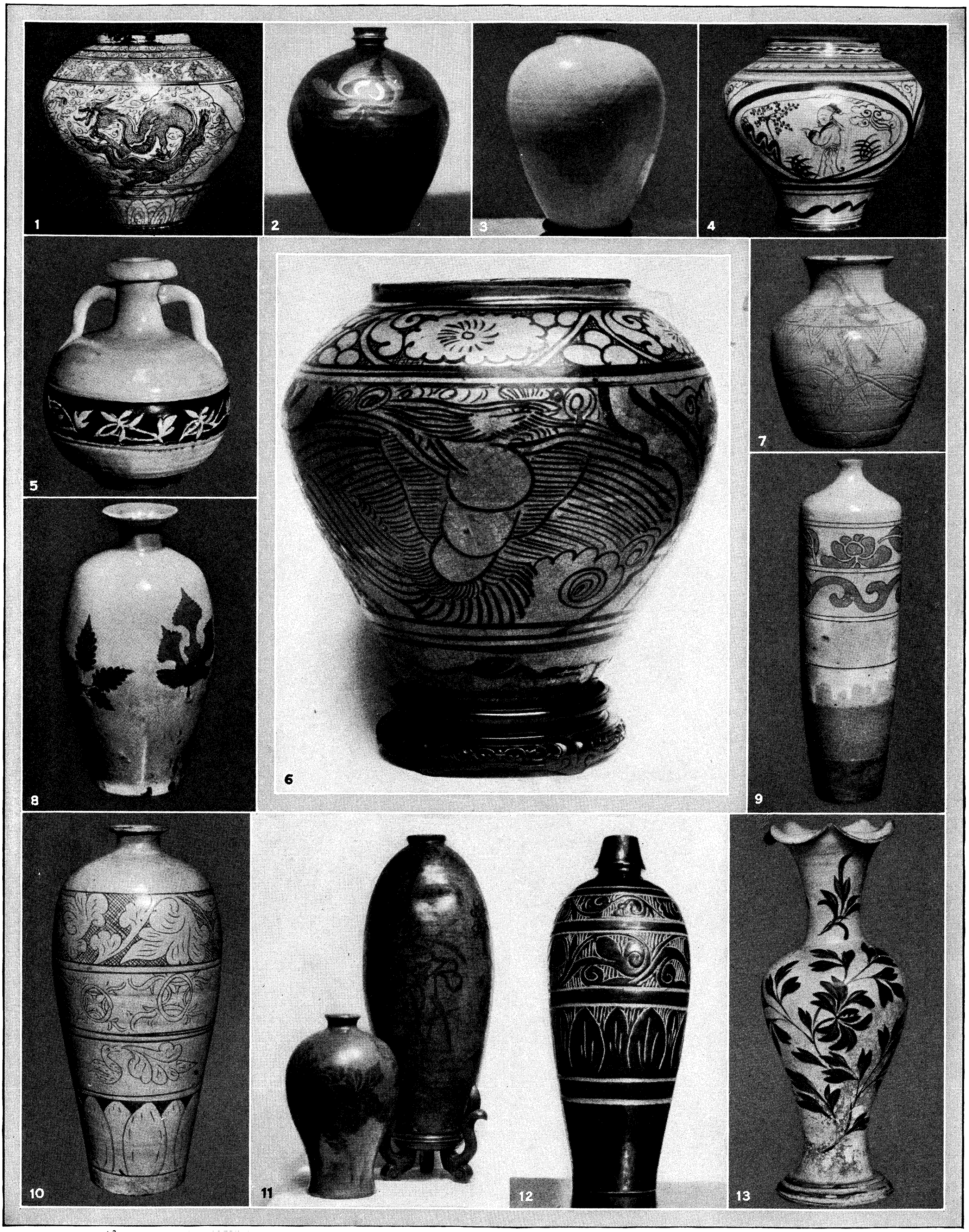
There is a peculiarly beautiful group of wares which belong to the Chün class, and, if fineness is a criterion, also to the Sung period. They have the grey porcellanous body of the numbered Chun wares, and an opalescent glaze which is, however, thinner and smoother than the usual Chün glaze. Its colour is lavender grey, but it is richly suffused, or splashed, with a lovely plum purple and this purple sometimes dominates the whole surface. The glaze flows more or less evenly down to the edge of the base-rims and it usually reappears on a small patch on the base. Sometimes the purple splashes on this ware are symmetrically disposed and even deliberately designed to suggest the forms of fishes, birds, animals or fruits, showing clearly that these patches, though doubtless at first accidental, were later brought under control. To what factory does this group belong? Is it inerely a variety of the Chün Chou ware or is it something else? One of



FROM THE GEORGE EUMORFOPOULOS COLLECTION

MING THREE-COLOUR ENAMEL WARE

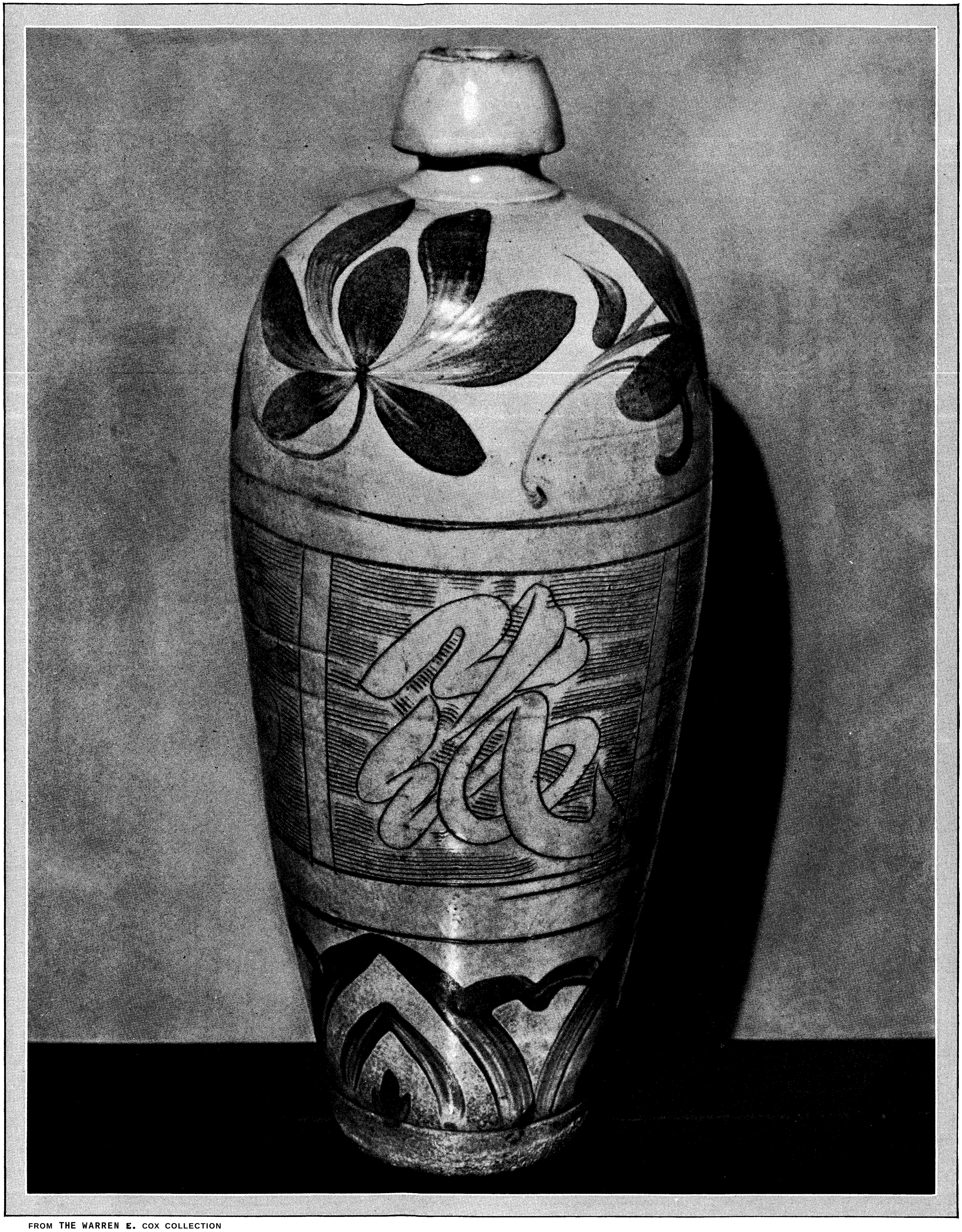
1. Incense bowl with low relief decoration. Height 7"
2. Bottle-shaped vase with usual ridges on outlines of design to keep colours from running in firing. Height 10.75"
3. Vase from bronze form. Height 13.7"



BY COURTESY OF (2, 6) THE FREER GALLERY OF ART, (5) OTTO FUKUSHIMA; FROM (1, 3, 4, 7, 8-11) THE WARREN E. COX COLLECTION, (12, 13) THE GEORGE EUMORFOPOULOS COLLECTION

VASES OF THE SUNG DYNASTY (960–1279)

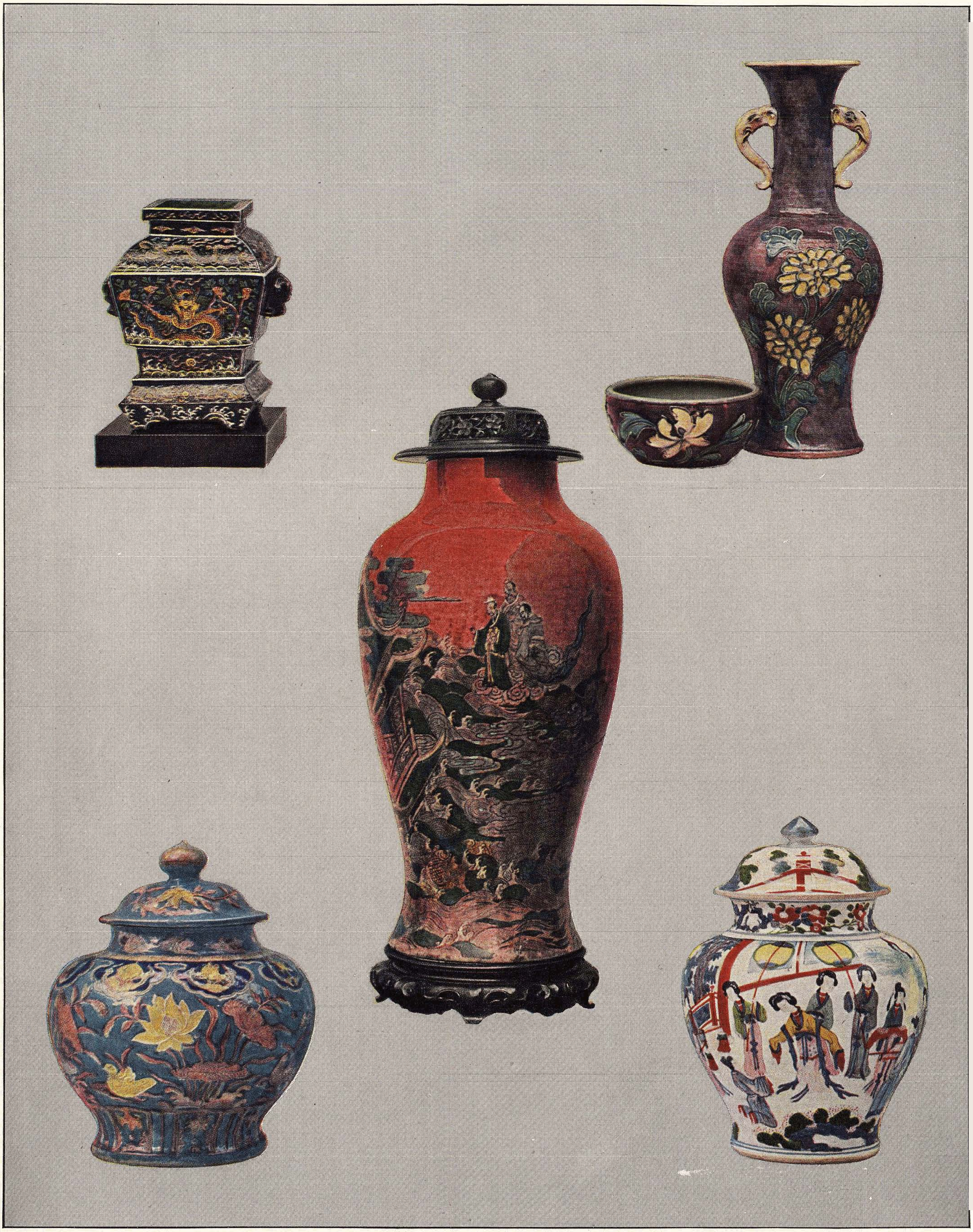
1, 4, 13. Show vigorous painted designs in brown on cream slip and glaze
2. "Ternrnoku" type (see Plate XL.)
3. Pure, perfect vase form covered with cream coloured slip and glaze
5. Low relief decoration with background in brown "Temrnoku" glaze
6, 11. Vases decorated with painting in brown and covered with blue glaze
7, 8, 9, 10. Vases decorated with incised slip and glaze
12. Vase decorated with incised brown or "Temrnoku" glaze



FROM THE WARREN E. COX COLLECTION

TZ'Ŭ CHOW VASE. SUNG DYNASTY (960–1279)

The remarkable painting of the lotus—each petal of which is executed with a single vigorous brush stroke—and with strong quality of the incised characters, meaning "snow," "moon," "wind," "flower," make this an outstanding specimen of its type



CENTRE VASE—WARREN E. COX COLLECTION; OTHERS—THE METROPOLITAN MUSEUM OF ART, NEW YORK

CHINESE POTTERY AND PORCELAIN, MING DYNASTY (1368–1644)

Upper left: Black rectangular vase bearing Wan Li mark (1573–1619) decorated with enamels. *Upper right:* three-colour vase and bowl with aubergine ground; 16th–17th century. *Centre:* Large deep peach-bloom glazed vase decorated with enamels and bearing Hsüan Tê mark (1426–35). *Lower left:* Three-coiour jar and cover with turquoise ground; 15th century. *Lower right:* Five-colour jar and cover; 16th century the descriptions given of the Northern Kuan ware suggests that it may belong to that obscure category; and some collectors distinguish it as Chün ware of Kuan type.

It is evident that many kilns were at work on the Chün type of ware, and probably in other districts besides Chun Chou, but we have little or no information on this point. We do, however, know that the Chun wares had many imitators. Good copies were made at Ching-tê Chên, probably as early as the Ming dynasty, certainly in the Yung Chêng period of the Ch'ing dynasty (1723–35); but there is little difficulty in distinguishing these later copies which have a white porcelain body and sometimes even a reign-mark. Other imitations made elsewhere can also be detected by variations of the body material and peculiarities of the glaze. Such are the Fatshan Chun ware made at the famous stoneware factories at Shekwan near Fatshan, in Kwangtung (*q.v.*), in Ming and later times; and the Yi-hsing Chüns which were made at Yi-hsing near the Great Lake in Kiangsu, the home of the red stoneware tea-pots. The Yi-hsing imitations have a buff or red stoneware body and a thick opalescent glaze of lavender turquoise colour with or without obviously artificial splashes of purple and crimson. While easily distinguished from the real Chün wares, they are often mistaken for another type which remains to be considered. This is the "soft Chun" (also called *ma chün* by Chinese traders), an attractive ware with light buff body and a beautiful, opaque turquoise or lavender blue glaze closely crackled and suffused here and there with purple or crimson splashes. Where it was made and when are by no means certain; but the shapes of the ware suggest in some cases the Sung and in others the Ming period, and the glaze is of the northern type. A degenerate descendant of this soft Chun is still made at Yu Chou which is the modern name of Chun Chou, and probably this was the original home of the ware.

Chien Wares.—Another large and widely distributed group of stoneware is commonly called, for want of a better general term, by the Japanese name *temmoku.* This name was first given to the black tea bowls for which Chien-an and afterwards Chien-yang, in Fukien, were noted in the Sung dynasty and even earlier. They are made of a blackish stoneware with a thick treacly glaze of purplish black shot with brown lines like hare's fur or mottled with brown like the breast feathers of a partridge. Their glaze stops in a thick irregular welt short of the base outside and forms in a deep pool on the bottom inside. The "hare's-fur or partridge" cups were commonly preferred for use in the tea-testing competitions, as their thick structure made the cup cool to handle and their dark glaze showed up the least trace of the green tea dust. In Japan they have always been fashionable in the tea ceremonies. The Chien glaze owes its colour to iron, which under varying conditions produces a reddish brown as well as a black colour. Indeed the brown and black seem to be always struggling for the mastery in the Chien glaze. Sometimes the brown completely dominates the black: sometimes it only emerges in streaks and spots, and sometimes again these spots are crystalline and have a silvery sheen.

The black ferruginous glaze is by no means confined to the Fukien factories. It was, and still is, made in many parts of China, chiefly in the north; and one of the northern wares which has this black and brown glaze over a whitish stoneware body is known to collectors as Honan *temmoku.* The northern black glazes are often of a peculiarly rich and luscious quality, and sometimes they are boldly flecked with lustrous brown and even painted with sketchy designs of flowers and birds in the same brown. On rare specimens the glaze is strewn more or less regularly with silvery crystals, the "oil spots" so greatly prized by the Japanese; while on others it comes out a uniform reddish brown, the *kaki temmoku* of the Japanese. Another ware which is commonly grouped with the *temmoku* is that believed to have been found on the site of the old Sung potteries at Yung-ho Chên near Ch'i-an Fu, in Kiangsi. In this case the body is a buff stoneware and the glaze is a rather thin blackish brown which flows evenly to the base and is often mottled with golden brown in tortoise-shell fashion or streaked and dappled with frothy grey. A further feature is painted ornament—prunus blossoms and sprays, birds, butterflies, inscribed medallions and symmetrical designs—in dull golden brown in the black or dappled glaze.

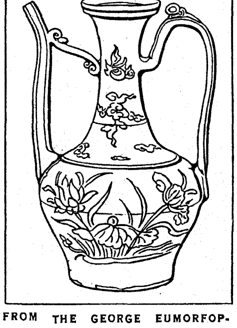
Tz'u Chou.—The last important group of Sung wares takes its name from the great pottery centre Tz'ŭ Chou, once in Honan and now in the south-west corner of Chihli. The Tz'ŭ Chou ware is a grey or buff-grey stoneware, which is usually coated with white slip and covered with creamy glaze. The plain cream white Tz'ii Chou stoneware has been mentioned among the Ting types, but the ware is more usually decorated with painted or incised designs.

The painted designs, floral or otherwise, are laid on with a bold brush in black or brown slip, sometimes supplemented by an ochreous red under the cream glaze. Painting in enamels—green, yellow and red—over the glaze was also used, occasionally in the Sung period and frequently in later times. The incised, or *graj'iato,* Tz'ii Chou ware has many varieties. Simple incised designs are comparatively scarce, the more usual practice being to coat the vessel nith white or brown slip which was then scraped away so as to leave the design slightly relieved in white or brown against a buff-grey body. A coating of transparent cream glaze over this produced cream white design on a mouse grey ground, if the slip was white. Where brown was used the slip usually contained the glazing material and the design appeared in brown or black glaze against an unglazed ground. Both of these *graj'iato* types have great decorative value. The black and brown painted Tz'ii Chou is the commonest type and its merits vary with the quality of the drawing.

The Tz'ŭ Chou potteries have a history which can be traced from the 6th century to the present clay, and there will always be room for debate as to the age of particular specimens. Further, most of the Tz'fi Chou types were made at other potteries scattered over northern China, and doubtless much that we call Tz'ii Chou really belongs to other potteries which worked on similar lines. This will explain variations in the body material of wares of the Tz'fi Chou type, and why a red body, quite unlike the original buff grey, is found on some of the most beautiful members of the group, such as the vases with black painted and *graffiato* designs under transparent green glaze or with black painted designs under a lovely peacock blue.

The potters who made these choice objects must have been among the foremost of their craft, but, though they used the Tz'fi Chou methods, their wares differ fundamentally from what we know as Tz'fi Chou.

Chinese ceramic records name several other Sung potteries in various parts of China, but they are hardly more than names to us and we know little or nothing of their productions. Practically all the Sung wares which we know, however, are comprised in the types already described. The forms, except where they were moulded after those of old bronzes, are simple and elegant, such as come naturally from the hands of a gifted "thrower" on the potter's wheel. The character of the classic Sung wares may be summed up in two words, simplicity and refinement.



FROM THE GEORGE EUMORFOPOULOS COLLECTION
MING EWER (1368–1644); INCISED DECORATION AND TURQUOISE GLAZE

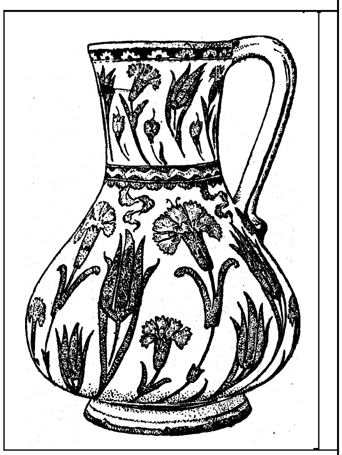
For the purpose of this brief sketch the Yuan dynasty (1280–1368) may be regarded as a continuation of the Sung. The Mongol conquerors had nothing to bring into the stock in trade of the Chinese potter except a taste for certain Western forms and designs acquired in the other extreme of their transcontinental empire. Further we are told that they were hard task-masters and that the ceramic industry, in common with many others, especially the more artistic crafts, lost ground under their unsympathetic rule.

The Ming Dynasty **(1368–1644).**—In 1368 the Yüan was replaced by the native dynasty of the Ming. which ruled China till 1644; and, when the country had recovered from the interdynastic struggles, the ceramic art took a new lease of life, though under somewhat changed conditions. The Sung monochrome wares, the celadons, Chun wares, etc., went out of favour and the old factories sank into obscurity, while the fame and importance of the great porcelain town of Ching-tê Chên, near the Po-yang lake in Kiangsi, overshadowed all the rest. The first Ming emperors had their capital in Nanking and the proximity of Ching-tê Chên to the seat of government doubtless helped its development. At any rate from this time onwards the fine white porcelain of Ching-tê Chên was in general demand and the imperial factory there was rebuilt and reorganized to keep the court supplied with it; and Chinese ceramic writers thenceforward speak of Ching-tê Chên and little else.

The neighbourhood of Ching-tê Chên had long been noted for its excellent ceramic wares. It was ordered to supply goods to the court as early as the 6th century, and it received its present name in the Ching TC period of the Sung dynasty (1004–07). All that the industry required in the way of material was lavishly supplied by the neighbouring hills, kaolin (china clay) for the body of the porcelain and *petuntse* (china stone) to mix with it and to form the glaze, wood ashes to soften the glaze, and cobaltiferous ore of manganese to make the blue for the underglaze painting and the blue glazes. The staple product of Ching-tê Chên is the fine white porcelain which has made China a household word throughout the world; and as this ware lent itself peculiarly well to painted decoration, the vogue for painted porcelain rapidly replaced the old Sung taste for monochromes. They fall into three chief groups, namely blue and white, enamelled wares and three-colour glazed wares, all of which are essentially pictorial in their decoration.

Blue and White.—The beautiful cobalt blue is one of the few ceramic colours which will stand the high temperature required to melt the porcelain glaze, and which consequently can be used under the glaze. Thus the blue colour, painted on the body of the ware and covered with a transparent sheet of glaze, gives a perfectly protected picture which will last as long as the porcelain itself. The idea of painting porcelain in this fashion was not new in the Ming dynasty. It was known to the Sung potters, but it was only in the Ming dynasty that blue and white became fashionable. Nor is the idea necessarily of Chinese origin, for blue painting was certainly known to the Near-Eastem potters as early as the 9th century, and we have as yet no indication of its use in China at so early a date. In the Ming dynasty, however, the Ching-tê Chên potters made it specially their own, and their blue and white was not only supplied in large quantities to the imperial court but was exported all over the eastern hemisphere.

During certain reigns—Hsuan Tê (1426–35), Chêng Tê (1506–21) and Chia Ching (1522–66)—the native supplies of cobalt blue were supplemented by a superior blue imported from the Near East and known as Mohammedan blue. This imported material was scarce and costly and was at first reserved for the imperial factory, and even so it was usually diluted with the common native cobalt. Later on supplies of it found their way into the hands of the private manufacturers. According to Chinese accounts it varied much in tone, but the kind best known to us is the Mohammedan blue of the Chia Ching period which is a dark violet blue of great strength and intensity. In general the Ming blue is painted in one of two ways, either in finely pencilled line drawing or in strongly outlined designs filled in with flat washes. The better class of Ming porcelain, made for imperial and native use, was potted thin and finely shaped; and this is now rare and only to be acquired from Chinese collections. But there is a commoner class which was more strongly and roughly fashioned to meet the exigencies of the export trade, and this has been found in considerable quantities in India, the East Indies, Persia, Egypt and even in Europe. But all the Ming blue and white, whether made for home or foreign consumption, is distinguished by a freshness and freedom of design which make the commonest specimen a desirable possession.



BY COURTESY OF THE BRITISH MUSEUM
TURKISH POTTERY JUG

Another colour used, like the cobalt blue, under the glaze, is a red derived from copper. It was a difficult colour to control but it was used with success in several Ming reigns, notably the Hsuan Te (*see* page 363) and Ch'êng Hua, both as monochrome and in designs painted in the same way as the blue and white.

Ming Enamelled Wares.—Pictorial designs having become fashionable, means were found to paint them on the glaze as well as under it. The chief advantage in on-glaze painting lies in the wider range of colours available. The over-glaze colours, commonly distinguished as enamels, are made of coloured glass ground to powder and liquefied so as to be usable on a brush. They are "fixed" in a small stove, or muffle, at a low temperature which is sufficient to melt the enamel powder and make it adhere to the glaze without actually melting the latter.

The colours used are leaf green and turquoise green derived from copper, a brownish yellow derived from iron, and aubergine purple derived from manganese, besides which a dry black pigment was obtained from manganese and a thin tomato red (halfway between a pigment and an enamel) from iron. The Ming red is apt to become iridescent and lustrous; both it and the black are used for painting outlines, and the latter was sometimes washed on and covered with transparent green to form a composite black. Gilding was also used. With this palette the Ming potters produced richly coloured porcelain, decorated with pictorial designs and formal brocade patterns. In some cases the enamels were combined with underglaze blue and this colour scheme, though known in the 15th century, was so popular in the Wan Li period (1573–1619) that it has come to be known as the wan *li wu ts'ai* or Wan Li polychrome. Another type, known as the "red and green family," is characterized by the absence of blue and the predominance of red and green, and again there are effective combinations of two colours such as red and yellow, blue and yellow, blue and green, red and green, red and gold and more rarely green and gold.

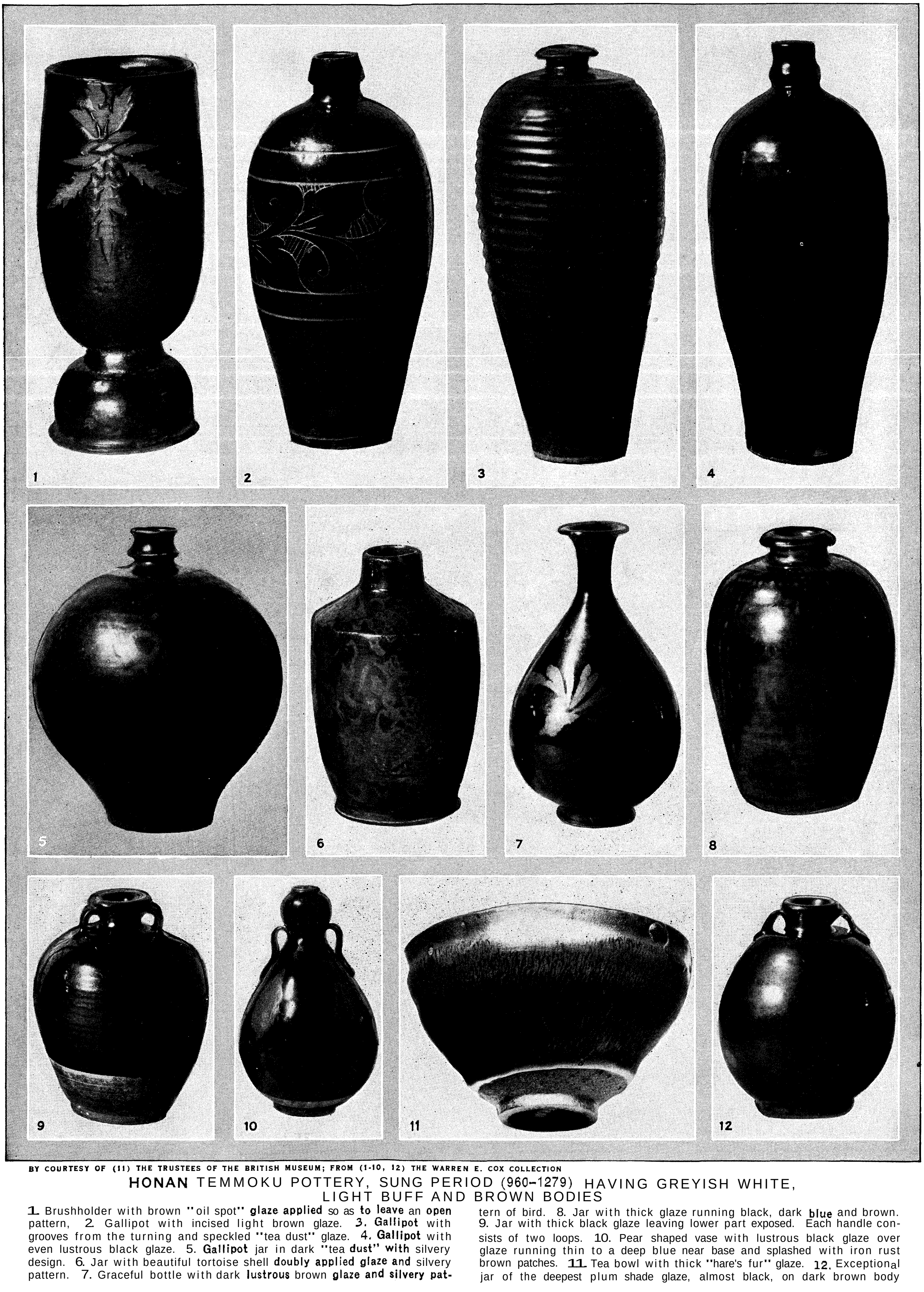
Besides being painted on the glaze the enamel colours were sometimes painted on the biscuit, *i.e.*, the fired but unglazed porcelain body; but this technique was commoner in the succeeding dynasty and will be discussed later.

"Three-colour" Ming Wares.—There are few kinds of ceramic ware, Chinese or otherwise, that make such a brave show as the Ming three-colour (*san ts'ai*) porcelain. Though nominally combinations of three, the glazes which make up the colour scheme of this group are dark violet blue, turquoise, aubergine purple, yellow and a neutral white; and they are used in washes over designs set in single-colour ground'which is usually dark blue or turquoise. To prevent the colours from overrunning each other the designs are outlined by incised lines or by threads of clay, or they are carved in open work. The glazes themselves, though harder than the enamels discussed in the last section. do not require the full heat of the porcelain kiln to melt them, and consequently the ware has to be "biscuited" (subjected to a preliminary firing) and then, when the glazes have been applied, fired again in the cooler parts of the kiln.

They are, in fact, what the French call them, glazes *du demi-grand feu.*

The decoration of the three-colour ware is bold; it includes large floral subjects, lotus and cranes, peonies and peacocks, and a few set figure subjects such as the Eight Immortals paying court to the God of Longevity, Wang Chih watching the game of chess, etc. The details are often built up in slight relief, certain parts such as faces and hands of human figures being left unglazed. The glazes are thick and inclined to be opaque. Much of the three-colour ware dates from the 15th century. In the 16th century the glazes tend to become sleeker, smoother and more transparent, and incised decoration is used

The three-colour decoration was not confined to porcelain. Excellent specimens of it are seen on both stoneware and earthenware bodies. Indeed some of the most beautiful three-colour



BY COURTESY OF (11) THE TRUSTEES OF THE BRITISH MUSEUM; FROM (1-10, 12) THE WARREN E. COX COLLECTION

HONAN TEMMOKU POTTERY, SUNG PERIOD (960–1279) HAVING GREYISH WHITE, LIGHT BUFF AND BROWN BODIES

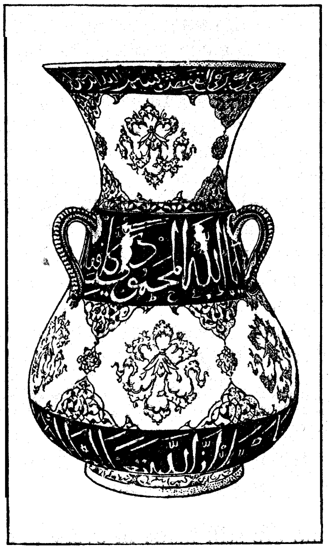
1. Brushholder with brown "oil spot" glaze applied so as to leave an open pattern, 2. Gallipot with incised light brown glaze. 3. Gallipot with grooves from the turning and speckled "tea dust" glaze. 4. Gallipot with even lustrous black glaze. 5. Gallipot jar in dark "tea dust" with silvery design. 6. Jar with beautiful tortoise shell doubly applied glaze and silvery pattern. 7. Graceful bottle with dark lustrous brown glaze and silvery pattern of bird. 8. Jar with thick glaze running black, dark blue and brown. 9. Jar with thick black glaze leaving lower part exposed. Each handle consists of two loops. 10. Pear shaped vase with lustrous black glaze over glaze running thin to a deep blue near base and splashed with iron rust brown patches. 11. Tea bowl with thick "hare's fur" glaze. 12. Exceptional jar of the deepest plum shade glaze, almost black, on dark brown body

FROM THE GEORGE EUMORFOPOULOS COLLECTION

CHINESE VASE

Lang Yao sang-dedoeuf vase of the K'ang Hsi period (1662–1722). Height 17½ inches vases have a buff stoneware body and bold floral designs in minutely crackled glazes which include a peacock blue of peculiarly attractive tone. Where this group of fine pottery was made is not known; but it is found in widely separated parts of China and may have been made in several factories.

Other Ming Wares.—Though monochrome porcelains no longer held the premier position, they were still made in considerable quantity and some of them received special notice from Chinese writers. The sacrificial red (chi hung) of the Hsuan Te and Ch'êng Hua periods, a brilliant underglaze red derived from copper, was most noted; and next came the chi ch'ing, an intense blue glaae of the Hsuan Te period; and a lovely blue glaze of slightly mottled texture is found on some of the Chia Ching porcelains. There were, besides, celadon green, lustrous black and brown glazes; and all the denzi-grand feu glazes of the three-colour porcelains were used individually as monochromes, the turquoise blue being especially effective.



BY COURTESY OF THE BRITISH MUSEUM
LAMP FROM THE MOSQUE OF OMAR

Beautiful, too, are the pure white porcelains (white was the colour required in certain forms of ritual and also by the court during periods of mourning); and special mention is made of the exquisite white "egg-shell" bowls of the reign of Yung Lo (1403–24) and of the white altar cups of the Hsiian Te and Chia Ching periods. If any decoration was added to these white wares it was faintly carved, incised or traced in white slip under the glaze, a subtle form of ornament known as an hua or secret decoration. Another and more conspicuous form of slip decoration is traced in white on blue or green glazes in a manner resembling the modern *pâte* sur *pâte*. Reliefs in white biscuit and remarkably fine open work distinguish some of the later Ming porcelains, the open work being of such superhuman delicacy that it was called kuei kung or devil's work. A quantity of stoneware and earthenware was made all over China in the Ming period. The best known are the tile work and architectural pottery which are often finely modelled: they are usually glazed with green, yellow, aubergine purple, turquoise or blue. On parts of the famous Nanking pagoda, built in the beginning of the 15th century, white porcelain was also employed for the same purpose. Many vases and vessels of everyday use were also made as by-products of the tile works which existed in all large centres of population to supply local needs; but it is hard to distinguish the common pottery of the Ming from that of the earlier and later periods, except where there is a close analogy with some known type of Ming porcelain to help us.

In the early years of the 16th century direct contact was established between Europe and China; and Chinese porcelain, together with silk and tea, soon became an important item of European trade. From this time onwards we note the influence of European taste affecting the Chinese porcelain to a steadily increasing extent.

The **Ch'ing** Dynasty **(1644–1911)**.—The Ch'ing dynasty of the Manchus replaced the Ming in 1644; but it was not till about 1680 that its rule was firmly established over a pacified country. A succession of three able and enlightened emperors—K'ang Hsi (1662–1722), Yung Chêng (1723–35) and Ch'ien Lung (1736–95)—gave China a long period of good rule and the ideal conditions for the development of the arts, which indeed enjoyed at this time an unusual amount of imperial patronage. The imperial porcelain factory at Ching-tê Chên was managed by a series of exceptionally capable directors. Ts'ang Ying-hsüan, appointed in 1682, remained in charge till the end of the K'ang Hsi period. Nien Hsi-yao was appointed by the Emperor Yung Chêng and in 1728 he was given as an assistant the celebrated T'ang Ying, who succeeded him in 1736 and held the post with great distinction till 1749. T'ang Ying left behind him several treatises on the manufacture under his control, and in addition to these we have the letters of the Jesuit father d'Entrecolles which were written from Ching-tê Chên in 1712 and 1722, giving us an intimate picture of the life and industry of the great porcelain centre with its 3,000 furnaces.

The period from 1680 to 1749 must be regarded as the most fertile in the annals of Chinese ceramics. The porcelains of this time are distinguished by fine finish and perfect command of material and technique. They do not, however, differ basically from those of the Ming potters, who had little to learn in the essentials of their craft; and on the whole they suffer by comparison with the Ming in the matter of originality and freshness. The Ch'ing wares indeed are often a trifle stale and mechanical. Still they have enjoyed a long period of popularity in Europe, and their relative weakness has only recently become apparent; for we have only recently made acquaintance with the better types of Ming porcelain.

Ch'ing Blue and White.—Old Nanking is a household phrase in Europe for Chinese blue and white. None the less it is a misnomer, for while much of that ware was transhipped from Nanking, none of it was actually made there. Old Nanking is in fact the blue and white porcelain of Ching-tê Chên and chiefly that made in the K'ang Hsi period and imported into Europe by the Dutch and other East India merchants. It was justly famous, for never was more care expended on the preparation of the ware and the refining of the blue. The best K'ang Hsi blue is pure sapphire, without the tinge of violet or grey so often observable in the Ming blue; and it is usually laid on in graded washes which give it its splendid, vibrating depths. As to the painted designs they are mainly Ming themes, when they are not of the formal arabesque type; but some of them are of outstanding beauty, such as the design of ascending and descending branches of flowering prunus reserved in white in a ground of marbled blue which is netted over with lines suggesting cracked ice.

The prunus blossom falling on the breaking ice is a symbol of returning spring; and this motive is a favourite one for the decoration of the jars in which gifts of fragrant tea and sweetmeats were sent at the new year—a festival which falls in China three to seven weeks later than in our calendar. The vogue of blue and white seems to have died down at the end of the K'ang Hsi period, for after that time the ware in general sank into mediocrity, though exceptions must be made of two types. One is the close imitations of Ming blue and white made in the Yung Chêng period; and the other is the so-called "soft paste" blue and white, a ware prepared with "soapy rock" (hua shih), a kind of pegmatite, and exquisitely painted with the finest brushwork and the purest blue under a soft-looking crackled glaze. Another name given to this porcelain is "steatitic," in the belief that the hua *shih* was soap-stone or steatite. It was an expensive ware and chiefly used for small objects such as snuff bottles and the furniture of the writing table, in which the Chinese *literati* take special delight.

Famille Verte.—This is the name given to the K'ang Hsi porcelain decorated in transparent enamels. These enamels are in the main the same as those used in the Ming period, but there are a few differences. The iron red is a coral rather than a tomato red, the yellow is clearer than the brownish Ming yellow, there are additional shades of green, and the Ming turquoise green is replaced by a beautiful violet blue enamel.

The enamels are either painted over the glaze or are washed over black-outlined designs painted direct on the unglazed porcelain or biscuit. The latter process was not unknown in the Ming period, but most of the existing specimens, though often miscalled Ming, belong to the Ch'ing dynasty. Some of the finest Ch'ing porcelains are enamelled on the biscuit, such as the sumptuous vases with grounds of green-black (*famille noire*), figures and groups.

Not unlike the porcelain enamelled on the biscuit is that decorated with washes of coloured glazes, chiefly green, yellow and aubergine. This is the Ch'ing version of the Ming three-colour ware; but the Ch'ing glazes are sleek and transparent. Sometimes they are laid on in patches making a motley decoration which is known in the trade as "egg and spinach" glaze.

Ch'ing Monochromes.—The Ch'ing monochromes comprise the Ming types, close imitations of the old Sung glazes and many novelties.

Among the best known is the *lang yao* red, which follows the Ming *chi hung* but has a character of its own, varying from bright cherry red and deep ox-blood *(sang de boeuf)* colour to a dappled glaze of crushed strawberry tint. This red is called after a potter family of the name of Lang; and, though imitated in subsequent reigns, it was never so well controlled or so fine in colour as on the K'ang Hsi porcelain. Another success of the K'ang Hsi period was the "peach bloom" glaze. pinkish red in colour but flecked with russet spots and broken by passages of green. Between the peach red and *lang yao* are many shades of maroon and liver colour. Other K'ang Hsi glazes are the mirror-black, the powder-blue and the pale lavender or *clair de lune;* and Chinese writers mention turquoise, eel-skin yellow and snake-skin green as specialties of the period.

We need not dwell on the many other monochromes—whites. celadons, lustrous browns, aubergine purples, violet blues and so forth; but there is a group of composite glazes which requires notice.

They are formed by washes of enamel over a stone-coloured crackled glaze; and they include "apple-green," camellia leaf green, sage green and mustard yellow. Coral red was also used in monochrome, but this and many enamels of the *famille rose* types belong chiefly to the Ch'ien Lung period, as also do the splashed or *flambe' reds* which came at first by accident but which T'ang Ying succeeded in getting under perfect control.

Famille Rose.—In the third decade of the 18th century a revolution took place in the enamelled porcelains. A new palette of colours was introduced, opaque enamels among which rose pinks (derived from gold) are most conspicuous. The Chinese called these new colours *juan ts'ai* (soft colours) or *yang ts'ai* (foreign colours), and we have adopted for them the French name *famille rose.* The *famille rose* displaced the *famille verte,* and it brought with it a new and more effeminate type of decoration with delicate designs executed with a miniature-like refinement. The colours are seen at their best on the Yung Chêng porcelain with a few sprays of flowers thrown artistically across the white surface. The move elaborate ruby-back dishes and table services with crowded figure-subjects and complicated borders are less satisfactory; but these were painted in the Canton enamelling establishments and were destined for the European trade. At Canton. too. were decorated large quantities of Ching-tê Chên porcelain with coats of arms and other European designs directly ordered by the foreign merchants

The *famille verte* enamels, though eclipsed by the *famille* rose, were not entirely suppressed; and they emerged again in a mixed palette of transparent and opaque colours. These mixed enamels were effectively used by a school of painters who worked in the style of one Ku Yueh-hsiian, a maker and decorator of glass in the early years of Ch'ien Lung's reign. Good specimens are rare, for they are prized by Chinese collectors. Other specialities of the Ch'ien Lung period are "lace-work" porcelain with designs deeply incised and forming semi-transparencies; and "rice-grain" porcelain in which the designs are actually cut out of the side of the vessel though allowed to fill up with glaze. A third type, known as *graviafu,* has a covering of opaque *famille rose* enamel which is diapered with incised scroll-work.

The monochromes of the Yung Chêng and Ch'ien Lung periods include those of the K'ang Hsi with numerous additions, some of which have already been mentioned. Great ingenuity was exercised by the Ch'ien Lung potters in the imitation of naturai substances in glaze; the effects of tea dust, iron-rust and bronze are cleverly produced, and enamelled metal, shells, birds' eggs, grained wood, jade, ivory, etc., are copied so closely as to deceive the eye. But these *tours de force* are symptoms of an art which had passed its maturity; and after the 18th century the porcelain has little interest, being mainly of an imitative kind. Exceptions may be made of the Peking medallion bowls, the finer snuff bottles of the Tao Kuang period (1820–50) and some of the imperial porcelains which maintained a high standard of technique. The devastation of Ching-tê Chên during the T'ai-p'ing rebellion in 1853 was a crowning disaster to the ceramic industry of China.

Provincial Porcelains and Pottery.—The bulk of the Ch'ing dynasty porcelains which have reached Europe is of Ching-tê Chên make; but there were many provincial factories which supplied local needs and which also catered for the sea-borne trade to India and the East Indies. These provincial wares are generally of a coarse type; but a shining exception is the white porcelain made at Tê-hua in the province of Fukien. This is the *blanc de Chine* of the old French catalogues, which was freely exported from Amoy in the 17th and 18th centuries, and which served as a model for most of the early European porcelains. It is a beautiful, translucent ware with a soft-looking, melting glaze of milk or cream white, sometimes warmed with a pinkish tinge; and it was chiefly used for ornamental objects such as vases, libation cups, incense burners, figures and groups, less often for table wares. It is decorated, if at all, with slight, applied reliefs, moulded or incised designs, rarely with painted enamels. The TC-hua factories are known to have existed in the last half of the Ming dynasty, and they are still active to-day; and as the character of the ware has changed very little, the dating of specimens will always be difficult.

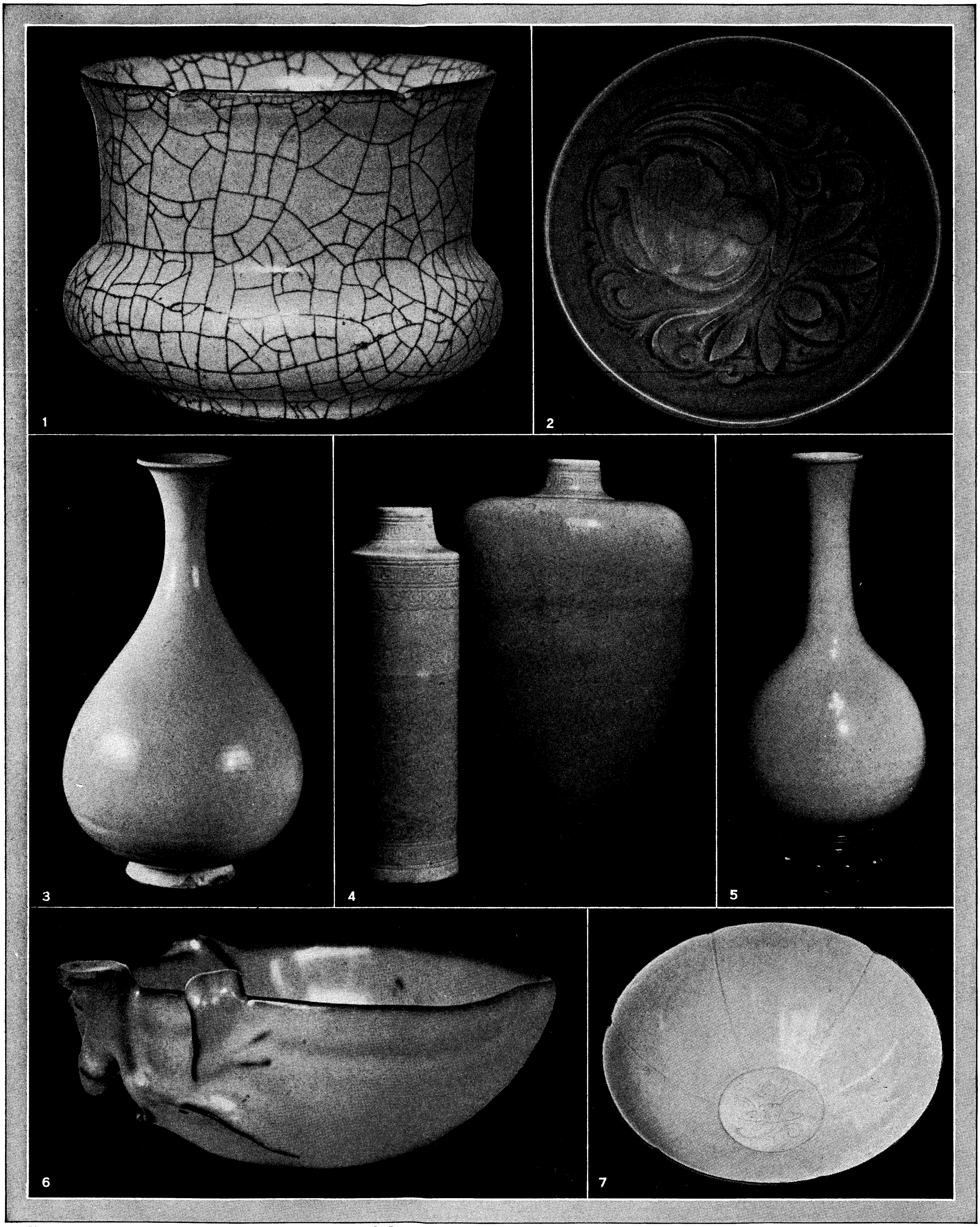
Immense quantities of earthenware and stoneware have been and are still made in every part of China. We know little of the individual potteries, but there are two centres which must be mentioned. Yi-hsing, on the west side of the Great Lake in Kiangsu, has been noted since the 16th century for a fine stoneware, chiefly red but also buff, grey and of other colours formed by clever blending of the local clays. The red tea ware of Yi-hsing came to Europe with China tea as early as the 17th century. It was classed at that time with the American *buccaro* ware; and it was copied closely by Dutch, English and German potters, notably by Bottger at Dresden and by Dwight and Elers in England. The Yi-hsing tea-pots were cleverly fashioned, often in fanciful shapes, and decorated with reliefs, moulded and incised designs and in some cases with glazes and even enamels.

The second centre lies in the province of Kwangtung, the principal potteries being at Shekwan near Fatshan, a few miles west of Canton. The Shekwan ware is a stoneware verging on porcelain; and the standard type has a thick flocculent glaze of brown mottled with blue and grey and sometimes with vivid red. Glazes of the Sung Chün type and celadon green, as already mentioned, besides *flambé* red were also used; and some of the Shekwan stoneware dates back to the Ming period, though the bulk of it is of comparatively recent date.

The reader is reminded that true Chinese decoration is never meaningless. Its meaning may be directly expressed in semi-religious emblems such as the Eight Buddhist Symbols, the attributes of the Eight Immortals, the Eight Precious Things, etc.; or indirectly by motives which suggest good wishes, such as the peach, crane, tortoise and pine (long life), the bat (hdppiness), the pomegranate (fertility). Again combinations of flowers, animals, etc., can be read rebus-fashion into auspicious phrases; for the Chinese language abounds in homophones and the Chinese delight in puns. They also delight in themes of religious and historical import; and the understanding of their decorative designs involves a deep study of their religion, history and folk-lore.

Numerous marks and seals are used on Chinese pottery and porcelain; but for these again the reader must consult special books. The most important and the most frequent of the marks are the reign-names *(nien hao)* of the emperors; but there are also potters' names, phrases of good omen, symbols and the names of halls and workshops, which it would be futile to enumerate without giving the actual marks and their readings.

BIBLIOGRAPHY.—*General:* F. Brinkley, *China,* Its *History, Arts and Literature* (1904); W. Burton and R L. Hobson, *Marks on Pottery and Porcelain* (1912); S. W Bushell, *Chinese Att* (2 vols., 1906), *Description* of *Chinese Pottery and Porcelain* (1910), being a transla-



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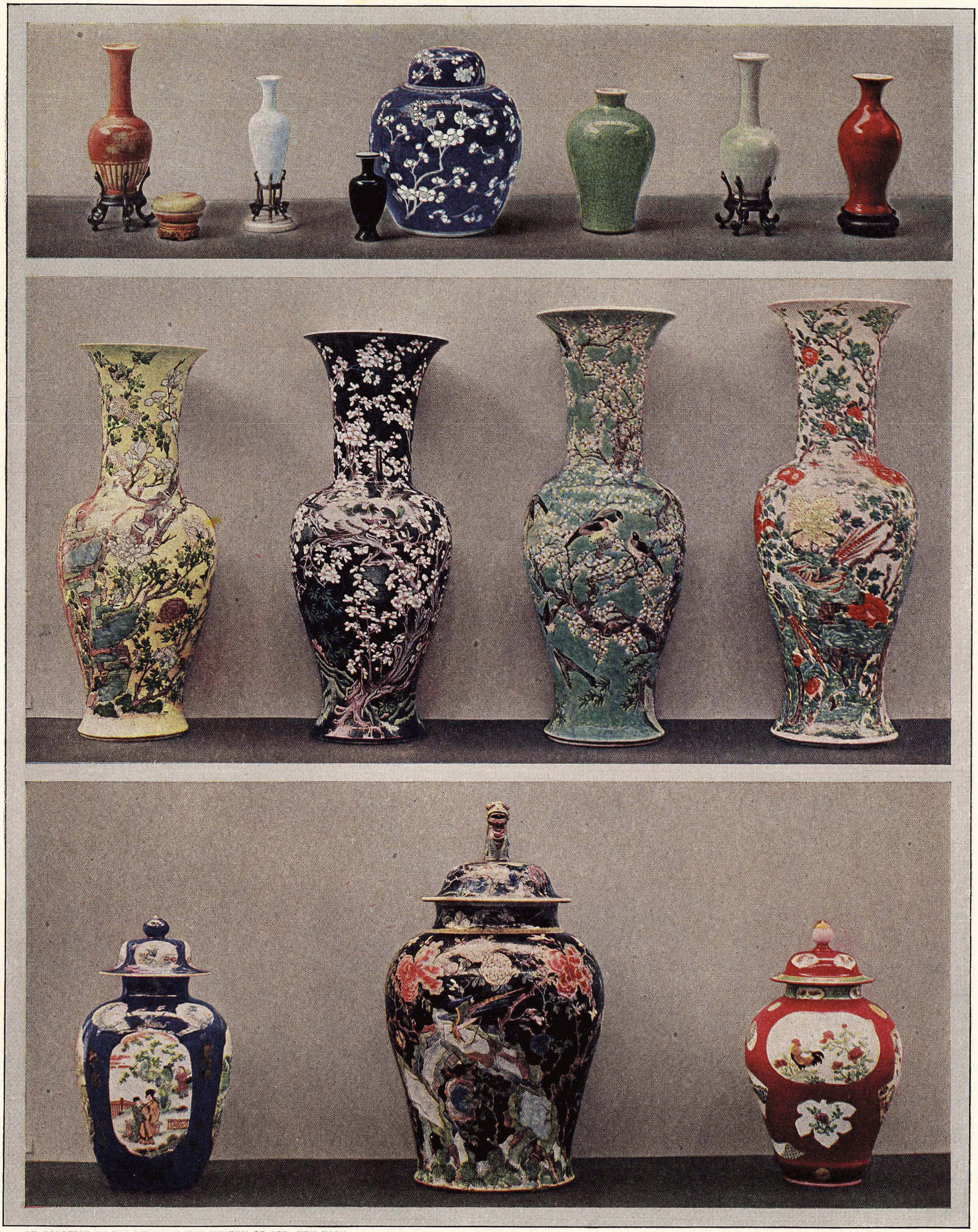
POTTERY AND PORCELAIN OF THE SUNG DYNASTY (A.D. 960–1279)

1. Ko ware, pale *café* au lait
2. Northern Celadon with characteristic incised design, olive green
3 and 5. Ting ware, pure white
4. Tu Ting ware with lightly incised design
6. Kuan ware, pale bluish grey
7. Ting ware, pure white

POTTERY AND PORCELAIN



CHINESE PORCELAINS OF THE K'ANG HSI (1662–1722) **AND CH'IEN** LUNG (1736–95) **PERIODS**

Top Row: Peach-bloom chrysanthemum vase marked Ta Ch'ang **K'ang Hsi** Nein Chih, and rouge cup. ***Clair-de-lune*** Amphora. Mirror black Amphora, later period. Blue and White Hawthorn Ginger Jar. Apple Green Galley pot. Celadon Chrysanthemum Vase. Coral red enamel vase of the later period. Second Row: Temple Jars of the so-called ***Farnille Verte*** type painted with enamels, the two at the left being called ***Famille Jaune,*** and ***Famille Noire*** because of their back-ground colouration. Bottom Row: Powder blue Temple Jar with reserved medallions in enamel decoration. ***Famille Noire*** Temple Jar. ***Famille Rose*** Temple Jar of later period with enamel decorations

tion of the *T'ao shuo, Oriental Ceramic Art* (1899); E. Hannover, *Pottery and Porcelain*, vol. *II., The Far East* (1925); R. L. Hobson, *Chinese Pottery and Porcelain* (2 vols., 1915), *Catalogue of the Eumorjopoulos Collectton* (6 vols, 1925–28), *Guide to the Pottery and Porcelain of the Far East* (1924); St. Julien, *Histoire et Fabrication de la Porcelaine Chinoise* (1856), being a translation of the greater part of the *Chtng tê chên t'ao lu*, with notes and additions; E. Zimmermann, *Chinesisches Portellan* (Leipzip, 1923).

Early Periods: J. G. Andersson, *Bulletin of the Geological Survey of China*, No. 5 (1923), *Memoirs of the Geological Survey of China*, Series A, No. 5 (1925); T. J. Arne, *Palaeontologia Sinica* (1925), Series D, vol. I., No. 2, C. Hentze, *Les Figurines de la Céramique Funéraire* (Hellerau, 1927); A L. Hetherington, *Early Ceramic Wares of China* (abridged ed, 1924); B. Laufer, *Chinese Pottery of the Han Dynasty* (Leyden, 1909), *The Beginnings of Porcelain in China* (Chicago, 1917); O. Rücker Embden, *Chinesische Frühkeramik* (Leipzig, 1922).

Later periods: R. L. Hobson, *The Wares of the Ming Dynasty* (1923), *The Later Ceramic Wares of China* (1925); A. E. Hippisley, *Catalogue of the Hippisley Collection,* Smithsonian Institute, Washington (1900).

KOREA

The geographical position of Korea makes it a natural link between China and Japan. In close contact with China the Koreans were ahsorhing Chinese influences from the Han dynasty onwards; and Chinese graves of the Han period excavated in Korea prove by their contents that the Koreans must have been familiar with the arts of their great western neighbour. But in actual fact the early Korean pottery, though doubtless its essentials were learnt from the Chinese, developed on lines of its own. It is a hard, slate-grey ware, unglazed except for an accidental smear of glossy brown which probably came from the wood ashes in the kiln, and ornamented with large perforations, rather crude reliefs and simple incised patterns. This is the ruling type found in the tombs of the Silla period, which is generally regarded as extending from the 1st to the 10th century, though the Silla state did not actually become paramount till the 7th century. Naturally the Silla pottery varies considerably in such a great space of time, and some of it is potted thin, fired hard and of a neat and almost ornamental appearance.

The Korai Period (918-1392).—But the heyday of Korean ceramics belongs to the succeeding Koryu or Korai period, when the Korean potters suddenly developed a skill which was the admiration of the Chinese themselves. There can be little doubt that this sudden change was wrought either by Chinese refugees or by Koreans who had gone to China to study. For the home of the new industry was in southern Korea, in the Zenra district; and, as Dr. Nakao has pointed out, this district is connected by the most convenient sea route with the coast of Chekiang, the home of the Chinese celadon in the imitation of which the Koreans specialized. The characteristic Korean ware of the Korai period is a porcellanous stoneware with a celadon glaze which at its best resembles blue green ice, but which varies in tone to olive green and brown. A Chinese writer, Hsü Ching, who visited Korea in 1125 compared this ware in one passage with the secret-colour (pi *sê*) ware of Yueh Chou and the contemporary Ju Chou porcelain, and in another passage with the celadon of Lung-ch'üan. The same writer adds that in form and style it resembled Ting Chou porcelain, a statement of which we quickly realize the truth in comparing the etched, engraved and moulded designs in the Korean bowls with those of the ivory white Ting ware Incidentally it may be mentioned here that a white porcelain of Ting type and a bluish white porcelain of *ying ch'ing* type have both been found in Korai tombs; but whether they were, all or some, made in Korea itself or imported from China are questions not yet decided. The finest Korai ware is undoubtedly the blue green celadon made in the best period which may be placed between 1050 and 1170; and it is either plain or delicately decorated with etched or carved designs. Sometimes the glaze is more grass green like the typical Lung-ch'iian celadon or olive green like the so-called northern celadon (see above).

Indeed there are specimens which could hardly be distinguished from this latter ware, were it not for the typical Korean finish of the base which is shallow and covered with glaze and almost always scarred with the marks of the spurs or sand on which the piece was supported in the kiln This rough finish of the base and a tendency to lose shape in the firing are two defects which are apt to mar even the best Korean ware.

It was probably in the last half of the 12th century that a typically Korean method of decorating the celadon ware was first used, namely inlaying the incised designs with black and white clays. Discreetly used this decoration produced a very charming effect; but it was overdone and soon became hackneyed. The easy but mechanical method of stamping the designs instead of drawing them with the stylus was adopted, and a stiff and crowded ornamentation resulted To this inferior class belongs the so-called "Mishima" ware with its radiating cord patterns which recalled to the Japanese the lines of their Mishima almanac.

Other less usual kinds of decoration on the Korai ware are painting in underglaze red, painting in bold, but often rather crude, designs in brown (rarely in white) in the style of the Chinese Tz'ŭ Chou pottery, and blending variously coloured clays so as to make a marbled body. Black- and brown-glazed wares of the "Honan *temmoku*" class are also found in Korea, but, as with the ivory white and ying *ch'ing* types, their native origin remains to be proved By the end of the 13th century the Korai pottery had become definitelv decadent: the beautiful celadon glaze had turned brown and cement-coloured, and the inlaid and brown-painted wares were coarse and clumsy.

The Korai dynasty was followed by the Yi which lasted from 1392 to 1910. The capital was removed from Song-do to Seoul and the name of the kingdom was changed to Chosen. But the country was impoverished by many calamities and the final blow to its prosperity came with the invasion of the Japanese under Hideyoshi at the end of the 16th century. From this time Korea was virtually closed to the outside world and became a veritable hermit kingdom. We know little of the early Yi pottery except so far as it is reflected in Japanese imitations. From these we would infer that it included a rough kind of red or grey pottery with translucent glaze varying from brown to light grey tinged with pink; coarse *mishima*, and brown-painted wares which the Japanese call e-gorai (painted Korean); a creamy buff ware with closely crackled glaze; and grey ware with opaque milk white glaze of thin paint-like appearance which the Japanese call koma-gai. For the rest, specimens of the 17th to 19th century wares in our collections comprise porcellanous stoneware with crackled grey or buff glaze, plain or painted with sketchy designs in dull underglaze blue; and white porcelain painted in underglaze blue and red, with occasional relief decoration and open work.

BIBLIOGRAPHY.—*Kanroku Korai-yaki Gwacho* (Album of Korean Pottery) (1910); N. Nakao, "Old Korai China," *Manchurian Daily News* (monthly supplement, Aug–Oct. 1925); B. Rackham, *Catalogue of the Le Blond Collection of Corean Pottery* in the Victoria and Albert Museum (1918).

JAPAN

Japan, like every other country, has its primitive pottery, a rough hand-made material sometimes mat-marked like the primitive Chinese. A more advanced type is found in the dolmen burials which date from the 3rd century B.C. to the 7th AD. The dolmen-builders were invaders from the mainland, doubtless from Korea, and the dolmen pottery closely resembles the Korean wares of the Silla period The development of the potter's art in Japan was slow—perhaps it was retarded by the preference for other materials, such as lacquer, for the articles of every day use—and it seems at first only to have moved forward under the stimulus of foreign influences The first foreign influence was Korean. The next was Chinese, and this must have been felt as early as the 8th century, for the treasure of the Emperor Shomu, preserved at Nara, includes a few specimens of motley glazed pottery of T'ang type. In the 13th century Kato Shirazaemon is said to have gone to China to study the work of the Sung potters, and to have set up kilns in Seto on his return. Reputed specimens of his work are tea jars and tea bowls with thick treacly glazes of black, amber brown, chocolate and yellowish grey colour. This type of pottery took a firm hold in Japan and variations of the Seto glazes were subsequently made in many factories throughout the country. A second and more potent wave of Korean influence flooded Japan after Hideyoshi's campaigns in the 16th century, from which he brought back a large number of Korean captives. It happened too that about the same time the famous aesthete Senno Rikiu organized the tea ceremony, which has played ever since an important part in Japanese social life. The masters of the tea ceremony decided that pottery was the most fitting material for the tea vessels; and the Japanese potters soon learnt from the Koreans how to meet the demand satisfactorily. Hence the numerous imitations of Korean Yi dynasty wares to which allusion was made in the last section. Indeed many of the best known Japanese potteries, such as those of Karatsu, Satsuma, Shigaraki, Takatori and Hagi, owe most of their importance, and also very often their origin, to Korean teachers. From the 16th century onward Japanese pottery developed rapidly and many new and original types were invented, of which the *raku* ware is one of the most important (Plate XLII., fig. 8).

Though the credit for the invention of *raku* ware is given to a Korean family settled in the Kioto district, the ware itself is essentially Japanese. It is a soft, hand-made earthenware, requiring only a slight firing, and covered with a peculiarly waxen, treacly and semi-opaque glaze of various colours of which the black and salmon are the earliest and the yellow, green, cream white and mixed colours later.

Another successful Japanese creation is the antithesis of the *raku* ware. It is a hard reddish brown stoneware unglazed as a rule, except for an accidental smear, and evidently well suited for figure modelling. Its habitat is the province of Bizen, where the industry can be traced back to the 14th century. A fine, hard, buff pottery with closely crackled cream glaze is another Japanese specialty. It is a development of the Korean *koma gai,* or white ware; and it reached its finest expression in Satsuma. Here and at numerous factories in Kyoto it was used as the vehicle for enamelled decoration.

The art of enamelling on porcelain was learnt from China, the story being that Sakaida Kakiemon, an Arita potter, was instructed in it by a Chinese ship's master about the middle of the 17th century. One of the most celebrated Japanese potters, whose art-name is Ninsei, adapted its use to the cream glazed pottery and developed a special style of enamelling in purely Japanese taste. Ogata Kenzan, another of the great Japanese ceramic artists, at the end of the 17th century found a way of using enamelled decoration on the soft *raku* glazes (Plate XXVII., fig. 1). From this time onwards Chinese influence was discounted in the pottery which displays much originality and a true national style.

Japanese Porcelain. — Meanwhile the manufacture of porcelain had started in Japan. Needless to say the technique was learnt from the Chinese, a potter named Gorodayu go Shonzui visiting Ching-tê Chên itself to study in the 15th century. Shonzui's difficulty on his return to Japan was to find suitable raw material and he was forced to work with imported Chinese clays. Not till the beginning of the 17th century did the discovery of the important deposits of porcelain stone on Izumi Yama, in the Arita district of Hizen, permit the establishment of the Japanese porcelain industry on a firm basis. The Arita district was the chief centre of the manufacture; and it was here, at the seaport Imari, that the Dutch traders obtained the "Old Imari" porcelain with which they flooded Europe. Here too Kakiemon practised his new-found art of enamelling, in a style which is for ever associated with his name. The Kakiemon enamels were soft orange red, grass green and lilac blue, supplemented by pale primrose yellow, turquoise green, gilding and occasionally by underglaze blue; and his decorations are slight and in the best Japanese taste. A few blossoms, a floral medallion, a flowering prunus tree, a banded hedge with birds, quails and millet, a tiger and bamboos (Plate XXVII., fig. 3) a dragon and sometimes children are motives of the nicely balanced Kakiemon designs which have been imitated wherever porcelain has been made (Plate XLII., fig. 2). The "Old Imari" of the Dutch importers included another highly specialized but less artistic kind of porcelain. It was painted with masses of heavy impure blue supplemented by red and gold and to a less extent by enamel colours. The designs are irregular and confused, asymmetrical panels enclosed by mixed brocade patterns. Over-loaded, but not without decorative value, they appealed strongly to the Dutch taste.

Many factories were started in the Arita district, those of the princely houses of Hirado and Nabeshima being the most noted; and the industry soon spread to other provinces. It was early established in the Kutani district of the province of Kaga and at a little later period at Seto in Owari, Mino, Kioto and many other places. The Kaga potteries in the 19th century popularized a special kind of decoration in red and gold; but on the whole Japanese painted porcelain follows closely on Chinese lines, and the highest ambition seems to have been to make wares which could be mistaken for Ming porcelain. The Koto factory on the shore of Lake Biwa was noted for its enamelled porcelain in the middle of the 19th century; and good imitations of Chinese celadon were made in the Arita district at an early date and at Sanda and Kioto since the end of the 18th century. In the early 19th century remarkably fine porcelain of "egg-shell" thinness was made at Mikawachi, in Seto, Shiba and Mino.

Since the reopening of Japan to the foreigner in 1868 vast quantities of pottery and porcelain have been made for the Western market. These wares, usually overloaded with ornament, do not represent true Japanese taste, which requires that a piece of pottery be made strictly to serve its useful purpose and decorated soberly in a style appropriate to its form and use.

It is not practicable within the compass of this article to describe the work of individual potters, and the mere mention of famous names, such as Banko, Hozan, Dohachi, Eisen, Rokubei and Zengoro Hozen, cannot serve any useful purpose. The potteries are very numerous, being for the most part small family concerns; and as each had its individual mark or seal and a proper pride in using it, the list of Japanese potter's marks is a formidable one, for which the reader must consult works cited below.

BIBLIOGRAPHY.—F. Brinkley, *Japan, Its History, Arts and Literature* (1904); A. W. Franks, *Japanese Pottery,* Victoria and Albert Museum Art Handbook (1906), *Catalogue of the Franks Collection of Oriental Pottery and Porcelain* (1879); E. S. Morse, *Catalogue of the Japanese Pottery in the Museum of Fine Arts* (Boston, 1901).

PERSIA AND THE NEAR EAST

The ceramic history of the Near East between late Roman and Islamic times is still obscure. Little Sassanian pottery of any importance has been identified, and the excavations at Constantinople which should tell the Byzantine side of the story have hardly begun. But the continuity of ceramic tradition in these regions is not for a moment in doubt. The most'familiar of all the Persian glazes is the blue-green which appears on late Babylonian, Parthian and late Roman wares; while in Egypt there is no real break in the sequence of potters from early dynastic times to the present day, though the chain of evidence is very weak in the period immediately preceding the coming of Islam.

The "Gabri" Types.—What is reputed to be the earliest type of mediaeval Persian pottery has been called "Gabri" because it was believed to have been made by the pre-Islamic, fire-worshipping (Gabri) peoples. It is an earthenware with a reddish body which is usually concealed by a coating of white slip (liquid clay) and covered with a transparent lead glaze. The commonest form of decoration was effected by cutting or scratching a design through the slip coating so as to expose the red ware below; and by varying the naturally yellowish colour of the glaze by washes of green and purplish brown, derived respectively from copper and manganese. This technique is probably of Byzantine derivation, but it has been used since in every civilized country and at all periods. The Gabri ware, though often crude and bucolic, is attractive for its bold designs and warm colouring, and in the best specimens the rendering of animal forms among floral scrolls (Plate XXXIX., fig. 4) and of ornamental inscriptions is highly artistic. In point of date some of it may go back to the early days of Islam (7th century), but the bulk of it may safely be placed between the 10th and 13th centuries. In Egypt the same technique was largely used on the armorial pottery of the 15th century. Gabri ware has been excavated chiefly in northern Persia, at Zendjan, Rhages and Hamadan; and a kindred ware reputed to come from Amul, south of the Caspian, is distinguished by the additional colours, yellow and ochreous red. A rare type

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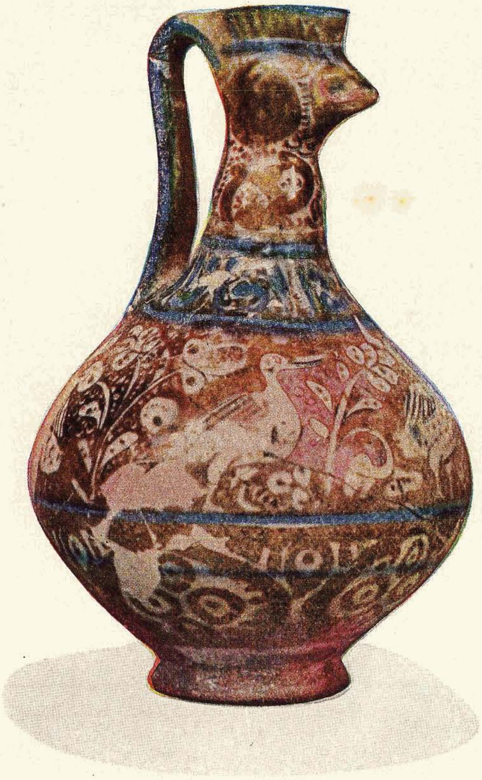
CHINESE PORCELAINS

1. Yung Chêng eggshell porcelain
2. *Famille verte* dish, K'ang Hsi period
3. K'ang Hsi group with coloured glazes
4. Powderblue bowl
5. Chia Ching jar, blue and white
6, 7. K'ang Hsi vases, blue and white

POTTERY AND PORCELAIN



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PERSIAN POTTERY

1. Jug from Sultanabad, 13th century, decorated with metallic lustre and turquoise glaze. Height 7½″
2. Mihrab tile, 13th century, modelled in low relief and decorated with glaze and lustre. Length 12″
3. Dish, Rakka or Rhages, 12th century, incised and deaorated with glaze. Diameter 16¾″
4. Star tile, 13th century. Length 8″

reputed also to be of Amul make has painted designs in white on a background of black slip. A red ware with painting in coloured slips, as well as with incised ornament, has been found in some quantity as far east as Samarkand.

Samarra.—A shining exception to the usual haphazard excavation is the work done by Profs. Sarre and Herzfeld in the ruins of Samarra on the Tigris, a site which was occupied for about 50 years in the 9th century. The finds made here are of the utmost historic importance, and they include a variety of interesting pottery types. One is a thin reddish buff earthenware decorated in low relief with formal designs under a green lead glaze and strongly reminiscent of the lead glazed wares of the late Roman period. Another and more characteristic type is a close-grained, buff pottery with an opaque greyish white glaze which is sometimes painted with a dark cobalt blue, sometimes with lustre pigments of golden brown, green or blood red tones. The blue-painted ware is varied at times with patches of green and manganese brown. The same Samarra body is found with monochrome white, green and yellow glazes, and also with glazes splashed and mottled with green and yellow in the style of the Chinese T'ang wares with or without incised designs. Indeed it is clear that the Samarra potters deliberately set themselves to copy Chinese wares, fragments of which in company with white and celadon porcelain have been found on the site. But the most important of the Samarra fragments are those decorated with lustre.

Lustre painting is perhaps the chief contribution of the Near East to ceramic decoration. When and where it was first used are still debated questions, but one fact at any rate is established by the Samarra finds, namely that the process was fully developed in the 9th century. The lustre is applied in the form of a metallic salt (derived from copper or silver) which is painted on the glazed ware and developed at a low temperature in a special kind of kiln. This process deposits a film of metal on the surface of the ware, in colour golden brown, greenish or red, and when the film is thin enough to allow the light to penetrate it, it glows with beautiful rainbow reflections. The blue-painted and the lustred pottery of the Samarra type have been found at Susa certainly, and, according to report, at Rhages also; and examples of the lustred types have all been found in the waste heaps at Fostat in Egypt.

Rakka Ware.—Extensive pottery remains, including a number of kiln wasters, have been dug up at Rakka, in Syria, a place situated on the Euphrates about 100 m. E. of Aleppo. Rakka is a very ancient site and one which had considerable importance between the 8th and the 14th centuries. It includes ruins of several cities, one of which was the residence for a time of the Caliph Harun Al-Rashid. The pottery found at Rakka is of a type which became general in the Near East after the 10th or 11th century. It has a sandy, white or buff white body, loosely constructed and friable, and it is covered with a clear silicious glaze which became opaque when tinted with certain colours. A bowl of Rakka ware figured in Chatfield Pier's book is said to have a dated inscription of the year 831: it is painted in black under a pale blue glaze. Other Rakka wares are decorated with a characteristic brownish lustre; and some of these may date back to the 10th or 11th century. Others again have designs in bold relief which is lustred, or covered with opaque turquoise or translucent bluish green glaze. But the most characteristic type is painted in black under a pale blue glaze or in blue and black under a clear glare.

Sometimes the glaze is coloured a fine purplish brown with manganese. The blue and black painted ware is common to Syria and Egypt, whence its name Syro-Egyptian, and the bulk of it was made between the 13th and the 15th centuries.

Kiln sites have also been found at Rakka with remains of another kind of ware which appears to belong to the 11th or 12th century. It is white with engraved designs under a clear glaze which is sometimes coloured with dabs of blue. Probably other colours also were used, for specimens of this type reported to come from Rhages have the same features with the addition of green, yellow and manganese purple.

Rhages Ware.—To return to Persia, the ruins of Rhages have long been a happy hunting ground for pottery seekers, and they have produced wares of great variety and of many periods. There is little doubt that Rhages was an important centre of the ceramic industry, though very few waste pieces have been found to indicate the presence of kilns. The city, once the capital of the Djebal, was laid waste by the Mongols in 1220, and, though not completely abandoned till the 17th century, it never recovered from this disaster. The classic period of Persian pottery is from the 12th to the 14th century; and among the fragments found at Rhages are some of the most beautiful Persian wares. They are mostly made of the sandy white material; and the glaze is usually opaque and of a creamy tone, and much of it is finely painted with golden brown lustre with or without touches of blue. Another beautiful type, specially associated with the name of Rhages, is painted in enamel colours heightened by leaf gilding on a cream white or turquoise blue glaze. The Rhages enamels include blue, turquoise, manganese purple, red, green, mixed colours and white, and, with the exception of the blue, they generally have a mat appearance which gives a subdued splendour to the colour scheme. The designs on this Rhages enamelled ware are pencilled with miniature-like fineness recalling to a great extent the beautiful workmanship in the manuscript illuminations of the early 13th century. Indeed it has been thought that the court miniaturists may have assisted at the work. In some cases, especially with the more formal designs, parts of the pattern are built up in relief and these incrustations are jewelled with enamels and gilding.

Again the red, white and gold are effectively used in tracing formal designs on a fine dark blue glaze or on an opaque turquoise glaze which frequently covers moulded reliefs. Enamel colours too are sometimes used on the unglazed water jugs of porous buff earthenware, which are found all over the Near East and which are often decorated with artistic relief ornament.

The ruins of Sultanabad, in Kazvin, have also given us much fine pottery of the classic period, wares painted in lustre with or without blue, decorated in strong relief under blue, turquoise or green glazes, and painted in blue and brown under a clear glaze. The most characteristic Sultanabad type is a variety of the last mentioned, with animals, birds or human figures set in a background of close foliage, outlined in black and washed in with blue. The central motives are frequently speckled with black dots, and parts of the ornament are slightly raised.

The beauty of these specimens is further enhanced by the warm grey tone of the glazed ware in the remaining spaces. Chinese influence is frequently observable in the drawing of the figures, and pure Chinese motives such as the dragon and phoenix also appear. These features indicate a date in the second half of the 13th century after the Mongol conquest. Excavations at Khar have produced pottery of the best Rhages types, and it is probable that many other sites could be found equally productive, for there is no doubt that pottery centres were widely distributed throughout Persia and that Rhages and Sultanabad are only two of many.

Persian Tiles.—One of the most attractive forms of Persian pottery, the beautiful lustred wall tiles, have been found at Rhages Veramin, Koum, Natinz, Meshed and Kashan, and it is reasonable to suppose that such things were manufactured on the spot. But the wall tiles illustrate almost every phase of Persian ceramic art. Some of the earliest have ornamental inscriptions in strong relief and a coating of monochrome glaze, light blue or green. Next came the splendid lustred tiles, cut into star shapes and decorated with a complete design on each, chiefly consisting of ornamental foliage which sometimes encloses animals, birds and even human figures. An inscribed border usually completes the tile, and many of the inscriptions have the added interest of dates in the 13th and 14th centuries. The designs are sometimes painted direct in the lustre pigment, sometimes reserved in a lustred ground: details are etched with a needle point and parts of the design, especially the borders, are often touched with blue and occasionally with turquoise. It was soon discovered by the craftsmen that a slight relief gives additional play to the lustre, and reliefs were freely used, especially on the larger mihrab tiles. In place of lustre we also find traceries of red, white and gold on dark blue or turquoise glaze as on the Rhages wares. Another characteristic Persian mural decoration is in a mosaic composed of glazed pottery sawn in intricate patterns and embedded in mortar. There are fine examples of this work on buildings of the 14th century. Later the same general effect was produced by the easier method of painting the design in coloured glazes leaving the outlines dry to represent mortar.

Before leaving the classic period of Persian pottery mention should be made of the fairy-like effects obtained in the sides of bowls and vases by open work designs into which the glaze has been allowed to run, forming transparencies. This beautiful decoration is seen on white wares which may be as old as the 11th century and on the pottery found at Rhages, Sultanabad and Fostat. It reappears at a later date on the so-called Gombroon ware.

Later Persian Wares.—In the post-classical period, from the 15th century onwards, the fashions in Persian pottery underwent considerable change. Few of the older styles survived, and those which did are barely recognizable. The body of the ware is the same sandy white material; but it is more highly vitrified and quite often it is translucent in the thinner parts, a condition only occasionally noticeable in the early wares. It is in fact a kind of soft porcelain. Chinese influence is very strong in the decoration. Celadon greens and other colours are copied as monochromes or painted with traceries of white slip: the painted designs in blue and black, or in blue alone, under a clear glsze, so closely follow the Ming blue and white that they are often mistaken for it. The Persian potters even marked their wares with imitations of Chinese seals. Survivals of the old Persian types include decoration scratched through a black slip under a pale blue glaze, painting in black under a blue glaze, and lustre ware, but in every case the character of the designs has changed. As to the lustre ware it would perhaps be more correct to describe it as a revival, for we have no examples made during the century which preceded the reign of Shah Abbas (1587–1629). On the revived ware the lustre is greenish or reddish brown in colour and its reflections are generally coppery, but sometimes of a beautiful ruby tint. It is applied over a white, or a vivid blue, glaze, rarely over yellow; and the designs are freely drawn trees and plants, among which the cypress occurs frequently, animals and birds and formal patterns, arabesque scrolls, leaf medallions and cable borders. The old device of reserving the design in a ground of lustre does not seem to have been used. Though this ware is generally known as Shah Abbas lustre, the only published specimen with a date was made in the year 1651 (or 1673 according to the reading), and a jug in the British Museum has a metal mount of about 1700. The ware in fact seems to be a 17th century revival but there is no evidence that it continued beyond that period.

The effective use of pierced ornament filled with transparent glaze on the earlier wares has already been noted. After a long interval it reappears on the white translucent ware of the later periods. The incised patterns are of a simple kind and they are supplemented as a rule with a few sprays or arabesques in blue and black. This singularly light and elegant pottery has been called Gombroon ware, because it was believed to have been shipped from the port of Gombroon; but it was probably made in many places, and the material differs in no respect from the contemporary ware made all over Persia. The few known dated examples are of a rather coarse type and belong to the early years of the 19th century; but the ware was largely made in the 18th and some of it may date back to the 17th century.

The late Persian types are no easier to localize than the earlier. Chardin, who travelled in Persia in the 17th century, tells us that faience in Chinese style was produced all over the country, but that the best came from Shiraz, Meshed, Yezd, Zorende and Kerman. There is an interesting product of Yezd in the Eritish Museum, a kettle-shaped ewer of fine white ware well painted in blue in Chinese style and inscribed "The Work of Mahmûd Mi'mar of Yezd. The decorator of it the poor Zari. 102 j" (=A.D. 1616). Hannover describes a pottery decorated in blue, green and a red similar to that used on the Turkish wares (*see* below), which he believed to be of Kerman make. Kubatcha in the Caucasus is also credited with the manufacture of a ware painted in similar colours or in a greyish blue under a glaze which tends to crackle. A typical specimen of this ware is a dish with a female bust surrounded by floral ornament, while others have rather coarsely painted designs in the style of Chinese blue and white; but all that can be said with certainty is that pottery of this kind has been found in the neighbourhood of Kubatcha. With even less reason a considerable group of post-classical pottery with black designs under a transparent blue glaze, which is inclined to crackle, have been assigned to Kubatcha; but there is little doubt that this type was made in various parts of Persia and certainly at Damascus. Specimens exist with dates around the year 1500.

The later tile work tends to be pictorial, with hawking figures on horseback and the like in slight relief in a ground of landscape and flowers. One of the best examples of the 17th century tile work is in the Victoria and Albert Museum, a large panel made up of many plaques and representing a princess and court ladies in a garden of flowers and cypress trees.

In the middle of the 18th century overglaze enamel painting in the colours of the Chinese *famille* rose came into use on tiles and on ordinary pottery. But the late 18th century and the 19th century Persian wares are in the main coarse versions of older types.

Mention has already been made of the early lustred pottery, the *graffiato* wares, and the blue and black painted wares of Syrian type found in Egypt, and of the continuity of the potters' art there from early dynastic times to the present day. Most of the early Persian and Syrian types were made in Egypt in the neighbourhood of Cairo; and the finds at Fostat are specially rich in lustre wares of all kinds, in pottery painted in black and blue under a clear glaze, and in monochromes which imitate Chinese porcelain.

Turkish and Damascus Wares.—Little is known of the potteries of Asia Minor in the middle ages, but in the 16th century under Ottoman rule they became iamous for a pottery which is unsurpassed for its bold designs and powerful colouring. It is directly descended from Persian wares, but it has decided characteristics of its own which reflect the taste and temperament of the Ottoman peoples. It has the standard Near Eastern body of sandy whitish material, but in all the better specimens this body is dressed with a slip of fine white clay. On this the decoration is painted in black outlines which are filled in with brilliant blue, turquoise, green, and either manganese purple or thick red, under a clear glassy glaze. The colours are laid on with a full brush, and the Turkish designs have a distinctive character. They consist chiefly of sprays of certain flowers such as the narcissus, tulip, carnation, rose, fritillary, etc., naturalistically treated, or of arabesques of feathery leaves; and the dishes have borders of spiral clouds.

The transition from the old Persian types to the full-blown Turkish ware is abrupt; but a link may be found in the pottery of Damascus.

Outside this important city, kiln sites have been found with remains of a pottery of the 14th century Syro-Egyptian type, painted in blue and black under a clear glaze; and there is a vase with lustred decoration on a blue glaze, bearing legend "painted by Yussuf of Damascus" which implies a knowledge of the lustre technique among the Damascenes. Pottery painted in black under a blue glaze has been found in some quantity near Damascus and tiles of the same kind of ware adorn buildings in the city. Some of thcsc have delicate Persian scroll-work suggesting a date not later than the 15th century, while other specimens have the large feathery leaf designs which appear on the Turkish wares. Finally Damascus has been credited with the manufacture of the most refined of the wares of Turkish type, distinguished from the rest by soft colours which include a dull lilac in place of the thick Turkish red, a delicate turquoise blue and sage green, and also by a certain Persian flavour in its arabesque ornaments. It must be admitted, however, that the claims of Damascus to a monopoly of this ware are more than doubtful.

The most outstanding feature of the pure Turkish pottery is a brilliant red colour, made with Armenian bole, which is laid

BY COURTESY OF (1, 5, 9, 10) THE METROPOLITAN MUSEUM OF ART, NEW YORK, (3, 6, 8) THE MUSEUM OF FINE ARTS, BOSTON, (7) JOHN PLATT; FROM (2, 4) THE WARREN E. COX COLLECTION

KOREAN POTTERY

1. Wine pot and cover of gray porcellanous clay, green celadon glaze, Korai period **(918–1392 A.D.).** Height **8½″.** 2. Mishima ware. **3.** Vase, dragon design, Korai period. 4. Rare saki bottle with reticulated superstructure, 5. Vase dark brown painted design on gray clay, greenish glaze. Height 10½″. **6.** Jar, lotus design, Korai period. 7. Plaque, celadon with black and white inlay. 8. Vase. Korai period. 9. Winepot with spout and handle, buff clay, coffee brown glaze of ***temmoku*** type, probably Korean, Korai period. Height 7″. **10.** Box, inlaid design, Korai period. Height 3″

14TH CENTURY SYRIAN VASE

Syrian vase with typical tapering neck, made of light buff pottery covered with a deep blue glaze and then decorated and refired with metallic lustre. Now in the Victoria and Albert Museum on in palpable relief. Its manufacture must have been widely spread over the Turkish dominions, for the ware is found effectively decorating the walls of mosques and public buildings from Adrianople to Cairo. Important centres of the manufacture were at Constantinople, Nicaea, Broussa and possibly in the island of Rhodes, though the old tradition that the ware came exclusively from Rhodes has been proved erroneous. The dating of the Turkish ware is established by the tiles on various buildings of which the history has been preserved. by a few specimens with European metal mounts and by still rarer pieces with dated inscriptions. From these sources we learn that the best period was in the 16th century, and that the quality of the ware had deteriorated by the last part of the 17th century, when the designs had become coarse and hackneyed and the ware itself dirty and yellowish. A beautiful mosque lamp of the finest Turkish ware in "Damascus" style in the British Museum bears the date 1549. A ware of such individuality could not fail to affect the pottery of other regions, and its influence can be traced on the Persian pottery of the 17th century, and particularly on the kind which is called Kubatcha.

Kutahia in Anatolia was till quite recent times a busy ceramic centre. From the 17th century onwards a pottery of Turkish type was made here, but painted with small patterns—palmettes, scrolls and flowers, scale and leaf diapers, etc.—in lively colours including blue, turquoise, green, yellow and the Turkish red. It is a crisp ware, thinly potted and sometimes engraved with criss-cross patterns in the paste. Dated specimens of the years 1719 and 1787 are known. A much more artistic ware painted in shades of blue has also been attributed to Kutahia; but this attribution rests on the reading of an inscription of a ewer in the Godman collection (Cat. Pl. LV., No. 35) which is given as follows: "This mass cruet commemorates the servant of God, Abraham of Kutahia, Anno Armen: 959" (=A.D. 1510). The date is interesting, but if the reading is correct it still leaves open the question whether the ewer was made at Kutahia or elsewhere.

BIBLIOGRAPHY.—A. J. Butler, *Islamic Pottery* (1927); O. von Falke, *Maiolica* (1907); H. Gallois, *Islamische Kunst in het Gemeente-Museen* (The Hague, 1924); E. Hannover, *Pottery and Porcelain*, vol. I. (1925); D. Kelekian, *Catalogue of the Kelekian Collection* (Paris, 1910); E. Kühnel, "Datierte Persische Fayencen," *Jahrbuch der Asiatischen Kunst* (Leipzig, 1924); R. Meyer Riefstahl, *The Parish Watson Collection of Mohammedan Pottery* (1922); G. Migeon, *Manuel d'Art Musulman* (1927); G. Migeon and Armenag Bey Sakisian, *La Ce'ramique d'Asie Mineure et de Constantinople du XIVe au XVIIe siècles* (1923); M. Pézard, *La Ce'ramique archaique de l'Islam* (1920); G. Chatfield Pier, *Pottery of the Near East* (1909); F. Sarre, *Die Keramik in Euphrat- und Tigris-Gebiet* (1921), *Die Keramik von Samarra* (1925); H. Wallis, *Persian Ceramic Art* (in the Godman Collection) (1891). (R. L. Ho.)

UNITED STATES

It is difficult to write an accurate comprehensive story of pottery and porcelain in the United States. There are several reasons. First, local history is inadequate. In some parts of the country where the potters did not belong to the group considered socially important, it is almost impossible to trace accurately their activities because they mere seldom mentioned in newspapers or records. In other sections, the potters were among the leaders so that complete records are available. As a result, it is sometimes incorrectly supposed that certain parts of the country had practically no pioneer potters. The second reason is that until the 20th century, ceramic history centred attention on foreign developments. The third reason is that nowhere is terminology clear-cut, due to the fact that pottery began before there were printed records and has continued to spread and develop in many directions ever since so that each new development has been a gradual merging of one phase of expression into another. Such changes often took place simultaneously even in different parts of the same country. Twentieth century commercial practice added to the confusion of terms. Often manufacturers gave to their ware trade names which erroneously suggested classification within groups popularly considered valuable. Because of looseness in terminology, it was usually impossible to determine unquestionably where one classification ended and another began, or to list characteristics which could remain unchallenged as distinguishing qualities of a given group.

Historically, development of pottery and porcelain in the United States was practically a duplication of the progress of ceramic history of the world except that, due to an accumulated ceramic knowledge and new scientific and industrial processes, ceramic development in the United States took place within about 300 years, while the world development had been going on for many centuries. The history of American pottery and porcelain can be divided into three distinct periods. The first comprised pioneer pottery made by individual potters for utilitarian purposes. By gradual change, ceramics became an important industry supplying quantities of inexpensive ware made by mass production methods, and about the middle of the 19th century the decoration and making of pottery and porcelain began as an art.

Pioneer Pottery.—Pioneer pottery resulted from the use of natural local materials made simply and directly into articles needed in the everyday life of the group wherein the potter lived. As a result, the ware had a ruggedness, directness and simplicity which are usually lost as soon as civilization reaches the point where needs are less demanding.

Potteries were operated by three and four generations of the same family The principles and problems of the potter's life were similar to those of a carpenter or blacksmith--only materials and equipment were different. Often the potter was part farmer or tradesman. Usually, the red firing clay was baked at a comparatively low temperature so that the ware was porous and easily broken. Glazes were lead or a mixture of lead, flint and clay. Workshops were fitted with a wheel and a kiln. Near by was a clay pit with a paddle turned by a mule or horse for mixing. In most cases, ware was thrown on the wheel but occasionally it was pressed into or over moulds of fired clay or wood. Often pieces were decorated with quaint designs, mottoes or patriotic inscriptions. The drawing was childlike, the craftsmanship varied.

Decoration was done in various ways. In one method, slip (liquid clay) of a different colour was painted on by means of a brush or slip cup. This was called "slip painting." Sometimes a piece was partially or completely covered by slip and later, when the piece was "leather-hard." the design was scratched through the slip. This method was known as "sgraffito." At other times a design was cut or scratched into the clay without the coating of slip. Such objects as churns, crocks, pitchers, plates and toys were made. The colours were terra-cotta, white, dark brown and yellow, with touches of green and blue. Often the ware was distributed by boat, especially throughout the Ohio and Mississippi valleys as far south as New Orleans. At other times it was sold in local stores or peddled from door to door. Some pieces are valuable historically because important events were recorded and dated. Examples of this ware can be found both in museums and in private collections. One of the best displays is in the Pennsylvania museum in Philadelphia.

The term "pioneer" potter refers more to a point of view or a stage of development than to chronology. During the colonization period, pottery enterprises spread. In each case, the simplest use of local clays made into utensils was the most logical beginning.

By the early 17th century, many pioneer potteries were established, though the exact date and location of the first potter is not known. In 1641, John Pride was working in Salem, Massachusetts. There are indications that potteries were in Jamestown, Virginia, at the time of Captain John Smith and it is known that as early as 1650 several potteries had been established in Virginia. It appears that in 1684, a pottery was functioning in Burlington, New Jersey. Dr. Daniel Coxe of London, once governor of New Jersey, caused the pottery to be built. In eastern Pennsylvania, Germans settled as early as 1735, then spread southward and westward. Beginning about 1750, over 115 potteries were recorded in eastern Pennsylvania alone, making colourful slip-painted and sgraffito ware according to the German tradition. All were small. The Bell pottery of Waynesboro boasted six wheels. It was considered large. Peter Craven, the first of the Jugtown potters in North Carolina, is said to have come from Staffordshire, England, about 1750. From that time to the present date Jugtown potters have supplied the needs of that community. The ware is shaped on the wheel and glazed with simple glazes. The first pottery known west of the Alleghenies was built at Morgantown, West Virginia, by Foulke, about 1784, and continued until 1890. William McFarland went from Kentucky to Losantiville, later called Cincinnati, and many others followed to various parts of Ohio, Indiana, Illinois, Minnesota, Missouri and farther west. The Moravians were established in North Carolina about 1840. They were the same race and religion as the German settlers of Pennsylvania. Their ware was similar. One potter was named Brother Aust. He must have been successful because the authorities of the colonies complained that people came from a radius of 50 to 60mi. to buy. He was ordered to discontinue sales to outsiders "on account of the crowd it draws."

Refinement of Ware.—As communities became more established and there were time and money for more than bare essentials, pottery began to leave the pioneer stage. This took place as a gradual natural growth, affected tremendously by the development of the machine age and greater use of available scientific knowledge. These changes brought about increased refinement of clays, more expert workmanship, higher fire-effecting harder bodies and glazes—mould production, improved machinery and new decorative processes. Thus, generally speaking, one may say that pottery began with pioneer ware—soft, crude and red—and progressed by successive steps through Rockingham ware to a gray stoneware often glazed with salt, and on to white china and porcelain.

During the early part of the 18th century potteries sprang up in many places and great development followed. Two families, headed by John Remmey and William and Peter Crolius, established themselves at "Pot Baker's Hill" or "Potters' Hill," New York city, in 1745. The two families worked and lived as neighbours for several generations. Both families included members influential in public life. Connecticut, the birthplace of the beanpot, led in quantity production of pottery and earthenware from 1771 to 1850. In 1793, Captain John Norton, who had learned his trade in Litchfield, Connecticut, founded a pottery in Bennington, Vermont. It functioned over a century. The ware of this period was glazed in several ways; one was by throwing salt into the fire so it would volatilize and coat the piece with sodium silicate, thus making what is known as "salt glaze ware." In a second method, a stoneware clay was coated with Albany slip, a low-burning red clay. By firing the coated piece to a high temperature, the slip melted into a beautiful brown glaze.

Beginning of White Ware.—Next came interest in a whiter ware. During the last part of the 17th century and throughout the 18th, England, France and Germany were striving to produce ware equal to porcelains from China. In the Bodleian Library at Oxford an old record indicates that "white Chiney Ware" was made at the pottery established by Dr. Daniel Coxe near Burlington, New Jersey. It may have been the first white ware made in the United States. In 1745, William Cookworth, an important potter of England, wrote referring to a "china earth" discovered in Virginia. He said, "I have lately with me the person who hath discovered the china earth. He had samples of the china ware of their making with him, which were, I think, equal to the Asiatic. 'Twas found in the back of Virginia. He has gone for a cargo of it, having bought the whole country from the Indians." Some authorities believe the samples referred to were made in the United States; others think they were made in England from clay imported into England from the United States. In a patent taken out in 1774 by Edward Heylyn and Thomas Frye of the Bow Pottery in England for the making of "china ware" it was stated that the material was "an earth, the product of the Chirokee nation in America, called by the natives 'Unaker'." Samples found at the Wedgewood factory and tested by William Burton proved that "Unaker" was a china clay.

During the 18th century, after Philadelphia had become the social capital of the United States, there was a demand for better ceramic wares to supply the needs of a well-to-do class. With this background, more refined ware began to succeed. In 1765, Josiah Wedgewood was worried because potteries were being established in the American colonies. Referring to the colonial market, he wrote, "We cannot make anything too rich and costly"

For about 100 years, potters tried to make chinaware before they were able to record commercial success. During that time, numerous fortunes were lost. Many of these efforts took place in or near Philadelphia. Alexander Trotter was mentioned in 1808 as a leading manufacturer of Queensware (earthenware). Another Philadelphia potter was Abraham Miller, member of a family of potters, an expert modeller, member of the State senate, and a leading member of the Franklin Institute. In 1824, he exhibited a silver lustre pitcher and a specimen of porcelain. In 1842, he showed decorated plates, vases and ornamental flower pots. By the time he died in 1858, excellent American porcelain was being made, equal in quality to the best produced in England. Around 1850, American potters began to succeed in producing a vitrified earthenware and parian—a hard, unglazed white ware, which required fewer skilled workmen and presented no problems with glaze and cblour. Later, a modified parian appeared as a very thinly cast glazed ware. It was called Belleek. Although small amounts of high grade white ware had been made, it was not until about 1825 that porcelain was manufactured in any quantity. About 1820, William E. Tucker, a member of a Quaker family of educators in Philadelphia, undertook to decorate imported white ware by the overglazed process. Soon he became interested in making his own ware for decorating. The beginnings were crude, but several medals were earned. In 1825, he succeeded in making hard-paste porcelain. Eventually, there were financial struggles and changes in partnerships until, in 1832, Joseph Hemphill joined the firm, bringing financial backing and a great capacity for business. Soon Tucker died and Hemphill imported capable workmen from Europe. As a result, the firm experienced a period of producing excellent ware of expert workmanship and a better quality of design.

Moulds for Quantity Production.— In 1859, the demand for cheaper domestic ware had grown sufficiently to enable potters to establish themselves on a sounder financial basis. Mould making was being carried on as a trade by men who made and sold moulds, though exclusive rights mere not yet practised. Small potteries often purchased their moulds from a mould maker or a defunct potter. Probably no one person contributed as much practical information toward this change in production as William Bloor. In Trenton, New Jersey, from 1854 to 1859, he was associated with James Taylor and Henry Speeler who established the first pottery factory in Trenton in 1852. In 1856, a medal was awarded the firm by the Franklin institute of Philadelphia. In 1859, he went to East Liverpool from whence he had come in 1854. There, in 1860, he manufactured on a commercial scale the first white ware to be made in East Liverpool, Ohio, now one of the great pottery centres of the world. The ware was translucent and well vitrified. Most of it was made in moulds and skilfully decorated with designs painted by expert workmen. This success had a great influence on the production of moderately priced white ware. In 1865 he returned to Trenton, which at that time was America's pottery centre and helped establish the firm which later became the Eutreria pottery where a high quality Belleek china and fine ivory porcelain were made.

In 1870, he went back to East Liverpool where he supplied the potteries with materials from mines he had discovered and owned in New England, Maryland and Missouri. Later, he helped establish the Dresden pottery of which firm he was a member when he died in 1877. In the *Journal of the American Ceramic Society* it is stated of Bloor: "Giving information freely to competitors in Trenton and East Liverpool, the transition from yellow ware to white ware was quickly made under Bloor's tutelage. Americans were ready and able to purchase white ware made on Bloor's formulas and by Bloor's methods. Thus the white dinnerware industry of Trenton and East Liverpool was started by Mr. Bloor."

One pioneer in the manufacture of pottery in Trenton, New Jersey, told how he had travelled over the States of New York, Pennsylvania, Delaware and Ohio, searching for the best place to manufacture pottery. He had chosen Trenton because it mas between the two great markets—New York and Philadelphia—and because the section was healthy, abounding with fine clay and convenient for the collection of other materials by canal or river.

Referring to development during a few years following 1861, he wrote: "If the business increases at the same ratio, Trenton is destined to be the Staffordshire of America and in 50 years hence but little ware will need to be imported." In 1890, Mrs. Benjamin Harrison wished to buy domestic tableware for the White House but could find nothing suitable. It was not until 1918 that Lenox, Incorporated, Trenton, New Jersey, supplied the White House with the first American-made table service

Imported Workmen. — Far-sighted manufacturers often brought skilled workmen from France, England and Germany to improve the quality of their ware. About 1835, Joseph Hemphill of Philadelphia imported experts from Sevres who produced pieces more or less copies of Sevres ware. In 1843, Julius Norton, the third generation of potters at Bennington, Vermont, brought over John Harrison, modeller from Copeland; he brought many of the latest moulds and designs being used in England. About the middle of the 19th century, Charles Csrtlidge and Company of Green Point, New York, brought Josiah Jones from the Staffordshire pottery in England. He was a designer, modeller and ceramist. Soon after his arrival he imported Elijah Tatler, a decorator of great ability. In 1853, the firm sent ware to the International exhibit in New York. It included tea and dinner sets in bone china, as well as earthenware and statuettes, modelled by Jones. There are good specimens of these in the Metropolitan museum and the Pennsylvania museum.

Handicaps. — From the beginning, unfamiliarity with new materials was a definite handicap to the potter. One who had been a master workman in the old country might find himself bankrupt in the new country before he became accustomed to materials. Since there was little scientific ceramic knowledge he had to discover correct materials and proportions by the trial and error method before his funds were depleted. While the problems of new materials were being overcome, and better ware was being developed, a more sophisticated social life was evolving so that the potter had to deal with a public prejudice against American-made ware. Sometimes the cause of the prejudice was due to the fact that American-made ware was more crude, but often people considered it elegant to use imported ware. The European manufacturers encouraged that feeling. At times there was sabotage among the American workmen, sympathetic with the mother country. At other times the markets were temporarily flooded with ware to be sold at a price the local manufacturer could not meet, so that the potter had to go out of business or move to a section where there was less competition.

Toward the end of the 19th century, there were other handicaps. Both in Europe and the United States, emphasis had been placed upon improved techniques for mass production at the expense of sound design. As a result, many pieces were created primarily as demonstration of technical skill with little thought of good design. Eventually there was a reaction, especially in Europe where simpler and better design began to replace the extravagantly ornate. The designers in the United States still clung to the type of design traditional with the designers, who were usually old countrymen. Conservatism and prejudice against ware made in the United States lasted well into the 20th century.

Ceramics Becomes Scientific. — Up to the end of the 19th century, ceramic information had been guarded and handed on from generation to generation. New discoveries were kept secret and experimentation was carried on by rule of thumb. While working on the minerals from 1884 to 1894, Edward Orton, Jr., discovered a dearth of literature concerning the science of ceramics. Being a public spirited, practical man, he succeeded in getting sufficient support for a lam authorizing the establishment of a ceramic department at Ohio State university in Columbus in 1894. It was the first school in the United States for the scientific study of ceramic engineering. Not long after that the New York State College of Ceramics was established at Alfred, New York, with Charles F. Binns as its director. Dr. Binns had had life-long acquaintance with ceramics since his father was a factory superintendent in England and he himself was for some time superintendent in the Royal Porcelain Works at Worcester, England. Soon other States had established similar departments. At these schools scientific methods were developed for compounding efficient bodies and glazes and for solving problrms encountered by the potters. The ceramists turned more and more to the fields of chemistry, physics, geology, mineralogy, microscopy and other sciences to discover what those fields might contribute.

Under the leadership of Edward Orton, Jr., the American Ceramic Society was founded in 1898 to co-ordinate ceramic interests and further progress. Its work was carried on by meetings, by collecting, publishing, and distributing available ceramic information and by encouraging research. Thus ceramic knowledge became accumulative so that early in the 20th century a person successfully completing a four-year ceramic course had the opportunity of a better understanding of the science of ceramics than a master under the old system could have had after working a lifetime.

As trained ceramists were gradually absorbed into the potteries, they greatly influenced production — making better-wearing bodies and glazes and developing cheaper factory methods. However, because emphasis was put on science and technique, at the expense of good design in form, colour and decoration, the country was soon producing ware which was of the best technically but the designs were often copies of European patterns or a conglomeration of patterns produced under a variety of conditions. As a result, the ever-developing taste of the American public continued to be prejudiced in favour of imported ware, but this time for a different reason. It was no longer the quality of the ware or workmanship which was responsible for the prejudice but instead lack of beauty and distinction and the absence of that intangible quality which comes from the hand of a skilled creator but is lost by one who copies — regardless of how accurately the work is done.

Pottery and Porcelain as an Art. — About the middle of the 19th century, European women were interested in doing overglaze decorating. The idea spread to America where it became fashionable for women to go to Europe to study the subject. In 1879, the Cincinnati Pottery Club was formed by a group of women for the purpose of encouraging sound pottery production. They did under- and over-glaze decoration and made porcelain. Much credit is due this pioneer work. In 1891 the National Ceramic Association was founded. Ten thousand women were actively engaged in the United States working at ceramics. Five thousand earned a living doing over-glaze painting. The association was organized in Chicago where there were 1,000 pottery decorators. The object was to advance the art and secure the finest possible exhibition for the World's Fair. In 1892 Mrs. S. S. Frackelton of Milwaukee, Wisconsin, organized the "National League of Mineral Painters." Its aim was to bring into closer relationship the overglaze painters in order to define lines of study and to aid in the development of a national school of ceramic art. At one time the membership became as high as 500 women. They exhibited in many places and took part in international expositions, often winning recognition for exceptional achievement. Later, Mrs. Frackelton did excellent work with salt glaze in an effort to use a humble material as a medium for artistic expression. She received honours at home and abroad. Many of the decorators became interested in creating the forms they were to decorate. Some of those creating the forms continued to expand until a business or profession was established. As a result of the activity of the Cincinnati Pottery Club, the Rookwood pottery developed. The Pewabic pottery was established by Mrs. Stratton in Detroit. Mr. and Mrs. A. Robineau in Syracuse, New York, turned to porcelain, carved decoration, crystalline and other glazes. Also, they were in charge of a ceramic department at the University of Syracuse. Charles F. Binns in his work at the New York State College of Ceramics lent valuable support to the expression of ceramics as an art. Besides helping to organize the science of ceramics, he made excellent stone ware of the quality of the Chinese. He knew factory methods and was an expert craftsman who often explored the historical background of ceramics. Because of his broad interests and high standards, he was an inspiring teacher in the field of ceramic art. Many excellent ceramic artists were trained by him and valuable research was done under his direction.

It was only natural that the increased interest in the art expression of ceramics should result in new scientific developments among the artists and improved design for individual and manufactured ware. To study and further these ends, a section of the American Ceramic Society was organized which was known as the Art Division of the American Ceramic Society. Work of the division is carried on through regular meetings, exhibitions and research reports and other articles published in the *Journal of the American Ceramic Society*. The most important regular exhibition is organized annually at the Syracuse Museum of Fine Art as a Robineau Memorial Ceramic Exhibition. It was started in 1932 by Ann Wetherill Olmstead, director of the museum. Because of Miss Olmstead's work, American potters were invited to send an exhibition to museums in the Scandinavian countries, to England, and to many important museums and galleries of the United States. As a result of various efforts the quality and appearance of mork done by studio potters improved greatly during the first half of the 20th century and the design of ware for reproduction methods is given increasing attention.

After about 150 years of technical, financial and artistic struggle, it is encouraging to find that in 1940, the best of the United States pottery and porcelain is as good in quality and design as any made. Ceramic artists in many parts of the country mork as designers, studio potters and teachers; the number increases steadily and standards constantly improve as the general public learns to understand the beauty of fine ceramics.

Many States have tax-supported ceramic schools. Art schools advocating better designs for industrial use encourage the ceramic department to study mass production possibilities and methods along with the craft of the potter. Pottery work is taken more and more seriously in public schools. The national, State and local governments are sponsoring the making of pottery as an art expression. A U.S. ceramic experiment station is in the Tennessee Valley. *(See* also NORTH AMERICA: *Distribution of Cultures.)*

BIBLIOGRAPHY.—*Books,* John Ramsay, *American Potters and Pottery* (1939); Edwin Atlee Barber, *Tulip Ware of Pennsylvania-German Potters* (1903); Jennie Young, *The Ceramic Art* (1873). *Magazines,* Charles Fergus Binns, "Pottery in America," *The American Magazine of Art* (Feb. 1916); Frederick H. Rhead, "America as a Ceramic Art Center," chap. I. *Fine Arts Journal* (April 1910); Evelyn Marie Stuart, "America as a Ceramic Art Center," chap. II, *Fine Arts Journal* (May 1910); Clara Ruge, "American Ceramics—A Brief Review of Progress," *International Studio* (Vol. 28, Mar.–June 1906 pp. supp. 21–29), many numbers of the magazines: *Antique; Design,* November numbers; *Bulletin of American Ceramic Society.* (M. M. F.)

POTTER'S CLAY: *see* CHINA-CLAY,

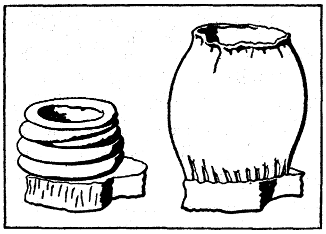
POTTERY, PRIMITIVE. Receptacles of some kind are essential to man, however primitive, and are made of basketry, skins, gourds and other suitable natural objects. But over all these pottery has an advantage, for it can be brought into contact with fire and not be destroyed, and it is therefore valuable for cooking purposes.

Pottery-making is not universal, however; partly because its construction is not easily carried on under certain cultural conditions, *e.g.,* a nomadic life; partly because it depends upon suitable materials being available, though sometimes potters obtain their clay from other districts. It is absent from large regions of America, and in certain islands of the west Pacific has become a lost art. The knowledge of pottery-making was, at one time, believed to mark a stage in the cultural development of mankind, but its presence among such peoples as the Andamanese, Eskimo, Bushmen and Hottentots, and its absence among the advanced Polynesians, make this questionable

The manufacture of pottery falls into five stages: preparing the *body* or raw material; shaping the pot; drying and firing it; decorating it; and varnishing or in some other way rendering it non-porous. This last is often lacking in the pot-making of primitive peoples, but the other four processes are found in the manufacture of the simplest wares.

As regards the raw material, it seems that the clay is frequently dug and seasoned for a while before using. Clays vary very greatly. Those which are highly plastic and hold the water, though convenient for working. are liable through excessive shrinkage to crack in the drying or firing of the pot and must therefore be *opened* by mixing them with non-plastic materials Sand is often used to this end, or carbonaceous materials such as chopped grass, cinders, dried cow or donkey dung; frequently old potsherds are ground up for this purpose. In mixing the *body,* the proportion of clay, *opener* and water necessarily varies greatly and is judged empirically by the potter.

Shaping.—The body having been prepared, the next stage is the shaping. There are three main ways of doing this: by hand, with the aid of a few simple implements; by moulding; and by throwing on the potter's wheel. Of these, the first is by far the most common. There are two hand techniques—modelled and coiled. The simplest way in which a pot is modelled is that used by the women of the Baronga in South Africa. Having kneaded the body into a very soft ball, the woman "makes a hole in it, which she enlarges by degrees, hollowing it out and gradually giving it the shape she wishes. . . . It is astonishing to see the beautiful symmetry of these utensils." (H. Junod, *The Life of a South African Tribe.)* If the pot is to be a big one, the initial lump of clay may not be enough and more is added to build up the walls of the vessel. Frequently the pot is modelled in parts, which are then welded together.



FROM DALE & SMITH, "THE ILA SPEAKING PEOPLE OF NORTHERN RHODESIA" (MACMILLAN)

FIG. 1.—STAGES IN PRIMITIVE POTTERY PRODUCTION

Left, rings of clay piled up. Right, walls completed by scraping the clay upwards

In the coiling technique, the raw material is rolled out into a slender rope which is coiled upon itself (fig. 1).

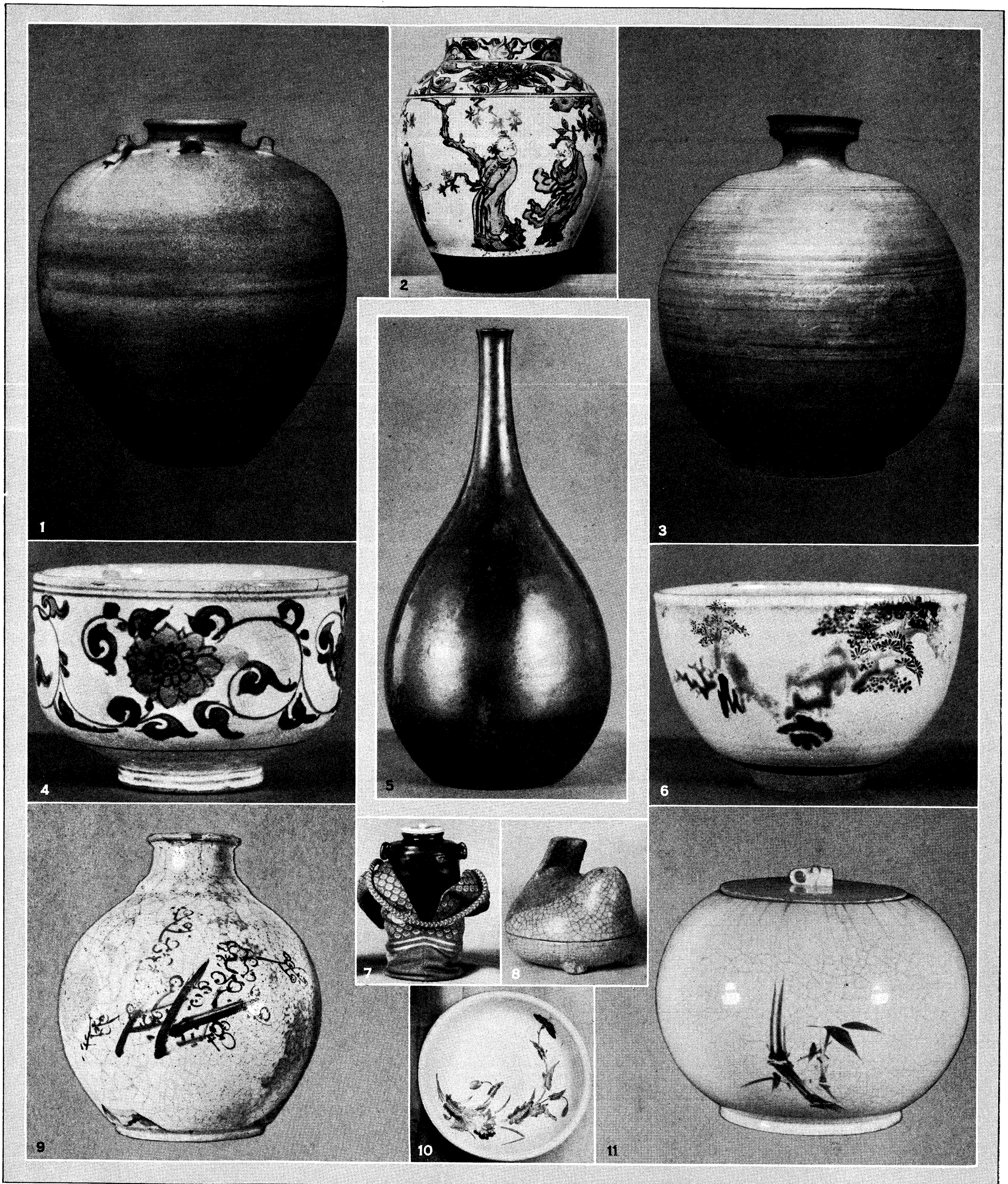
The coils are carefully worked together with the fingers and the unevennesses smoothed away, so that, when the pot is finished, no trace of them is visible except occasionally in faint ridges on the inner surface. The modelled and coiled techniques may be combined; the base of the pot is modelled from a lump and the coils built up on this.

Certain tribes used baskets for moulds. These were subsequently burned in the firing. A similar method is used by shaping the belly of the pot over a ring of vegetable fibre, then adding the neck and base. In these examples a mould is destroyed with every pot made. More advanced is the method by which one mould is made to serve several times. Among the Hausas of Nigeria, a pot is inverted and over this a sheet of clay is spread so as to form a bell-like dome. This is then removed from the mould and the shoulders and neck modelled by hand (fig. 2). A moulded pot may be made in two or more sections, then joined.

Shaping a pot by means of throwing on the wheel is little known among primitive peoples, because primitive potters can make by hand pots which rival those thrown and because it takes years to learn to throw expertly.

Drying and Firing.—When a pot is finally shaped, it is necessary to render the clay hard by firing it. The material of which a vessel is composed contains a certain amount of free water which can be removed by leaving it to dry or be sun-baked for a time; but it also contains a quantity of combined water which is only liberated at a temperature of from 350°–400° C. If only sun-baked, the vessel when filled with water would absorb this and after a short while collapse into a shapeless mass. But when the combined water has been liberated the clay is completely decomposed; it is impossible for it to become malleable again and it will hold water safely. Except, therefore, for certain pots which are destined only to contain grain and other dry goods, all vessels must be fired.

After being shaped the pot is set aside to dry for some hours, usually where there is a free current of air. Except in a few cases, ware is fired but once. Usually the firing is done in the open. The pyre is carefully built and the pots stacked so that the heat may circulate freely. A genuine kiln has only been recorded from the region of the Lower Congo. It seems to be a beehive shaped structure. The more common primitive practice is to bake the ware in a hole in the ground. The "oven" is fairly elaborate, for charcoal is used andopenings are therefore cut through the soil to the chamber that bellows may be employed to sustain the



JAPANESE POTTERY

1. Jar, Hagi, Nagato province, 18th century
2. Jar, Kutani, Kaga province, 17th century
3. Jar. Karatsu, Hizen province
4. Tea bowl, by Goroshichi, Hizen province, c. 1530
5. Wine bottle for offerings, Imbe, Bizen province, c. 1780
6. Bowl, by Ninsei, Yamashiro province, *c.* 1650
7. Teajar, Seto, Owari province
8. incense box, Raku
9. Bottle, Karatsu, Hizen province, 17th century

13. Dish, Kakiemon, Hizen province, 18th century

11. Jar for cake, Tada, Suo province, c. 1770

1

2

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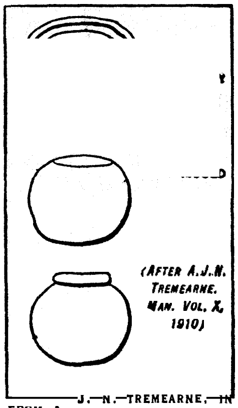
BY COURTESY OF THE TRUSTEES OF THE BRITISH MUSEUM

PERSIAN DISHES

1. Rhages dish, decorated in gold and red on cobalt blue ground. Diameter 14". 13th century
2. Rakka dish, showing strong virile design in black on turquoise and gold iridescence caused by time. Diameter 10". 11th century
3. Rhages dish, incised and glazed. Diameter 15". 12th century
4. Sultanabad dish, incised and glazed. Diameter 10¾". 13th century

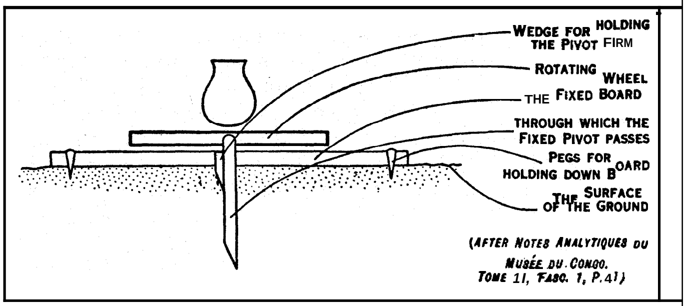
necessary heat. The time taken for firing varies greatly, from about half-an-hour to two days. Pots which have been fired for only a short time are less durable than others. There is great diversity of shapes and an amazing similarity in wares widely separated from each other in time and space. Some elaborate forms have a utilitarian purpose, others a religious significance, while others appear to be the outcome of the artist's desire to create something beautiful. In many cases, the pots are modelled in imitation of natural or manufactured objects, which before the introduction of ceramics served the people as vessels.



FROM A. J. N. TREMEARNE IN "MAN"
FIG. 2.— POTTERY MAKING
1. Clay spread over inverted pot, 2. Clay removed from mould and shaped, 3. New pot with roll of clay for modelling mouth

Decoration and Colour.—In most primitive pottery decoration is done by means of incised lines, made with a pointed stick, thumbnail or coil of rope. Sometimes wooden stamps are used or the "beater" with the aid of which the pot is modelled is carved or wrapped about with string and the designs may be but the marks thus left on the surface. Where pots are moulded over baskets, the clay will be decorated by the impress of these. The most usual designs are bands of chevrons or other rectilinear skeuomorphs, though animal and plant, and occasionally human motifs, do occur. To increase the effect, the incisions are often filled with powdered lime or some other substance which shows up against the dark background of the vessel. Less common are ornaments applied to the surface such as knobs, scrolls and figurines. Raised designs are also produced by pressing out the wall of the pot from within. Another method, of restricted distribution, is that of scraping away the surface so as to leave the figures in relief.

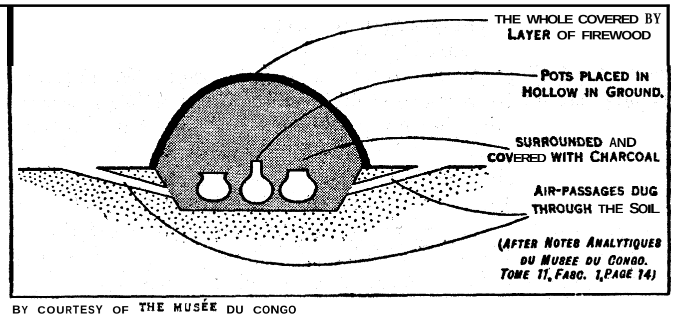
The colour of a vessel is to a great extent dependent upon the composition of the body and the method of firing. Of materials present in bodies, iron is usually the only colouring element. This, on being subjected to heat under oxidizing conditions, is changed into a red iron oxide and gives a shade varying from yellow to an orange or red; under reducing conditions producing a colour which ranges from light bluish gray to a deep, sometimes metallic, black. Usually among primitive peoples no effort is



BY COURTESY OF MUSÉE DU CONGO BELGE
FIG. 3.— DIAGRAM OF POTTERY MOULDING MACHINE

made to produce certain shades by regulating the conditions of the firing. A dark colour is often the result of a pot's being smoked; this may be an unintentional incident of the firing, but among the Ashanti it is brought about by setting the vessel, while still red-hot from the furnace, on a heap of dry tinder. This it ignites.' Water is then poured on and the pile is left smoking. The smoke permeates the heated clay and deposits on and sometimes through it a mixture of finely divided tar and carbon, rendering it non-porous. Decoration by means of slip is occasionally found, but true painted pottery is extremely rare among primitive peoples.

Varnishing.— Fired pots are nearly always porous. They are therefore frequently varnished and this varnish is often decorative as well as useful. Many different methods are employed to treat the surface with a resin, gum, fat or gelatinous substance. Similar in artistic effect to varnishing but without so great utilitarian value is the practice of polishing or burnishing the ware, but this is only possible where the clay is of a fine body. Though vessels are the most common pottery products of primitive peoples, other things are sometimes made, such as tobacco pipes, drums, toys and figurines.



BY COURTESY OF THE MUSÉE DU CONGO
FIG. 4.—DIAGRAM SHOWING PROCESS OF BAKING POTTERY

Sociological and Religious Aspect.—Little attention has as yet been paid by ethnologists to the religious and sociological aspects of pot-making. Generally the craft is confined to one sex, usually the female, except where the potter's wheel is used, which is always operated by men. In so far as domestic utensils are naturally matters which concern women it is not strange that they should be the potters, but this does not explain why, in many cases, men are definitely prohibited from potting nor why their very presence during the manufacture is inimical to it. Thus among the Sema Nagas of Assam a man may not even speak to a woman thus engaged nor approach her work. The making of ceramics is often the prerogative of certain families or a certain district and any infringement of this may easily cause trouble. Even where this is not so, certain villages become famous for their wares. Theories of origins are necessarily speculative, but in evolving them it must not be forgotten that clay shaped and burnt does not produce a pot. The body must be properly prepared, the vessel properly dried and fired under suitable conditions. The accidental discovery of pottery, therefore, is not so easy as has sometimes been implied.

BIBLIOGRAPHY.—No work has yet been written on primitive pot-making, but the following monographs and articles contain more or less detailed accounts of the methods of individual tribes. (1) *Africa.* W. Scoresby Routledge, *With a Prehistoric Pebple* (1910); *J.* Roscoe, *The Baganda* (1911) and *The Bakitara* (1923); *E.* Smith and A. M. Dale, *The Zla-Speaking Peoples of Northern Rhodesia* (1920); C. K. Meek, *The Northern Tribes of Nigeria* (1925); P. A. Talbot, *The Peoples of Southern Nigeria* (1926); H. Junod, *The Life of a South African Tribe* (1927); R. Rattray, *Religion and Art in Ashanti* (1927); *Notes Analytiques sur les Collections Ethnographiques du Musée du Congo* t. *I.* fascicule I. "La Céramique" (of theoretical as well as descriptive interest). (2) *America.* The following articles in the Fourth Annual Report of *The Bureau of American Ethnology (1886):*—*F.* H. Cushing, "A Study of Pueblo Pottery"; W. H. Holmes, "Pottery of the Ancient Pueblos," "Ancient Pottery of the Mississippi Valley," "Origin and Development of Form and Ornament in Ceramic Art" (of theoretical interest). (3) *Further India and Indonesia. E. H.* Man, "The Nicobar Islands," in *Journ. Royal Anthrop. Inst.*, vol. xxiii. (1893); A. R. Brown, *The Andaman Islanders* (1922); J. H. Hutton, *The Sema Nagas* (1922). (4) *General.* O. T. Mason, *Woman's Share in Primitive Culture,* chap. V. (1894) and *The Origins of Invention,* chap. V. (1895); Handbook to the Horniman Museum, *The Evolution of the Domestic Arts,* Part II. (1924); Louis Franchet, *La Ceramique Primitive* (1911); James R. Partington, *The Origins and Development of Applied Chemistry* (1935). (5) *Near East.* Henri Frankfort, *Studies in the Early Pottery of the Near East.* (Occasional papers No. 6 and No. 7 Royal Anthropological Institute 1924–27).

POTTHAST, AUGUST (1824–1898), German historian, was born at Hoxter on Aug. 13, 1824, and was educated at Paderborn, Miinster and Berlin. He assisted G. H. Pertz, the editor of the *Monumenta Germaniae historica,* and edited the *Regesta pontificum romanorum, r198–1304* (1874–75). From 1874 to 1894 he was librarian of the German Reichstag. Potthast compiled the monumental and indispensable *Bibliotheca historica medii aevi* (1862; new enlarged ed., 1896), a guide to the sources of European history in the middle ages. The work, in the form of an index, gives particulars of practically all the historical writers of Europe and their work between 375 and 1500. Potthast died on Feb. 13, 1898.

POTTINGER, SIR HENRY (1789–1856), British administrator, was born in Ireland, Oct. 3, 1789. In 1804 he became attached to the British army in India and during the next 35 years served successively as collector of Ahmadnagar, resident of Cutch and resident of Sind. In 1840 he was appointed envoy and plenipotentiary to China, a war having broken out between Britain and that eountry over the opium trade. In 1842, the struggle having been successfully terminated, Pottinger was responsible for the drawing up of the treaty of Nanking, the terms of which included the cession of Hongkong to Britain. He was made governor and commander in chief of Hongkong in 1843, the first to hold that office under English rule. He held the governorship for a year and subsequently served for a short time as governor of the Cape of Good Hope (1846–47). In Aug. 1847 he was appointed governor of Madras, where he remained until 1854. He died at Malta, March 18, 1856.

POTTO, the name of the West African slow-lemurs, *Perodicticus,* popularly miscalled "sloths." The aborted condition of the index finger is their most distinctive feature. The ordinary potto (P. *potto*) is about the size of a squirrel, with large staring eyes and a stump of a tail; its colour is rufous brown. Bates's potto (P. *batesi*), of the Congo, is nearly allied; the awantibo (*P. calabarensis*), of Old Calabar, has no tail (see PRIMATES).

POTTSTOWN, a borough of Montgomery county, Pennsylvania, U.S.A., on the Schuylkill river, 40 mi. N.W. of Philadelphia; on federal highway 422; served by the Pennsylvania and the Reading railways. Pop. (1920) 17,431 (90% native white); (1940) 20,194. It is the centre for a population of 90,000; and has important manufactures, notably of iron and steel, but including a large variety of other industries. The aggregate factory output in 1939 was valued at $25,677,000; retail sales (1940) amaunted to $11,307,000. In a natural park 3.5 mi. N. are the "ringing rocks," covering about 150 ac., which give different tanes of the musical scale when struck. Pottstown was founded in 1753 by John Potts, and was called Pottsgrove until 1820. It was incorporated as a borough in 1815. In this neighbourhood the first commercially important iron furnace in America was established in 1716.

POTTSVILLE, a city of Pennsylvania, U.S.A., the county seat of Schuylkill county; on the Schuylkill river, go mi. N.W. of Philadelphia. It is served by the Lehigh Valley, the Reading and the Pennsylvania railways. Pop. (1920) 21,876 (92% native white); 1940 federal census 24,530. It ha5 a picturesque location (700 ft. above sea level) at the gap made by the river through Sharp mountain and is in the midst of the southern ("Schuylkill") region of the anthracite coal field. Besides its large coal-mining interests, it has railroad shops and a variety of manufacturing industries, with an output in 1939 valued at $8,000,000. Bank clearings for the year 1940 aggregated $14,528,601. The city operates under a commission form of government. The first white family that settled here was massacred by the Indians in Aug. 1780. Permanent settlement dates from about 1795, and soon after that an iron furnace was set up. In 1804 this furnace was bought by John Potts, founder of the borough. Coal was discovered in 1807. The town was laid out in 1816, incorporated as a borough in 1828, became the county seat in 1851 and was chartered as a city in 1911. It was a centre of the Molly Maguires (*q.v.*) disturbances (1854–77) and some of the leaders were tried here and convicted in 1876–77.

POUCHED MOUSE, any member of the polyprotodont marsupial genus *Phascologale* (see MARSUPIALIA). There are over a dozen species, none larger than a rat. They feed almost entirely on insects. Pouched mice are found throughout Australia, where all the species have uniformly coloured furs, and in New Guinea and the Aru islands; most of the Papuan forms are distinguished by striping on the back.

PQUGHKEEPSIE, a city of New York, U.S.A., the county seat of Dutchess county; on the east bank of the Hudson river, midway between New York city and Albany. It is on federal highway 9E, and is served by the New York Central and the New York, New Haven and Hartford railways, river steamers and ferry to Highland. Pop. (1920) 35,000 (82% native white); 1940 federal census 40,478. A cantilever railroad bridge, 6,767 ft. long, with approaches, and zoo ft. above the water, spans the Hudson at this point, and a highway bridge there was completed in 1930. Intercollegiate boat races are rowed on the river annually. The city is built on terraces rising to 200 ft. above the river. On its eastern boundary is the extensive campus of Vassar college (*q.v.*), and 2 mi. N. of the city is the Hudson River State Hospital for the Insane (1871). There are several private schools in the city. and several charitable institutions, including a hospital (1878) and a home for old men (1881) founded by the Vassar brothers. The manufactures (valued in 1937 at $25,042,259) are numerous and widely diversified. The city's assessed valuation for 1940 was $46,757,761. Poughkeepsie was settled by the Dutch about 1698. It was incorporated as a village in 1799 and as a city in 1854. The New York legislature met there in 1778, 1780, 1781, 1782, 1788 and 1795, and there on July 26, 1788, the State Convention ratified the Federal Constitution. The name is a modification of an Indian word, meaning the reed-covered lodge by the little water place.

POULENC, FRANCIS (1899–), French composer, was born in Paris on Jan. 7, 1899. His first important work, the *Rapsodie Nègre,* played in Paris in 1917, excited much interest as the work of so young a composer. It was followed by Le bestiaire and Cocardes (1919) and Quatre *poèmes* de Max Jacob (1921) for solo voice and chamber orchestra. In 1920–21 he wrote the comedy-bouffe, *Le gendarme incompris,* with an ensemble of one violin, one violoncello, one double-bass, one clarinet, one trombone and triangle. A ballet, Les Biches (1925) was followed by Concert *champêtre* (1927) and by his Aubade for orchestra (1929).

POULSEN, VALDEMAR (1869–1942), Danish engineer, was born at Copenhagen, Nov. 23, 1869. He became an assistant in the technical section of the Copenhagen telephone establishment and in 1898 invented the telegraphone, an electro-magnetic phonograph capable of registering human speech by the alternating magnetization of a wire. In 1900 Duddell (*q.v*) devised his singing "arc" by connecting an inductance and a capacity with an ordinary arc; and in 1903 Poulsen invented a modification of this by means of which he produced continuous oscillations of frequencies used in wireless telegraphy (*q.v.*), thus solving one of the greatest problems in the science of radio technique. The Poulsen arcs are used by radio stations throughout the world.

POULTRY AND GAME. The term poultry includes fowls, ducks (domestic), turkeys, guinea fowl and geese; the word game is usually applied to wild duck, partridges, grouse, pheasants, quails, deer (venison) and other edible wild birds and beasts. Rabbits, hare and pigeons are usually classed with game.

Poultry and game may be cooked in a variety of ways: roasted; boiled; grilled; stewed in various forms; boned and made into galantines; baked in pies, puddings, vol-au-vents, pasties, etc.; combined with cereals, jellies and special sauces, or pounded and used for spreading on pastry or bread and butter.

Preparation of Game and Poultry.—Poultry and feathered game should be plucked and then singed to remove any stray hairs or feathers. It is easier to pluck poultry when warm. The neck is cut off at the shoulder, leaving the skin. There are two ways to draw poultry. The English loosen the skin around the vent with the point of a knife, lay the bird on a board, back uppermost, make a small incision in the skin of the neck lengthwise, insert the fingers through the opening and draw out the entrails, being careful to avoid breaking the gall. Americans cut a slit from the vent of about two inches and draw out the entrails from there. The gizzard, from which the inner bag has been removed, heart and liver are saved for giblet gravy or used in the stuffing. The bird is then washed thoroughly inside and out with cold water. Chop off the ends of the claws and fold back the pinions in the form of a triangle; turn the bird over and bend back the legs towards the neck. Either pin in place with a skewer (if a small bird) or use a trussing needle and stitch through the bird under the knee-bones, at the same time, securing the flap and pinions Birds which need larding should then be covered with bacon fat.

Roasting. — Birds which require stuffing should be filled with a suitable forcemeat (chopped meat, spiced and seasoned) which ought, if possible, to include the pounded liver of the bird. Turkeys and large fowls (capons) are frequently stuffed with veal and ham forcemeat flavoured with lemon peel and nutmeg or with chestnuts; geese and ducks with sage and onions chopped finely and mixed with other forcemeat ingredients, and ducks are occasionally stuffed with prunes and apples. Roast wild duck, widgeon, teal and most small game birds are generally served without stuffing, though pheasants may be stuffed with chestnuts. To keep game birds moist while cooking, a small piece of butter or rump steak is often placed inside the bird. Small birds should be protected with a buttered paper or larding. To roast very small birds, *e.g.*, larks, place them on a skewer.

The best way to roast a haunch of venison is to wrap it in buttered paper and seal this over with a flour and water paste. Ordinary dripping is used for basting poultry and venison, but butter is preferable for basting game birds. About 10–20 minutes before poultry and game have finished cooking remove buttered paper or larding and dredge with flour.

A good gravy with roast poultry or game is essential. Stuffed birds need a thickened gravy. Bread, cranberry, mushroom or chestnut sauce may be served with turkey, and sausages or bacon is a common addition. Roast fowl, pheasant, partridge and grouse are all usually accompanied by rashers of bacon and bread sauce. Water-cress is used as a garnish. Fried breadcrumbs are served with partridge, pheasant and grouse. Red currant jelly should always accompany roast venison and hare. Apple sauce is substituted for bread sauce in serving roast goose.

Poultry is boned and stuffed to form a galantine. Remove the head and feet; then draw the bird. Divide the skin down the back with a sharp knife and turn down the flesh from the ribs, breast and side bones, leaving these as bare as possible. Pull legs and wings carefully out at the sockets, cutting the sinews through with a knife, and turn these inside out with the rest of the outside skin. Free the skeleton and turn the skin outwards again. Stuff the bird to restore its original shape.

Other Methods of Cooking. — All poultry may be boiled in the same way as butcher's meat, *i.e.*, in a well-flavoured stock (see COOKERY) and served with different sauces, *e.g.*, boiled chicken and egg sauce. As a general rule, game is not boiled. Both game and poultry are used for making entrées and these may take the form of elaborate stews (brown stews flavoured with special condiments, such as mushrooms, truffles, orange peel, vegetables, etc.); salmi of game; timbales (moulds of cold poultry and game); creams (purées with cream and egg liaison); fricassées; blanquettes; spatchcock of game (split bird grilled and served with melted butter to moisten); jellies (cold game and poultry purées formed into shapes and masked with aspic or white sauce. or both mixed together); minced game and poultry formed into rissoles or croquettes and dipped in batter, rolled in pastry or dipped in egg and breadcmmbs and fried in deep fat.

In the making of soups, game and poultry are also used as foundations, and any game or poultry may be used for making raised pies, ordinary pies, pasties and vol-au-vents. (See PASTRY.) Where sufficient giblets are available these may also be used for pie-making. To prepare giblets, first scald them and remove any outer skins, such as tough skin adhering to gizzards, etc., take out crop and remove gall. Cut into convenient pieces and partially stew before adding to the pie.

Rabbits and Hares. — For roasting, rabbits and hares are first cleaned and then filled with stuffing; after which they are sewn up. Extend the fore-legs straight along the sides and skewer through the body. Bring the hind-legs forward and bend back the head on to the shoulders and fix into place by passing a skewer through the mouth into the body. For stewing, brown the meat in the same way as for meat. Rabbits may also be curried. For jugged hare, skin and clean the hare, joint it and remove the liver; place in an earthenware pot and add a bunch of sweet herbs, onion stuck with cloves, blade of mace, piece of lemon rind, celery seed or stalk of fresh celery, carrot and a few button mushrooms. Cover with stock Cook slowly until the flesh is tender. Strain off the gravy and thicken with flour, pounded liver and some of the blood of the hare. Stir in one tablespoon of red currant jelly, one tablespoon of Worcester sauce and a dessertspoon of mushroom ketchup. A wineglass of port wine is frequently added to this dish. Serve with fried or poached forcemeat balls and red currant jelly.

POULTRY AND POULTRY FARMING. In practically all countries poultry farming for the purpose of producing meat and eggs for table use is carried on to some extent. In fact, few other agricultural enterprises are so widespread, and in Eire, China, Canada, Denmark, England, Australia and the United States and some other countries, the poultry industry is one of the leading branches of agriculture. Within each country the egg and chicken business is by far the most important branch of the poultry industry.

In most countries turkey production is carried on to a limited extent only, although in the United States it is a relatively important enterprise. The raising of ducks for eggs is an industry of moderate importance in England, the Netherlands and Belgium and for meat production primarily in the United States Geese are raised exclusively for meat, goose production being of limited importance in practically all countries except Germany and in one or two other European countries. The raising of guinea fowl for meat production is of relatively little importance in any country.

In all countries most flock owners of chickens are primarily interested in egg production because more income is obtained from egg production than from chicken-meat production. In certain sections of some countries, especially France, England and the United States, however, producers receive practically all of their poultry receipts from market poultry. It is true, of course, that on farms where egg production is the primary consideration most of the males raised each year are sold as broilers, fryers or roasters.

Domestic breeds of chickens descended from the jungle fowl of India. The numerous modern breeds of chickens known throughout the world may be conveniently classified into the following five classes, on the basis of their origin: English, Asiatic, American, Mediterranean and Continental European. The breeds belonging to the Mediterranean class are for the most part somewhat smaller in body size and more active than the breeds belonging to the other classes. Also, Mediterranean breeds lay white-shelled eggs, become broody relatively seldom, and have white ear lobes whereas most of the breeds belonging to other classes lay brown-shelled eggs, are likely to become quite broody, and have red ear lobes. The Mediterranean breeds are not as well suited for meat production as most of the other breeds. The Asiatic and some of the Continental European breeds have feathered shanks whereas other breeds have nonfeathered shanks.

Principal Breeds and Varieties.—Although there are more than 100 breeds and varieties of chickens, the number kept primarily for meat or egg production or both is very limited, several breeds and numerous varieties having been developed because of some unique structural character, such as an odd shape of comb or the presence of a crest on the top of the head, or because of the beauty of the plumage pattern. All birds belonging to the same breed have the same shape. Varieties within a breed differ with respect to colour of plumage. There are numerous Bantam breeds, kept by some poultrymen as novelties. Only the more popular breeds and varieties of outstanding economic importance can be discussed here.

Australorp.—This breed originated in Australia and was developed primarily as an egg producer, although its medium size makes it a good meat bird. The comb is single, the skin white and the plumage black. It is kept to some extent in the United States but is more popular in Australia.

Dorking.—The Dorking is an English breed and of the three varieties, the White, the Coloured, and the Silver Gray, only the last named variety has assumed importance in England. Dorkings have long, broad, deep and low-set bodies and five toes, most other breeds having four toes. The Silver Gray Dorking has a single comb and white skin, is an excellent meat bird and is used to a considerable extent in England for crossing with some of the Game breeds.

Leghorn.--Of the 12 different varieties of Leghorns, only the Single-Comb White is kept extensively in any country. The Leghorns belong to the Mediterranean class. White Leghorns have been bred to a high level of egg production in England, Canada, Australia and the United States and for years have occupied a very prominent place on commercial poultry plants devoted to market egg production. Its white-shelled egg and yellow skin enhance its popularity, although Leghorns do not make as good table birds as most of the larger sized breeds. For market egg production, exclusively, and for economy of production the Single-Comb White Leghorn is pre-eminent.

New Hampshire.—The New Hampshire is an American breed, with single comb and yellow skin, popular in the United States and Canada as an egg and meat producer. In both sexes the plumage over most of the body is chestnut red, and there is some black in wing and tail feathers; in the male the hackle and saddle feathers are reddish bay. Well bred New Hampshires grow fast and mature early and for that reason have been used extensively for the production of broilers and fryers. For this same purpose New Hampshire females are crossed with Barred Plymouth Rock males with good results.

Orpington.—This is a single-combed English breed of which there are four varieties: Buff, Black, White and Blue. The Buff and White varieties have enjoyed more popularity in England than the other varieties. The Orpington is an egg producer of moderate ability as compared with the Leghorn and the more popular American breeds. The white skin is largely responsible for the raising of the Buff variety in the middlewestern section of the United States, where a dressed carcass with a light-coloured finish is sometimes desired.

Plymouth Rock.—Among seven different varieties of this American breed, only the Barred and the White varieties have assumed a place of economic importance, although the Buff variety is kept to some extent. The comb is single and the skin is yellow. In the Barred variety the black and white bars should be of equal width in males, and the white bars should be one-half as wide as the black bars in females. In both sexes the end of each feather is black. In the United States Barred Plymouth Rock males are crossed extensively with New Hampshire females to produce chicks for commercial broiler and fryer raisers because some markets prefer a barred bird, barring being dominant to the New Hampshire plumage colour. After about 1935, White Plymouth Rocks increased in popularity, especially in the U.S. middlewest. The Plymouth Rock is a bird of good size, with good fleshing properties, and when properly bred lays well.

Rhode Island Red.—The Rhode Island Red is another American breed, the single comb variety being much more popular in England, Canada and the United States than the rose-comb variety. The skin is yellow. The plumage should be rich dark red over all parts of the body, there being black in the tail and parts of the wing feathers. The Single-Comb Rhode Island Red has been bred extensively for egg production and in the United States especially, and some strains lay as well as some of the best strains of Single-Comb White Leghorns. The Red is also a good meat producer.

Sussex.—This English breed contains the Light, Speckled and Red varieties, the Light variety being by far the most popular in England although but few of any Sussex varieties are kept in other countries. The comb is single and the skin is white. In plumage colouration the Light Sussex is similar to the Light Brahma. Sussex fowl have long been noted for the excellence of their flesh and are kept extensively in England for the production of roasters. After about 1925, English poultry breeders made considerable improvement in the laying qualities of the Light Sussex.

Wyandotte.—Among several varieties of this American breed, the White Wyandotte is the only variety bred extensively in England, the United States, or other countries. Wyandottes have rose combs and yellow skins. Like several other American varieties, they are a good general-purpose fowl, suitable for both meat and egg production. In England, egg production has been developed to a higher level among White Wyandottes than in other countries. In the United States White Wyandotte has largely been supplanted in popularity by the other previously mentioned American varieties.

Other Breeds *and* Varieties.--Of hundreds of other breeds and varieties of chickens kept in various countries, only a few can be mentioned. The Ancona is a Mediterranean breed with mottled plumage. The Dark Cornish is of English origin and has a very broad, compact body, ideal as a roaster type but a poor layer; it is sometimes used for crossing with other breeds. The Faverolle is a French breed with feathered shanks; in England the Salmon Faverolle is crossed extensively with the Light Sussex for roaster production. Old English and Modern Game breeds make excellent roasters but are poor layers and are kept largely by fanciers. The Jersey White Giant is the largest of the American breeds. developed primarily as a meat breed and is not noted for egg production. The Light Brahma has always been the most popular representative of the Asiatic breeds but is kept to a limited extent only. The Black Minorca is the largest of the Mediterranean breeds but has never been kept to any great extent in any country. The Black Sumatra is a native of Sumatra and is a fancier's breed exclusively.

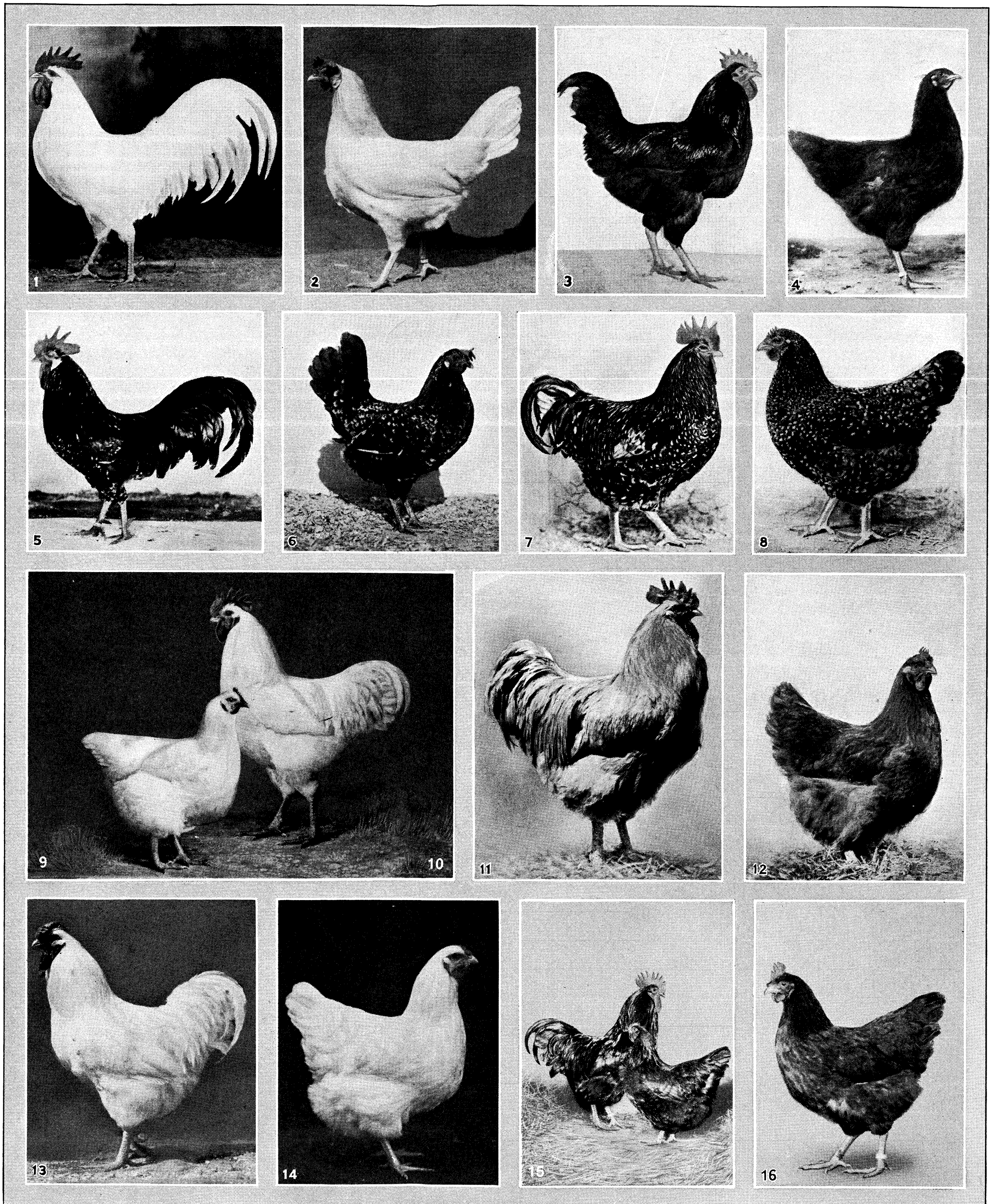
Breeding for Meat and Egg Production.— Success in raising chickens for meat and egg production is largely a matter of good stock plus good management. Good stock can be secured only from carefully selected, well bred parents that are properly mated.

Meat Production Standards.— For profitable meat production, chickens must grow at a rapid rate and make good gains in body weight for the feed they consume. Usually the fewer pounds of feed consumed per pound of gain in body weight, the greater the profit in meat production. The characteristics which birds raised for meat production should possess include: (1) good health and vigour; (2) fast wing feathering at hatching time and fast tail feathering at 10 days of age; (3) well feathered over the back by 8 weeks of age; (4) rapid growth to marketing time; (j) well proportioned body, with good length and width and fair depth in proportion to shank length, body depth being uniform from front to rear; (6) good fleshing on breast and thighs. The selection of breeding stock on the basis of these six characteristics implies that the poultry breeder must carry on a definite selection program from hatching time to the time of mating.

Commercial poultrymen interested in poultry meat production exclusively frequently resort to crossbreeding with beneficial results, since crossbreeding tends to stimulate growth during the first 10 or 12 weeks, and mortality is usually less than among purebred chickens. However, the actual results secured from crossbreeding depend largely on the breeding quality of the parental breeds crossed. In England, and to a lesser extent in some other English-speaking countries, new breeds have been developed by crossbreeding for the purpose of enabling the sexes to be separated at hatching time according to differences in the colour of the down. This makes it possible for meat producers to purchase male chicks only and market egg producers to purchase female chicks only.

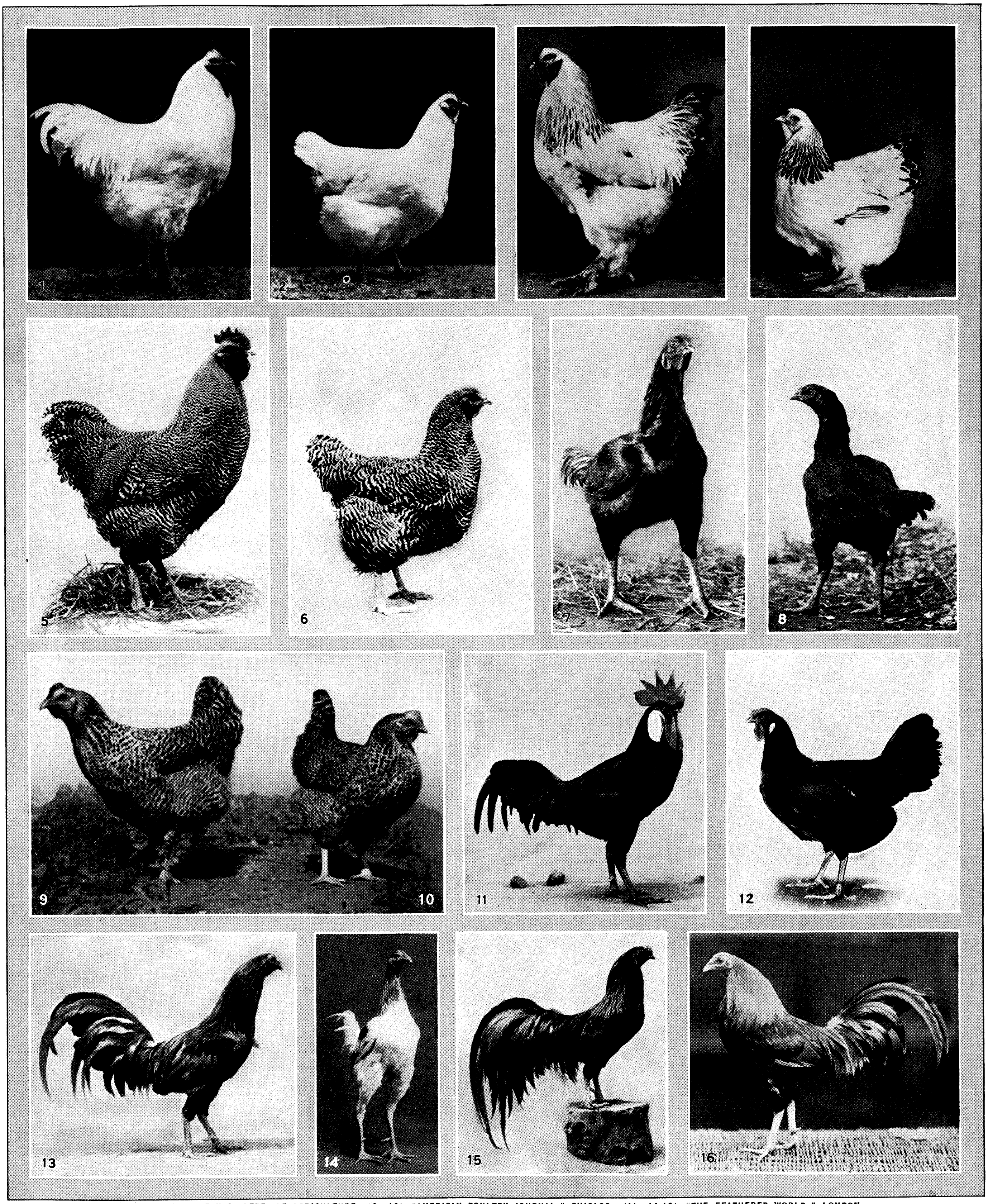
Egg Production Standards.— In addition to the six characteristics for meat production given previously, a pullet, to lay well, should possess the following four outstanding characteristics: (7) early sexual maturity; White Leghorns should commence to lay at about 150 days of age and Light Sussex, New Hampshires, Plymouth Rocks, Rhode Island Reds and other general-purpose birds at about 170 days of age; (8) pullets of all varieties should lay at a rate of at least 50% production, or a minimum of 15 eggs per month; (9) there should be little or no broodiness; White Leghorns usually do not exhibit much broodiness, but general-purpose varieties must be bred for non-broodiness or there will be numerous interruptions in laying; (10) pullets of all varieties should continue to lay for a period of approximately 10 months from the time they start to lay.

In order to develop a strain of birds noted for a high level of egg production, the poultry breeder must adopt a rigid prograrn



BY COURTESY OF (1, 2, 4, 5, 6, 7, 8, 11, 12, 13) THE U.S. DEPARTMENT OF AGRICULTURE, (3, 14) "THE FEATHERED WORLD," LONDON, (9, 10, 15, 16) "AMERICAN POULTRY JOURNIL," CHICAGO

1. White Leghorn cock
2. White Leghorn hen
3. Rhode Island Red cockerel
4. Rhode Island Red pullet
5. Ancona cockerel
6. Ancona hen
7. Speckled Sussex cock
8. Speckled Sussex hen
9. Jersey White Giant pullet
10. Jersey White Giant cockerel
11. Buff Orpington cock
12. Buff Orpington hen
13. White Wyandotte cock
14. White Wyandotte pullet
15. Australorps, cock and hen
16. New Hampshire Red pullet



BY COURTESY OF (1-8, 12, 13) THE U.S. DEPT. OF AGRICULTURE, (9, 10) "AMERICAN POULTRY JOURNAL," CHICAGO, (11, 14-16) "THE FEATHERED WORLD," LONDON

EUROPEAN AND AMERICAN BREEDS OF POULTRY

1. White Plymouth Rock cock
2. White Plymouth Rock hen
3. Light Brahma cock
4. Light Brahma hen
5. Barred Plymouth Rock cockerel
6. Barred Plymouth Rock pullet
7. Dark Cornish cockerel
8. Dark Cornish pullet
9, 10. Cross-bred pullets of Barred Plymouth Rock male and Rhode Island Red female cross
11. Minorca cockerel
12. Black Minorca pullet
13. Old English Black and Red game cock
14. Modern game cock
15. Sumatra game cock
16. Old English game cock

of selecting his breeding stock from year to year. The program of selection should be based on minimum standards for early sexual maturity, rate of laying, non-broodiness and persistence of production. Selecting birds with good pedigrees for future breeding purposes is an additional help in developing a good laying strain. The best help of all in selecting females for breeding purposes is to select them from among the families of full sisters that are outstanding in laying performance. Males for future breeding purposes should also be selected from the outstanding families but too close inbreeding should be avoided.

Additional Standards of a Good Strain.—In addition to the 10 desirable characteristics previously mentioned, a good strain of chickens should also possess the following essential characteristics: (11) good egg size, eggs attaining approximately standard weight (2 oz. each) within about 60 days from the time a pullet commences laying; (12) eggs of good interior quality; (13) hatchability of at least 75% of all eggs incubated; (14) low mortality among growing chickens and laying stock; the strain should possess the ability to resist disease to a marked degree; (15) long productive life.

Renewing the Flock—Whether chickens are raised for meat production or pullets are kept for egg production, the entire flock or part of it has to be renewed every year. Commercial producers of broilers and fryers renew their flocks several times a year, depending upon the number of lots produced annually. Market egg producers should plan each year to replace about two-thirds of the layers with a fresh lot of pullets because birds usually lay about 20% fewer eggs in their second than in their first laying year.

In practically all English-speaking countries it is possible for the great majority of poultry producers to secure from hatcheries the chicks necessary to renew their flocks. Hatching chicks in incubators rather than under broody hens makes it possible to secure larger numbers earlier in the season, which is a distinct advantage. Some farmers still hatch their own chicks in oil-heated incubators of limited capacity. The egg capacity of incubators used by a commercial hatchery operator may run up to several thousand eggs. these incubators being heated for the most part by gas, coal or electricity.

Hatchery operators may be divided roughly into two groups: (1) those who produce their hatching eggs with their own breeding flocks and (2) those who secure their hatching eggs from flocks owned by others. The hatchery operator who produces his own hatching eggs naturally has complete control over his flock and is thus in a position to do a great deal toward improving the quality of chicks hatched for customers. The most progressive hatchery operators who secure their hatching eggs from various flock owners adopt a system of close supervision concerning the management of the flocks and see to it that the females are carefully selected and are mated to males with as good breeding as possible.

Since many of the chickens raised in different countries each year are secured as chicks from hatcheries, it is quite apparent that they occupy a very important place in the poultry industry. The quality of chicks produced by hatcheries determines very largely the results secured by those who purchase the chicks for meat or egg production.

Rearing **Chickens.**—If a few chickens only are to be raised, they may be brooded with hens, hut if a few hundred or more are to be raised, they should be brooded artificially. hloreover, brooding chicks artificially makes it possible to raise a larger number at one time than with natural brooding so that a larger number of pullets of the same age may be placed in the laying house in the fall of the year.

There are several different types of brooders for artificial brooding, varying according to size, design and the kind of fuel used to supply heat. Brooders differ in size from those accommodating about 50 chicks to those accommodating several thousand chicks.

Most makes of brooders are portable and can be nioved from place to place. Many of the portable brooders are equipped with canopies or hovers for conserving the heat to a limited area near its source. There are colony brooders for lots of about 60 to a few hundred chickens, continuous brooders for brooding chickens by the thousands, and battery brooders for brooding in strict confinement. The kind of fuel used to supply heat in colony brooders may be kerosene, coal, wood, distillate oil, gas, or electricity. Continuous brooders are heated by burning coal, gas, or distillate oil. Battery brooders are usually heated electrically.

When only a few chickens are to be raised, some kind of lamp brooder is often justified, because the initial expense is relatively low. On the other hand, if a few hundred or more chickens are to be raised, one of the other types of brooders would undoubtedly be justified.

Most poultrymen use electric or wood-burning or coal-burning portable brooders. Best results are usually secured when not more than 250 chickens are brooded together.

For the first few days, the temperature under the hover of the brooder should be about 95° F. at about 2 in. above the floor. The temperature should be lowered about 5° each week depending upon the time of the year and the outside temperature. The temperature of the brooder house should be about 70° F. The most critical period in brooding is the first two weeks; thus the most careful attention should be given the brooder during this time. Drafts in the brooder house should be avoided and the litter should be kept dry to prevent the spread of disease. When the chickens are well feathered, they require little heat. They should be given access to a grass or other succulent green range when a few days old. Plenty of waterers and hopper feed space should be provided, larger sized waterers and dry mash hoppers being provided as the chickens grow.

A 10 ft. x 12 ft. or a 12 ft. x 12 ft. colony brooder house is large enough for brooding 250 chickens up to about eight weeks, when the sexes should be separated. The pullets may be moved to range shelters to be reared on range, and the cockerels may be kept until they attain broiler, fryer or roaster stage.

Feeding Problems.—Several different kinds of nutrients are required for growth and for egg production. Water, carbohydrates, fats, proteins, minerals and vitamins are all necessary. Ample supplies of carbohydrates and fats are supplied by the cereal grains and their by-products, since these ingredients constitute such a large part of the diet. Particular attention must be given to the selection of protein, mineral and vitamin supplements used to balance the diet.

White Leghorn chickens reared on range, both sexes in approximately equal numbers, should weigh about 2 lb. each at 12 weeks of age and would have consumed about 7.5 lb. of feed per bird; at 24 weeks they should average about 4.25 lb. each and would have consumed about 24 lb. of feed per bird. Chickens belonging to the general purpose breeds, both sexes in approximately equal numbers, should weigh about 2.75 lb. each at 12 weeks and would have consumed about 8.75 lb. of feed per bird; at 24 weeks they should average about 6 lb. per bird and would have consumed about 30 lb. of feed per bird.

Among laying birds of the same size, those that lay well consume more feed than those that lay poorly, but egg production is more efficient. For instance, a 4-lb. 100-egg bird consumes on the average about 71 lb. of feed in a year, whereas a 4-lb. 200-egg bird consumes about 85 lb. of feed in a year. Nevertheless, the 200-egg bird is much more efficient, because she consumes about 5 lb. of feed for every dozen eggs produced, whereas the loo-egg bird consumes about 8.5 lb. of feed per dozen eggs produced.

Laying birds averaging 4 lb. and laying at the rate of 30% consunie about 8 lb. of feed per dozen eggs produced, whereas the same birds laying at the rate of 70% consume about 4.5 lb. of feed per dozen eggs produced. Laying birds averaging 6 lb. and laying at the rate of 30% consume about 10 lb. of feed per dozen eggs produced, whereas the same birds laying at the rate of 70% consume about 5 lb. of feed per dozen eggs produced.

Housing the Laying Stock.—The purpose of housing is to give the layers protection and keep them comfortable so that they will be efficient egg producers. In extremely hot weather the layers are very likely to suffer considerably if they cannot secure relief in a cool house. The chicken has no sweat glands to assist in keeping the body cool. In extremely cold weather, chickens not only suffer from the cold in a poorly built house but use too much of the energy contained in their feed to conserve body heat instead of to produce eggs. The primary objective in housing laying stock, therefore, is to protect the birds against excessively high and low temperatures and especially against sudden changes in temperature. In addition, the proper housing of the layers makes it possible to manage them more efficiently.

The location of the laying house should be such as to provide for the proper circulation of air within the house and at the same time avoid unnecessary exposure to the wind. A southern, well-sheltered slope which offers good air and water drainage is usually the most desirable. The size of the house needed varies according to the size of the flock. For flocks of 15, 25 and 50 birds, houses should have about 70, 100 and 180 sq.ft. floor space, respectively. A flock of 125 birds should have about 400 sq.ft. floor space. A flock of several hundred or a few thousand birds should be divided into units of about 125 or 250 birds per unit, several units being housed in one long continuous house.

It costs less, on the average, to build a square house than a long narrow one, which is likely to be drafty. Houses for small flocks should be at least 10 ft. deep, and houses for large flocks should be at least 16 ft. or better still, 20 or 24 ft. deep. Large flocks may be kept in houses that are two, three or four stories high. A multistoried house reduces the labour required to manage a large flock, as compared with a single-storied house. A multistoried house simplifies ventilating problems to some extent and makes it possible to maintain more uniform temperatures in summer and winter.

A concrete floor is more durable and much more sanitary than a board floor. Insulating the walls and roof, especially the latter, helps greatly to keep the house cool in summer and warm in winter. The proper ventilation of the house is necessary in order to remove excessive moisture and provide fresh air but, at the same time, drafts should be avoided. Sunlight in the laying house is desirable not only because it brightens up the house but also because it tends to keep the house dry and is a good germicide, being effective in destroying disease organisms.

Moreover, sunlight is a good source of vitamin D. A good absorbent litter helps to keep the floor dry. How frequently the litter should be removed depends largely on the number of birds in the house, weather conditions, and the extent to which the house is properly ventilated.

Marketing Eggs.—Nearly all eggs at the time they are laid are of superior quality. They represent the kind of eggs that most consumers would like to purchase the year round. The proper steps to preserve fresh-laid egg quality are far more important than most producers realize. The proper preparation of eggs for market and marketing them to best advantage are just as important, in many respects, as producing them efficiently.

Since the germ of a fertile egg begins to develop at about 69" F., eggs for market should be kept at a temperature lower than 68° F., a temperature of 55° F. being desirable. All producers of market eggs should keep the males away from the females except during the breeding season.

Unless eggs are gathered frequently and cooled promptly in warm weather, they commence to deteriorate. In fact, the higher the temperature and the drier the air of the room in which eggs are held, the more rapid the deterioration. Some of the most striking changes that take place in eggs subjected to high temperatures and dry atmosphere are: (1) water evaporates through the porous shell, (2) the thick white tends to break down into thin white, (3) the yolk membrane becomes weaker, and (4) the yolk becomes more flaccid.

The excessive heating of eggs, whether from being exposed to the sun's rays or held for a long time in a warm room, results in a complete breakdown of the thick white, giving the entire white a watery appearance.

Clean litter and clean nests, one for every five hens, are essential for the production of clean eggs. The eggs should be gathered in wire baskets three or four times daily in warm weather and stored in a room in which the temperature is about 55° F. and the relative humidity about 75%.

Flock owners who only have a few layers often sell all of their surplus eggs direct to consumers. This is especially true of flock owners in villages or those living in areas adjacent to towns and cities. In the case of farm and commercial flock owners the eggs may pass through any one of several different marketing channels before reaching the consumer. Selling market eggs on a graded basis is in the best interests of producers, dealers and consumers. Eggs are graded according to size, shell cleanliness, size of air cell, and the quality of the yolk and white.

The method of packing eggs in different countries varies. In several European countries, for instance, long wooden boxes are used for packing eggs in straw whereas in Canada and the United States different kinds of containers are used, including cartons holding ½ doz. or 1 doz., fibre or cardboard boxes holding 15 or 30 doz., or wooden egg cases holding 30 doz. From the surplus producing areas in a country, eggs are shipped by express to consumers or retailers in consuming centres or they are shipped in refrigerated cars or trucks to wholesalers who sell them to retailers.

Co-operative egg marketing methods have been developed extensively in various English-speaking countries, especially Australia and the United States as well as in such countries as Eire and Denmark.

Prior to World War II some countries, including China, Denmark, Australia, New Zealand, South Africa and Eire, exported considerable quantities of eggs annually to Great Britain, which is primarily an importing country. (See also EGGS.)

Marketing Chickens.—Chickens are sold alive at various ages, ranging from those about 8 weeks old, weighing about 1 lb. each, to those that are several years old. They are all called "chickens" when one wishes to distinguish them from turkeys, guineas, ducks and geese. From the market standpoint, however, the term "chicken" is usually used to distinguish growing birds, except stags and capons, from cocks and hens, the latter usually being referred to as "fowl." Stags are older than chickens, have more prominent spurs, and the flesh is not so tender. Capons are male birds that were castrated while young, the flesh being relatively tender even when the birds are almost fully grown.

While the marketing of live chickens is an important industry in many countries, the proportion of dressed poultry marketed by live-poultry buyers increased considerably after about 1930. In all countries the great bulk of market poultry is sold to consumers either in the dressed, drawn or cut-up form. A dressed bird is one that has been killed and plucked. A drawn bird is a dressed bird from which the head, feet and entrails have been removed. A cut-up chicken is a drawn bird that has been cut up into parts suitable for frying.

Feed should be withheld from birds for about 15 hours before they are killed and plucked. The different methods of plucking chickens include dry plucking, hard-scald plucking, semiscald plucking, wax plucking, and machine plucking. Dry plucking must be done the moment the bird is killed, while the body is still warm. The hard-scald method involves immersing the bird for a few seconds, except the head and feet, in water kept at a temperature of 180° to 190° F. If the water is too hot or the birds remain in the water too long. the skin will have a scalded appearance. For semiscalding, the temperature of the water should be approximately 127° F. for broilers, 128° F. for fowl, and the birds should be kept in the water for 30 to 35 sec. Wax plucking is a somewhat involved process in which a special kind of melted wax is used to facilitate the removal of feathers, pinfeathers and hair. Plucking machines are used to some extent, especially in England and the United States. Some of the machines are equipped with a revolving disc or cylinder for dry plucking and others are equipped with a revolving cylinder to which rubber "fingers" are attached for plucking by the semiscald method.

After the birds have been plucked, the heads, feet and vents are cleaned thoroughly in order to give the dressed carcasses an attractive appearance. After the birds are dressed, they should be cooled thoroughly by immersing them in cold water for about an hour, or they may be held for about a day in a room for dry cooling at a temperature of 32° to 34° F. If the dressed birds are to be packed in boxes or other containers for shipment to market, the heads are wrapped in parchment or kraft paper waxed on one side.

In some countries, especially the United States, dressed birds are drawn in poultry-packing plants and after being inspected and cleaned are prepared so that they are ready to be placed in the consumer's oven for roasting. Such poultry is called quick-frozen full-drawn, the carcasses being frozen immediately after being drawn at temperatures which range as low as −20° F.

The practice of selling fresh-killed chickens cut in pieces suitable for frying has gained considerable impetus in Canada and the United States. Buying cut-up chicken is popular with many housewives, because practically no labour is necessary in preparing the poultry for the frying pan.

Great Britain is the principal importer of dressed poultry. Prior to World War II most of its imported supplies were obtained from Eire, France, Austria and Latvia.

Raising Ducks for Meat and Eggs.—Duck raising is practised on a limited scale in practically all countries. for the most part as a small farm enterprise; but in such countries as England and the Netherlands they are kept extensively for egg production, and in the United States a considerable number of commercial plants have been developed for meat production exclusively. The Runner duck, formerly called the Indian Runner, and the Khaki-Campbell are especially adapted for egg production, whereas the larger sized Pekin breed is a meat producer of exceptional merit. Some strains of Runners and Khaki-Campbells will lay better than many strains of chickens. Pekin ducks grown commercially for meat are marketed from about 8 to 12 weeks of age, when they weigh from about 43 to 7 lb. each. In England the Aylesbury is the kind kept for meat production. The Muscovy duck, of South American origin, is kept on farms for meat production to some extent because it does not "quack."

Goose Raising.—Goose raising is a farm enterprise of limited proportions in practically all countries, although in Germany, Austria, parts of France, and certain sections of other countries, goose raising on a commercial basis is carried on extensively. The Toulouse, predominantly gray in colour, and the Embden, a white breed, are the two outstanding meat-producing breeds. On some commercial plants, market geese are fattened by a special process, the forced-feeding of noodles sometimes being practised, resulting in a considerable enlargement of the livers.

Some goose raisers make a practice of plucking feathers from the live birds, usually just before the birds moult, up to one pound of feathers being obtained from a bird.

Guinea Raising.—Guineas are raised as a sideline on a few farms in various countries. In some cities there is a relatively good market for them, and they are often used as a substitute for game birds, such as quail, grouse, pheasant and partridge.

BIBLIOGRAPHY.—Edward Brown, *Poultry Breeding and Production,* (1929); E. W. Benjamin and H. C. Pierce, *Marketing Poultry Products,* (1937); Morley A. Jull, *Poultry Husbandry,* (1938); William C. Lippincott and L. E. Card, *Poultry Production,* (1939); H. C. Knandel, *Profitable Poultry Keeping,* (1940); Morley A. Jull, *Poultry Breeding,* (1940); A. R. Winter and E. M. Funk, *Poultry Science and Practice,* (1941); E. N. Barger and L. E. Card, *Diseases and Parasites of Poultry,* (1943); H. E. Biester and Louis Devries, *Diseases of Poultry,* (1943); Morley A. Jull, *Successful Poultry Management,* (1943).
(M. A. J.)

POUND, SIR (ALFRED) DUDLEY (PICKMAN ROGERS) (1877–1943), first sea lord and admiral of the British fleet during World War II, was born Aug. 29, 1877, on the Isle of Wight. He was educated in grammar schools in Surrey and Greenwich until 1891, when he entered the navy. In 1913–14, Pound attended the Naval War college, and in 1914 was raised to the rank of captain and appointed naval assistant to Lord John Fisher, then first sea lord. He commanded H.M.S. "Colossus" during the battle of Jutland and for his part in the engagement was mentioned in dispatches. From 1922–25 he served in the admiralty as director of the plans division and in 1925 entered two years' service as chief of staff to the Mediterranean fleet's commander in chief, Admiral Sir Roger Keyes. In 1926 he was promoted to rear admiral and from 1927–29 was assistant chief of the naval staff. From 1929–31 he commanded a battle cruiser squadron. In 1932, having reached the rank of vice admiral, he was made second sea lord and chief of naval personnel at the admiralty, and in 1935 he was made admiral and temporary chief of staff of the Mediterranean fleet. From 1936–39 he was commander in chief of that fleet. On May 17, 1939, he was advanced to first sea lord and chief of the naval staff and in July 1939 was made admiral of the fleet. He resigned Oct. 4, 1943, because of ill health and died the following Oct. 21.

POUND, EZRA LOOMIS (1885–), U.S. poet, was born in Hailey, Idaho, Oct. 30, 1885. He was educated at the University of Pennsylvania and at Hamilton college, N.Y. He taught until 1907, when he left the United States to travel in Europe, and except for two brief return visits to the United States, he remained in Europe thereafter, living successively in London, Paris and Italy. Although Pound had written a number of works by 1912, his first important publication, *Ripostes,* was printed in that year. This volume contained five imagist poems by T. E. Hulme and its appearance was regarded as the beginning of the imagist movement. Pound gave further impetus to the movement in 1914 with *Des Imagistes,* an anthology of imagist poetry. From 1917–19 he was London editor of *The Little Review.* In 1924 he settled in Italy, where, in 1941, he began to make daily pro-Fascist broadcasts from Rome. In 1943 he was one of eight indicted in the United States for treason by a federal grand jury.

Pound was responsible for bringing to English poetry a number of new techniques as well as for introducing Chinese and Greek influences. His other writings include poems, operas, translations and a number of prose works, most of the last being political documents.

POUND, ROSCOE (1870–), American jurist and educator, was born at Lincoln (Neb.), Oct. 27, 1870. He graduated at the University of Nebraska and studied law in the Harvard law school 1889–90.

On his admission to the bar in 1890 he commenced practice in Lincoln, Nebraska. He was commissioner of appeals of the supreme court of Nebraska 1901–03.

He was assistant professor of law at the University of Nebraska 1899–1903, and dean of the law faculty 1903–07; was professof of law at Northwestern university 1907–09, and at the University of Chicago 1909–10. In 1910 he accepted the Story professorship of law at the Harvard law school, becoming Carter professor of jurisprudence there in 1913 and dean from 1916 to 1936.

Pound has written *Phytogeography of Nebraska,* with F. E. Clements (1898); *Readings on Roman Law* (1906); *Lectures on the Philosophy of Freemasonry* (1915); *The Spirit of the Common Law* (1921); *Criminal Justice in the American City* (1922); *Introduction to the Philosophy of Law* (1922); *Interpretations of Legal History* (1923); *Law and Morals* (1924); *Readings on the History and System of the Common Law,* 3rd ed. (1927); *Criminal Justice* (1930); *The Fornzative Era of American Law* (1938); *History and System of the Common Law* (1939); *Organization of Courts* (1940); *Appellate Procedure in Civil Cases* (1941).

POUND (1) An enclosure in which cattle or other animals are retained until redeemed by the owners, or when taken in distraint until replevied, such retention being in the nature of a pledge or security to compel satisfaction for debt or damage done. Animals may be seized or impounded when (*a*) distrained for rent; (b) damage *feasant, i.e.,* doing harm on the land of the person seizing; (*c*) straying; (d) taken under legal process. The pound-keeper is obliged to receive everything offered to his custody and is not answerable if the thing offered be illegally impounded.

Where cattle are impounded the impounder must supply sufficient food and water (Cruelty to Animals Acts, 1849 and 1854); any person, moreover, is authorized to enter a place where animals are impounded without food and water more than 12 hours and supply them; and the cost of such food is to be paid by the owner of the animal before it is removed. Pounds are almost obsolete. (See DISTRESS; REPLEVIN.)

POUND (2)—(*a*) a measure of weight; (b) an English money of account. (a) The English standard unit of weight is the *avoirdupois* pound of 7,000 grains. The earliest weight in the English system was the Saxon pound, subsequently known as the Tower pound, from the old mint pound kept in the Tower of London. The Tower pound weighed 5,400 grains and this weight of silver was coined into 240 pence or 20 shillings, hence pound in sense (2) (a pound weight, of silver). The pound troy, probably introduced from France, was in use as early as 1415 and was adopted as the legal standard for gold and silver in 1527. The act which abolished the Tower pound (18 Hen. VIII.: the "pounde Troye which exceedeth the pounde Tower in weight iii. quarters of the oz.") substituted a pound of 5,760 grains, at which the pound troy still remains. There was in use together with the pound troy, the merchant's pound, weighing 6,750 grains, which was established about 1270 for all commodities except gold, silver and medicines, but it was generally superseded by the pound avoirdupois about 1330. There was also in use for a short time another merchant's pound, introduced from France and Germany; this pound weighed 7,200 grains. The pound avoirdupois has remained in use continuously since the 14th century, although it may have varied slightly at different periods—the Elizabethan standard was probably 7,200 grains. The standard pound troy, placed together with the standard yard in the custody of the clerk of the House of Commons by a resolution of the House of the 2nd of June 1758, was destroyed at the burning of the houses of parliament in 1834. In 1838 a commission was appointed to consider the restoration of the standards, and in consequence of their report in 1841 the pound avoirdupois of 7,000 grains was substituted for the pound troy as the standard. A new standard pound avoirdupois was made under the direction of a committee appointed in 1834 (which reported in 1854), by comparison with authenticated copies of the original standard (see *Phil. Trans.* 1856). This standard pound was legalized by an act of 1855 (18 & 19 Vict. c. 72). The standard avoirdupois pound is made of platinum, in the form of a cylinder nearly 1·35 in high and 1·15 in. in diameter. It has a groove or channel round it to enable it to be lifted by means of an ivory fork (for illustration see MEASURES AND WEIGHTS) and is marked "P.S. 1844. 1 lb." P.S. meaning Parliamentary Standard. It is preserved at the Standards Office, in the custody of the Board of Trade. Copies were also deposited at the Houses of Parliament, the Royal Mint, the Royal Observatory and with the Royal Society.

See the *Reports of the Standards Commission (6* parts, 1868–73).

POUND STERLING. Immediately prior to the outbreak of the World War the pound sterling circulated in the United Kingdom in two main forms, namely, gold sovereigns and Bank of England notes. Both were legal tender for any amount, but the latter were not issued in smaller denominations than five pounds. In addition, certain banks, mainly Scotch and Irish, issued their own notes.

The relative purchasing power of the pound in Britain is shown in the table below. Abroad, it would purchase $4.87; 25.22frs., and 20.43 marks. The Bank of England had a note issue of £55,000,000, of which £30,000,000 was in circulation and the remainder held in the Bank's own "Reserve." £38,000,000 in gold was held by the Bank, and an unknown number of sovereigns and half-sovereigns were held by the banks and the public. Gold was free to leave the country and the Bank was bound to redeem its notes in gold on demand.

War Results.—With the outbreak of the war, British bankers and financiers called their foreign funds home, and in so doing forced the American exchange for a day or two to above $5.00. Secondly, the public demand for gold ran the Bank's stock down from 38 to 27 millions, and its "reserve" of notes from 25 to 8 millions. Thirdly, a new form of pound had to be instituted to meet the public demand for currency. This was the currency-note, issued by the treasury in denominations of one pound and ten shillings, which, like the sovereign and the bank-note, was legal tender for any amount.

The rise of the pound against the dollar was short-lived, war expenditure, Government borrowing, and heavy purchases of munitions from abroad having their inevitable effect. The check upon inflation imposed by the Peel's Bank Act had been abolished by the institution of the currency-notes, which could be issued without limit. Artificial means were adopted to maintain gold stocks and the pound against foreign currencies. The export of gold and even its withdrawal from the Bank was discouraged, and the exchange on New York was "pegged" at parity. (See PEGGING THE EXCHANGE.) Foreign securities were mobilized and bought up by the British Government to pay for imports of food and munitions, and luxury imports were checked. At home, commodity prices were "controlled."

Great Britain came out of the war with over £320,000,000 in currency-notes and a huge floating debt, much of which was pure inflation, and when the props were removed from the pound the inevitable collapse followed, the relative purchasing power of the pound, wholesale, being as shown below:—

	Purchasing power of the pound					
	June 1914	Dec. 1919	Apr. 1925	Feb. 1928	Sep. 1931	Oct. 1935
Flour, lb.	200	126	113	145	294	209
Potatoes, cwt.	5	2	2	3	3	3
Beef, stone	4	2	3	4	4	4
Cotton, lb.	31	8	19	24	64	37
Wool, lb.	10	3	4	5	13	10
Steel rails, cwt.	3	1	2	2%	2½	2½
Copper, lb.	37	19	37	36	81	65
Steam coal, cwt.	28	10	21	27	26	26
Rubber, lb.	7	8	11	15	101	38
Dollars	4.87	*3.67	4.87	4.88	4.86	4.92

*Jan. 1920; the following month it fell to 3.2.

In round figures, in early 1920, the pound had lost two-thirds of its value, measured in its internal purchasing power, and one-third of its value as against the dollar. Furthermore, in 1919, when the exchange was "unpegged," the export of gold had to be prohibited, or else all Britain's gold stocks would have been lost within a short space of time.

Post-war Recovery.—April 1920 to April 1925 was a period of such drastic deflation that at the latter date the gold standard could be restored; but the currency note remained part of the monetary system; currency notes and bank-notes were made irredeemable in gold on demand; and the Bank of England was not required to sell gold in less quantities than 400 oz. fine (then equal to £1,700 in value). In 1928, the currency-note and bank-note issues were amalgamated under the Bank of England, and the normal fiduciary note issue was fixed at £260,000,000.

Between 1925 and 1931 world prices gradually fell while British costs failed to follow. The result was that British prices stood some 10 per cent above the world level, causing an unbalanced trade position and a steady drain of gold. Through this and other causes, accentuated by the crisis of 1931, Great Britain abandoned the gold standard on September 21, 1931.

Thereafter the Bank of England was not obliged to sell gold at all, and the pound was free to vary in terms of foreign currencies. After many vicissitudes, including the devaluation of the dollar in 1934, the pound settled down at approximately its old parity with the dollar, but at about 60 per cent of its 1925–31 parity with the franc. In 1932 the government established a special Exchange Equalisation Account to minimise fluctuation in the exchange value of the pound. In 1935 there was no prospect of an early return to gold, but British prices had ceased to be above the world level. (See also MONEY; CURRENCY.) (N. E. C.)

POURTALES, COUNT FRIEDRICH VON (1853–1928), German diplomatist, was born at Oberhofen, Switzerland, on Oct. 24, 1853. After a brief period of service in the army, he entered the German Foreign Office in 1880. He was for the seven years immediately preceding the World War, German ambassador at St. Petersburg. He published in 1927, Meine *letzte Verhandlungen in St. Petersburg Ende Juli 1914,* in which he relates his last effort to dissuade the tsar from mobilization in July 1914. He died at Bad-Nauheim on May 4, 1928.

POUSSIN, NICOLAS (1594–1665), French painter, was born at Les Andelys (Eure) in June 1594. He learned painting under Quentin Varin, a local painter, till he went to Paris, where he entered the studio of Ferdinand Elle, a Fleming, and then of the Lorrainer L'Allemand. He improved himself by studying prints after Raphael and Giulio Romano; and in 1624 he proceeded to Rome, where he stayed for six years, and married Anna Maria Dughet, a Frenchwoman. His intimacy with Du Quesnoy, afterwards celebrated under the name of Il Fiammingo, may have led Poussin to the careful study of antique reliefs, many of which he modelled. He also attended the academy of Domenichino, whom he considered the first master in Rome. Among his first patrons were Cardinal Barberini, for whom was painted the "Death of Germanicus" (Barberini palace); Cardinal Omodei, for whom he produced in 1630, the "Triumphs of Flora" (Louvre); Cardinal de Richelieu, who commissioned a Bacchanal (Louvre); Vicenzo Giustiniani, for whom was executed the "Massacre of the Innocents," now in the museum at Chantilly; Cassiano dal Pozzo, who became the owner of the first series of the "Seven Sacraments" (Belvoir castle); and Fiéart de Chanteloup, with whom in 1640 Poussin, at the call of Sublet de Noyers, returned to France. Louis XIII. conferred on him the title of "first painter in ordinary," and in two years at Paris he produced several pictures for the royal chapels (the "Last Supper," painted for Versailles, now in the Louvre) and eight cartoons for the Gobelins, the series of the "Labours of Hercules" for the Louvre, the "Triumph of Truth" for Cardinal Richelieu (Louvre), and much minor work. In 1643, disgusted by the intrigues of Simon Vouet, Feuquières and the architect Lemercier, Poussin withdrew to Rome. There, in 1648, he finished for De Chanteloup the second series of the "Seven Sacraments" (Bridgewater gallery), and also his noble landscape with Diogenes throwing away his Scoop (Louvre); in 1649 he painted the "Vision of St. Paul" (Louvre) for the comic poet Scarron, and in 1651 the "Holy Family" (Louvre) for the duke of Créqui.

The finest collection of Poussin's paintings, as well as of his drawings, is possessed by the Louvre; but, besides the pictures in the National Gallery and at Dulwich, England possesses several of his most considerable works. The "Triumph of Pan" is at Basildon (Berkshire). Other important works are in the collection of Sir Herbert Cook, Richmond; the duke of Bedford, the earl of Carlisle, the earl of Yarborough, the duke of Devonshire, Burdett Coutts and at Longford castle. The Prado, Madrid, the Dresden museum, the Eremitage at Leningrad, possess a number of representative pieces by this prolific master. The prints that have been engraved after his principal pictures amount to upwards of 200.

Nicolas Poussin was an eclectic, selecting and combining what he admired in the classic art of the past. He not only emulated Titian's glowing colour and the rhythm of Raphael's design; he also borrowed figures out of pictures by these masters (from Titian's "Bacchanal" and Raphael's "Stanze" for instance) and introduced them into his canvases. Yet he was no mere copyist. His conceptions are essentially French, and his characters might be staged in one of Corneille's dramas. His art is reasoned and intellectual. The Greek law of unity in space and time is realized. His statuesque figures are ranged parallel to the picture plane as in antique reliefs. The landscape background is similarly arranged; and he applied the principles of figure composition to his landscapes. His influence on French painting was great and lasting. It was felt in the work of successive generations—of David, Ingres, Delacroix, Chassériau, Puvis de Chavannes and Corot, down to modern times. He stands for the classical tradition, for the balance and harmony in things, for the rhythmic movement of line, for decorative arrangement in composition after which modern artists since Cézanne have been striving, in reaction to impressionism. Poussin's immediate follower was Gaspard Dughet, his brother-in-law and pupil, who through this double bond of relationship shared the name of Poussin,

GASPARD POUSSIN (1613–1675) devoted himself to landscape painting and rendered admirably the severer beauties of the Roman Campagna. He worked for three years in the studio of his brother-in-law and then came under the influence of Claude Lorrain. He worked mainly at Rome, thence making excursions to Milan, Perugia, Castiglione, Florence and Naples. A noteworthy series of works representing various sites near Rome is to be seen in the Colonna palace; other important works are in the Doria and Borghese palaces; but one of his finest easel-pictures, the "Sacrifice of Abraham," formerly the property of the Colonna, is now in the National Gallery, London. The frescoes executed by Gaspard Poussin in S. Martino di Monti are in a bad state of preservation. Gaspard died at Rome on May 27, 1675.

See G. P. Bellori, *Le Vite de Pittori, scultori ed architetti moderni* (1672); Sandrart, *Acad. nob. art. pict.*; *Lettres de Nicolas Poussin* (1824); Félibien, *Entretiens* (1666–88); P. Desjardins, *Poussin* (1903): W. Friedländer, *Nicolas Poussin* (Munich, 1914).

POUT or **BIB** (*Gadus luscus*), a small fish of the Mediterranean and the Atlantic coast of Europe, differing from its relative the cod, in the deeper body, larger eye, etc. It is coffee-coloured, with broad, dark transverse bands.

POVERTY LINE. The words "poverty line" have only come into use in comparatively recent years, and probably, to the general public, they merely represent a vague social cleavage between people living in varying degrees of security and comfort and people who are constantly exposed to actual privation. To the social student, however, the term has gradually acquired both greater content and greater precision.

It was first made familiar by Charles Booth, in his monumental *Life and Labour of the People,* commenced in 1886. In analysing the population of London, he divided it into eight classes, four of which he defined as poor, the other four as "above the line of poverty." "My 'poor,'" he wrote, "may be described as living under a struggle to obtain the necessaries of life and make both ends meet, while the 'very poor' live in a state of chronic want. It may be their own fault that this is so: that is another question; my first business is simply with the numbers who, from whatever cause, do live under conditions of poverty or destitution."

Booth found 30% of the population of London living under such conditions, or "below the line of poverty."

Illuminating, however, as were Booth's researches, they left the actual basis of the poverty line indefinite. In 1899 Seebohm Rowntree made a somewhat similar investigation into poverty in York, a city with a population at that time of about 76,000. The comparative smallness of the area covered enabled him to undertake a closer analysis of the poverty problem and to distinguish between "primary" and "secondary" poverty.

By the former he implied poverty due solely to lack of sufficient income to maintain a family of normal size in a state of physical efficiency, even though all the resources available were economically administered. "Secondary" poverty, on the other

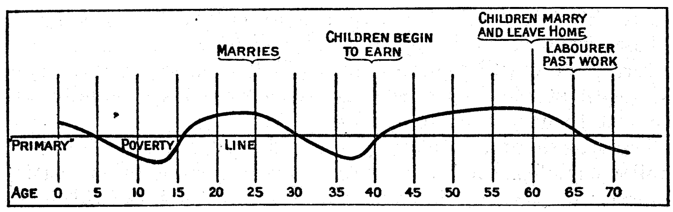


DIAGRAM SHOWING AGES AT WHICH THE POVERTY LINE VARIES

hand, was due to the expenditure of some part of the income on objects other than the maintenance of physical efficiency.

Requirements of Physical Efficiency.—In order to fix his primary poverty line it was necessary to calculate the bare minimum requirements of physical efficiency and the cost of satisfying these. The procedure was as follows:

The requirements of physical efficiency were classified under three headings: (1) Food, (2) House rent including rates, (3) Household sundries, such as clothing, light, fuel, etc. With regard to food, certain standards, in terms of calories per day, were established, in the light of the latest scientific evidence available, for adult males, adult females, and children of varying ages. The standard adopted for the adult male was 3,500 calories per day, this being the amount required for men doing moderate work. Due proportions of this were fixed for women, adolescents and children. In this way the food required by any given family could be expressed in the terms of a common unit, namely, the calories consumed "per man per day." The dietary selected by Rowntree to provide the necessary calories was based upon the cheapest rations falling within the Local Government board order for workhouses, and included no alcohol, no tobacco and no meat, with the exception of a little bacon, being less generous than the average dietary required for workhouse purposes. It was then priced according to the cheapest rate ruling in York at that time, and the following figures were adopted as representing the necessary minimum expenditure for food, viz., 3s. each per week for adults, and 2s.3d. each per week for children.

With regard to rent, the actual sums then paid were taken as the necessary minimum. As regards household sundries, the sum allowed for a family of father, mother and three children for clothing, fuel and all other sundries was 4s. 11d. per week—a figure arrived at after detailed investigation. Allowing 4s. for rent, these figures totalled up to £1 1s. 8d. a week for a family of five. With the prices ruling on Feb. 1, 1928, this figure becomes £2 1s. 11d., made up as follows:—food £1 3s. 11d.; clothing, fuel, and all other sundries 10s. 8d.; rent 6s., and compulsory insurance 1s. 4d. No allowance was made for so much as a tram ride or a postage stamp during the year, or for any expenditure whatever upon moral, mental, or social development, and even the sick club and the funeral club were excluded. The aim was simply to ascertain the lowest cost at which bare physical efficiency could be achieved, if the housewife were a woman of considerable experience, commonsense, and strength of will.

Having fixed the primary poverty line, the next step was to ascertain what proportion of the population of York were living in primary and secondary poverty respectively.

York's Ten Per Cent of Primary Poverty, 1899.—In order to do this trained investigators visited every working class house in York, and gathered together with other facts, information which enabled a reasonably accurate estimate to be made of the income of each family. In the course of the visits note was taken of every family which was evidently living in poverty as judged by the housing conditions and the signs of malnutrition. The number of those living in secondary poverty was ascertained by subtracting from the total population found to be living in poverty those whose incomes placed them below the primary poverty line. It was found that 10% of the total population of the city or 15½% of the working-class population were living in primary poverty, and 18% of the total population or 28% of the working-class population were in secondary poverty. It may be noted that when the two groups of "primary" and secondary poverty are taken together we have figures, namely, 43% of the working classes and 28% of the total population of York, which are readily comparable with the results obtained by Booth.

Rowntree, in analysing the immediate causes of primary poverty, showed that more than one half of it was due solely to the death of the wage earner, 22% to largeness of family, and the rest to miscellaneous causes.

The causes of secondary poverty do not lend themselves to similar classification, but Rowntree stated them as drink, betting, ignorant or careless housekeeping, and other improvident expenditure, and put drink as the predominant factor.

It may be added that subsequent investigators, such as Prof. A. L. Bowley and Miss Hogg, have practically ignored the existence of secondary poverty, concentrating rather on the endeavour to estimate the number of those who in any given area are compulsorily below the poverty line or are living in primary poverty.

Later Enquiries.—The enquiries of Booth and Rowntree were followed by other investigations of particular areas. In 1912 and 1913 investigations were made by Prof. A. L. Bowley and Prof. A. R. Burnett-Hurst into conditions in certain typical provincial towns, namely, Reading, Northampton and Warrington, and the mining area of Stanley. These were supplemented a little later by a similar enquiry into conditions in Bolton, and the results of these researches were published in *Livelihood and Poverty* in 1915. The lines followed were similar to those of Rowntree, save that the method of taking samples of each town was adopted, in place of the investigation of every household. The results were measured by Rowntree's "poverty line" and also by the authors' "new standard," based upon that of Rowntree, with certain minor variations—the general effect of which was to make the standard somewhat higher for an adult and somewhat lower for a child. The net difference per family between the two standards, however, was comparatively slight. With prices ruling on Feb. 1, 1928, Bowley's standard amounted to £2 1s. 2d., made up as follows:—food £1 2s. 6d.; clothing, fuel and sundries 9s. 4d.; rent 8s. 0d., and compulsory insurance 1s. 4d. This compares with Rowntree's £2 1s. 11d.

The conclusion reached by those adopting the new standard, assuming full time wages to be earned in every case, was that in these five towns 11% of working-class families were below the primary poverty line. It should be noted that this figure makes no allowance for loss of earnings due to unemployment, and therefore it cannot properly be compared with Rowntree's figures, which were based upon the actual average income over the year. The fundamental principle, however, that of a poverty line determined by the requirements of bare physical efficiency, remains precisely the same.

Investigation of 1924.—In 1924 a similar investigation was made in the same towns with a view to discovering whether poverty had diminished in the intervening period. The results of this appear in *Has Poverty Diminished?* by Prof. Bowley and Miss Margaret H. Hogg. Taking the "New Standard" as the basis of comparison, and allowing for the increase in the cost of living, the investigation showed that the proportion of the working-class population below the primary poverty line had fallen from 11% in 1912–14 to 3·6% in 1923–4, assuming full time wages to be earned in every case, or to 6·5%, assuming that the actual incomes of the families observed during the week of the investigation were equal to their average weekly incomes throughout the year. The latter basis is the more appropriate for purposes of comparison with Rowntree's figures.

Although not claiming exact accuracy, such figures afford strong evidence that the volume of poverty in Britain has continued to diminish throughout the first quarter of the 20th century. Probably the proportion of the population living below the primary poverty line in 1925 was less than half the proportion in 1900. At the same time the gravity of the position should not be underestimated. Taking 6·5% of the working-class population as representing 4% of the total population, we had in 1924 in the British Isles practically 2,000,000 persons living below the standard necessary for the maintenance of mere physical efficiency. Moreover, the number of different individuals who at one time or other fall below the poverty line is much greater than those who fall below it at a given moment.

From the national standpoint it is serious that in any given family the period of greatest want occurs before any of the children begin to earn. At that time those living near the poverty line are liable to fall below it, and the stress is most severe upon the younger children, and women who are bearing children. According to Bowley and Hogg, even in our improved post-war conditions, more than one child in six lives below the poverty line at some period, while a smaller proportion of children live below it for many years together.

Nevertheless, there has certainly been a striking reduction in the proportion of primary poverty. One of the outstanding characteristics of post-war conditions is the rise in the real wages of the lowest paid labour. Between 1913 and 1924 the wages of unskilled labour approximately doubled, whilst the cost of living was only 70% higher. A second characteristic is the reduction in the average size of the family. The census figures of 1921 showed the average number of children under 14 years of age per "family" to be 1·12 against 1·29 in 1911. Thus, the effect of increased wages in reducing poverty appears to be twice as great as the reduction in the size of families.

All the above figures refer to Great Britain only. There are no comparable figures for other countries—though undoubtedly the proportion of people below the poverty line is less in the British Dominions and in the United States than in Great Britain. It may possibly be less in Holland, Denmark and Switzerland; but, in the absence of figures, this is only guess-work. It is almost certainly greater in the other European countries, while in Japan, China and India it is enormously greater, even after making full allowance for differences in climate and national customs. To raise the standard of living in the East is perhaps the most urgent material task confronting civilisation.

BIBLIOGRAPHY.—Charles Booth, *Life & Labour of the People* (1892); B. Seebohm Rowntree, *Poverty: A Study of Town Life* (1901, 1922); L. G. Chiozza-Money, *Riches & Poverty* (1905); A. L. Bowley & A. R. Burnett-Hurst, *Livelihood & Poverty* (1915); B. Seebohm Rowntree, *The Human Needs of Labour* (1918); A. L. Bowley & Margaret H. Hogg, Has *Poverty Diminished?* (1925); A. M. Carr-Saunders and D. Caradog Jones, *A Survey of the Social Structure of England & Wales* (1927). (B. S. R.)

POVINDAH, a class of warrior nomadic traders in Afghanistan, who belong chiefly to the Ghilzais. Their name, which designates their occupation, is derived from the same root as the Pushtu word for "to graze." They are almost wholly engaged in the carrying trade between India and Afghanistan and Central Asia.

See Census of India 1921, Vol. I. 1924, p. 96.

POWELL, FREDERICK YORK (1850–1904), English historian and scholar, was born in Bloomsbury, London, on Jan. 14, 1850. Much of his childhood was spent in France and Spain. He was educated at Rugby, and at Christ Church, Oxford, was called to the bar at the Middle Temple in 1874, and married in the same year. He became law-lecturer and tutor of Christ Church, fellow of Oriel college, delegate of the Clarendon Press, and in 1894 he was made regius professor of modem history in succession to J. A. Froude. He assisted Professor Gudbrandr Vigfússon in his *Icelandic Prose Reader* (1897), *Corpus poeticum boreale* (1887), *Origines islandicae* (1905), and in the editing of the Grimm Centenary papers (1886). He took a keen interest in the development of modern French poetry, and Verlaine Mallarmé and Verhaeren all lectured at Oxford under his auspices. He was also a connoisseur in Japanese art. York Powell befriended refugees after the Commune, counting among his friends Jules Vallès the author of *Les Réfractaires;* and he was also a friend of Stepniak. He died at Oxford on May 8, 1904.

See the *Life,* with letters and selections, by Oliver Elton (1906).

POWELL, JOHN WESLEY (1834–1902), American geologist and ethnologist, was born at Mount Morris, N.Y., March 24, 1834. His parents were of English birth, but had moved to America in 1830, and he was educated at Illinois and Oberlin colleges. He began his geological work with a series of field trips including a trip throughout the length of the Mississippi in a rowboat, the length of the Ohio, and of the Illinois. When the Civil War broke out he entered the Union Army as a private, and at the battle of Shiloh he lost his right arm but continued in active service, reaching the rank of major of volunteers. In 1865 he was appointed professor of geology and curator of the museum in the Illinois Wesleyan university at Bloomington, and afterwards at the Normal university.

In 1867 he commenced a series of expeditions to the Rocky Mountains and the canyons of the Green and Colorado rivers, during the course of which (1869) he made a daring boat-journey of three months through the Grand Canyon; he also made a special study of the Indians and their languages for the Smithsonian Institution, in which he founded and directed a bureau of ethnology. His able work led to the establishment under the U.S. Government of the geographical and geological survey of the Rocky Mountain region with which he was occupied from 1870 to 1879. This survey was incorporated with the United States geological and geographical survey in 1879, when Powell became director of the bureau of ethnology. In 1881, Powell was appointed director also of the geological survey, a post which he occupied until 1894. He died in Haven, Ma, on Sept. 23, 1902.

His principal publications were: *Exploration of the Colorado River of the West and its Tributaries* (1875), *Report on the Geology of the Eastern Portion of the Uinta Mountains* (1876), *Report on the Lands of the Arid Region of the United States* (1879), *Introduction to the Study of Indian Languages* (1880), *Canyons of the Colorado* (1895), *Truth and Error* (1898).

See F. S. Dellenbaugh, *Romance of the Colorado River* (New York, 1903), and *Canyon Voyage: Second Powell Expedition* (New York, 1908); Wm. H. Brewer, "Obituary of John Wesley Powell," *Silliman's Journal,* series 4, vol. 14 (1902), pp. 377–383.

POWELL, VAVASOR (1617–1670), Welsh Nonconformist, was born in Radnorshire and educated at Jesus College, Oxford. About 1639 he became an itinerant preacher, and for preaching in various parts of Wales he was twice arrested in 1640. During the Civil War he preached in and around London. In 1646 he returned to Wales, and with a salary granted by parliament resumed his itinerant preaching. In 1650 parliament appointed a commission "for the better propagation and preaching of the gospel in Wales," and Powell acted as one of the principal advisers of this body. In 1653 he returned to London, and having denounced Cromwell for accepting the office of Lord Protector he was imprisoned. At the Restoration in 1660 he was arrested for preaching, and after a short period of freedom he was again seized, and he remained in prison for seven years. He was set free in 1667, but in 1668 he was again a prisoner, and he died in custody on Oct. 27, 1670.

See *The Life and Death of Mr. Vavasor Powell* (1671), attributed to Edward Bagshaw the younger; *Vavasoris Examen et Purgamen* (1654), by E. Allen and others; D. Neal, *History of the Puritans* (1822); and T. Rees, *History of Protestant Nonconformity in Wales* (1861).

POWER. The word "power," as used by the engineer, indicates energy under human control and available for doing mechanical work. The principal sources of power are the muscular energy of men and animals; the kinetic energy of the winds and of streams; the potential energy of water at high levels, of the tides and of waves; the heat of the earth and of the sun; and heat derived from the combustion of fuels. Of these sources of power the winds, waves and solar heat suffer the disadvantage of being essentially intermittent and therefore requiring some method of storage of power if the demand for power is continuous. From the point of view of the size and cost of the power plant, when large amounts of power are required, windmills, wave motors, and solar engines are not adaptable to large-scale power-generation; tidal power, while it may be developed in certain places for large power, usually entails excessive first cost; volcanic power or natural steam has been used in Italy and experimented with in California; hydraulic turbines and heat engines alone permit the construction of compact plants of practically unlimited capacity and of moderate first cost. The commonly accepted unit of power is the horse-power, which was defined by James Watt in 1783 as the equivalent of 33,000 ft.lb. of work per minute. This is about ten times as much work as can be done per minute by a labourer working eight hours per day.

The use of domesticated animals was the first enlargement of the power of man and the beginning of his civilization. The use of the wind for sailing vessels was an early development but its use in operating windmills dates from about the 12th century. Water-wheels were known in Greek times and are described by Vitruvius, but their capacity was very small. To the end of the 18th century the largest water-wheels for industrial use did not exceed 10 horse-power. The earliest operative heat engine is the cannon, used first at the end of the 13th century. The social consequences of its invention were momentous; it had a great part in the destruction of the feudal system. It represented a greater concentration of power than had been possible previously. Its indirect influence in stimulating the development of the art of cutting metals is of prime importance in the history of the heat engine.

The special incentive which gave birth to the steam engine was the desire to remove water from mines (particularly the tin mines of Cornwall). In 1698 Capt. Savery's engine was patented and a number of his engines were built. They were found to be extravagant in their use of coal. Four years later the first steam engine using a cylinder and piston was devised by Newcomen. It was while repairing a model of this engine that James Watt made the improvements that resulted in the modern steam engine. In 1782 Watt patented a double-acting rotative engine which, for the first time, made steam-power available for driving all kinds of mechanism. The result of this invention was the factory system and the industrial revolution. It became possible also to apply steam-power to navigation and to railroads.

The next important advance in power generation was the invention by Fourneyron of the hydraulic (reaction) turbine in 1827, for utilizing the energy of water available under high heads. Impulse water-turbines of the Pelton type, adapted to use the highest heads, were developed in California about 1860. Hydraulic turbines have now reached a high degree of perfection giving efficiencies in excess of 90%. The largest unit built up to 1928 has a capacity of 100,000 horse-power.

The thermal efficiency of a heat engine is a function of the maximum and minimum temperatures of the working substance and also of the cycle of operations. The cycle of maximum efficiency for given temperature limits is the Carnot cycle. Combustion, which is the source of heat in heat engines, either may occur outside the engine (external combustion) or may occur inside the engine (internal combustion). In external-combustion engines the working substance is distinct from the products of combustion and heat travels to it by conduction through containing walls such as boiler heating-surface. The maximum temperature of the working substance is then limited by the strength of the containing walls at high temperature; in 1928 the practical limit of temperature was about 900° F. With internal combustion the products of combustion are used as the working substance and there is no maximum temperature limit since the containing walls, piston and valves can be water-cooled. The theoretical thermal efficiency of the steam turbine, operating under the limiting conditions of 1928, is about 36%, of the Diesel engine about 50%. The brake thermal efficiencies actually realized are considerably lower. The internal-combustion engine is compact, of light weight, instantly available for use, has low labour cost and no stand-by losses. Its principal disadvantage is that it uses a fuel more costly than coal except in Diesel engines utilizing the cheapest grades of oil.

The first practical internal-combustion engine was that of Lenoir (1860). Two years later Beau de Rochas showed that for good efficiency it is necessary to compress the explosive mixture before igniting it; and in 1876 this idea was effectively realized in a successful explosion engine by Otto. The Otto cycle is the standard cycle in automobile, aeroplane and many stationary and marine engines. The fuel used by Lenoir and Otto was coal gas but in 1883 Daimler substituted volatile liquid hydro-carbon fuel (gasolene or petrol) and thereby made the engine available for automotive purposes. The use of less volatile hydro-carbon fuels (kerosene, fuel oil, etc.) was first successfully developed by Hornsby in the Hornsby-Ackroyd engine of 1894. A year later Diesel built his first engine, in which the air is brought up to the temperature of ignition of the fuel by the work of compression alone and fuel is injected in a finely atomized state after the compression is completed. It is possible to burn in it any fuel that can be atomized by high pressure air injection, by spraying under very high pressure through small openings, or by other means. It offers the combination of the cheapest fuel and the highest efficiency of utilization. The Diesel engine was slow in development at first because of many practical difficulties, especially from heat stresses. Its use in the automotive field is just beginning, particularly for trucks. In the aviation field it is particularly desirable in order to diminish the fire risk of the fuel.

The principal uses for power up to about 1890 were for driving shafting, pumps, compressors and hoists, for locomotives and for marine propulsion. With the improvements that had recently been made in the use of electricity the power station appeared. Electricity is a means for transmission of power and the only means which is economical for long distances and for complicated systems. The earlier power transmission systems by rope drives, compressed air and water under pressure, were too costly and cumbersome to survive. The maximum size of the electrical units installed increased rapidly from about 150 kw. in 1886 to 5,000 kw. in 1900.

The larger the engine the lower is its rotation speed. Large reciprocating engines are complex, heavy and costly, adapted only to special conditions. In 1884 Parsons had taken out a patent for a reaction steam turbine and in 1891 made it into a condensing unit and began to supply it to electric-power stations. In 1889 De Laval introduced the first practical impulse steam turbine. These turbines and those developed from them operate at high speeds of rotation, occupy little space, require no fly-wheels, are exceedingly simple, and have high steam efficiencies. The largest unit built up to 1929 is of 208,000 kw. capacity. This is equivalent to 279,000 h.p. or the work of 837,000 horses, or over 8,000,000 men working eight-hour shifts. Single power plants develop over 1,000,000 kilowatts.

In order to obtain high thermal efficiency it is desirable not only that the maximum temperature of the working substance should be high but also that the amount of thermal energy available at high temperature should be considerable. This condition exists with a saturated vapour because the abstraction of latent heat results in change of state without change in temperature. For this reason pressures of 1,400 lb. per square inch are now being used in a few plants, corresponding to a saturation temperature of nearly 600° F. At the critical pressure the temperature is only a little over 700° F, so that the limit of possible efficiency with steam is nearly reached; higher efficiencies with external-combustion engines can be obtained by the use of a combination of two working substances or the so-called binary-fluid system. A large-scale installation of a mercury-water system has yielded a brake thermal efficiency of about 35%, which is much more than is possible with any steam plant and practically the same as for a good Diesel engine. This system is still regarded as under development. The natural line of progress in power generation would seem to be the development of an internal-combustion turbine. Unfortunately all attempts along this line appear destined to fail until progress in metallurgy has produced some metal which will maintain adequate strength at high temperatures and also until the compression of the charge can be carried out much more efficiently than is possible with present-day centrifugal compressors.

The history of the development of power shows a constant striving for greater economy, greater compactness of the units and greater capacity of each unit. The present limits of capacity have already been indicated and they will certainly be extended. The cost of power is now becoming so low that no considerable improvement is to be anticipated. In a steam-turbine plant, with a consumption of 1 lb. of coal per hour per horse-power and with coal at \$5 per ton, the cost of the fuel is $\frac{1}{2500}$ of the cost of man-power when labour is paid \$5 per eight-hour day. The total cost of power, taking all costs into consideration, is only about $\frac{1}{800}$ of the cost of man-power. In a Diesel engine plant the cost of power is still lower.

See Diesel Engines; Electric Generator; Electrical Power in Agriculture; Electrical Power Generation; Electrical Power: National and Regional Schemes; Electric Motors; Electrical Power Transmission; Internal Combustion Engines; Motor Car; Pneumatic Power Transmission; Power Transmission: *Variable* Gears; Power Transmission: *Mechanical;* Turbine: Steam: Turbine: Water; Water Power; Windmills and Wind Power.

(L. S. Ma.)

POWER ALCOHOL: *see* Alcohol in Industry.

POWER AMPLIFIER. In radio work the ratio of the alternating-current power produced in the output circuit to the alternating-current power supplied to the input circuit is known as the power amplification. A power amplifier is an amplifier which is capable of producing relatively large power in an output circuit. (*See* Amplification.)

POWER OF ATTORNEY or Letter of Attorney is a written authority, usually, though not necessarily, under hand and seal, empowering the person named therein to do some act or acts on behalf of the principal, which otherwise could only be done by the principal himself. It is either general or special. A general power of attorney authorizes the agent to act for his principal in all matters, or in all matters of a particular nature, or generally in respect of a particular business. A special power of attorney authorizes the agent to represent his principal only in regard to some particular specified act. A power of attorney expires with death of the principal, and is revocable at his will, even by a verbal notice, unless it has been given for a valuable consideration to secure some interest of the donee. The law relating to powers of attorney is a branch of the law of agency. Powers of attorney are used freely in the United States where their form and usage follow that of England. (*See* PRINCIPAL AND AGENT.)

POWERS, HIRAM (1805–1873), American sculptor, the son of a farmer, was born at Woodstock, Vt., on June 29, 1805. In 1819 his father removed to Ohio, where the son attended school for about a year. After leaving school he found employment in a reading-room in the chief hotel of the town; but, being, in his own words, "forced at last to leave that place as his clothes and shoes were fast leaving him," he became a clerk in a general store in Cincinnati and afterwards a mechanic in a clock and organ factory. In 1826 he began to frequent the studio of Eckstein, and at once conceived a strong passion for sculpture. His proficiency in modelling secured him the situation of general assistant and artist of the Western museum in Cincinnati, where his ingenious representation of scenes in Dante's Inferno met with extraordinary success. At the end of 1834 he went to Washington, where his remarkable gifts soon awakened attention. In 1837 he settled in Florence, Italy, where he remained till his death. While he found it profitable to devote the greater part of his time to busts, his best efforts were bestowed on ideal work. In 1839 his statue of "Eve" excited the admiration of Thorwaldsen, and in 1843 he produced his celebrated "Greek Slave," which at once gave him a place among the leading sculptors of his time. Among the best known of his other ideal statues are the "Fisher Boy," "Il Penseroso," "Proserpine," "California," "America" (modelled for the Crystal Palace, Sydenham), and the "Last of his Tribe." He died on June 27, 1873.

POWER TRANSMISSION. The appliances connected with installations for the utilization of natural sources of energy may be classified into three groups:—(1) Prime movers, by means of which the natural form of energy is transformed into mechanical energy. To this group belong all such appliances as water turbines, steam turbines, steam engines and boilers, gas producers, gas engines, oil engines, etc. (2) Machinery of any kind which is driven by energy made available by the prime mover. To this group belong all machine tools, textile machinery, pumping machinery, cranes—in fact every kind of machine which requires any considerable quantity of energy to drive it. (3) The appliances by means of which the energy made available by the prime mover is transmitted to the machine designed to utilize it. The term *power* is used to denote the rate at which energy is transmitted. The unit of power in common use is the horse power, and one horse power means a rate of transmission of 550 foot-pounds per second.

In many cases the prime mover is combined with the machine in such a way that the transmitting mechanism is not distinctly differentiated from either the prime mover or the machine, as in the case of the locomotive engine. In other cases the energy made available by the prime mover is distributed to a number of separate machines at a distance from the prime mover, as in the case of an engineer's workshop. In this case the transmitting mechanism by means of which the energy is distributed to the several machines has a distinct individuality. In other cases prime movers are located in places where the natural source of energy is abundant, namely, near waterfalls, or in the neighbourhood of coal-fields, and the energy made available is transmitted in bulk to factories, etc., at relatively great distances. In this case the method and mechanism of distribution become of paramount importance, since the distance between the prime mover and the places where the energy is to be utilized by machines is only limited by the efficiency of the mechanism of distribution.

Prime movers are considered in the articles STEAM ENGINE; INTERNAL COMBUSTION ENGINES; DIESEL ENGINE; TURBINE, STEAM; MOTOR, ELECTRIC; HYDRAULIC MACHINERY, and machines are treated in various special articles. For the methods and mechanisms of distribution or transmission reference should be made to the following articles:

1. ELECTRICAL POWER TRANSMISSION
2. HYDRAULIC POWER TRANSMISSION
3. POWER TRANSMISSION, MECHANICAL
4. PNEUMATIC POWER TRANSMISSION

and to the articles ELECTRICAL POWER, NATIONAL AND REGIONAL SCHEMES; ELECTRICITY SUPPLY; ELECTRIFICATION OF INDUSTRY; POWER TRANSMISSION: VARIABLE GEARS. (X.)

POWER TRANSMISSION, MECHANICAL

Mechanical transmission of power is effected generally by means of belts or ropes, by shafts or by wheel gearing and chains. Each individual method may be used separately or in combination. The problems involved in the design and arrangement of the mechanisms for the mechanical distribution of power are conveniently approached by the consideration of the way in which the mechanical energy made available by an engine is distributed to the several machines in the factory. By a belt on the fly-wheel of the prime mover the power is transmitted to the line shaft, and pulleys suitably placed along the line shaft by means of other belts transmit power, first, to small countershafts carrying fast and loose pulleys and striking gear for starting or stopping each engine at will, and then to the driving pulleys (*q.v.*) of the several machines.

Quantitative Estimation of the Power Transmitted.—In dealing with the matter quantitatively the engine crank-shaft may be taken as the starting point of the transmission, and the first motion-shaft of the machine as the end of the transmission so far as that particular machine is concerned.

Let T be the mean torque or turning effort in ft.lb. which the engine exerts continuously on the crank shaft when it is making N revolutions per second. It is more convenient to express the revolutions per second in terms of the angular velocity ω, that is, in radians per second. The relation between these quantities is $\omega = 2\pi N$. Then the rate at which work is done by the engine crank shaft is $T\omega$ foot-pounds per second, equivalent to $T\omega/550$ horse power. This is now distributed to the several machines in varying proportions. Assuming for the sake of simplicity that the whole of the power is absorbed by one machine, let T_1 be the torque on the first motion-shaft of the machine, and let ω_1 be its angular velocity, then the rate at which the machine is absorbing energy is $T_1\omega_1$ foot-pounds per second. A certain quantity of energy is absorbed by the transmitting mechanism itself for the purpose of overcoming frictional and other resistances, otherwise the rate of absorption of energy by the machine would exactly equal the rate at which it was produced by the prime mover assuming steady conditions of working. Actually therefore $T_1\omega_1$ would be less than $T\omega$ so that

$$T_1\omega_1 = \eta T\omega,$$

where η is called the efficiency of the transmission. Considering now the general problem of a multiple machine transmission, if T_1, ω_1, T_2, ω_2, T_3, ω_3, $\cdots$ are the several torques and angular velocities of the respective first motion shafts of the machines,

$$(T_1\omega_1 + T_2\omega_2 + T_3\omega_3 + \cdots) = \eta T\omega \qquad (2)$$

expresses the relations which must exist at any instant of steady motion. This is not quite a complete statement of the actual conditions because some of the provided energy is always in course of being stored and unstored from instant to instant as kinetic energy in the moving parts of the mechanism. Here, η is the over-all efficiency of the distributing mechanism. We now consider the separate parts of the transmitting mechanism.

Belts.—Let a pulley A (fig. 1) drive a pulley B by means of a leather belt, and let the direction of motion be as indicated by the arrows on the pulleys. When the pulleys are revolving uniformly, A transmitting power to B, one side of the belt will be tight and the other side will be slack, but both sides will be in a state of tension. Let t and u be the respective tensions in pounds on the tight and slack side; then the torque exerted by the belt on the pulley B is $(t-u)r$, where r is the radius of the pulley in feet, and the rate at which the belt does work on the pulley is $(t-u)r\omega$ foot-pounds per second. If the horse power required to drive the machine be represented by h.p., then

$$(t-u)r\omega = 550 \text{ h.p.}, \tag{3}$$

assuming the efficiency of the transmission to be unity. This equation contains two unknown tensions, and before either can

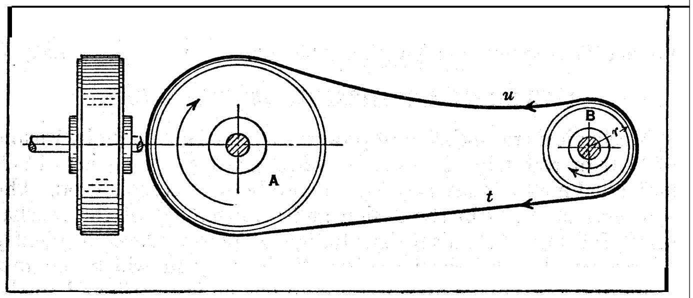


FIG. 1.— SHOWS BELT TORQUE

be found another condition is necessary. This is supplied by the relation between the tensions, the arc of contact θ, in radians (fig. 2), the coefficient of friction μ between the belt and the pulley, the mass of the belt and the speed of the belt. Consider an element of the belt (fig. 2) subtending an angle $d\theta$ at the centre of the pulley, and let t be the tension on one side of the element and $(t+dt)$ the tension of the other side. The tension tending to cause the element to slide bodily round the surface of the pulley is dt. The normal pressure between the element and the face of the pulley due to the tensions is $t\,d\theta$, but this is diminished by the force necessary to constrain the element to move in the circular path determined by the curvature of the pulley. If W is the weight of the belt per foot, the constraining force required for this purpose is $Wv^2d\theta/g$, where v is the linear velocity of the belt in feet per second. Hence the frictional resistance of the element to sliding is $(t-Wv^2/g)\mu d\theta$, and this must be equal to the difference of tensions dt when the element is on the point of slipping, so that $(t-Wv^2/g)\mu d\theta = dt$. The solution of this equation is

$$\frac{t-Wv^2/g}{u-Wv^2/g} = e^{\mu\theta}, \tag{4}$$

where t is now the maximum tension and u the minimum tension, and e is the base of the Napierian system of logarithms, 2.718. Equations (3) and (4) supply the condition from which the power transmitted by a given belt at a given speed can be found. For ordinary work the term involving v may be neglected, so that (4) becomes

$$t/u = e^{\mu\theta}. \tag{5}$$

Equations (3) and (5) are ordinarily used for the preliminary design of a belt to calculate t, the maximum tension in the belt necessary to transmit a stated horse power at a stated speed, and then the cross section is proportioned so that the stress per square inch shall not exceed a certain safe limit determined from practice.

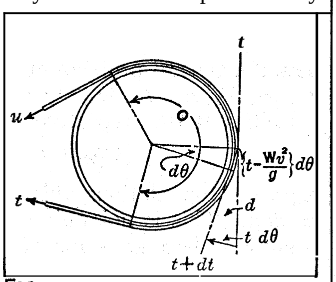


FIG. 2.— COEFFICIENT OF FRICTION

To facilitate the calculations in connection with equation (5), tables are constructed giving the ratio t/u for various values of μ and θ. (See W. C. Unwin, Machine *Design*, 12th ed., p. 377.) The ratio should be calculated for the smaller pulley. If the belt is arranged as in fig. 1, that is, with the slack side uppermost, the drop of the belt tends to increase θ and hence the ratio t/u for both pulleys.

Example of Preliminary Design of a Belt.—The following example illustrates the use of the equations for the design of a belt in the ordinary way. Find the width of a belt to transmit 20 h.p. from the flywheel of an engine to a shaft which runs at 180 revolutions per minute (equal to 18·84 radians per second), the pulley on the shaft being 3 ft. diameter. Assume the engine flywheel to be of such diameter and at such a distance from the driven pulley that the arc of contact is 120°, equal to 2·094 radians. and further assume that the coefficient of friction $\mu = 0{\cdot}3$. Then from equation (5) $t/u = e^{2.094\times 0\cdot 3} = 2.718^{0.6282}$; that is $\log_e t/u = 0.6282$, from which $t/u = 1{\cdot}87$, and $u = t/1{\cdot}87$. Using this in (3) we have $t(1-1/1{\cdot}87)\ 1{\cdot}5\times 18{\cdot}84 = 550\times 20$, from which $t = 838$ lb. Allowing a working strength of 300 lb. per square inch, the area required is 2.8 sq.in., so that if the belt is $\frac{1}{4}$ in. thick its width would be 11·2 in., or if $\frac{3}{16}$ in. thick, 15 in. approximately.

The effect of the force constraining the circular motion in diminishing the horse power transmitted may now be ascertained by calculating the horse power which a belt of the size found will actually transmit when the maximum tension t is 838 lb. A belt of the area found above would weigh about 1·4 lb. per foot. The velocity of the belt, $v = \omega r = 18{\cdot}84\times 1{\cdot}5 = 28{\cdot}26$ ft. per second. The term Wv^2/g therefore has the numerical value 34.7. Hence equation (2) becomes $(t-34{\cdot}7)/(u-34{\cdot}7) = 1{\cdot}87$, from which, inserting the value 838 for t, $u = 464{\cdot}5$ lb. Using this value of u in equation (1)

$$\text{H.P.} = \frac{(838-464{\cdot}5)\times 18{\cdot}84\times 1{\cdot}5}{550} = 19{\cdot}15.$$

Thus with the comparatively low belt speed of 28 ft. per second the horse power is only diminished by about 5%. As the velocity increases the transmitted horse power increases, but the loss from this cause rapidly increases, and there will be one speed for every belt at which the horse power transmitted is a maximum. An increase of speed above this results in a diminution of transmitted horse power.

Belt Velocity for Maximum Horse Power.—If the weight of a belt per foot is given, the speed at which the maximum horse power is transmitted for an assigned value of the maximum tension t can be calculated from equations (3) and (4) as follows:—

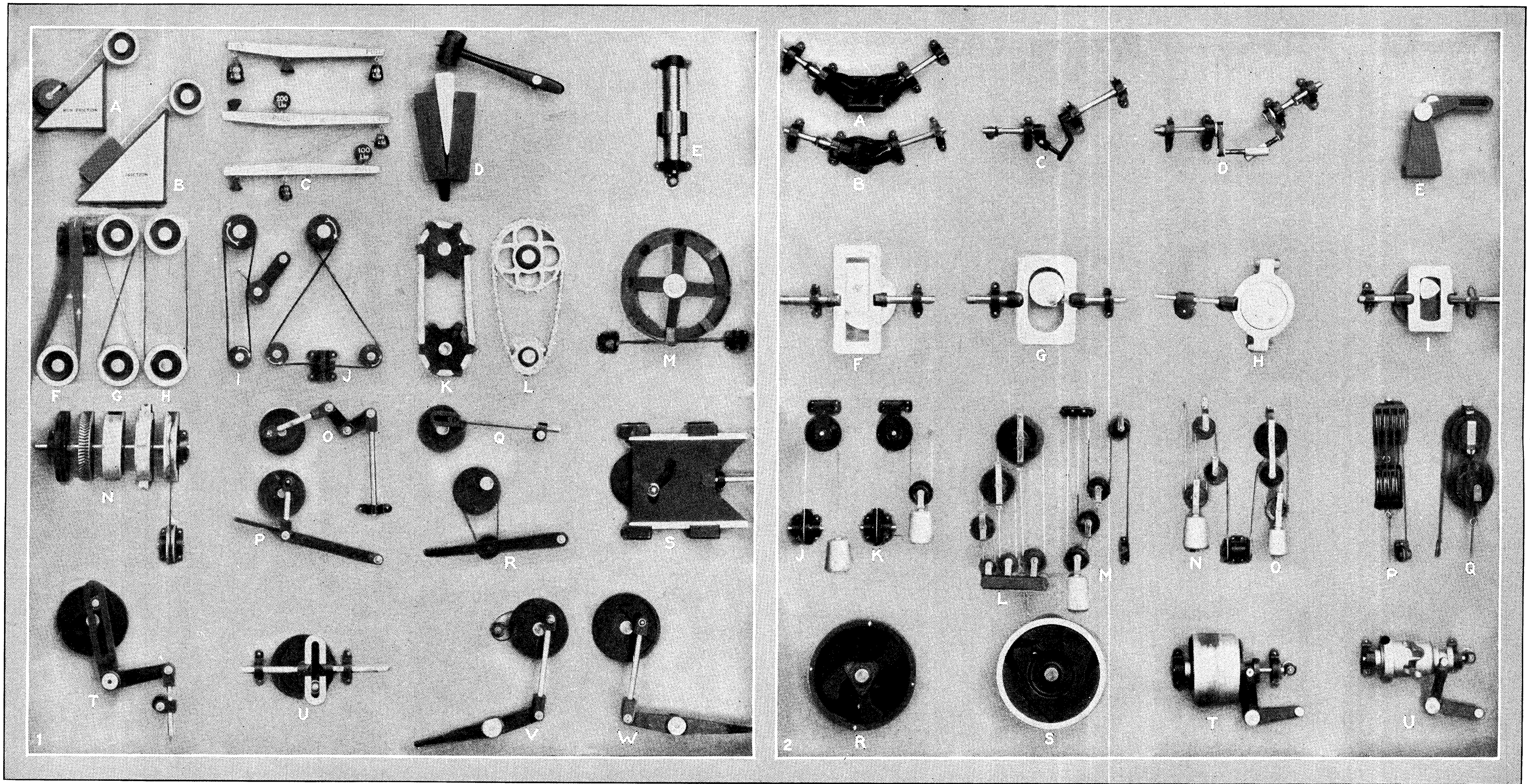
Let t be the given maximum tension with which a belt weighing W lb. per foot may be worked. Then solving equation (4) for u, subtracting t from each side, and changing the signs all through: $t-u = (t-Wv^2/g)\ (1-e^{-\mu\theta})$. And the rate of working U, in foot-pounds per second, is

$$U = (t-u)v = (tv - Wv^3/g)(1-e^{-\mu\theta}).$$

Differentiating U with regard to v, equating to zero, and solving for v, we have $v = \sqrt{(tg/3W)}$. Utilizing the data of the previous example to illustrate this matter, $t = 838$ lb., $W = 1{\cdot}4$ lb. per foot, and consequently, from the above expression, $v = 80$ ft. per second approximately. A lower speed than this should be adopted, however, because the above investigation does not include the loss incurred by the continual bending of the belt round the circumference of the pulley. The loss from this cause increases with the velocity of the belt, and operates to make the velocity for maximum horse power considerably lower than that given above.

Flexibility.— When a belt or rope is working power is absorbed in its continual bending round the pulleys, the amount depending upon the flexibility of the belt and the speed. If C is the couple required to bend the belt to the radius of the pulley, the rate at which work is done is $C\omega$ foot-pounds per second. The value for C for a given belt varies approximately inversely as the radius of the pulley, so that the loss of power from this cause will vary inversely as the radius of the pulley and directly as the speed of revolution. Hence thin flexible belts are to be preferred to thick stiff ones. Besides the loss of power in transmission due to this cause, the bending causes a stress in the belt which is to be added to the direct stress due to the tensions in the belt in order to find the maximum stress. In ordinary leather belts the bending stress is usually negligible; in ropes, however, especially wire rope, it assumes paramount importance, since it tends to overstrain the outermost strands and if these give way the life of the rope is soon determined.

Rope Driving.— About 1856 James Combe, of Belfast, introduced the practice of transmitting power by means of ropes run-



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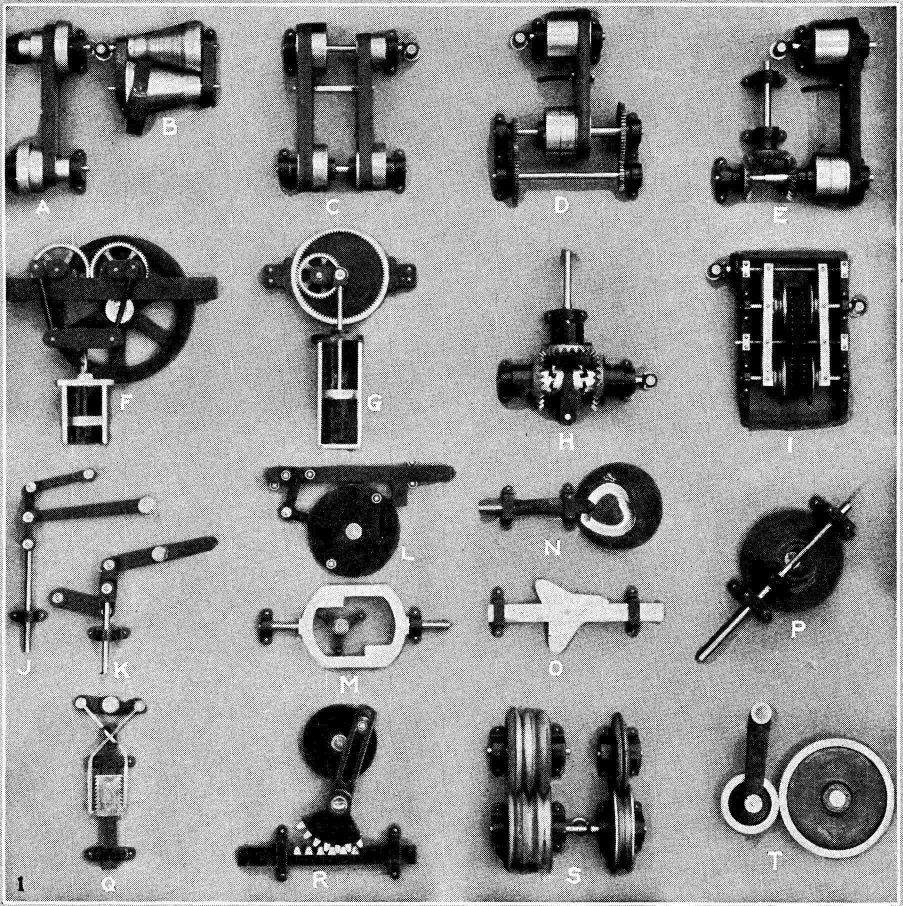
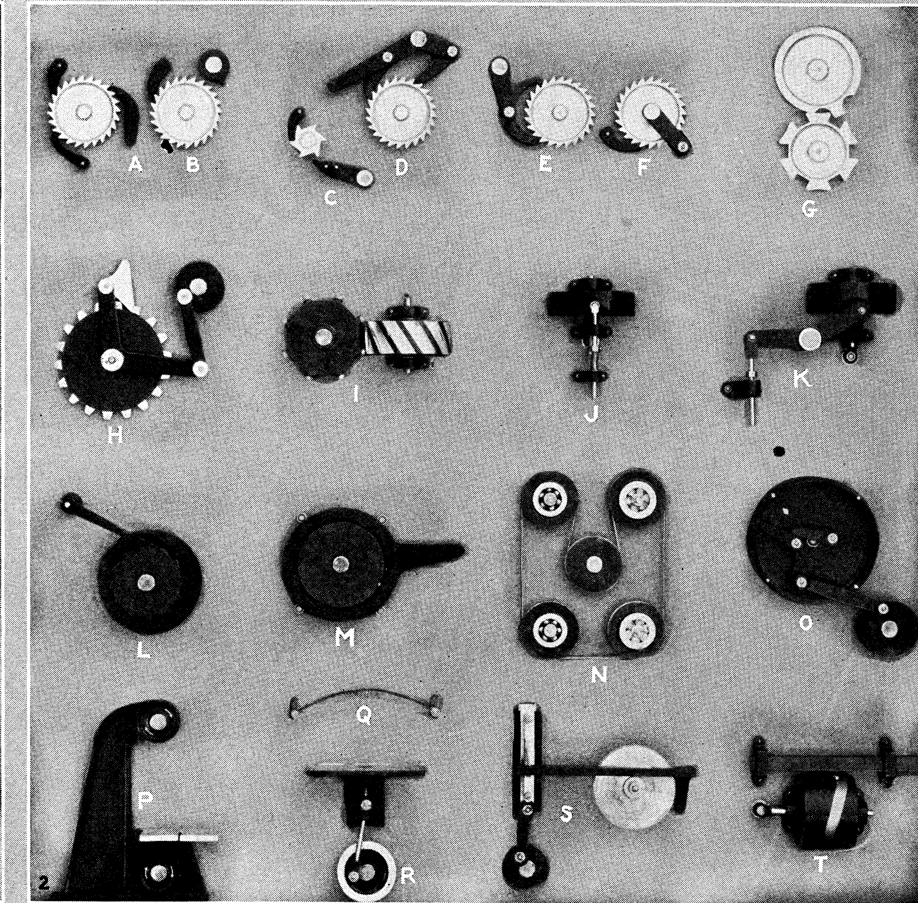
FUNDAMENTAL PRINCIPLES OF MECHANICS

1. A. Incline plane showing little friction by rolling weight. B. Incline plane showing friction by sliding weight. C. Three types of levers showing various positions of fulcrum in weight balancing. D. Principle of the wedge. E. Principle of the screw. An inclined-threaded plane roped around a cylinder. F. Pulleys at right angle belt drive. G. Reverse belt drive. H. Straight belt drive. I. Use of idler pulley; adding friction to belt drive to control speed. J. Principle of drum pulley. This principle is used in hand steering apparatus of vessels. K. L. Two types of sprocket chain drives. (L) commonly used in bicycle. M. Rope drive, the drum is connected to water wheel to transmit mechanical power from water wheel to motors. N. Five types of pulleys used in rope drive. From left to right: Common V type; notched V type; common flat pulley; chain pulley; warped grooved pulley. O. Belt crank drive. P. Treadle drive. Q. Slotted connecting rod. R. Bell treadle drive. S. Slotted cross head drive used to convert reciprocating motion to rotary motion. T. Slotted bell crank. U. Slotted yoke drive. V. Off-centre treadle drive employing spring. W. Off-centre treadle drive. 2. A. Double universal joint producing uniform rotation. B. Single universal joint producing non-uniform rotation. C. Out of line joint employing a single rod. D. Out of line joint with rods employing a sliding coupling. E. Out of line drive for parallel shaft. F. Scotch yoke. G. H. I. Three eccentric drives. (G) using circular cam shaft to change reciprocating motion to rotary motion, (H) circular belt cam commonly used in steam engine pumps, (I) using heart cam to change rotating motion to a quick reciprocating motion, sometimes used to control valves. J. Simple pulley having no mechanical advantage, ratio 1–1. K. Double pulley having a mechanical advantage whose ratio is 2–1. L. Complicated system of pulleys having a mechanical advantage, ratio 14–1. M. A system of pulleys whose mechanical advantage is a ratio of 8–1. N. A set of pulleys, ratio 4–1. O. A set of pulleys, ratio 3–1. P. Common type of hoisting pulleys giving a mechanical advantage of 7–1. Q. Similar type of pulleys whose mechanical advantage is 6–1. R. One type of centrifugal clutch employing three weights influenced by centrifugal force. S. Another type of centrifugal clutch employing three wedges. T. Cone clutch formerly used in automobiles. U. Tooth clutch used in modern machinery





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1. PULLEYS, CAM MOTIONS AND DRIVES

A–B. Variable speed pulleys: (A) step pulleys used for changing speed, *e.g.*, on lathes and drill presses; (B) cone pulleys used for great variety of speeds. C. Two speed countershaft employing two belts. D. Two speed countershaft with idler employing gear drives. E. Reversing device using belt shift. F. Straight line drive employing two crank shafts geared to flywheel, used in early steam engines. G. Straight line drive by internal gearing used in early steam engines. H. Reversing device using tooth clutch. I. Reeves variable speed device used for machines where a critical change of speed is necessary as in baking bread. J–K. Two types of straight line motions commonly used in indicators. L–M. Devices to turn rotary motion into reciprocating rectilinear motion: (L) rectilinear motion and stop produced by bell crank; (M) rectilinear motion using star wheel with yoke. N–O. Irregular cam motions: (N) positive motion heart cam; (O) clover-leaf cam giving positive rectilinear motion. P. Variable speed and reversing drive used in early automobiles. Q. Ratchet lift. R. Whitworth's quick return motion principle. S. Triple and single friction drives. T. Eccentric friction drive

2. PRINCIPLE OF RATCHET PAWLS AND SAWS

A. Pawls of various forms used on ratchet wheels to prevent backward motion. B. Intermittent circular motion from constant rotary motion. C. Pawl giving intermittent circular motion from reciprocating circular motion. D. Double pawl ratchet wheel, with lever, used in non-concentric shaft. E. Double pawl ratchet using claw movement. F. Intermittent circular motion from reciprocating circular motion used on concentric shafts. G. Geneva movement giving intermittent circular motion from constant circular motion used on the motion picture machine. H. Intermittent circular motion employing bell crank. I. Intermittent rotary motion from a shaft at right angles. J. Vibrating toothed wheel giving quick return rectilinear motion. K. Wave motion given to bell crank from constant circular motion. L. Double pawl ratchet in different form as (E.) M. Ratchet head with spring pawls. N. Ball and roller bearings for reducing friction. O. Intermittent circular motion from pendulum motion of a lever by friction pawls. P. Band saw for scroll sawing. Q–R. Jig saw for scroll sawing. This has a reciprocating motion: (Q) jig saw; (R) source of power. S. Vertical and circular gang saws, for multiple work. T. Drum cam giving reciprocating motion ning in grooves turned circumferentially in the rim of the pulley (fig. 3). The ropes may be led off in groups to the different floors of the factory to pulleys keyed to the distributing shafting. A groove was adopted having an angle of about 45°, and this is the angle still used in the practice of Messrs. Combe, Barbour and Combe, of Belfast. A section of the rim of a rope driving wheel showing the shape of the groove for a rope of $1\frac{3}{4}$ in. diameter is

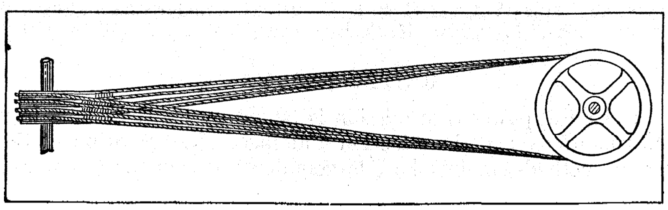


FIG. 3.— GROUP SYSTEM OF ROPE DRIVE

shown in fig. 4, and a rope driving pulley designed for six $1\frac{3}{4}$ in. ropes is shown in fig. 5. A rope is less flexible than a belt, and therefore care must be taken not to arrange rope drives with pulleys having too small a diameter relatively to the diameter of the rope. The principles of §§ 3, 4, 5 and 6, apply equally to ropes, but with the practical modification that the working stress in the rope is a much smaller fraction of the ultimate strength than in the case of belting and the ratio of the tensions is much greater. The following table, based upon the experience of Messrs. Combe, presents the practical. possibilities in a convenient form:—

Diameter of rope	Smallest diameter of pulley, which should be used with the rope	H.P. per rope for smallest pulley at 100 rev. per minute
In.	In.	
$\frac{3}{4}$	14	$\frac{5}{8}$
1	21	1
$1\frac{5}{8}$	42	8
$2\frac{1}{8}$	66	16

The speed originally adopted for the rope was 55 ft. per second. This speed has been exceeded, but, as indicated above, for any particular case there is one speed at which the maximum horse power is transmitted, and this speed is chosen with due regard to the effect of centrifugal tension and the loss due to the continual bending of the rope round the pulley Instead of using one rope for each groove, a single continuous rope may be used, driving from one common pulley several shafts at different speeds. For further information *see* Abram Combe, *Proc. Inst. Mech Eng.* (July 1896). Experiments to compare the efficiencies of rope and belt driving were carried out at Lille in 1894 by the *Société Industrielle du Nord de la France*, for an account of which *see* D. S. Capper, *Proc. Inst. Mech. Eng.* (October 1896). Cotton ropes are used extensively for transmitting power in factories, and though more expensive than Manila ropes, are more durable when worked under suitable conditions.

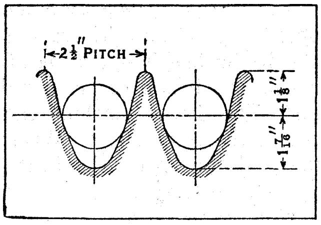


FIG. 4 —SECTION OF RIM FOR ROPE PULLEY DRIVE

Shafts.—When a shaft transmits power from a prime mover to a machine, every section of it sustains a turning couple or torque T, and if w is the angular velocity of rotation in radians per second, the rate of transmission is $T\omega$ foot-pounds per second, and the relation between the horse power, torque and angular velocity is

$$T\omega = 550\,\text{H.P.} \tag{6}$$

The problem involved in the design of a shaft is so to proportion the size that the stress produced by the torque shall not exceed a certain limit, or that the relative angular displacement of two sections at right angles to the axis of the shaft at a given distance apart shall not exceed a certain angle the particular features of the problem determining which condition shall operate in fixing the size. At a section of a solid round shaft where the diameter is D inches, the torque T inch-pounds, and the maximum shearing stress f pounds per square inch, the relation between the quantities is given by

$$T = \pi D^3 f/16, \tag{7}$$

and the relation between the torque T, the diameter D, the relative angular displacement θ of two sections L inches apart by

$$T = C\theta\pi D^4/32L, \tag{8}$$

where C is the modulus of rigidity for the material of the shaft. Observe that θ is here measured in radians. The ordinary problems of shaft transmission by solid round shafts subject to a uniform torque only can be solved by means of these equations.

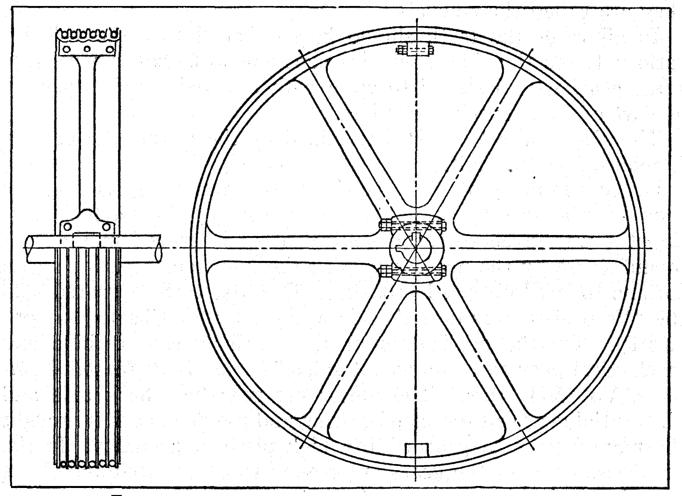


FIG. 5.— DESIGN OF PULLEY FOR SIX ROPE DRIVE

Calculate the horse power which a shaft 4 in. diameter can transmit, revolving 120 times per minute (12.56 radians per second), when the maximum shearing stress f is limited to 11,000 lb. per square inch. From equation (7) the maximum torque which may be applied to the shaft is $T = 138{,}400$ inch-pounds. From (6) $\text{H.P.} = \dfrac{138{,}400 \times 12\cdot 56}{12 \times 550} = 264$. The example may be continued to find how much the shaft will twist in a length of 10 ft. Substituting the value of the torque in inch-pounds in equation (8), and taking 11,500,000 for the value of C,

$$\theta = \frac{138{,}400 \times 120 \times 32}{11{,}500{,}000 \times 3\cdot 14 \times 256} = 0\cdot 057 \text{ radians,}$$

and this is equivalent to 3·3°.

In the case of hollow round shafts where D is the external diameter and d the internal diameter equation (7) becomes

$$T = \pi f(D^4 - d^4)/16D, \tag{9}$$

and equation (8) becomes

$$T = C\theta\pi(D^4 - d^4)/32L. \tag{10}$$

The assumption tacitly made hitherto that the torque T remains constant is rarely true in practice; it usually varies from instant to instant, often in a periodic manner, and an appropriate value of f must be taken to suit any particular case. Again it rarely happens that a shaft sustains a torque only. There is usually a bending moment associated with it. For a discussion of the proper values of f, to suit cases where the stress is variable, and the way a bending moment of known amount may be combined with a known torque, *see* STRENGTH OF MATERIALS. It is sufficient to state here that if M is the bending moment in inch-pounds, and T the torque in inch-pounds, the magnitude of the greatest direct stress in the shaft due to the effect of the torque and bending moment acting together is the same as would be produced by the application of a torque of

$$M + \sqrt{(T^2 + M^2)} \text{ inch-pounds} \tag{11}$$

It will be readily understood that in designing a shaft for the distribution of power to a factory where power is taken off at different places along the shaft, the diameter of the shaft near the engine must be proportioned to transmit the total power transmitted whilst the more remote parts of the shaft are made smaller, since the power transmitted there is smaller.

Gearing. Pitch Chains.—Gearing is used to transmit power from one shaft to another. The shafts may be parallel; or inclined to one another, so that if produced they would meet in a point; or inclined to one another so that if produced they would not meet in a point.

In the first case the gear wheels are called spur wheels, sometimes cog wheels; in the second case bevel wheels, or, if the angle between the shafts is 90°, mitre wheels; and in the third case they are called skew bevels.

In all cases the teeth should be so shaped that the velocity ratio between the shafts remains constant, although in very rare cases gearing is designed to work with a variable velocity ratio as part of some special machines.

The size of the teeth is determined by the torque the gearing is required to transmit.

Gearing is noisy at high speeds unless special care is taken in the manufacture to secure exact uniformity in pitch. Great impetus was given to the development of improved methods of manufacture by the need of gearing the high speed marine steam turbine to the low speed propeller. The first turbine geared ship the "Vespasian" was described in a paper by Sir Charles Parsons entitled "On the application of the marine steam turbine and mechanical gearing to merchant ships." *Proc. Inst. Naval Architects,* Vol. LII. 1910. The motor car gear box, back axle and differential gear call for silent gearing and the demand has brought the manufacture of gearing to a high pitch of accuracy. In the best class of work the gears are ground to exact pitch and shape after hardening,

Pitch chains are closely allied to gearing; examples are offered by many automobile engines, *e.g.,* the pitch chain often found driving the large shaft, etc Pitch chains ane used to a limited extent as a substitute for belts, and the teeth of the chains and the teeth of the wheels with which they work are shaped on the same principles as those governing the design of the teeth of wheels.

If a pair of wheels is required to transmit a certain maximum horse power, the angular velocity of the shaft being ω, the pressure P which the teeth must be designed to sustain at the pitch circle is 550 $\mathrm{H.P.}/\omega R$, where R is the radius of the pitch circle of the wheel, whose angular velocity is w.

In the case of transmission either by belts, ropes, shafts or gearing, the operating principle is that the rate of working is constant, assuming that the efficiency of the transmission is unity, and that the product Tw is therefore constant, whether the shafts are connected by ropes or gearing Considering therefore two shafts, $T_1\omega_1=T_2\omega_2$; that is $\omega_1/\omega_2=T_2/T_1$; *i.e.,* the angular velocity ratio is inversely as the torque ratio. Hence the higher the speed at which a shaft runs, the smaller the torque for the transmission of a given horse power, and the smaller the tension on the belts or ropes for the transmission of a given horse power.

Long Distance Transmission of **Power.**—C. F. Hirn originated the transmission of power by means of wire ropes at Colmar in Alsace in 1850. Such a telodynamic transmission consists of a series of wire ropes running on wheels or pulleys supported on piers at spans varying from 300 to 500 ft. between the prime mover and the place where the power is utilized. The slack of the ropes is supported in some cases on guide pulleys distributed between the main piers. In this way 300 h.p. was transmitted over a distance of 6,500 ft. at Freiberg by means of a series of wire ropes running at 62 ft. per second on pulleys 177 in. diameter. The individual ropes of the series, each transmitting 300 h.p., were each 1·08 in. diameter and contained 10 strands of g wires per strand, the wires being each 0.072 in. diameter. Similar installations existed at Schaffhausen, Oberursal, Bellegarde, Tortona and Zürich. For particulars of these transmissions with full details *see* W. C. Unwin's Howard Lectures on the "Development and Transmission of Power from Central Stations" (*Journ. Soc. Arts,* 1893, published in book form 1894). The system of telodynamic transmission would no doubt have developed to a much greater extent than it has done but for the advent of electrical transmission, which made practicable the transmission of power to distances beyond the possibilities of any mechanical system.

See W. J. M. Rankine, *Treatise on Machinery and Millwork;* and W. C. Unwin, *Elements of Machine Design;* and for telodynamic transmission *see* F. Reuleaux, *Die Konstrukteur. See* also, Daniel Adamson, "Spur Gearing," *Proc. Inst. Mech. Eng.* (1916 Jan.–May); *R.* J. McLeod, "Turbine Reduction Gearing and its Production," *Proc. Inst. Mech Eng.* (1924 Vol. 2); H F, L. Orcutt, "Characteristics and uses of Ground Gears," *Proc. Inst. Mech. Eng.* (1925 Vol. 2). (W. E. D.)

UNITED STATES

Mechanical power transmission is bound by many assumptions and conditions, and the selection and successful operation of the various methods employed are largely dependent upon: (1) source and kind of power; (2) character of equipment to be driven; (3) horse-power, speeds and ratios; (4) supports and foundations; (5) bearings—their construction, type and spacing; (6) lubrication; (7) shafting—size, quality and material; (8) belting—type, width, thickness and method of joining; (9) manner of loading and unloading the power to be transmitted; (10) mechanical and atmospheric conditions involved; (11) relation of distribution to prime mover; (12) alignment; (13) available space; (14) maintenance facilities.

Modern Methods.—Recent years have brought efficient and economical small-powered prime movers and improvements in mechanical power mechanisms. These developments have segregated the transmitting of mechanical power into certain groups which, when employed in proper relation to other essential operating factors, make for economy, efficiency and low maintenance. Modern mechanical transmission systems can be classified as follows: (1) direct motor coupled connection; (2) direct motor belt connection; (3) direct motor chain connection; (4) belt and line shaft group system; (5) gear reduction unit system; (6) open gear connection system; (7) multiple fabric or manila rope systems; (8) the variable speed connection unit; (9) the combination of one or more of the above systems.

Direct motor coupled connections afford compactness and are most extensively employed for the driving of modern machine tools (*q.v.*). The connection medium between motor and the power-receiving shaft should be a flexible coupling.

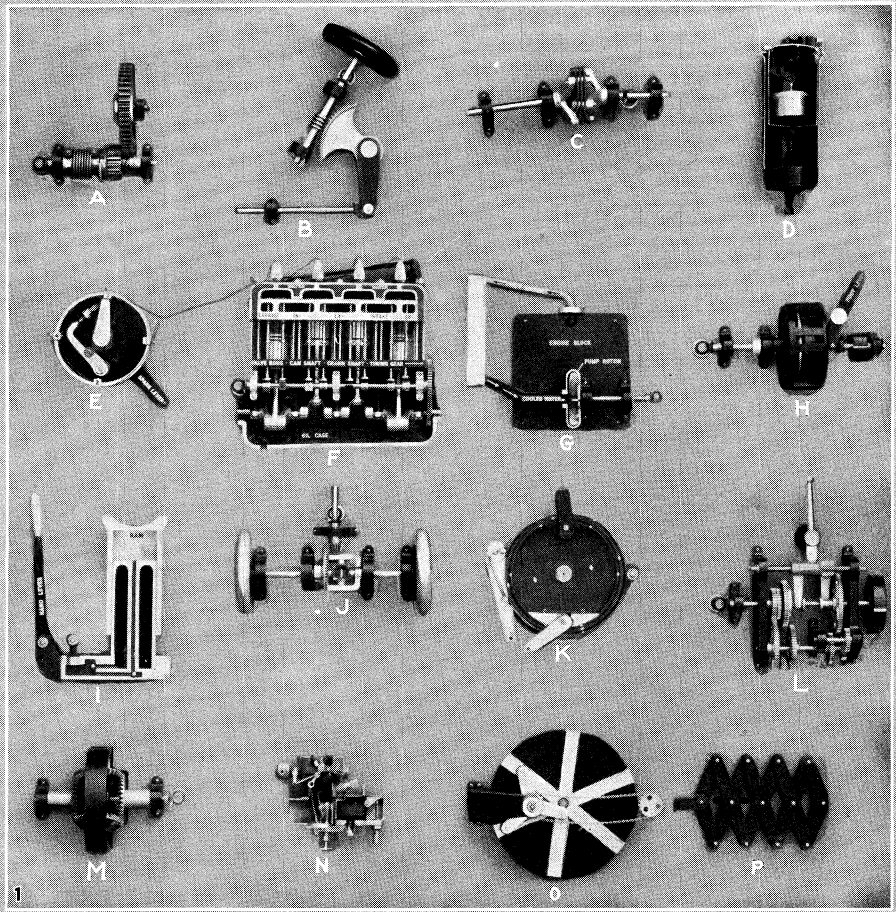
Direct motor belt connections employ a belt as the connection between the motor and power-receiving shaft of the mechanism and are extensively employed for various apparatus and machine tool driving. With this method any ratio up to 6 to 1 is practicable from the motor to machine.

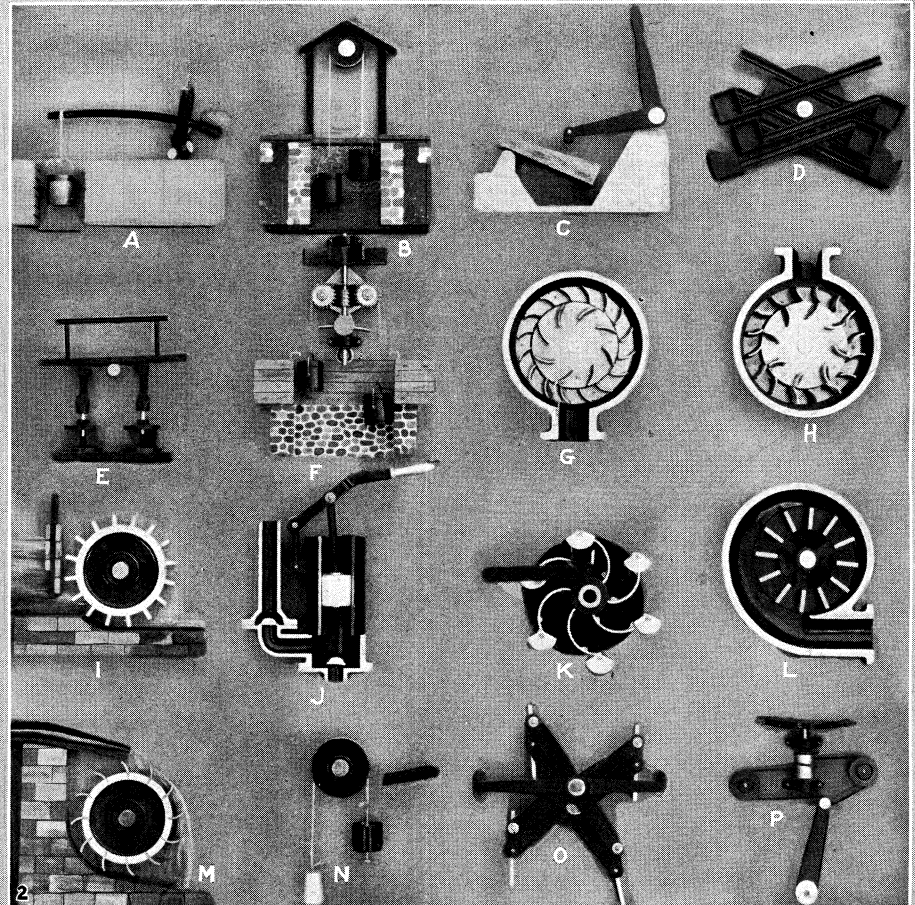
Direct motor chain connections employ chain of various types as the connection between the motor and power-receiving shaft of the mechanism. It is successfully operated on machine tools and line shaft drives. Ratios up to 7 to 1 on short centres are practicable.

The group system is extensively used in modern industrial operations. Group driving is most practicable from 5 to 50 h.p. and if the line is operating at the normal speeds of 150 to 300 r.p.m., one belted or chain reduction is sufficient from motor to line. The driven machine can be belted from the line through countershafts or direct. With this system, the size of the prime mover is based on the aggregate of the running loads of the machines driven.

Gear reduction unit systems. The electric motor has the inherent characteristic of operating at high speed. In many industrial operations the power-receiving shaft of apparatus or machine to be driven must run at slow speed. Ratios of 50 to 1 and 100 to 1 are frequent from prime mover to apparatus, therefore the use of the modern gear reduction unit. Ratios such as these if attempted by the belting and shafting method would require a large amount of transmission equipment. Spur gear reducers are manufactured with ratios up to 500 to 1 and reduce in a straight line. The worm gear reducer has reached a high state of perfection. The single unit can be employed on drives requiring speed reductions of 100 to 1.

The open gear connection system is employed where extremely close centres and moderate ratios are desired such as on small



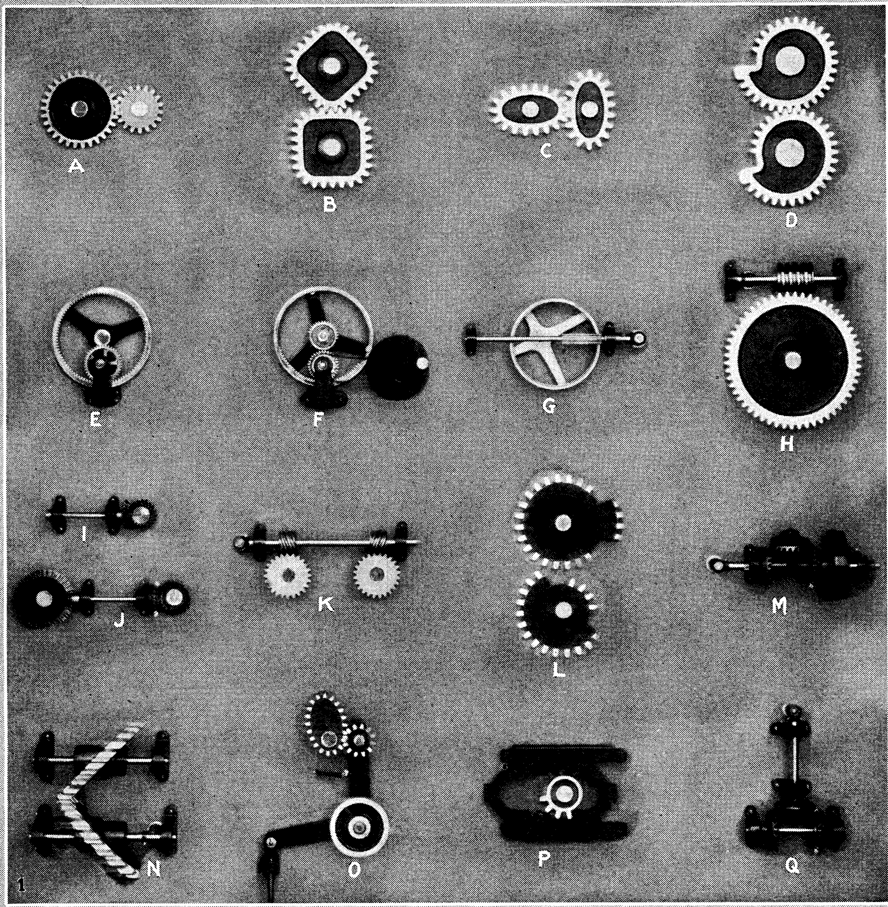


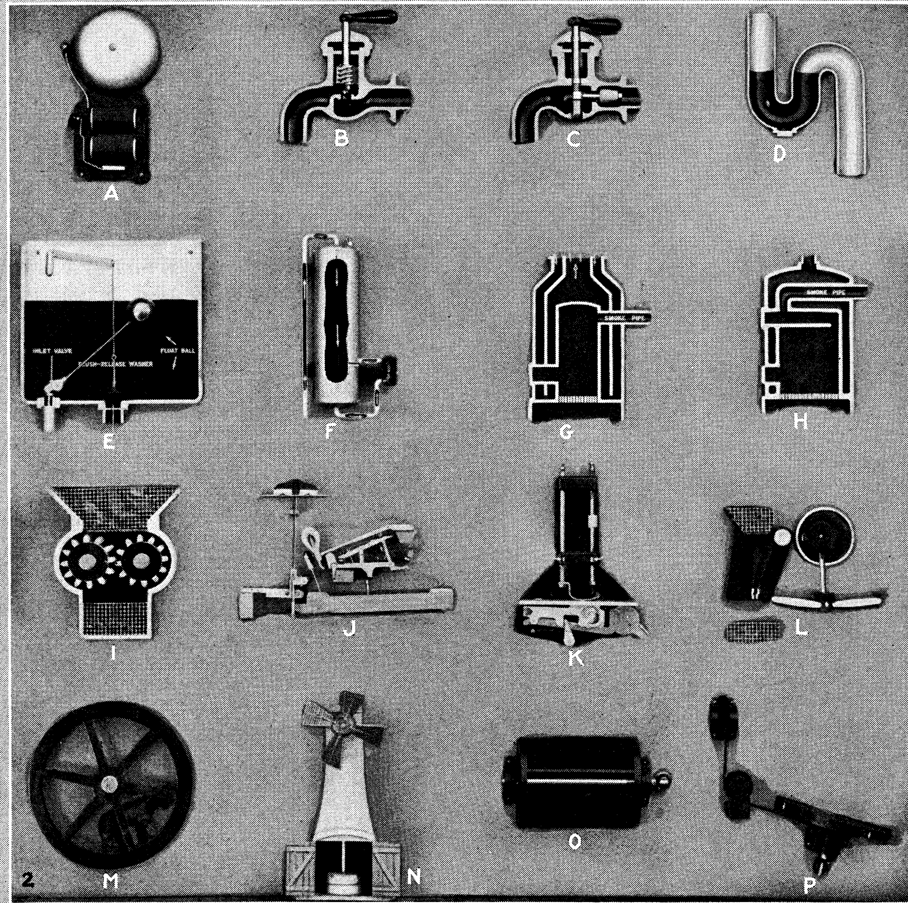
1. PARTS AND MOVEMENTS OF AUTOMOBILE

A. Bendix drive for self starter. B. Worm and worm wheel used for steering apparatus. C. Universal joint. D. Vacuum tank. E. Spark timer and distributor. F. Cross-section of a four-cylinder four-cycle gasoline engine showing cylinders and cylinder rods attached to drive shaft. G. Principle of a water cooling system. H. Multiple disc clutch. I. Hydraulic ram for jacking. J. Rear end and differential. K. Internal and external brake for foot and emergency brakes. L. Principle of gear shift. M. Power measuring dynamometer. N. Section of a carburettor. O. Speed reducer employing rollers and slots. P. Lazy tongs used to extend telephones.

2. PRINCIPLE OF WATER TRANSMISSION

A. Well bucket using balanced lever to draw up bucket. B. Double well bucket, one used to balance the other. C. Bailing scoop to raise water from one level to another. D. Pendulum water lift to raise water for irrigation purposes. E. Double pump operated by a person shifting his own weight. F. Double bucket lift using wind mill as the power. G. Water turbine having the external wheel rotating. H. Water turbine having the internal wheel rotating. I. Undershot water wheel. J. Cross-section of simple force pump. K. Double discharge current power water lift for irrigation. L. Volute water turbine. M. Overshot water wheel. N. Water bucket lift. O. Paddle wheel for side wheel propulsion where the paddles remain vertical. P. Steering wheel and winch for boats





1. VARIOUS TYPES OF GEARS

A. Spur gears commonly used in machines. B. Square gears producing a variable speed from a constant speed; not commonly used. C. Elliptical gears rotating about their centre producing a variable speed governed by the shape of the ellipse. D. Scroll gears for increasing or decreasing the speed gradually during one revolution. E. Internal gearing producing rotation in the same direction. F. Gear combination producing a slow forward and quick back circular motion from the continuous circular motion of a gear wheel. G. Eccentric crown gear and pinion producing variable circular motion. H. Worm and worm wheel high speed reducer, used on rear ends of automobile trucks. I–J. Mitre and bevel gears for transmitting power at right angles. K. Left and right-hand worm gears and pinions. L. Sector gears producing two different speeds and stop during one revolution of the driver. M. Epicyclic gear train bevel gears. N. Swash plate gears invented for mixing machines; produces uniform rotation but a kneading action at the same time. O. Geared cam producing reciprocating motion to a bell crank. P. Sector pinion and double rack giving rectilinear reciprocating motion from the continual motion of a sector pinien. Q. Bevel gears and bevel gear sector producing uniform reciprocating circular motion

2. VARIOUS TYPES OF SIMPLE MECHANISMS

A. Continuous ringing electric bell. **B.** Faucet employing a screw to open valve: common type. C. Faucet using crank to open valve. D. Common S trap to collect dirt and prevent gases from entering household. E. Section of common flush tank showing operation. F. Household gas hot water heater. G. Section of hot air furnace for the household. H. Section of a steam or hot water furnace for the household. **I.** Gear type coal breaker. J. Piano key action and damper. K. Sewing machine producing lock stitch using only one thread; showing action of needle and interlocking mechanism for thread. L. Stone crusher with toggle joint. M. Horse power wheel. N. Windmill and grinder. O. Chinese tread wheel for power. **P.** Sloping tread wheel platform machine tools and large apparatus. Composition or non-metallic gears are used on the prime mover shaft to eliminate the noise of high speed metallic gears meshing together. Large apparatus at slow speeds are frequently direct geared to the motor and where a greater ratio is necessary than is practicable with one reduction, a back geared motor is employed. This type of motor combines one geared reduction integral with itself.

The multiple fabric rope system is of recent development. The ropes are of "V" shaped endless construction and operate on "V" grooved wheels. Ratios up to 7 to 1 and extremely short centres are possible. It is applicable for direct driving of almost any class of machine or apparatus where adjustment between driver and driven is possible. There are now in use two systems of *manila rope driving:* the American or continuous method and the English or multiple method. The American system employs but one continuous rope winding over all of the grooves with the rope on the slack side forming a loop over an idler sheave and a travelling tightener which automatically regulates the tension of all the wraps of the rope. The English system employs separate and independent endless ropes in each groove of the wheels. The American system will transmit power for great distances and in any direction. The English system is most adaptable for direct high power driving.

Variable speed connection units are used to meet the requirements of numerous industrial operations. Variations in applied speed are absolutely necessary, and the control of this speed change must be smooth or without shock. In modern practice this is accomplished by variable speed motors or by mechanical speed change devices. It frequently happens that it is necessary to employ a *combination of methods* of driving because of limited space. The compactness of modern methods is then an advantage.

Mechanical Consideration. — Consideration affecting power methods are space, speed, ratios and method of control. Mechanical driving requires *space,* the amount being dependent on the method employed. If ratios are low and ample centres are available the "group" system of belt driving should be employed. If space is limited and ratios are high, the close coupled installations such as chain, worm or spur gear reducers, multiple rope and direct gear connections should be used. Space governs moderate *speed ratios,* but available area does not warrant the use of shafting and belting when ratios of 25, 30, 50 and 100 to 1 are necessary. For these ratios gear reduction units should be used.

The method of control is an important factor since it is frequently necessary to change speeds or shut down the machine during operation and then start under load. Unless a slip ring motor is employed, direct connection by any rigid means should not be used. Shafting should be employed for this service equipped with belting or chains controlled by either clutch or shifters.

Plant Considerations. — Plant considerations affecting power methods are power sources and costs. In industry where power is either purchased or generated, the *power source* has no effect on the problem, but in plants where natural power has been harnessed by cumbersome methods and modernizing is desired, the problem is somewhat difficult. Here power is distributed by long lines of shafting and numerous wide belts. If the plant is large, the friction load is high and maintenance excessive. By the installation of gear reduction units and short centre devices much shafting and belting can be removed. *First cost* of mechanical transmission equipment should not be considered to such an extent that the cheapest method is the best. In many instances high initial expenditures are economical. In large industrial operations, *maintenance costs* are of necessity high, but when good quality transmission equipment is installed it should be given care and attention. Careless joining, wrong type and size of belting and injurious dressings are all causes of high maintenance. Inattention to lubrication, poor adjustments, careless installing and overloading cause the maintenance bills to rise on transmission appliances such as bearings, clutches, pulleys and shafting.

Belting. — Power belting is the medium of delivering a given amount of power at a given point at the least cost per unit of time, which should result in the transmission of power at the lowest cost per horse power per year over the longest period of useful service. If the belting fails, the mechanism stops. If the belting slips, the mechanism slows down. It is necessary that the user have some knowledge of the attributes and characteristics of the various power belting materials and the correct atmospheric and mechanical conditions. (*See* BELTING.) The open belted short centre driving installation is not efficient. Its faults have led to the development of modern methods for driving at close centres by flexible shock absorbing non-metallic mediums.

The Automatic idler system is a development of the ordinary tightener pulley. Its chief function is to increase the arc of contact on the driving pulley. The fulcrum or idler pulley is applied to the belt so as to equal the belt tension and to increase the arc of contact both permanently and automatically and in accordance with the load transmitted. The permanent increase is attained by the proper location of the idler fulcrum. The automatic increase is accomplished by wrapping every possible inch of belting around the smaller of the two pulleys. The elongation or stretch of the belt due to its elasticity is in synchronism with the variations in the power transmitted; when the power is maximum, the arc and the grip of the belt on the pulley is also maximum.

The multiple "V" shaped rubber and fabric rope drive is an adaptation of the English multiple endless rope-driving method with the exception that it employs "V" shaped ropes made of rubber and fabric composition operating on multiple "V" grooved wheels. It is an excellent transmitter of power at close range. The greater the load tension, the greater the adhesion to the grooves of the wedge-shaped belting sheaves, therefore, slip is almost entirely eliminated. This method of driving is successful on short centre work, with centre distances up to 12 feet. It has a range in power capacity from $\frac{1}{2}$ h.p. to 2,000 h.p., depending on the number and size of "V" ropes employed.

High Ratio Short Centre Device. — There are occasions for ratios from 15 to 1 to 30 to 1. Solving such reductions by shafting and belting may be out of the question. Worm gear or spur gear reduction units may be too rigid. To meet such requirements a new device has been recently developed, which gives a compact, flexible, short-centre and high-ratio drive. It is composed of a gear, pinion, pulley, spindle and fulcrum arm. The pulley and pinion are keyed to the spindle which is supported by the fulcrum arm centred on the shaft to be driven. The gear is keyed on the shaft to be driven and meshes with the pinion on the spindle. Thus, in the rotation of the spindle by the aid of a belt drive to the spindle pulley, the pinion tends to make an epicyclic movement around the gear wheel with which it meshes, but such movement is restrained when the belt has been tensioned and the continued rotation of the pinion will rotate the gear wheel and operate the apparatus or lineshaft. The degree of tension on the driving belt depends upon the inertia to be overcome in starting the load and in the continued running, so that the belt always retains the correct tension for the power requirements. The chief feature of this method of driving is the absolute automatic load tension on the ordinary open driving belt without the aid of spring or weight controlled idler pulleys. The belt is always in correct tension because the load controls it.

Power Shafting Bearings. — There are various types of bearings manufactured for industrial power transmitting. They are designed to support shafting and the factors which determine the selection of any given design are: (1) diameter and speed of shaft; (2) power transmitted and kind of load; (3) supporting structure; (4) lubrication; (5) space limitations; (6) operating conditions. Bearings are made of iron or steel, bushed or lined with brass, bronze and various anti-friction metals. (*See* BEARINGS.) When bearings are lined with babbitt metal, as is common practice, the shaft beds itself down and distributes its weight uniformly over the entire bearing surface. Industrial bearings are subjected to "moderate" or "excessive" pressures. Moderate pressures exist in industrial head, line, jack and counter shaft operations if the correct number of bearings are employed for the load demand. Standard bearings for this class of work have ample bearing surface for the pressures involved. Excessive pressures on bearings are due to extreme weight, pull or thrust conditions. Excessive dead load causes extreme weight. Excessive pull is due to high belt or rope tension. Excessive thrust is due to abnormal duty or to faulty mechanical adjustments.

Solid babbitted bearings of babbitted cast iron should be used on slow speed shafting under $4\frac{7}{16}$ in. diameter. Lubrication is by grease cup or plain oiling. *The split flat box* type of babbitted cast iron, furnished with a cap, is employed where moderate powers and speeds are involved, but not on shafting over $3\frac{15}{16}$ in. diameter. Grease or oil is used as a lubricant.

The self-oiling rigid pillow block type of babbitted cast iron is designed to feed the oil to the shaft, by the ring, chain, collar or capillary method. This type should be lubricated by the ring, chain or collar method up to 110 r.p.m. Above this speed the capillary system should be used.

The angle self-oiling rigid pillow block type is similar to the self-oiling rigid pillow block except that the split is at an angle of approximately 45°. This bearing should be employed when a severe power pull is directly on the cap.

The ball and socket self-oiling pillow block type is of cast iron construction, is equipped with ring or capillary oiling features, accommodates itself to shaft movement and possesses vertical adjustment. It is made in sizes from $1\frac{7}{16}$ in. to $4\frac{15}{16}$ in. diameter. It is employed for shafting supported from concrete piers or timbers and particularly on line shafting supported from walls of buildings.

The adjustable drop hanger is designed to support line shafting. It can also be used for head, jack or counter shafting. It is constructed of cast iron and equipped with a self-oiling bearing. The ball and socket type has vertical adjustment through threaded plungers and side adjustment through slotted holes. in the base. The 4-point suspension type can be adjusted both vertically and horizontally but the bearing is held more rigidly than that of the ball and socket type. These types of hangers are manufactured for shafting $\frac{15}{16}$ in. to 6 in. diameter.

The adjustable ball and socket post hanger type is of cast iron and is equipped with a self-oiling bearing. It is designed for head and line shafting that must be supported from columns. It has vertical adjustment and the bearing can arrange itself to the shaft movement. It is made for shafting $\frac{15}{16}$ in. to 6 in. diameter. (*See* BEARINGS.)

Transmission by chain has progressed to the extent that there is a type of chain for most any service. The general advantages of chain driving are: (1) very high efficiency; (2) relatively high speeds available; (3) reversability; (4) unaffected by heat, cold or moisture; (5) wide power transmitting range; (6) a positive velocity ratio; (7) utility on short or long centres; (8) security from slippage.

Detachable malleable iron chain is composed of individual malleable iron links so designed as to allow ease of assembly. It finds application in practically every form of industry where the speeds and ratios are held within 400 r.p.m. and under, and the ratio held to not more than j to 1.

Steel Roller Chains.—While malleable iron chains have given satisfactory service for the transmission of power in their field, a demand for chains which will operate at higher speeds and carry heavier loads was responsible for the development of a more accurate steel chain. These chains range from a rugged low speed class to machine finished high speed chains.

Light steel roller chain is an accurately pitched chain of light construction, three times the tensile strength of the malleable iron type and operates on the same cast tooth sprockets. It is constructed with medium carbon hot rolled steel side bars. The pins and bushings are of hardened steel and the rollers are of either malleable iron or hardened steel. It is applicable where the speeds and ratios are held within 700 r.p.m. and under, and the ratio held to not more than 5 to 1.

Finished steel roller chain is intended for general power transmission purposes and operates on accurately cut sprocket wheels. This chain is manufactured in a number of pitches ranging from $\frac{1}{2}$ to 4 inches. It is constructed with special rolled steel, heat-treated side bars. The pins are made from alloy steel hardened and the bushings are steel, case hardened. The rollers are high carbon steel. heat treated and can either be made curled or solid. It can be had either riveted or detachable and is made in single or multiple widths. It is possible to operate this chain at 1,000 f.p.m. and with ratios up to 10 to 1, but it is more desirable from an economical and long life standpoint to limit its operating speed to approximately 700 r.p.m. and its ratio to 7 to 1.

The silent chain is manufactured for any reasonable power capacity, and is designed for high speeds. It is therefore employed in connection with motor applications. The silent chain is an assembly of specially designed links which operate on cut tooth sprockets, generally termed pinion and gear. The silent chain drive is applicable in all channels of industrial operations. It is particularly adaptable for direct chain connection between motor and machine or motor and line, head or counter shafting. The most desirable speed for this type of chain is 1,200 to 1,500 r.p.m. and ratios of 1 j to 1 have proven successful. (*See* CHAIN MANUFACTURE.)

Gear **Reduction** Units.—Motor speeds of 500 to 1,800 revolutions per minute are too high for industrial purposes, therefore, some mechanical reduction medium must be interposed between the motor and driven machine. The modern speed reduction gear unit has made possible the elimination of a multiplicity of chains, gears, shafting and belting for ratios such as 15 to 1 and higher. It utilizes four general types of gearing, namely, the worm, the spur, the herringbone and the bevel. Reduction units using these various types are available in suitable sizes and ratios for almost any power and speed reduction required. Each type has inherent limitations, therefore, care should be exercised based on a knowledge of the units in question before a selection is made for a particular requirement. One of the most important factors in the successful operation of a speed reduction gear whether it be the worm, spur, herringbone or bevel type, is the connection to the motor and the connection to the shaft of the driven machine or apparatus. The flexible type of coupling is imperative at these points, because it is not mechanically possible to line two shafts perfectly, each supported on its own bearings, so that both will revolve about the same axis.

The efficiency of a modern *worm gear speed reducer* is entirely dependent in many cases on the helix angle of the thread of the worm. The greater the helix angle (up to about 42°) the greater the efficiency; and the smaller the angle, the greater the power loss. The worm of a modern reducer is usually integral with an alloy steel shaft with threads hardened and ground. This combination is rigidly supported on ball or roller bearings, the rear bearing being of the double row maximum type, capable of carrying the full thrust load of the worm in either direction as well as one half the radial load. The other half of the radial load is taken by the forward bearing. The worm gear usually consists of a chilled cast bronze rim shrunk on and pinned to a high grade cast iron centre. The housing of the reducer is cast iron, compact and sealed tight so that the oil in which the gearing operates can be perfectly maintained.

Ratios of 60 or 70 to 1 are common, but beyond this the efficiency drops rapidly. To obtain higher reductions and stih retain the right angle feature of the worm drive, two methods may be employed. One is to provide an auxiliary shaft supported independently, on which is mounted a pinion which in turn meshes with another gear. Another more recent method is to employ a reduction unit specially designed with suitable bearings to permit the mounting of the pinion directly on the slow speed shaft. For special applications and ratios up to 10,000 to 1, the double reduction worm gear unit may be employed. Modern worm gear reduction units can be operated at worm speeds up to 4,000 r.p.m. and are therefore, suitable for direct connection to steam turbines.

The spur gear reduction ***unit*** has been evolved to cope with ratios as high as 500 to 1 and reduces in a straight line. The spur gear reducer can be classified into two distinct types, the planetary and the non-planetary. The planetary type is capable of giving the largest speed reduction because it consists of spur gears or idlers radially disposed about a central pinion and in turn mesh with a stationary internal gear. The planetary reducer with single reduction is satisfactory for ratios between 4 and 8 to 1, but shouid not be considered for ratios of less than 3 to 1. High ratios such as

100, 200, 400 and 500 to 1 are obtainable in the planetary type by the reductions being doubled or tripled and coupled in series in the same cast iron housing. The non-planetary type of spur gear reducer has the advantage of giving comparatively low reductions and keeping the rotational speeds at minimum. Ratios as low as 1 to 1 and as high as 300 to 1 are practical with the non-planetary system. This type consists usually of spur gears radially disposed about a central pinion. Each of the spur gears is keyed directly to pinions which in turn mesh with a central gear mounted upon the slow speed shaft.

***The** herringbone gear speed reducer* does not possess the right angle feature of a worm drive nor the "shafts in line" feature of the spur gear reduction unit. It reduces in parallel. The single reduction type is manufactured up to a ratio of 8 to 1. In ratios over this the reduction is obtained in two steps. There are two distinct types of the double herringbone reduction unit. One type consists of two sets of herringbone gears arranged in series. In the other type, the first set of gears is split, one set being cut right and the other left hand. They are mounted far enough apart to allow the insertion of the final drive pinion between the helical gears This form of construction equalizes the loads of all bearings as well as making a more compact drive. These two types are manufactured in ratios up to 60 to 1.

Variable Speed Mechanisms.—Methods both electrical and mechanical have been devised for varying applied speed to apparatus. For many operations of this character, the variable speed motor is ideal, but generally, this type of motor possesses a certain definite range of speed alterations, and therefore is not suitable for close speed adjustment. Fine adjustment is possible with modern mechanical speed transformers. These devices operate in connection with constant speed motors and are most efficient. There are certain phases of industrial operations where speeds must be gradually increased or decreased, otherwise destruction of the product results. For operations such as this, the mechanical speed transformer is imperative. (W. STA.)

VARIABLE GEARS

This article is concerned with variable transmission of power, and not merely variable speed transmission, otherwise it would have to include the consideration of a multitude of appliances such as speed indicators, integrators and many kinds of calculating machines.

Power transmission gears may be divided into two classes (1) that in which there is a step by step change and (2) that in which the change is gradually effected and an infinite range of velocity ratio is possible.

Step by step variable gears are familiar to all who have passed through an engineer's workshop, in which lathes, drilling machines and other tools are operated by stepped belt pulleys or trains of wheels of different size, these devices being used to effect variable transmission. A familiar example on the roads is the motor-car, in which with very rare exceptions the change of speed is effected by means of a gear box containing a number of different sized pairs of tooth wheels, arranged so that a change of speed can be effected at will by operating a gear lever. On the other hand infinitely variable transmission is less familiar and until comparatively recent times had no particular application except for very light powers. The increasing employment of infinitely variable transmission is due to the fact that the electric motor, steam turbine, and most of all the internal-combustion engine (*q.v.*) have for many purposes superseded the steam engine. One feature of the greatest value in the steam engine is its flexibility; the inferiority in this direction of other kind; of motive power being very marked. For this reason there have been attempts in recent years to find either by frictional, electric, hydraulic or other mechanical means some practicable and effective form of infinitely variable transmission.

Before proceeding to describe various types of variable transmission it must be understood that it is quite possible to vary the speed of transmission by a slipping clutch and claims are often put forward for such a clutch as effecting infinitely variable transmission. This, however, is not correct, being only a case of variation in speed by a direct loss of energy and not true variable transmission. The true test of variable transmission is as to whether it fulfils, at any rate approximately, what is called the Law of Work that "what is lost in force is gained in speed" and vice versa. Thus, for instance, apart from the unavoidable loss of efficiency due to friction, either a train of wheels or a combination of belt pulleys obey the law of work and overcome a greater resistance by a corresponding reduction of speed. On the other hand, if a lesser resistance is to be overcome the rate of operation can be proportionately increased by suitable alteration of the train of wheels employed.

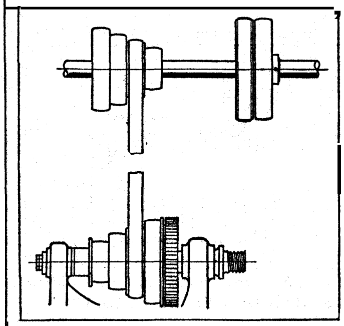


FIG. 1.— DIAGRAM SHOWING STEP PULLEY SYSTEM OF BELT DRIVE FOR AN ORDINARY LATHE

Classification of Methods.—In order to understand the different types of variable transmission they may be classified under the following heads; Frictional, Mechanical, Pneumatic, Electric, and Hydraulic.

Frictional.—Fig. 1 shows the step pulley system, the lower series operating in the headstock of the lathe, and the upper deriving motion from the driving shaft. As the belt is shifted from right to left off and on the different pulleys the speed of the lathe can be increased; or when from left to right the opposite effect is obtained. Corresponding to step by step movement, fig. 2 shows an infinitely variable transmission by pulleys which forms part of the cotton spinning device of Houldsworth invented just a century ago. Here the variation of speed between the driving and driven pulleys is obtained by shifting the belt to and fro along drums of nearly conical form. A modern form of variable transmission was in 1910 and later applied successfully to motor bicycles. Each pulley has a groove of "V" shape, the driving and driven pulleys being both capable of expansion and contraction. This expansion or contraction is effected by shifting in one direction or another the conical movable side of the pulley. The closer the sides come together the greater will be the effective diameter of the pulley. Powerful springs ensure that the driving belt shall be gripped on both pulleys, an idle wheel running between two pulleys accurately to secure the correct location of the conical surface.

A development is now taking place of this type of variable transmission for larger powers. In a useful form variation of the distance apart of the conical sides of a driving and driven pulley is effected when much power has to be transmitted by a hand wheel that operates a combination of worm and worm wheel so as to turn to other worms and thereby move levers, which respectively operate the movable cheeks of the conical pulleys either inwards or outwards. In all probability the oldest type of infinitely variable gear is that in which a friction roller is moved edgeways to and fro on the disk or circular flat plate. If, as in a certain type of motor-car the speed of the driven disk is least when the roller 'is nearest the edge, the greatest driving force is then obtained. On the other hand, when the roller has approached towards the centre of the disk p the greatest speed is obtained with corresponding reduction of driving force. The power transmitted with this gear is however comparatively small as it depends entirely on frictional contact of the surfaces and the wear of the frictional surfaces is considerable.

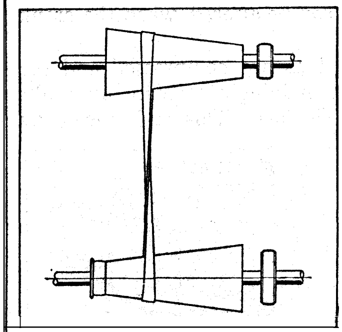


FIG. 2.— DIAGRAM OF A VARIABLE TRANSMISSION BY PULLEYS

Mechanical.——Variable transmission of mechanical kind can be said to be practically confined to the employment of trains of toothed wheels. The most familiar case of mechanical gearing is that of a lathe headstock, in which by coupling up the largest step pulley to the spur wheel to the spindle of the headstock a direct drive is obtained from the speed pulleys. If this coupling is released and by means of a handle shown in the figure the back axle is approached to the main spindle so as to bring into engagement the two pairs of tooth wheels, the driving now takes place through the pinion driven by the step cone pulley through the axle shaft, and back to the lay spindle. Increase of driving force with corresponding reduction of speed is thus obtained which in the present example is nine times as great as by the direct drive.

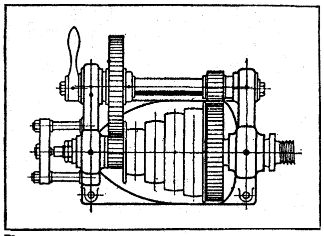


FIG. 3.— VARIABLE TRANSMISSION AS USED IN A LATHE HEADSTOCK

In a standard type of motor car change speed gear box, the engagement of different ratios of spur wheels and pinions is obtained by sliding the teeth sideways into mesh with each other. This is called the "clash" engagement. In another type of gear box no such sideway sliding takes place, the teeth of the respective wheels being always in mesh with each other. Change of gear in this case is effected by sliding the different jaw clutches into engagement with each other.

Pneumatic. — Many attempts have been made to introduce pneumatic variable transmission since 1900 by Dunlop, Lenz, Lebach and others The best account of these pneumatic devices as applied on a large scale to locomotives was given in La Revue *Générale* des *Chemins* de Fer, May 1923, by Brillé. Up to the present these devices, though extremely interesting and ingenious, have not proved efficient in practice.

Electrical. — Various inventors have suggested continuously variable electric change speed gear As already explained a mere reduction of effort by interposed resistance is not a true variable transmission, and all the most important examples of real variable electric transmission as on electric railways, is of essentially a step by step nature. Locomotive systems such as Crochat's mine locomotive, the loco-tractor of Moyse, those of Westinghouse, of Sultzer Diesel and Dewa are on the same fundamental principle as the Tilling-Stevens electric transmission, namely, production of electrical current by a dynamo from an internal-combustion engine and the operation by an electric motor of some form of gearing to turn the wheels.

Hydraulic. — The last form of transmission, and in its development the most recent, is hydraulic transmission. A beautiful device by Hastie was described as long ago as 1881. By means of two springs the stroke of the crank can be altered, when the crank pin slides in a groove

When the effort is great the springs are compressed and the stroke is increased correspondingly, enabling a constant hydraulic pressure to overcome a variable resistance. This resistance may vary within wide limits, with the corresponding econom) in the matter of the fluid employed. In the foregoing case the working fluid was water supplied by a high-pressure hydraulic main on the principle first introduced by Armstrong. Modern hydraulic variable gear in which oil is the working fluid has been brought into extensive operation chiefly to enable electrical power to overcome very variable resistance without causing a rise in the amperes transmitted. The principle of operation is exactly identical with the generation of electrical current by a dynamo, which current is transformed into mechanical effort by an electrical motor. In the case of hydraulic transmission, however, a variable stroke pump is employed to produce a flow of incompressible fluid, generally oil, which operates in a hydraulic motor. Thus it is only necessary to effect a change in the stroke of the pump when any required hydraulic pressure can be obtained with the great advantage of not unduly increasing the driving effort on the pump.

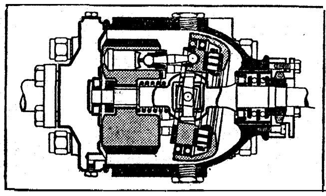


FIG. 4.— SECTION OF ONE ELEMENT OF THE JANNEY-WILLIAMS HYDRAULIC VARIABLE GEAR

Hydraulic variable gear has been employed for a great variety of purposes such as cranes, lifts, winches, tipping wagons, rail cars, gun mountings, planing and broaching machines, swing bridges, etc. The chief types of these gears may be distinguished as parallel and radial. Fig. 4 shows a section of the Janney-Williams gear (either pump or motor) which is an example of the former type, and it will be seen that the variation in effort is attained by varying the angle of what is known as a swash plate, with the result of altering the stroke of the pistons. As the stroke is reduced the working pressure can be increased; thus when the stroke is very small a very great pressure can be produced and consequently great resistance can be overcome. The necessary valve action is obtained by causing the opening at the inner end of the cylinders to pass in succession the supply and exhaust ports.

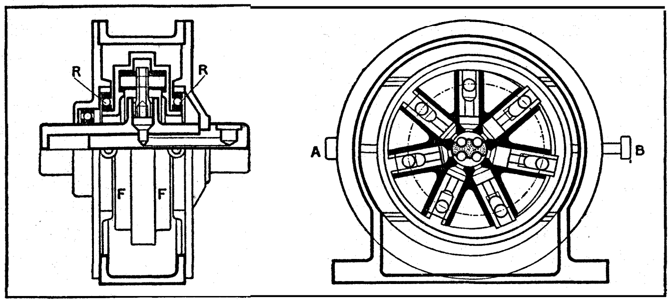


FIG. 5.— THE HELE-SHAW RADIAL STROKE PUMP

In the operation of the one radial type pump, the cylinder body revolves about a fixed axis which forms a cylindrical valve. As the cylindrical body revolves, the working fluid is alternately admitted from and exhausted into the two ports respectively. The fluid comes in under no pressure from the port and is driven out under any required pressure from the port along the shaft. In order to obtain any required variation of pressure the frame to which the connecting rod ends are attached is made to pivot about the fixed centre by a rod attached to the upper end of the frame. In the middle position there is obviously no stroke, and when the neutral position is passed the direction of flow is reversed.

Two views of another type of radial stroke pump are shown in fig. 5 (Hele-Shaw Pump), the left-hand view being in half section, the lower portion of which shows *ff* a revolving case called the "floating ring." The sectional portion in the view shows that this floating ring is carried on ball races *r* and *r*, their object being to reduce the frictional wear of the rollers or slippers by allowing the floating ring to rotate freely with the cylinder body, in which the pistons are carried. If the floating ring is moved bodily along guides on the line *a-b* (shown in the other view) the stroke of the pistons and the fluid pressure can be varied as required, just as in the previous example.

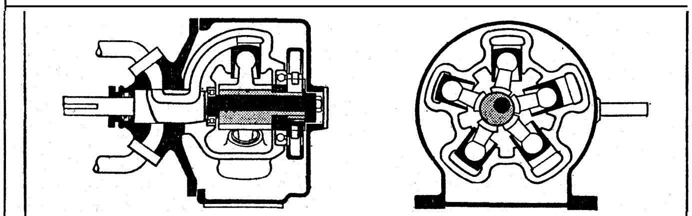
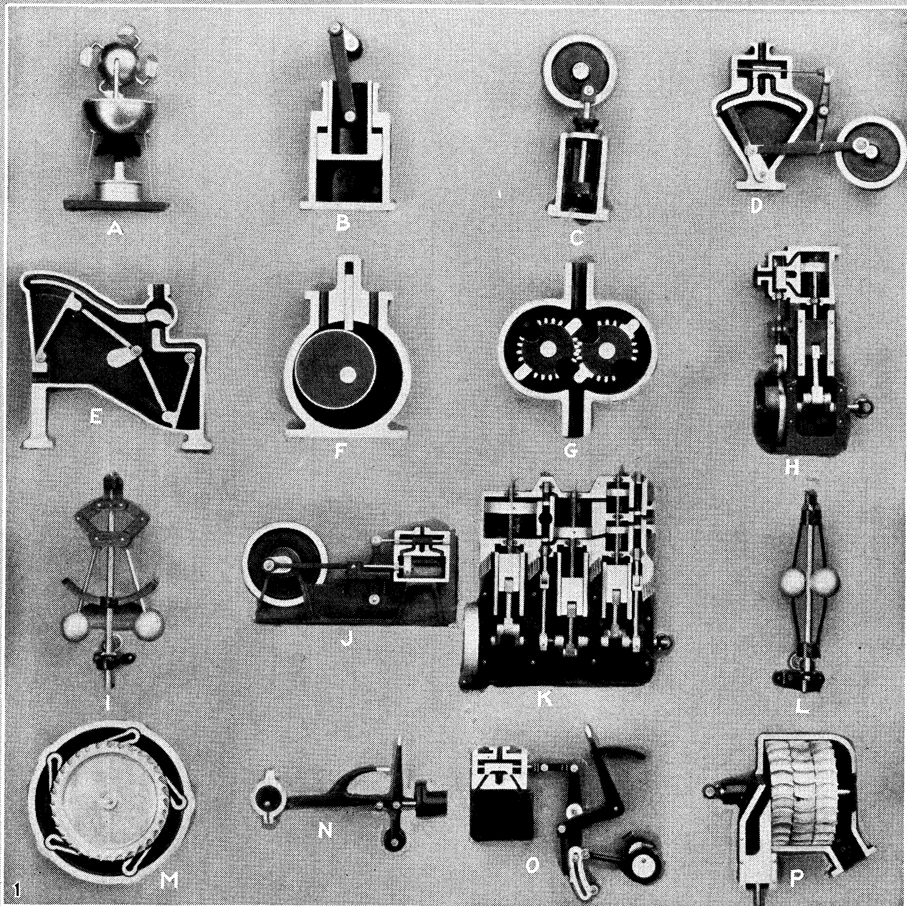
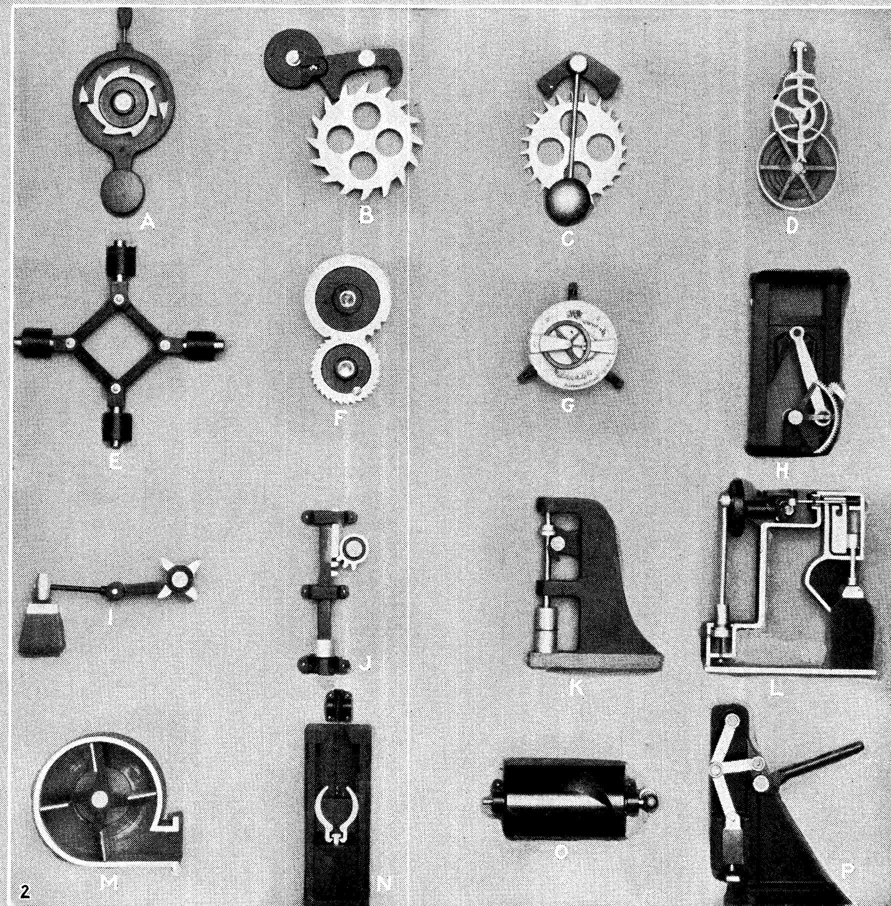


FIG. 6.— THE HELE-SHAW BEACHAM PUMP

An improvement in the foregoing pump has been devised, the Hele-Shaw Beacham pump, in which a central valve is employed, a radical change being effected by what is known in mechanical science as "inversion." Instead of pistons operating outwardly and obtaining their stroke from contact with an eccentric enclosing the whole cylinder body, the pistons are operated from a fixed crank, the cylinder body surrounding the crank and the pistons working inwardly. The variable stroke is obtained by altering the throw of the crank, which is otherwise fixed. The crank is in the form of a live ring mounted with roller bearings on a compound eccentric.





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1. PRINCIPLE OF STEAM ENGINES AND TURBINES

A. Model illustrating the theory of Heron of Alexandria (*fl. c.* 100 B.C.). B. Trunk type steam engine similar to the ordinary gasolene engine. C. Steam engine with oscillating cylinder dispensing with valve and valve mechanism. D. Oscillating piston engine. E. Double oscillating piston steam engine, early form. F. Eccentric rotary pump or engine, commonly used for positive pressure pumping. G. Gear pump or engine. H. Cross-section of a vertical steam engine with simple sliding valve. I. Steam engine governor, centrifugal type. J. Cross-section of a horizontal slide valve steam engine. K. Cross-section of a triple expansion compound steam engine. L. Steam engine governor, centrifugal type. M. Pelton wheel type steam turbine. N. Hand reversing mechanism for single cylinder steam engine. O. Stephenson link reversing mechanism for steam engines. P. Reaction type steam turbine, commonly used in electrical power plants

2. CLOCK ESCAPEMENTS, HAMMERS, ETC.

A. Early form of clock escapement used in wooden clocks. B. One form of clock escapement. C. Common form of clock escapement. D. Watch escapement mechanism with balance wheel and hair spring. E. Four way link movement. F. Stop wind for watches and clocks. G. Early form of watch showing movement of balance wheel. H. Hand bailing press. I. Gravity trip hammer used in early forging methods. J. Gravity gear drop hammer. K. Gravity cam drop hammer. L. Pneumatic air hammer for light drop forgings. M. Centrifugal air blower. N. Pile driver. O. Conveyor using the principle of Archimedes screw. P. Hand punch using toggle joint

The compound eccentric consists of two parts of equal eccentricity, the stroke-varying mechanism being arranged to effect rotation of these two parts in opposite directions with the result that the resultant eccentricity may be varied at will from zero to maximum in either direction. This gear was fully described in Engineering, Oct. 16, 1925.

Another important feature of the new pump is the fact that instead of the central plane of the valve ports coinciding with the central plane of the revolving cylinder body, it is displaced so that the central planes of the cylinders and that of the valve ports are separated from each other. Fig. 6 is a diagrammatic figure which will make the explanation clear. One remarkable effect is the improvement in the matter of silence. The opening and closing of the ports causes water-hammer blows due to the high pressure in an incompressible fluid. These blows are no longer transmitted so as to cause sound vibrations in the enclosing cylinder body.

BIBLIOGRAPHY.—A. Graham Clarke, *Text Book on Motor Car Engineering,* vol. i., "Construction" (1911); E. Butler, *Transmission Gears* (1917); F. D. Jones, *Mechanisms and Mechanical Movements* (1918); W. H. Berry, *Modern Motor Car Practice* (1921); G. Constantinesco, *Variable Transmission for Automobiles* (1924); G. H. C. Hartman, *Les Mécanismes* (1925). (H. S. H.-S.)

POWHATAN. This group of Algonkin Indian tribes in the tide-water portion of Virginia and southern Maryland had been welded into a confederacy by the conquests of an able chief known by the same name, shortly before the settlement of Jamestown in 1607. His daughter Pocahontas married John Rolfe. After Powhatan's death they massacred 347 British settlers in 1622. Fourteen years of relentless warfare followed until the Indians submitted, only to rise again in 1641 and slay 500 whites. This war broke them, and though in 1669 2,100 remained of the original 8,000, they have now dwindled to some 700, mixed with negro and white blood, and known as Chickahominy, Pamunkey, etc. (A. L. K.)

POWIS, EARLS AND MARQUESSES OF. Before the Norman Conquest the Welsh principality of Powis, comprising the county of Montgomery and parts of the counties of Brecknock, Radnor, Shropshire, Merioneth and Denbigh, was subject to the princes of North Wales. Early in the 12th century it was divided into upper and lower Powis. In 1283 Owen ap Griffin, prince of upper Powis, formally resigned his princely title (*nomen* et *circulum principatus*) and his lands to the English king Edward I. at Shrewsbury, and received the lands again as an English barony. (See Montgomeryshire Collections, 1868, vol. i.) This barony of Powis passed through female inheritance to the family of Cherleton and in 1421 to that of Grey. It fell into abeyance in 1551.

In 1587 Sir Edward Herbert (d. 1594), a younger son of William Herbert, earl of Pembroke, purchased some of the lands of the barony, including Red castle, afterwards Powis castle, near Welshpool, and in 1629 his son William (c. 1573–1656) was created Baron Powis. William's grandson, William, the 3rd baron (*c.* 1629–1696), was created earl of Powis in 1674 and Viscount Montgomery and marquess of Powis in 1687. The recognized head of the Roman Catholic aristocracy in England, Powis was suspected of complicity in some of the popish plots and was imprisoned in the Tower of London from 1678 to 1684. He followed James II. into exile and was created duke of Powis by the dethroned king. William, 2nd marquess, who had a somewhat chequered career as a Jacobite, died in October 1745, and when his son William, the 3rd marquess, died in 1748 the titles became extinct.

In 1748 Henry Arthur Herbert (d. 1772), who had been made Baron Herbert of Cherbury in 1743, was created Baron Powis and earl of Powis. The titles became extinct a second time when his son George Edward died in January 1801. George's sister and heiress, Henrietta Antonia (1758–1830), married Edward Clive (1754–1839), son and heir of the great Lord Clive. In 1804, he was created Baron Powis and earl of Powis.

POWNALL, THOMAS (1722–1805), British colonial statesman and soldier, born at Saltfleetby, Lincolnshire, was educated at Lincoln and at Trinity College, Cambridge, where he graduated in 1743. In 1753 he went to America as private secretary to Sir Danvers Osborn, just appointed governor of New York. Osborn committed suicide soon after reaching New York (Oct. 6), but Pownall remained in America, devoting himself to studying the condition of the American colonies. In 1756 he came home, and presented to Pitt a plan for a campaign against the French in Canada, to begin with the investment of Quebec. In 1757 Pitt appointed him governor of Massachusetts; he was transferred to South Carolina in February 1760. This office he held nominally for about a year; but he never went to South Carolina, and in June 1760 he returned to England. In 1762–1763 he was commissary-general of the British troops in Germany. He sat in parliament from 1768 to 1780, and died at Bath on Feb. 25, 1805. In 1764 he published (at first anonymously) his famous Administration of the Colonies advocating a union of all British possessions upon the basis of community of commercial interests.

See C. A. W. Pownall, *Thomas Pownall, M.P., F.R.S.* (1908).

POYNINGS, SIR EDWARD (1459–1521), lord deputy of Ireland, was the only son of Robert Poynings, second son of the 5th Baron Poynings. His mother was a daughter of Sir William Paston, and some of her correspondence is to be found in the *Paston* Letters. Robert Poynings was implicated in Jack Cade's rebellion, and Edward was himself concerned in a Kentish rising against Richard III., which compelled him to escape to the Continent. He attached himself to Henry, earl of Richmond, afterwards Ring Henry VII., with whom he returned to England in 1485. By Henry VII. Poynings was employed in the wars on the Continent, and in 1493 he was made governor of Calais. In the following year he went to Ireland as lord deputy under the viceroyalty of Prince Henry, afterwards King Henry VIII. Poynings immediately set about Anglicizing the government of Ireland, which he thoroughly accomplished, after inflicting punishment on the powerful Irish clans who supported the imposture of Perkin Warbeck. He then summoned the celebrated parliament of Drogheda, which met in December 1494, and enacted the "Statutes of Drogheda," famous in Irish history as "Poynings's law," subordinating the Irish legislature to that of England, till its repeal in 1782. After defeating Perkin Warbeck at Waterford and driving him out of Ireland, Poynings returned to England in 1496, and was appointed warden of the Cinque Ports. He was employed both in military commands and in diplomatic missions by Henry VII., and later by Henry VIII., his achievement being the negotiation of the "Holy League" in 1513.

See Sir Francis Bacon, *The History of the Reign of King Henry VII.* (1641); Richard Bagwell, *Ireland under the Tudors* (2 vols., 188;); J. T. Gilbert, *History of the Viceroys of Ireland* (Dublin, 1865); J. A. Froude, *The English in Ireland* (3 vols., 1872–74); Wilhelm Busch, *England under the Tudors,* ed. *by* James Gairdner (1895).

POYNTER, SIR EDWARD JOHN, 1ST BART. (1836–1919), English painter, son of Ambrose Poynter, architect, was born in Paris on the 20th of March, 1836. He pursued his art studies in England and in Paris (under Gleyre, 1856–1859), and exhibited his first picture at the Royal Academy in 1861. In 1869 he was elected an A.R.A., and in 1876 R.A.

In the decorative arts he practised freely as a designer in fresco, mosaic, stained glass, pottery, tile-work and the like. He was elected to the Royal Society of Painters in Water Colours in 1883.

As director for art in the Science and Art Department, and principal of the National Art Training Schools (now the Royal College of Art) at South Kensington Poynter proved himself a vigorous and successful administrator. He resigned his office in 1881, and in 1894 became director of the National Gallery. Under his rule the National Gallery of British Art, at Millbank, presented by the late Sir Henry Tate, became a department of the National Gallery. He edited the great Illustrated Catalogue of *the* National Gallery (1889- goo), in which every picture in the collection is reproduced.

On the death of Sir John Millais in 1896, Poynter was elected president of the Royal Academy, and was knighted. He was made a baronet in 1902. Poynter died in London on July 26, 1919.

See Cosmo Monkhouse, "Sir E. J. Poynter, P.R.A.: His Lift and Work." *Art Annual* (1897); *M.* H. Spielmann, "Sir E. J. Poynter. P.R.A., and his Studies," *The Magazine of Art* (1897).

POYNTING, JOHN HENRY (1852–1914), British physicist, was born at Monton, near Manchester, on Sept, 9, 1852. He studied at Owens college, Manchester, and at Trinity college, Cambridge. He was bracketed third wrangler in 1876. Poynting went as demonstrator in physics to Owens college, but returned to Cambridge in 1878 on his election as fellow of Trinity college. In 1880 he was appointed professor of physics at the Mason college, which afterwards became the University of Birmingham. He retained this post until his death at Birmingham on March 30, 1914.

Poynting carried out experiments over a period of 12 years to determine the gravitational constant and the mean density of the earth. He used a balance method and during the course of his experiments added considerable knowledge to the technique of accurate weighing. Poynting's best known work is that in the papers "On the Transfer of Energy in the Electromagnetic Field" (*Phil. Trans. A.*, 1884) and "On Electric Currents and the Electric and Magnetic Induction in the Surrounding Field" (*Phil. Trans. A.*, 1888). In the first paper Poynting showed that the flow of energy at a point could be expressed by a simple formula in terms of the electric and magnetic forces at that point. This is known as Poynting's theorem and the vector is also called by his name. Poynting also wrote papers on radiation and the pressure of light and several books.

Poynting's interests were very wide; he served as a justice of the peace, was chairman of the Birmingham Horticultural Society and acted as dean of the Faculty of Science. He was elected F.R.S. in 1888.

See his *Collected Scientific Papers,* edit. *by G.* A. Shakespear and G. Barlow (1920).

POZAREVAC or **PASSAROWITZ,** the capital of the Pozarevac department of Serbia, Yugoslavia. Pop. (1931) 14,055. It lies 8 m. from its harbour, Dubravitsa, on the Danube. The town has no special industry, but being a road centre, is the principal market of a large and fruitful plain. At Lubichevo, 2 m. W. is a State model farm, a stud farm, and a nursery for mulberries. Lignite is worked at Kostolats, 7 m. N. by E., and the hills in this district show many traces of Roman mines. Roman coins, sarcophagi and inscriptions are also found. The famous Treaty of Passarowitz between Austria and Turkey was signed here in 1718. The town was taken by the Serbs under Kara George in 1804, and in 1815 Prince Milosh of Serbia again defeated the Turks here. Germans occupied it in April 1941.

POZNAN or **POSEN,** a Polish province, bounded north by the province of Pomorze, east by the provinces of Warsaw and Lodz, south and west by Germany. The province was conquered by Germany in Sept. 1939. Area 9,243 sq.mi.; pop. (1931) 2,115,000; in 1935 92% were Poles, 7·9% Germans and 0·1% Jews. The Jews were formerly numerous in the province, but migrated to America in the second half of the 19th century, when the peasants organized co-operative societies. The Germans, who had settled under Government support, left after the reconstitution of the Polish state, in large numbers. The province, which contains 38 districts, has always formed a territorial unit since the dawn of history as Great Poland (Wielka Polska), the seat of the tribe which organized the Polish monarchy, and has always been one of the most enlightened, influential and patriotic parts of Poland. It is part of the central Polish plain, and consists of a low plateau intersected by the beds of the rivers Notec, Warta and Obra. These three rivers drain into the Oder, with which the Warta is also connected by the Obra canal. The east part of the province is in the basin of the Vistula, which is connected with the Notec by the Bydgoszcz canal. The surface is dotted with small lakes and ponds, and there are many broad fens and swamps. The soil is light and sandy, but much of the land reclaimed in the marshy districts is very fertile. The greater part of the province is under tillage, but 17·3% is occupied by forests. The principal crops are rye, wheat, oats, barley, potatoes, beets and hops. The vine is cultivated in the south-west corner, and tobacco is also grown. A feature of the country until World War II was the efficient organization of agricultural co-operative societies, culminating in the great union under Father Wawrzyniak, which enabled the Polish peasants to hold their own against their German competitors, and the fact that education made illiteracy, so prevalent in the "Congress Kingdom," a rarity in Poznan. The marshy tracts afford excellent pasture and support large numbers of cattle, horses, sheep and goats. The mineral resources of the province are small, but the industries, at first purely agricultural, such as distilling, brewing, sugar and tobacco, increased with the development of the Polish state. Locomotives are built at Poznan, while Bydgoszcz became the centre of the timber trade for all Poland. A timber exchange was established there, and the first paper mills in Poland. Trade is facilitated by the network of navigable rivers, canals and railways, while the roads are the best in the country. Trade after World War I suffered from the change of markets due to the transference of Poznan from Germany to Poland. There are several large towns: Poznan (272,000 in 1939), Bydgoszcz (141,000) and Gniezno (29,924 in 1931). Other towns are Inowroclaw, Ostrów, Leszno, Krotoszyn, Rawicz and the most ancient town of Poland, Kruszwica.

(A. B. Bo.; X.)

HISTORY

The history of the province of Western or "Great" Poland, of which Poznan (called by the Germans Posen) is the principal city (*see* p. 397), falls within the scope of the article POLAND. One of the oldest towns of the province is Gniezno (German Gnesen), originally the capital of the whole country, and still the seat of the primate of Poland. The tide of German immigration into the province flowed strongly in the 13th and the following centuries. The industrious German settlers were the principal factor in the development of trade and manufacture in the towns; they also did much to improve agriculture in the country. Since the re-union of the kingdom of Poland in the 14th century, the province of Poznan shared the fate of the united country.

During the 17th century, a Swedish invasion ruined the province, the commercial importance of the city began to suffer in consequence of the one-sidedly agrarian spirit of Polish legislation, and the strenuous efforts of the Jesuits, directed against the growth of Protestantism, introduced into the life of Poman the unrest of religious feuds, which were prolonged till the 18th century.

At the first partition of Poland, in 1772, the districts to the north of the river Notec (German, Netze) fell to the share of Prussia. The rest of the province followed in 1793 and 1795, and was united with the territory acquired in 1772 to form the province of South Prussia. In 1807, after the peace of Tilsit, the province was incorporated with the grand duchy of Warsaw, but in 1815 it reverted to Prussia as the grand duchy of Posen,

The Prussian regime, during the first decades after the Congress of Vienna, was conciliatory: a Polish nobleman, prince Anthony Radziwiłł, was appointed lieutenant-governor of the province; there was a provincial assembly, and there were local representative bodies. About 1830, however, a new current set in with the presidency of Flottwell: the experiment of settling subsidized German colonists on Polish soil—started by Frederick the Great in the 18th century—was resumed, and the Polish language deprived of its position of equality with German in the Government offices, the law-courts, and the schools. In the '40s, the revolutionary movement spreading throughout Europe, manifested itself in Prussian Poland and an armed rising in 1848 was suppressed by military force. A highly reactionary Prussian Government arose out of the turmoil of the revolutionary year, and measures of repression against Polish organizations followed. But a resolutely anti-Polish policy on a large scale was only originated by Bismarck, and was carried out in earnest after the creation of the new German empire in 1871. To the landed gentry and the clergy, who had been the mainstay of Polish nationalism so far, there were now added a body of increasingly prosperous and enlightened peasants in the country, and a growing, wealthy Polish middle class in the towns,—all these ranks of society being united in organized opposition to the policy of Germanization. Bismarck aimed cruel blows at the Polish clergy in conducting his *Kulturkampf* against the Catholic element in the ***Reich;*** but the effect was only to rally the Polish masses more effectually round the clergy, who became their leaders in economic as well as in political organization. More success was achieved by the measures in the field of education which gradually made the school system of the province thoroughly German while rendering it at the same time democratic, progressive and highly efficient. Similarly, in the development of the administrative system, improved efficiency and thorough Germanization went together. The powers of resistance of the Polish element, however, rapidly increased with its numbers and its prosperity; and the Prussian Government soon realized that only economic means would serve its ends. In 1888, the Colonizing Commission was established for the purpose of buying up Polish land for German colonists, and it was equipped with 100,000,000 marks (£5,000,000). The Polish element countered the attack by co-operative credit organizations, in which both the peasants and the middle class of the town took a prominent share; and soon the Poles succeeded in buying more land than they lost. The creation of a subsidized society—the Society of the Eastern Marches (known as the H.K.T. from the initials of its founders)—for the promotion of German advance in the east, the great increase of the funds at the disposal of the Colonizing Commission, the creation of a special fund of nearly half a million marks a year towards a campaign against the Polish middle class in the towns—all proved insufficient, and Bulow, Bismarck's most zealous successor, brought new legislative means into play: a bill in 1904 forbidding Poles to establish new peasant farms on soil of their own, and one in 1907 authorizing the Government to dispossess Polish landowners by force. These measures were accompanied by no less drastic ones in the field of education and administration: in 1901, much scandal was roused by the discussion in the Prussian parliament of the incidents at Wrzesnia (Wreschen), where Polish children had been beaten by German schoolmasters for refusing to say the Lord's Prayer in German; and in 1906, the Prussian Government was made somewhat ridiculous by the strike of some 100,000 Polish school-children, which, in spite of severe proceedings against their parents, continued for nearly a whole school year. In 1908, the notorious "Gagging bill" limited to a minimum the right of Polish citizens to form societies, and altogether forbade the use of Polish at public meetings.

The anti-Polish policy of Prussia, although occasionally criticized in the Reichstag, had, on the whole, both a majority of German opinion and the authority of the supreme power in the Reich behind it. But it was largely rendered futile by the disciplined organization of the entire Polish element, as well as by its large and continuous increase in numbers. While the German birth-rate began to fall rapidly, the birth-rate among Polish peasants remained very high; and the political struggle for the land in Prussian Poland resulted in a measure of agricultural prosperity which—in spite of drastic expulsions of foreign subjects, inaugurated by Bismarck in 1885—continued to attract immigrants from other parts of Poland. Prussian Poland shared in the material progress of Germany after 1870, and World War I found this province the most advanced and uniformly wealthy of all the three sections of Poland.

Even after all the losses and privations which the province, however out of sympathy with the German cause, had to undergo with the rest of Germany in 1914–18, the Prussian sector of Poland, when it shook off German domination shortly after the Armistice (Dec. 27, 1918), emerged as still the most prosperous of the three; its territory had not been devastated by actual warfare, as large portions both of Austrian and Russian Poland had. This gave the former Prussian Poles a certain advantage over the others; and they naturally clung to this advantage in the new and united Polish republic after the Peace of Versailles. A customs barrier continued, for a time, to separate the former Prussian province from the body of the new Poland; and a special "Ministry for former Prussian Poland" came into being, which existed for several years.

Such separatism was grounded on a somewhat distinct mentality which the struggle against Prussian rule had developed. The Poles under Prussia had acquired something of that crude belief in sheer force which was characteristic of Germany after 1870. They had not had the opportunities for intellectual refinement which home rule under Austria had given to their Galician brethren; but their peasantry had reached a much higher level of enlightenment than that of either Austrian or Russian Poland. In the new Polish State, in consequence of all this, the former Prussian province represented a solid block of hard-and-fast Nationalism as well as of uncompromising devotion to the Catholic Church, whose services to the national cause in Prussian times were gratefully remembered. Gradually, however, the ties of common political life began to produce their effect, and the parliamentary elections later found the population of former Prussian Poland differentiated politically on the same party lines as the rest of the republic. The new Polish university of Poznan (which had taken the place of a German academy), and other Polish educational and cultural institutions, worked for amalgamation.

Poznan, with half its borders along the German frontier, was difficult to defend in World War II and fell rapidly to the German army in Sept. 1939.

BIBLIOGRAPHY.—The German case, at the height of the anti-Polish policy on the eve of World War I, was summed up in an elaborate work by L. Bernhard, *Das polnische Gemeinwesen im preussischen Staate* (Leipzig, 1907). From the Polish point of view, the history of Prussian policy in Poznan has been told by Professor J. Buzek in *Historja polityki narodowościowej rządu pruskiego 1815–1908* (Lwów, 1909). For the history of the city of Poznan, *see* N. Pajzderski, *Poenan* (Lwów, 1922, ill.). **(R. DY.)**

POZNAN or **POSEN,** capital of the province of Poznan, in Poland, situated in a wide and sandy plain on the Warta, 180 mi. W. from Warsaw and 150 mi. E. from Berlin. Pop. (1939) 272,000. Germany conquered the province in Sept. 1939. Before World War I, half the population were Germans, who had been encouraged to settle by the Prussian government, and who returned to Germany after the restoration of Poland. The city is the centre of a network of railways connecting it with Warsaw, Berlin, Breslau and Torun. It is the centre of one of the five ecclesiastical provinces of the Catholic Church in Poland, and the seat of the most ancient Polish bishopric, founded in the 10th century. The old town (Stare *Miasto*) and the new town lie on the left bank of the Warta, with large suburbs on the right bank. There are 15 Roman Catholic churches, of which the cathedral contains many works of art and the tombs of the two first rulers of Poland. The town hall (Ratuse), rebuilt in 1552, is a magnificent building in the Romanesque style. A legacy of the former Prussian rule is the castle built by William II. There is a large library, the Raczynski library, two museums and a university. Industries are mainly connected with agriculture, such as distilling, brewing, sugar milling, agricultural machinery. The manufacture of locomotives was established after 1918. An annual fair was inaugurated in 1922, and there is an active trade, both by river and rail, in corn, cattle, wood, wool and potatoes.

Poznan is one of the oldest cities in Poland and the residence of the first king, Boleslaw the Brave, and of the first Polish bishop. The original settlement was on the right bank of the river, but German settlers in 1250 made the new town on the opposite bank a flourishing commercial centre. A charter in 1394 gave the city staple right for all wares passing from Poland into Germany, and from Germany into Poland. The German element was assimilated, though many foreigners settled there, including a colony of Scots. After the fires of 1536 and 1590, Poznan, formerly Gothic, was rebuilt in Renaissance style. The prosperity of Poznan declined with the economic decline of Poland in the 17th century, but revived in the 19th century, partly as the natural centre of a great agricultural region, partly as a bulwark of the Poles in their struggle against German penetration.

POZOBLANCO, a town of southern Spain in the province of Córdova, near the head-waters of the Guadamatillas and of other small sub-tributaries of the Guadiana. Pop. (1930), 15,843. Its fairs are famed for their live stock and agricultural products. There are zinc and argentiferous lead mines near by, and manufactures of cloth and leather in the town itself.

POZZO DI BORGO, CARLO ANDREA, COUNT (1764–1842), Russian diplomatist, was born at Alata, near Ajaccio, of a noble Corsican family, on March 8, 1764, some four years before the cession of the island to France. He was educated at Pisa, and in early life was closely associated with Napoleon and Joseph Bonaparte, the two families being at that time closely allied in politics. Pozzo was one of the two delegates sent to the National Assembly in Paris to demand the political incorporation of Corsica in France, and was subsequently a Corsican deputy to the Legislative Assembly, where he sat on the benches of the right until the events of August 1792. On his return to Corsica he was warmly received by Paoli, but found himself in opposition to the Bonaparte brothers, who were now veering to the Jacobin party. Under the new constitution Pozzo was elected *procureur-général-syndic*, that is, chief of the civil government, while Paoli commanded the army. With Paoli he refused to obey a summons to the bar of the Convention, and the definite breach with the Bonaparte family, who actively supported the revolutionary authorities. dates from this time. Eventually Paoli and Pozzo accepted foreign help, and from 1794 to 1796, during the English protectorate of Corsica, Pozzo was president of the council of state under Sir Gilbert Elliot. When Napoleon sent troops to occupy the island he was excepted from the general amnesty, and took refuge in Rome, but the French authorities demanded his expulsion, and gave orders for his arrest in northern Italy. After a short stay in London he accompanied in 1798 Elliot (now become Lord Minto) on an embassy to Vienna, where he lived for six years.

In 1804 through the influence of Prince Adam Czartoryski he entered the Russian diplomatic service. In 1805 he was Russian commissioner with the Anglo-Neapolitan, and in 1806 with the Prussian army. He was entrusted with an important mission to Constantinople in 1807, but the conclusion of the alliance between Alexander I. and Napoleon at Tilsit in July interrupted his career. He returned to Vienna, but on the demand of Napoleon for his extradition Metternich desired him to leave the capital. He then retired to London again and remained in England until 1812, when he was recalled by Alexander. He diligently sought to sow dissension in the Bonaparte household, and in a mission to Sweden he secured the co-operation of Bernadotte against Napoleon. On the entry of the allies into Paris he became commissary general to the provisional government.

At the Bourbon restoration Pozzo di Borgo became Russian ambassador at the Tuileries, and sought to secure a marriage between the duke of Berry and the Russian grandduchess Anna, Alexander's sister. He was present at the Congress of Vienna, and during the Hundred Days he joined Louis XVIII. in Belgium, where he was instructed to discuss the situation with Wellington. The tsar dreamed of allowing an appeal to the people of France on the subject of the government of France in accordance with his vague liberalizing tendencies, but Pozzo's suggestions in this direction were met by violent opposition, the duke refusing to make any concessions to what he regarded as rebellion; in St. Petersburg, on the other hand, Pozzo's attachment to the Bourbon dynasty was considered excessive. During the early years of his residence in Paris Pozzo laboured tirelessly to lessen the burdens laid on France by the allies and to shorten the period of foreign occupation. That his French sympathies were recognized in Paris is shown by the strange suggestion that he should enter the French ministry with the portfolio of foreign affairs.

Pozzo's influence at the Tuileries declined with the accession of Charles X., whose reactionary tendencies had always been distasteful to him; but at the revolution of 1830, when the Tsar Nicholas was reluctant to acknowledge Louis Philippe, he did good service in preventing difficulties-with Russia. In 1832 he visited St. Petersburg; the next year he was in London renewing his relations with Wellington, and early in 1835 he was suddenly transferred to the London embassy in succession to Prince Lieven. Although he did not lose in official standing, Pozzo was aware that this change was due to suspicions long harboured in various quarters in St. Petersburg that his diplomacy was too favourable to French interests. In London his health suffered, and he retired from the service in 1839 to Paris, where he died on Feb. 15, 1842. He had been made a count and peer of France in 1818.

See Ouvaroff, *Stein et Pozzo* (St. Petersburg, 1846); *Correspondance diplomatique du comte Pozzo di Borgo et du comte de Nesselrode*, ed. by Charles Pozzo di Borgo (2 vols., Paris, 1890–1897); Vicomte A. Maggiolo, *Corse, France et Russie. Pozzo di Borgo, 1764–1842* (Paris, 1890); J. B. H. R. Capefigure, *Les Diplomates européens* (4 vols., 1843–1847).

POZZUOLI (anc. PUTEOLI, *q.v.*), a seaport and episcopal see of Campania, Italy, in the province of Naples, $7\frac{1}{2}$ mi. W. of it by rail. Pop. (1936), 24,594 (town); 29.690 (commune). It is on the base of a hill projecting into the Bay of Pozzuoli, separated from the main portion of the Gulf of Naples by the promontory of Posilipo. The volcanic *pozzolana* earth (also found near Rome), used now as in Roman times for making cement and concrete, derives its name from the place. In the middle ages Pozzuoli was frequently sacked and also damaged by the natural convulsions of 1198 and 1538. It has large ironworks and melting furnaces; while to the west is a large artillery factory.

PRABHU, the writer caste of Western India, corresponding to the Kayasth of Bengal. Numbering only 21,941 in Bombay in 1921, they stand high socially and professionally.

PRACTICE AND PROCEDURE. The practice and procedure of the High Court of Justice in England is now regulated by the Judicature Act, 1925 (which repealed and consolidated nearly all the former Judicature Acts), and the various rules of court made pursuant to various Acts passed in and since 1883. Lest the Judicature Acts and Rules as so framed should not provide for every contingency, it was expressly provided by rule in 1883 that "where no other provision is made by the Judicature Act or Rules the procedure and practice existing in 1883 should remain in force." The object of the Judicature Acts and the Rules made thereunder was to improve a system of practice and procedure which had grown up through the centuries. Although those concerned to defend the ancient order were wont to say that it made for precision — particularly in the matter of pleadings there can be no doubt that its advantages were, or became, hidden under its chief defects — prolixity and technicality.

The following is an attempt to state, in outline, the practice and procedure in the High Court in England. In the performance of his task the writer has kept one fact constantly in mind, namely, that if the *reason* for a particular rule or canon of procedure is appreciated, the rule will be better understood. The rules of procedure did not spring into being in a single day: they are the result of years of experience. And it will always be found, that whether it be sound or not there *is* a reason for every rule, howsoever technical it may appear to be.

Some Technical Terms. — He who is minded to study the modern rules of practice and procedure must understand the meaning of various words (often Latin words), and phrases some of which are now obsolete. The following brief glossary may suffice. *Act on Petition* was a term used for a part of the procedure in the probate, divorce and admiralty division, now of infrequent occurrence. It was more freely used in the old admiralty and divorce courts before the Judicature Acts became law. *Answer* in English law was, prior to the Judicature Acts, the statement of defence especially as regards the facts and not the law. It is still applied in divorce proceedings to the reply of the respondents, and it occurs in the phrase "answer to interrogatories." (*See* "Discovery" below.) *Assets* in English law mean the property of a debtor in the hands of his representative sufficient for the satisfaction of his creditors or legatees; the word also occurs in the phrase "administration of assets." (*See* O. 55, r. 3, 4.) An *Associate* is an officer of the supreme court, whose duties are to draw up the list of causes, enter verdicts, hand the records to the parties, etc., and generally to conduct the business of trials. *Assumpsit* (Lat. "he has undertaken") was a word applied to an action for a breach of contract, and was always used in pleadings by the plaintiff to set forth the defendant's undertaking or promise. Hence the phrases "bring *assumpsit*" or "sue in *assumpsit*."

Declaration in an action of English law was formerly the first step in pleading — the precise statement of the matter in respect of which the plaintiff sued. It is also used in other legal connections, *e.g.*, declaration of insolvency, declaration of title. declaration (statutory) in lieu of an affidavit; and dying declaration. *In formâ pauperis* is the legal phrase for a method of bringing or defending a case in court on the part of persons without means. *Information* (*q.v.*) is a proceeding on behalf of the Crown against a subject otherwise than by indictment. Certain suits might formerly be filed in chancery by way of information in the name of the attorney-general. Informations are still filed by the attorney-general in revenue cases in the king's bench, Judgment summons is a summons issued under the Debtors Act 1869, citing a defendant against whom judgment has been entered to appear and be examined as to his means, and to show cause why he should not be committed for non-payment of his debts, *Summons* is, in English law, (1) a command by a superior authority to attend at a given time or place or to do some public duty; (2) a document containing such command. and not infrequently also expressing the consequence entailed by neglect to obey.

Various Forms of "Proceeding."—In the High Court of Justice, civil actions are begun by obtaining from the officers of the court a document known as a "writ of summons." In this document are stated the names of the parties and the nature of the claim made (which in the case of liquidated sums of money must be precise and particular). It is sealed and issued to the party suing it out, and served on the opposing party, not by an officer of the court but by an agent of the plaintiff. The tenor of the writ is to require the defendant to appear and answer the claim, and to indicate the consequences.

Many proceedings in the High Court are initiated by forms of summons different from the writ of summons. Of those issued in the High Court three classes merit mention:—

1. For determining interlocutory matters of practice and procedure arising in "a pending cause or matter." These are now limited as far as possible to a general summons for directions, introduced in 1883 so as to discourage frequent and expensive applications to the masters or judges of the High Court on questions of detail. These summonses are sealed and issued on application at the offices of the High Court. The matters raised are dealt with by a master with an appeal to a judge in chambers summarily. In matters of practice and procedure there is no appeal from a judge at chambers without leave from him or from the court of appeal.

2. For determining certain classes of questions with more dispatch and less cost than is entailed by action or petition. This kind of summons is known as an "originating summons," because under it proceedings may be originated without writ for certain kinds of relief specified in the rules (R.S.C., O. 55, r. 3). The originating summons may be used in all divisions of the High Court, but is chiefly employed in the chancery division, where it to a great extent supersedes actions for the administration of trusts or of the estates of deceased persons, and for the foreclosure of mortgages a similar but not identical procedure was created with reference to questions of title, etc., to real property. In the king's bench and probate divisions the originating summons is used for determining summarily questions as to property between husband and wife, or the right to custody of children, and many other matters (0. 54, rr. 4 B–4 F), but there is nothing to prevent a summons of this kind issuing in the king's bench for the determination of some such question as the construction of a bill of lading. The proceedings on an originating summons are conducted summarily at chambers without pleadings, and the evidence is usually written. In the chancery division when the questions raised are important the summons is adjourned into court. An appeal lies to the court of appeal from decisions on originating summonses. The forms of summonses and the procedure thereon in civil cases in the High Court are regulated by the Rules of the Supreme Court.

3. Certain proceedings on the Crown side of the king's bench division are begun by summons, *e.g.,* applications for bail; and in vacation writs of habeas corpus, *mandamus,* prohibition and certiorari are asked for by summons as the full court is not in session. (*See* Crown Office Rules, 1906.)

Mandamus has always been regarded as an exceptional remedy to supplement the deficiencies of the common law, or defects of justice. The writ is used to compel inferior courts to hear and determine according to law cases within their jurisdiction, *e.g.,* where a county court or justices in petty or quarter sessions refuse to assume a jurisdiction which they possess to deal with a matter brought before them. It has in recent years been employed to compel municipal bodies to discharge their duties as to providing proper sewerage for their districts, etc. The courts do not prescribe the specific manner in which the duty is to be discharged, but do not stay their hands until substantial compliance is established.

Besides the prerogative common law writ there are a number of orders, made by the High Court under statutory authority, and described as, or as being in the nature of, mandamus, *e.g.,* mandamus to proceed to the election of a corporate officer of a municipal corporation (Municipal Corporations Act 1882, s. 225); orders in the nature of mandamus to justices to hear and determine a matter within their jurisdiction, or to state and sign a case under the enactments relating to special cases.

At common law mandamus lies only for the performance of Acts of a public or official character. The enforcement of merely private obligations, such as those arising from contracts, is not within its scope. But now a mandamus may be granted by an interlocutory order of the High Court in all cases in which it shall appear to the court just or convenient that such an order should be made. (O. 53). The remedy which is thus created is an attempt to engraft upon the old common law remedy by damages a right in the nature of specific performance of the duty in question. It is not limited to cases in which the prerogative writ would be granted; but mandamus is not granted when the result desired can be obtained by some remedy equally convenient. beneficial and effective, or a particular and different remedy is provided by statute. An action for mandamus does not lie against judicial officers such as justices. The mandamus issued in the action is no longer a writ of mandamus, but a judgment or order having effect equivalent to the writ formerly used. (*See* INJUNCTION.)

The jurisdiction of the High Court, derived from the court of chancery, to decree specific performance of contracts has some resemblance to mandamus in the domains of public or quasi-public law.

Action at Law.—In English law the term "action" at a very early date became associated with civil proceedings in the court of common pleas, which were distinguished from pleas of the Crown, such as indictments or informations and for suits in the court of chancery or in the admiralty or ecclesiastical courts. The English action was a proceeding commenced by writ original at the common law. The remedy was of right and not of grace. As a result of the reform of civil procedure by the Judicature Acts the term "action" in English law now means at the High Court of Justice "a civil proceeding commenced by writ of summons or in such other manner as may be prescribed by rules of court" (*e.g.,* by originating *summons*). The proceeding thus commenced ends by judgment and execution. The stages in an English action are the *writ,* by which the persons against whom relief is claimed are summoned before the court; the pleadings and interlocutory steps, by which the issues between the parties are adjusted; the trial, at which the issues of fact and law involved are brought before the tribunal; the judgment, by which the relief sought is granted or refused; and *execution,* by which the law gives to the successful party the fruits of the judgment.

The procedure varies according as the action is in the High Court, a county court, or one of the other local courts of record which still survive; but there is no substantial difference in the incidents of trial, judgment and execution in any of these courts.

An action is said to "lie" when the law provides a remedy for some particular act or omission by a subject which infringes the legal rights of another subject. An act of such a character is said to give a "cause of action." When the rights of a subject are infringed by the illegal action of the State, an action lies in England against the officers who have done the wrong, unless the claim be one arising out of breach of a contract with the State, or out of an "Act of State." For a breach by the State of a contract made between the State and a subject the remedy of the subject is, as a general rule, not by action against the agenrs of the State who acted for the State with reference to the making or breach of the contract, but against the Crown itself by the proceeding called Petition of Right.

The Writ of Summons.—This is the universal means of commencing an action in the High Court. It is addressed to the defendant, and may be either generally or specially indorsed with a statement of the nature of the claim made. The latter form of indorsement is allowed in certain cases of debt or liquidated demand, and gives the plaintiff the great advantage of entitling him to sign judgment in default of appearance by the defendant, and even in spite of appearance unless the defendant can satisfy a judge that he ought to be allowed to defend. No statement of claim is necessary in case of a specially indorsed writ, the indorsement being deemed to be the statement. The writ may be issued out of the central office or out of a district registry, and the plaintiff may name on his writ the division of the High Court in which he proposes to have the case tried. There are special rules governing the issue of writs in probate and admiralty actions. The writ remains in force for 12 months, but may be renewed for good cause after the expiration of that time. Application for renewal should, however, be made before the expiration of 12 months from the date of the writ. Service must be personal, unless where substituted service is allowed, and in special cases, such as actions to recover land and admiralty actions. Service out of the jurisdiction of a writ or notice of a writ is allowed only by leave of a judge. Notice of the issue of a writ, and not the writ itself is served on a defendant who is neither a British subject nor in British dominions. The law is contained in the Rules of the Supreme Court, especially Orders ii.–xi. and xiv.

Appearance.—Every writ has upon it a memorandum pointing out to the defendant rhat he must, in due course, enter an appearance, otherwise judgment may be signed against him in default. Appearance is entered by the defendant delivering to the proper officer a memorandum stating the name of his solicitor or that he will defend in person (O. 12, r. 8). He must give notice of appearance to the plaintiff or his solicitor. He must give his address for service which, if he has entered appearance in London, must be within 3 m. of the Royal Courts of Justice, and if in a district Registry, the address must be within the district. In the vast majority of cases the defendant leaves it to his solicitor to enter appearance for him. He may enter a conditional appearance if he disputes the jurisdiction of the court, or desires to allege some informality or irregularity in the service of the writ (O. 12, r. 30).

If the defendant does not enter an appearance and the writ has been specially indorsed (*i.e.*, for a liquidated demand) the plaintiff may sign judgment in default for his debt and costs (O. 13, r. 3). But this rule does not apply where the defendant is an infant or a lunatic—the court, in the exercise of its parental jurisdiction, prohibiting such litigants from compromising without leave. Where, however, a defendant does not appear to a writ in which the plaintiff claims damages or other relief which cannot be claimed in a specially indorsed writ, the plaintiff can only sign on what is called interlocutory judgment, which leaves the *quantum* of the damages to be assessed in such manner as the court may think right (O. 13, r. 5). But judgment for the possession of land may be obtained owing to default in appearance. These rules as to default, however, are subject to this—that any judgment by default may be set aside on such terms as to costs or otherwise as to the court shall seem just (O. 13, r. 10). As a general rule, however, if the judgment has been regularly signed, it will only be set aside on very stringent terms, and the defendant must show that he has a meritorious defence.

Application for Summary Judgment.—Appearance having been entered, the next step is taken by the plaintiff. He issues either a summons for summary judgment or a summons for directions. A summons for judgment *can* only be issued, properly speaking, where the action is brought for a liquidated sum, *e.g.*, for money lent, the amount due, or for a cheque or bill of exchange, or where an action is brought by a landlord to recover possession from a tenant whose term has expired or has been duly determined by notice to quit. In all these cases the application must be supported by an affidavit to the effect that the money, etc., is due, and that, in the belief of the plaintiff there is no defence. If the defendant does not appear, or if he appears and shows no cause to the contrary, judgment will be given forthwith by the master in chambers. Where, however, the defendant appears in answer to the summons and shows by affidavit or otherwise that he has a defence, going to the whole cause of action, leave to defend will be given, and the master will then give directions as to the further conduct of the suit. Sometimes it will appear that the defendant has no answer to part of the claim. In that case the master generally orders payment to the plaintiff's solicitors in a certain time, or judgment in default, and gives directions as to the balance. In rare cases the master will order some part of the money sought to be recovered to be brought into court as a condition of leave to defend. But a plaintiff ought not to proceed for summary judgment unless he has substantial grounds for believing there is no defence to the action. Should it turn out that there is a defence of which he must, or ought to, have known, he runs the risk of having to pay the costs.

This (which has just been described) is the celebrated procedure under Order 14. Unknown to the public, and to a large section of the legal profession, enormous sums of money change hands each year in consequence of orders made by masters in chambers. The successful plaintiff receives a fixed sum for costs, the amount of which varies according to the amount of the claim, Claims for £20 and over may be prosecuted in this way. In its essence, this procedure, which allows a litigant to defend himself only when he swears to a defence, is a survival from ancient times when it was competent for a plaintiff to cause his debtor to be imprisoned unless he could show a defence. Consequently the court always takes a lenient view of any defence which may be put forward, acting on the principle that if the defendant swears to that which, if true, would constitute*a defence, he must not be precluded from putting his case before the court.

Having decided to give leave to defend, the next duty of the master is to say how the case shall be tried. If the issue is clear and simple he has power to send it for trial into the short cause list. In that case it is set down for trial without pleadings, and it comes on for trial before a judge alone in a very short space of time. Where, however, service issues are raised necessitating an order for discovery and pleadings, directions are given providing for those matters and settling the place of trial—whether in London or at assizes. If the amount is under £100, however, the case is generally remitted for trial in the county court, the costs being left to the county court judge. If it involves a technical or scientific enquiry, or the examination of accounts, the master may send it to an official referee. Finally, if the parties agree, he may order it to be tried before a master, who fixes a time and day and hears the whole case with witnesses. His decision on a reference of this kind is subject to an appeal to a divisional court.

From the decision of a master on a summons for judgment, an appeal lies to the judge in chambers, who may reverse or vary the master's order. It not infrequently happens that the party who is unsuccessful before the master carries in fresh evidence before the judge in chambers. From the judge an appeal lies (with leave) to the court of appeal, subject to this, that where the judge has given unconditional leave to defend, there is no further appeal of any kind.

Summons for Directions.—In all other cases commenced by writ and subject to an exception to be presently mentioned, the plaintiff in every action must take out a summons for directions. After the defendant has appeared, and before taking any fresh step in the action, other than applying for an injunction as receiver, or the entering of judgment in default of defence (O. 30, r. 1, [a] and [b]). In so far as it is compulsory, this rule does not apply to admiralty actions, nor to an action where the writ is specially indorsed, nor to any proceeding commenced by originating summons (O. 30, r. 1 [a]). The plaintiff must issue the summons within 14 days of the defendant's appearance, and if he does not do so, the defendant may apply to dismiss the action for want of prosecution. On the hearing of that application, however, the master may give direction (O. 30, r. 8).

The master generally deals in the first instance with the following matters: pleadings, discovery, and place and mode of trial. Either party may make application under it to the master on two days' notice for further directions, and every interlocutory application in an action which has to be made before judgment is so made (O. 30, r. 5). Even an application for leave to discontinue proceedings is so made.

Generally speaking, the effect of the order made on the application for directions is to set the case on its career through the courts.

Parties.—All persons may be joined in one action as plaintiffs in whom any right to relief arising out of the same transaction is alleged to exist, whether jointly or severally, or in the alternative where, if such persons brought suit separately, a common question of law or fact would arise (O. 16, r. 1). Should it appear, however, that any such joinder may embarrass or delay the trial, separate trials may be ordered (ib.). Again, if an action is by accident brought by the wrong plaintiff a new plaintiff may be substituted or added (O. 16, r. 2). As regards defendant, all persons may be joined as such against whom the right to any relief is alleged to exist, whether jointly or severally or in the alternative (O. 16, r. 4). If numerous persons having the same interest in the cause or matter desire to assert or defend their rights, the court may authorize one or more of them to represent all (O. 16, r. 9). As a corollary to the above rules it is important to notice that the court has ample power to strike out parties improperly joined, and to add others who should be before the court in order that the matters in dispute may be effectually determined (O. 16, r. 11). As regards lunatics and infants the rules are strict to prevent anything in the nature of a settlement or compromise of an action save with the consent of the court or a judge. Money recovered by an infant or lunatic may be kept in court or otherwise protected for the benefit of the party concerned.

It has been the law since the days of Henry VIII. that a man may sue in *formâ pauperis.* Formerly he had to show that he was not worth more than £25, his wearing apparel, tools of trade, etc. not being taken into account. He could have a solicitor and counsel assigned to him. Now any poor person (*i.e.,* a person who is not worth more than £50 or such larger sum not exceeding £100 as may be allowed in special circumstances or a person whose usual income is not more than £2 or in special cases £4 a week) may sue or defend without paying court fees and may have a solicitor and counsel assigned to him free of charge. (See generally O. 16 and 22 et *seq.)*

Third Party Procedure.—It is obvious that where A has a claim against B, B may have a claim against C which arises, or which he desires to assert, only because A has brought an action against him. It would be unfortunate, and would involve unnecessary expense to all parties if B were bound to refrain from suing C until A had sued him. A remedy for this is provided by what is known as third party procedure (O. 16, r. 48) under which, where a defendant claims contribution or indemnity against a person not a party to the action, he may, by leave, issue a third party notice. To that notice (which corresponds to a writ) the third party must appear, otherwise judgment may go against him by default (O. 16, rr. 49, 50). If he does appear, suitable directions may be given so that all the questions between all the parties may be tried in the same action (O. 16, r. 52). The third party may bring a fourth party from whom he seeks indemnity subject to the same rules as prevail in relation to third parties (O. 16, r. 54B).

An action does not abate because of the marriage, death, or bankruptcy, etc., of any party thereto, if the cause of action survives (O. 17, r. 1), and where any marriage, etc., takes place, or there is any devolution of estate by operation of law, the court may order that the husband, personal representative, trustee, or other successor to interest of any party shall be made a party and served with notice of the proceedings (O. 17, r. 2). Similarly, any person, who by reason of a marriage, death, bankruptcy or assignment after action brought acquires an interest in the dispute may apply to be made a party (O. 17, r. 4).

Several causes of action may be joined in the same action; but the court may order that there shall be separate trials if the various causes of action which appear upon the record cannot be conveniently tried together (O. 18, r. 1). This rule is subject to one notable exception. namely, that no other cause of action can be joined with an action for the recovery of land, except by leave of the court (O. 18, r. 1).

The Pleadings.—Normally, in an action tried in the king's bench divisions, "pleadings" are ordered to be delivered. They consist of a statement of claim, the defence (and counterclaim, if any), and reply, and, in rare cases, a rejoinder. No pleading subsequent to defence can, however, be delivered without leave.

A pleading is the term applied in English law to the preparation of the statement of the facts on which either party to a civil action founds his claim to a decision in his favour on the questions involved in the proceeding; and also to the document in which these statements are embodied. The term "pleadings" is used for the collected whole of the statements of both parties; the term "pleading" for each separate part of the pleadings.

The object of the pleadings is to secure that both parties shall know what are the real issues between them. A plaintiff must (in certain cases) deliver a statement of claim; a defendant must put in a defence and he may also plead a setoff or counterclaim. The plaintiff must (in certain cases) reply to the defence, and must put in a defence to the counterclaim. The rules of pleading are so framed as to restrict the length of pleadings as much as possible. So "every pleading shall contain, and contain only, a statement in a summary form of the material facts on which the party pleading relies for his claim or defence, as the case may be, but not the evidence by which they are to be proved." The pleader must confine himself to material facts—but an allegation may be material though it is not necessary. He must confine himself, too, to facts material at that stage of the action.

With a view to avoiding prolixity, the rules p ovide that a contract which is to be implied from a series of letters or conversations, or from various circumstances, may be referred to as a fact without setting out all the letters, etc., in detail. But reference to those letters, etc., and the substance of material conversation must be given. Matters of law need not be pleaded to. But even though it may necessitate a long and elaborate statement, all material facts must be set out in a pleading. If material, dates, names and items are not given, the pleader may be ordered to give particulars. A pleading may contain alternative and inconsistent allegations.

As indicated above, particulars may be ordered if a pleading is not sufficiently explicit. Particulars may be necessary to indicate to the opponent the nature of the evidence required by him.

A few examples must suffice. In an action for libel where the defendant has alleged that the plaintiff is a "swindler," or a "felon," pleads that the words are true, he must give particulars showing the nature of the alleged swindle or felony. In an action in which a plaintiff, suing for the balance of monies alleged to be due, gives credit for a lump sum, he must give particulars showing how the lump sum is made up. Where the plaintiff claims general damages (*e.g.,* in an action for personal injuries) "£1,000," he need not give particulars showing how he arrives at that figure; but if he claims special damage, *e.g.,* "£100 for medical expenses," consequent upon the injury, particulars will be ordered. It is no answer to a claim for particulars that they are within the applicant's own knowledge. He may still desire to know what facts the other party is going to rely upon in support of his case. Sometimes, however, a litigant asked to give particulars will be allowed to interrogate his opponent before complying with the order.

But where particulars would be in vain they will not be ordered. If the plaintiff, for example, asks for an account to be taken between him and the defendant, it is obvious to the defendant that all his dealings with the plaintiff will have to be enquired into. But if the plaintiff claims an account and £100 which he alleges will be due when the account is taken, it is clear that the defendant is entitled to know how that figure is arrived at. If, when asking for an account, he also asks particulars of money had and received, they will be refused, as the facts will emerge on taking the account.

With regard to the defence, it is seldom enough merely to traverse (*i.e.*, deny or refuse to admit) the matters in the statement of claim. For example, if the plaintiff sets up a contract which was in fact made, it would be idle for the defendant merely to deny the existence of a contract. He should confess (*i.e.*, admit) the contract and **avoid** the effect of that confession by setting up the Statute of Fraud or Limitations or by setting up (a) that the contract has been duly performed or rescinded; or (b) that it was illegal; or (c) that some condition precedent to his liability has not been performed. In an action of debt a mere denial of the debt is expressly declared by the rules to be inadmissible; and in an action for liquidated sums the defence must deny the order or contract, the delivery, or the amount claimed. Again, in an action for money had and received, the defence must deny the receipt of the money, or the existence of those facts which are alleged to make such receipt by the defendant a receipt to the use of the plaintiff. If the defendant desires to deny the right of a plaintiff to sue in a representative capacity, he must do so specifically (O. 21, r. 5). While the defendant should make every denial which is really necessary, he should avoid denying matters which are really immaterial. If he does so, the court has power to make him pay any extra costs occasioned thereby (O. 21, r. 9).

With regard to counterclaims, a defendant may counterclaim not only against the plaintiff but against other parties to the action, and against a person who is not a party (O. 21, r. 11). But whereas a counterclaim against a plaintiff and a person already a party is merely delivered, a counterclaim involving a "third party" must be served on him like a writ. Such third party must appear as if he were a defendant to an action, and, having done so, may deliver a defence without any leave from the court (O. 21, r. 14). It s competent for any person who is made defendant to a counterclaim to apply to the court for an order to exclude the counterclaim, on the ground that it cannot be conveniently or properly tried with the original action (O. 21 r. 15). If there is a counterclaim on the record, and the original action is stayed, discontinued or dismissed, the counterclaim can nevertheless be proceeded with (O. 21, r. 16). As to defences generally, one or two survivals from ancient times are to be found in the rules. Thus it is still competent for a defendant, in certain cases, to plead "not guilty by statute" — as when for example an action is brought for illegal distress. But it is unsafe to use this plea, as no other plea can be added save by leave (See O. 19, r. 12 ; O. 19, r. 20.) Again, a plea "in abatement" (*e.g.* that a third person should have been added as plaintiff) is not allowed. Finally in an action for the recovery of land against a defendant who is in possession by himself or his tenant the defendant (unless he has some equitable defence) need only plead that he is in possession. This puts everything in issue and enables him to raise any defence--even the Statute of Limitations (O 21, r. 21). The reason assigned for this (by Lord Justice Brett) is that the plaintiff in an action for recovery of land must recover on the strength of his own title and not through any defect in the defendant's title. "Possession is nine points of the law."

Payment into Court. — There is no part of the procedure in civil actions more important to the litigant than that which enables a defendant to pay money into court. By a judicious payment into court a defendant may bring proceedings to an end, and so avoid the costs of what may be an expensive action. Further, if he pays in enough or more than enough to satisfy the plaintiff's claim, the plaintiff will have to bear all costs incurred subsequent to the date of payment in.

The rules provide that in any action for debt or damages (not, *e.g.*, a mere action for an account) including actions for libel or slander, the defendant may, before defence, or with defence not denying liability, pay money into court in satisfaction of the whole or a specified part of the claim (O. 22, r. 1). By so paying in, he admits liability to that extent. The plaintiff may then take the money out and proceed with the action (O. 22, r. 5), or accept it in full satisfaction (O. 22, r. 5). In the latter case, if he accepts it within a certain time (prescribed by O. 22, r. 7) he may proceed to tax and recover his costs. If he does not so accept it but goes on with his action, and fails to recover anything more, the defendant will be entitled to all the costs incurred subsequent to the date of payment in.

There is one case in which the defendant ought certainly, in his own interest, to pay money into court. This is where in answer to a claim for a liquidated sum, he has made a tender before action. Tender of what is due is a complete defence to an action; but where there is a plea of tender upon the record, it will not avail the defendant unless he has brought the amount tendered into court. And this is good sense, because the defendant's attitude must be that he always was and still is ready and willing to pay his debt. But where money has been paid into court with a plea of tender, the plaintiff cannot terminate the action by taking that money out of court; for he will thereby admit the defence and the costs of the whole action will be the defendant's.

But it is not always necessary for a defendant to admit liability for the sum paid in. In any action of debt he may pay in without admitting liability (except when he pleads tender). This is a mere offer to secure peace, which may appear with any other defence, *e.g.*, a denial of the contract or a plea of performance. The plaintiff may accept it in satisfaction and take it out of court (O. 22, r. 6) and tax his costs (O. 22, r. 7). If he does not accept it in satisfaction, the money remains in court to abide the result of the action (O. 22, r. 6). The danger of denying liability, however, lies in this, that it puts the plaintiff to the proof of his case, and although he may recover no more than the sum paid in, the defendant may not get his costs of contesting those issues. In action for damages (except for libel or slander) the rule is very similar (O. 22, r. 1), but in libel and slander cases, payment in can only be made in satisfaction (*i.e.*, with an admission of liability) or else by way of compensation and amends, under the Libel Act 1843. If necessary, as where, for example, the claim involves several causes of action, particulars will be ordered showing how much of a payment in is to be applied to each cause of action.

Neither the fact of a payment into court having been made nor the amount of such payment must be revealed to a jury (O. 22, r. 22). If there has been such a revelation, the court will stop the case and discharge the jury. If more than enough has been paid in, the excess will be ordered to be repaid to the defendant.

To the general rule that it rests with plaintiff to say whether he will or will not accept money paid into court, there is an exception in any case where the plaintiff is an infant or a person of unsound mind. Acceptance of a sum paid in involves (or may involve) a compromise of the action, and the court, exercising a parental jurisdiction in such matters will refuse to allow a compromise which may not be fair to the plaintiff. And so the court has power, not only to refuse to allow a compromise, but it may provide, by order, for the money being retained in court and invested or otherwise disposed of for the benefit of the infant (until he attains the age of 21) or lunatic as the case may be. (See generally O. 22, r. 15.)

Reply and Subsequent Pleadings. — The defence having been delivered, the plaintiff may find it necessary to deliver a reply. Under the old rules a plaintiff was always entitled to reply — even if it was only to join issue. But now a mere joinder of issue is unnecessary and (O. 27, r. 13) no reply or subsequent pleading (*e.g.*, rejoinder, sur-rejoinder, etc.) can be delivered without order except in certain admiralty cases (O. 23). But a reply may be essential, *e.g.*, where there is a counterclaim (to which the reply is really a defence) or where the defendant has pleaded the Statute of Limitation, and the plaintiff desires to prove a payment which takes the case out of the statute. He must not, however, suggest a new cause of action in his reply, for that would be what the old pleaders called a "departure." And the reason is plain. To a new cause of action the defendant must be enabled to put in a defence in accordance with the rules. A new cause of action must therefore appear in an amended statement of claim.

Cases may occur in which, although the plaintiff had a good cause of action when he issued his writ, something happened afterwards to satisfy his claim or discharge the cause of action. For example, he may accept payment of the debt sued for, or a sum of money by way of compromise of a claim for damages. Such acceptance or compromise would constitute a defence. If it takes place before the expiration of the time limited for defence, the defendant may raise it in his defence, signifying that it arose since action brought (0. 24, r. 1). And even if it arises after that time, the defendant may raise it by leave (0. 24, r. 2). The plaintiff may thereupon "confess" such defence and tax his costs up to the time when it was delivered (0. 24, r. 3) unless the court shall otherwise order. A similar rule obtains with reference to a reply which sets up new matter in defence to a set off or counterclaim. A counterclaim may be founded on facts which have arisen since action brought, but it must be phrased as so arising.

Discontinuance. — In certain circuinstances an action may be discontinued, or a defence withdrawn. Thus at any time before receipt of defence, or after receipt thereof before taking any proceeding other than interlocutory (*e.g.*, a summons for particulars), the plaintiff may, *without* leave, by notice in writing discontinue the whole action, or withdraw any part of it as against all or any of the defendants, subject to the payment of costs (O. 26, r. 1).

Proceedings in Lieu of Demurrer. — In former days it was competent for a defendant to "demur" to the statement of claim on the ground that it disclosed no cause of action. The result was that many a claim was defeated and costs were often incurred merely because the plaintiff had not put his case in proper form. Now, however, demurrer is abolished (O. 25, r. 1) but any party may raise a point of law by his pleading, and the point so raised shall be disposed of at or after the trial subject to this, that if the parties consent or the court so orders the point may be set down for hearing and disposed of before the trial (0. 25, r. 2). If the decision substantially disposes of the whole action, the action may be dismissed (0. 25, r. 3). This course may be conveniently adopted where it is obvious that a serious question arises as to whether the statement of claim as drafted discloses any cause of action, or the defence any answer in law to the claim.

Striking Out Pleadings. — The court may order a pleading to be struck out on the ground that it discloses no reasonable cause of action or answer (O. 25, r. 4). In any such case, or if the action or defence be shown by *the pleadings* to be frivolous or vexatious, it may be stayed or dismissed, or judgment may be entered for the defendant accordingly as may be just (ib.). To succeed in such an application, an objecting party must be able to point to some defect in the pleading itself. The rule is only acted upon in plain and obvious cases. So if in an action on a contract it be clear that there is no contract between the plaintiff and the defendant; or no contract valid in law; or that the matter is already res *judicata,* or where the statement of claim on the face of it shows that there is a good defence, it will be struck out.

But the court will generally give a party leave to amend a pleading before striking it out. Apart from the rule above mentioned (and O. 19, r. 25, which enables anything scandalous or vexatious, or which tends to delay, etc., the trial of an action, to be struck out) the court has inherent jurisdiction to stay all proceedings before it which are obviously frivolous or vexatious or an abuse of its process. Discontinuance by the plaintiff does not alter a counterclaim, but a counterclaim cannot be set up after discontinuance.

A defendant may by leave, and only by leave, and upon terms, withdraw the whole or part of his defence or counterclaini. If the defence is withdrawn, the plaintiff can sign judgment in default of defence. An application so to withdraw may be made at any time. A cause entered for trial may be withdrawn by either plaintiff or defendant upon producing a consent in writing to the proper officer (0. 26, r. 2). The plaintiff must pay the defendant's costs if he discontinue an action (0. 26, r. 3); and if he bring another action for the same or substantially the same cause, it may be stayed if the costs of the former action are not paid (0. 26, r. 4).

Default of Pleading. — The rules of pleading are enforced by this — that if a party does not plead as and when required, he may if he is a plaintiff have his action dismissed, if he is a defendant have judgment signed against him. Thus if a plaintiff being bound to deliver a statement of claim does not do so within the time allowed, the defendant may apply to have the action dismissed for want of prosecution, and on the hearing of the application the court may either dismiss the action or make such order as shall be thought just (O. 27, r. 1). Where the plaintiff delivers his statement of claim after the application has been made, the court will generally make no order save that he pay the costs. The plaintiff need not deliver a statement of claim save under an order for directions, for which he must himself apply. If he does not so apply within 14 days of the defendant's appearance the defendant may have the action dismissed (0. 30, r. 8). A plaintiff may be in default in delivering a reply and defence to a counterclaim. If so, the defendant's only remedy is to move for judgment under O. 27, r. 11, even when the counterclaim is for a liquidated demand, and even if some other person has been made a defendant to the counterclaiin.

A defendant may make default either in not entering an appearance, or in not putting in his defence. If he has not appeared, and, the writ not being especially indorsed (*i.e.,* with a claim for a liquidated sum), he has had a statement of claim filed against him in default, he must appear and deliver his defence within ten days of the filing of the statement of claim. Otherwise he may have judgment signed against him with costs (O. 21, rr. 2–9). In such a case, however, if the plaintiff could have signed judgment merely in default of appearance, he can only have such costs as he would have had in that case. In other words, he will not be allowed the costs of the statement of claim. If a defendant has appeared to the writ other considerations arise. If the writ was specially indorsed he must deliver a defence within ten days unless the plaintiff has proceeded for summary judgment (O. 21, r. 6) and in other cases if a separate statement of claim has been delivered he must deliver his defence within the time limited by the summons for directions (O. 21, r. 8).

The procedure to be adopted if the defendant has not put in a defence depends upon the nature of the action. (See APPEARANCE, p. 400.)

Close of Pleadings. — There comes a time in every action when the pleadings are deemed to be closed. Where no reply or subsequent pleading is ordered then within four days of the delivery of the last pleading, or where a reply has been ordered within a certain time, at the end of that period the pleadings are to be deemed closed and all statements therein put in issue (0. 27, r. 13). This, however, does not apply to a reply to a counterclaim which is really a defence. Unless the plaintiff obtains leave to reply to a counterclaim, the statements of fact which it contains shall be deemed to be admitted after the expiration of ten days, unless a reply has been ordered, in which case, if the order is not complied with, the facts will be deemed to be admitted.

Amendment. — In former times the ends of justice were often defeated, and the litigant was put to an enormous amount of unnecessary expense, because the powers of the court to allow amendment of pleadings were greatly restricted. Now, however, the court or a judge may at any time, and on such terms as to costs or otherwise as may be thought right, amend any deficit in any proceedings, and all necessary amendments shall be made for the purpose of determining the real question or issue raised by or depending on the proceedings (0. 28, r. 12).

Amendment of Pleadings. — The court or a judge may at any stage of the proceedings allow either party to alter or amend his indorsement or pleadings in such manner and on such terms as may be just, and all such amendments shall be made as may be necessary for the purpose of determining the real question in controversy between the parties (0. 28, r. 1). Under this rule amendment will always be allowed, if it can be made without injustice to the other side. While a new cause of action may be introduced into the statement of claim by amendment, if the plaintiff, at the same time seeks to stand on his original claim, leaving his writ unamended, this is practically a discontinuance, for the new claim is wholly unsupported by the writ. Such an amendment will only be allowed on the terms that the plaintiff pays all costs down to the time of the amendment, and that all proceedings are stayed until those costs are paid.

A petition of right cannot be amended unless the amendment is such that if the petition had been presented as amended, the *fiat* of the attorney-general would have been granted.

To allow an amendment of a petition of right would be to derogate from the prerogative of the Crown. A common informer is but seldom allowed to amend his statement of claim in an action for penalties. Amendment is often allowed on an application to strike out a pleading as embarrassing or because it discloses no cause of action—*ut res magis valeat quam pereat*. Although, when a statement of claim is delivered the plaintiff may therein alter, modify or extend his claim without any amendment of the writ, he cannot add a claim on a wholly new and different cause of action except by leave; and if leave be given the writ should be amended. The writ or the statement of claim must be amended in one case, *i.e.,* where the plaintiff recovers by verdict of a jury more than the amount he has actually claimed. Otherwise he cannot recover the amount of the verdict. Amendment may be allowed at any time but it should obviously be made at the earliest possible moment. A defendant may have no answer to the claim as amended. A plaintiff may find it necessary to confess an amended defence and stop his action; or, where the amendment involves *a* payment of money into court, he may be content with the amount paid in.

A plaintiff may, in certain cases, and within a certain time amend his statement of claim, whether indorsed on the writ or not, without leave (O. 28, r. 2). But he cannot, in the exercise of this privilege, add a cause of action which has accrued to him since the writ—although he can do that by leave. Nor can he add new parties. If he has delivered particulars with the statement of claim he can amend them under this rule; but particulars delivered otherwise can only be amended by leave. Under this rule a special indorsement can be amended provided the claim is one which can be specially indorsed. A similar rule (O. 28, r. 3) applies to a counterclaim. But it is important to notice that any amendment so made without leave may be disallowed—or only allowed upon terms—on the application of the other side if the justice of the case so requires (O. 28, r. 4).

It has been stated that amendment to statement of claim or counterclaim without leave can only be made within a certain time. All other amendments to claim or defence, or to any other pleading, can only be made by the leave of the court or a judge and upon such terms as to costs as may be just (O. 28, r. 6). If an order giving leave to amend be made and the amendment is not made within the time limited or within 14 days of the date of the order, the order is void, unless the time be extended by the court or a judge (O. 28, r. 7). Moreover the amended pleading must be delivered to the opposite party within the time allowing the same (O. 28, r. 10).

Actions By or Against Firms.—If a firm desires to bring an action, or anyone desires to bring an action against a firm, in the firm name, especial considerations arise. Broadly speaking, a firm consisting of more than one person carrying on a business within the jurisdiction may sue or be sued in the firm name, but subject to this—that the names of the partners must, if required, be revealed to the other side. Where, however, a man carries on business in a name other than his own, he can only sue in his own name, but he may be sued in the name of his firm. He must, however, reveal his true name if required. Service of process on a firm may be effected either upon any one of the partners, or upon the manager at the place of business of the firm. The person served must be told, at the time, whether he is served as a partner or as manager. A firm cannot enter an appearance as such: it must appear by one of the partners personally; but an alleged partner may appear with a denial that he is a partner. The property of the firm within the jurisdiction can be seized in execution of a judgment against the firm, and so can the property of individual partners. This is but a summary of O. 48A which provides a complete code of rules on the subject. It must be carefully studied by anyone who is concerned in an action by or against a firm.

Discovery.—The pleadings having been closed, the parties in most cases proceed to have discovery, either of facts or documents or both. The English common law courts were originally unable to compel a litigant before a trial to disclose the facts and documents on which he relied. In equity, however, a different rule prevailed, there being an absolute right to discovery of all material facts on which a case was founded. Now the practice is regulated by the Rules of the Supreme Court, 1883, Order 31. Discovery is of two kinds, namely, by interrogatories and by affidavit of documents, provision being also made for the production and inspection of documents. Where a party to a suit can make an affidavit stating that in his belief certain specified documents are or have been in the possession of some other party, the court may make an order that such party state on affidavit whether he has or ever had any of those documents in his possession, or if he has parted with them or what has become of them. A further application may then be made by notice to the party who has admitted possession of the documents for production and inspection. Copies also may be taken of the more important documents. There is also discovery of facts obtained by means of interrogatories, *i.e.,* written questions addressed on behalf of one party, before trial, to the other party, who is bound to answer them in writing upon oath. In order to prevent needless expense the party seeking discovery used to have to secure the cost of it by paying into court a sum of money, generally not less than £5, but this rule has been abolished. Objection may be taken to discovery either of a fact or a document on the ground of privilege or that the matters sought to be discovered are criminatory.

Thus all documents and communications passing between a litigant and his legal advisers are absolutely privileged and need not be disclosed. Again, where an admission of a fact or the production of a document might involve the admission of a criminal offence, the litigant may refuse to give discovery. Where the opposite party is not satisfied with an affidavit of documents, or the answer to an interrogatory, he may, in certain cases apply for a further and better affidavit or answer, and in some cases the master to whom the application is made will himself examine a document in order to see whether it shall be disclosed or not. The advantage of discovery lies in this—that it forces a litigant to reveal his case on oath. It is one thing to make a statement or deny a fact in a pleading. That merely has effect to put the matter in issue. It is a much more serious matter to have to swear to a fact in an affidavit, because, in the case of the answer to an interrogatory, it may be put in evidence by the opposite party at the trial. Many an action is brought to a speedy end by an order for discovery, because the litigant is wholly unable to swear to the truth of the claim or defence which he has put upon his pleadings. Discovery will not be allowed if the remedy sought to be inforced is of a penal nature, or if the plaintiff is relying on a forfeiture.

Evidence on Commission.—Cases often arise in which it is impossible owing to illness or absence to secure the attendance of a witness at the trial. In such circumstances the court has power (conferred by O. 37, r. 5 et *seq.*) to direct that the evidence be taken anywhere before an officer of the court or any other person. It must be shown, however, that the witness will be unable to attend, either because of illness or because he is out of the jurisdiction, and cannot be compelled to attend by *subpoena*. Even a plaintiff may be allowed to give evidence on commission, but this is a privilege seldom granted. The evidence of the witness is written down and signed by him and can be put in at the trial. In certain foreign countries, where evidence cannot be taken on commission, it is secured by letters of request, which are sent through the Foreign Office.

Admission.—Although the pleadings show that everything is in issue in an action, it is competent for either party to give notice that he admits the truth of the whole or part of his opponent's case (O. 32, r. 1). This secures the costs of proving those facts, and, if the whole cause of action is admitted, enables the party to whom the admission is made to apply for judgment (O. 32, r. 6). Apart from this, either party may give notice to the other to admit facts and if he refuses to do so unreasonably he may have to pay the costs of the necessary proof of those facts (ib. [4]). Similarly notice may be given to admit documents; indeed the costs of proving any document may be disallowed if the notice is not given (O. 32, r. 3).

Special Case.—The parties to any cause or matter may concur in stating the questions of law arising therein in the form of a special case for the opinion of the court (O. 34, r. 1), and the court may order a question of law to be decided either by special case or otherwise before any question of fact is tried (O. 34, r. 2).

Transfer *and Consolidation* of Action.—Action may be transferred from one division of the High Court to another, or from one judge to another by order of the lord chancellor but subject to the consent of the president of the division (O. 59, r. 1). Causes depending in the same division may be consolidated with each other (O. 59, r. 8).

Application and *Proceedings* at *Chambers*.—All applications at chambers (*i.e.*, before a master or a judge) are made by summons unless they are made ex parte, that is to say, by one side only. Applications at chambers generally are regulated by O. 54, while O. 55 prescribes the rules observed in chambers in the chancery division.

Proceedings in District Registries.—To meet the convenience of suitors who do not live in or near London, district registries have been established in various parts of the country. Proceedings can only be taken in a district registry, in an action in which the writ has been issued out of that registry. Broadly speaking, the powers of a district registrar are similar to those of a master of the supreme court. In certain cases, however, where an action has been commenced in a registry the defendant can as of right have it moved to London, and the court has power in all cases to move an action from a registry to London or vice versa. (See generally O. 35.) As to appeals from district registries see APPEAL. Proceedings by poor persons under the Matrimonial Causes Acts in district registries are provided for by O. 35a.

Trial.—The places and mode of trial having been fixed by the order made on a summons for directions, the plaintiff must give notice of trial (O. 36, r. 11), and if he fails to do so, within the time prescribed by the rules, the defendant may do so, or else apply to have the action dismissed for want of prosecution (O. 36, r. 12). Trial follows upon the completion of the steps necessary to bring the parties before the court and to adjust the issues upon which the court is to adjudicate, which may be summed up in the term pleading. In England the trial is usually in open court, and it is rare to try cases in camera, or to attempt to exclude the public from the hearing. In practice hearing in camera is only ordered where to try in open court would be to defeat the ends of justice. The essential part of the trial is that there should be full opportunity to both sides for evidence and argument on the questions in dispute. At present in England, as distinguished from the rest of Europe, the evidence is ordinarily taken *viva voce* in court, and affidavits and depositions are sparingly accepted, whereas under the continental system the bulk of the proofs in civil cases are reduced to writing before the hearing.

In the High Court of Justice in England several modes of trial are now used:—

1. Trial by judge with a jury used in the king's bench division and in probate and matrimonial cases. There is a right to have a jury as a matter of course in actions of defamation, false imprisonment. malicious prosecution, seduction and breach of promise of marriage.

2. Trial by a judge without a jury is invariable in the chancery division and now common in other divisions. Cases in the chancery division are not tried with a jury unless a special order is made (O. 36, r. 3); and the High Court in cases in which trial without jury could be ordered without consent still retains the power of so trying them, and has also acquired power to direct trial without a jury of any issue requiring prolonged examination of documents or accounts or scientific or local investigation.

3. Trial with assessors, usually in admiralty cases (the assessors being nautical) but rare in other division?.

4. Trial by an official referee in certain cases involving much detail (R.S.C., O. 36).

5. Where the parties consent, trial may be had of any case in the king's bench division before a master in chambers.

A speedy trial may be ordered in certain cases (O. 36, r. 1A), but the power conferred by this order is sparingly exercised. The parties may be represented in the High Court by counsel or may conduct their case in person. The trial is carried on by stating to the court the pleadings if any and by opening the plaintiff's case. This is followed by the evidence of the witnesses, who are sworn and examined and cross-examined. On the completion of the plaintiff's case and evidence, the defendant's case is stated and evidence adduced in support of it. The plaintiff or his lawyer has, as a rule, the reply or last word unless the defendant has called no evidence. If when the trial is called on the plaintiff appears and the defendant does not, the plaintiff may prove his case (O. 36, r. 31). If the plaintiff does not appear, the delendant may have judgment dismissing the action, and may prove his counterclaim if he has one (O. 36, r. 32). But any judgment by default may be set aside on terms.

At the conclusion the judge sums up the law and facts of the case to the jury and their verdict is returned, or if there is no jury the judge gives judgment stating his conclusion on the law and the facts involved. He then directs that judgment shall be entered as he thinks right (O. 36, r. 39), and a memorandum is endorsed on the judgment pointing out that if it is not obeyed, the defendant will be liable to process of execution (O. 41, r. 5).

Juries.—In England the trial jury (also called petty jury or traverse jury) consists of 12 jurors, except in the county court where the number is eight. Women are now summoned as jurors, but a husband and wife cannot be summoned on the same occasion. A woman may, however, claim exemption on the ground that by reason of pregnancy or some other feminine condition or ailment she is or will be unfit to serve. Either party to the suit may apply to the court for an order that the jury shall consist wholly of men or wholly of women. In civil but not in criminal cases the trial may by consent be by fewer than 12 jurors, and the verdict may by consent be that of the majority.

The jurors are selected from the inhabitants of the county, borough or other area for which the court to which they are summoned is commissioned to act. In criminal cases, owing to the rules as to venue and that crime is to be tried in the neighbourhood where it is committed, the mode of selection involves a certain amount of independent local knowledge on the part of the jurors. Where local prejudice has been aroused for or against the accused, which is likely to affect the chance of a fair trial, the proceedings may be removed to another jurisdiction, and there are a good many offences in which by legislation the accused may be tried where he is caught, irrespective of the place where he is alleged to have broken the law.

Exemptions from juries include members of the legislature and judges, ministers of various denominations, and practising barristers and solicitors, registered medical practitioners and dentists, and officers and soldiers of the regular army. Persons over 60 are exempt but not disqualified. Lists of the jurors are prepared by the overseers in rural parishes and by the town clerks in boroughs, and are submitted to justices for revision. When jurors are required for a civil or criminal trial they are summoned by the sheriff or, if he cannot act, by the coroner.

For the purpose of civil trials in the superior courts there are two lists of jurors, special and common. The practice of selecting special jurors to try important civil cases appears to have sprung up, without legislative enactment, in the procedure of the courts.

The jurors are the judges of fact upon the evidence laid before them. Their province is strictly limited to questions of fact, and within that province they are still further restricted to matters proved by evidence in the course of the trial and in theory must not act upon their own personal knowledge and observation except so far as it proceeds from what is called a "view" of the subject matter of the litigation.

While the jury is in legal theory absolute as to matters of fact, it is in practice largely controlled by the judges. Not only does the judge at the trial decide as to the relevancy of the evidence tendered to the issues to be proved, and as to the admissibility of questions put to a witness, but he also advises the jury as to the logical bearing of the evidence admitted upon the matters to be found by the jury. The rules as to admissibility of evidence, largely based upon scholastic logic, sometimes difficult to apply, and almost unknown in continental jurisprudence, coupled with the right of an English judge to sum up the evidence (denied to French judges) and to express his own opinion as to its value (denied to American judges), fetter to some extent the independence or limit the chances of error of the jury.

The appellate court will not upset a verdict when there is substantial and conflicting evidence before the jury. In such cases it is for the jury to say which side is to be believed, and the court will not interfere with the verdict. To upset a verdict on the ground that there is no evidence to go to the jury implies that the judge at the trial ought to have withdrawn the case from the jury. Under modern procedure, in order to avoid the risk of a new trial, it is not uncommon to take the verdict of a jury on the hypothesis that there was evidence for their consideration, and to leave the unsuccessful party to apply for judgment notwithstanding the verdict. The question whether there was any evidence proper to be submitted to the jury arises oftenest in cases involving an imputation of negligence—*e.g.,* in an action of damages against a railway company for injuries sustained in a collision.

This statement indicates existing practice but scarcely determines what relation between the facts proved and the conclusion to be established is necessary to make the facts evidence from which a jury may infer the conclusion. The true explanation is to be found in the principle of relevancy. Any fact which is relevant to the issue constitutes evidence to go before the jury, and any fact, roughly speaking, is relevant between which and the fact to be proved there may be a connection as cause and effect. As regards damages the court has always had wide powers, as damages are often a question of law. But when the amount of the damages awarded by a jury is challenged as excessive or inadequate, the appellate court, if it considers the amount unreasonably large or unreasonably small, must order a new trial unless both parties consent to a reduction or increase of the damages to a figure fixed by the court; see Watt v. Watt (1905), App. Cas. 115.

Judgment and Execution. — Execution is allowed as a matter of course after judgment except where it has for some reason been stayed, *e.g.,* where an appeal is pending. (See generally R.S.C. O. 42.) A judgment for the recovery of money or costs is enforced, as a rule, by writ of *fieri* facias addressed to the sheriff, and directing him to cause to be made (*fieri* facias) of the goods and chattels of the debtor a levy of a sum sufficient to satisfy the judgment and costs, which carry interest at 4% per annum. The seizure effected by the sheriff or his officer, under this writ, of the property of the debtor, is what is popularly known as "the putting-in" of an execution. The seizure should be carried out with all possible dispatch. The sheriff or his officer must not break open the debtor's house in effecting a seizure, for "a man's house is his castle"; but this principle applies only to a dwelling-house, and a barn or outhouse unconnected with the dwelling-house may be broken into. The sheriff on receipt of the writ endorses it on the day, hour, month and year when he received it; and the writ binds the debtor's goods as at the date of its delivery, except as regards goods sold before seizure in market overt, or purchased for value, without notice before actual seizure (Sale of Goods Act 1893, s. 26, which supersedes s. 16 of the Statute of Frauds and s. 1 of the Mercantile Law Amendment Act 1856).

This rule is limited to goods, and does not apply to the money or bank-notes of the debtor which are not bound by the writ till seized under it (Johnson v. Pickering, Oct. 14, 1907, C.A.). The mere seizure of the goods, however, although, subject to such exceptions as those just stated, it binds the interest of the debtor, and gives the sheriff such an interest in the goods as will enable him to sue for the recovery of their possession, does not pass the property in the goods to the sheriff. The goods are in the custody of the law. But the property remains in the debtor who may get rid of the execution on payment of the claim and fees of the sheriff. The wearing apparel, bedding, tools, etc., of the debtor to the value of £5 are protected. Competing claims as to the ownership of the goods seized are brought before the courts by the procedure of "interpleader." In the king's bench division, the sheriff issues a summons before a master in chambers calling upon the execution creditors and claimant to appear and state their respective cases. If the claim is not admitted by the execution creditor, an issue is directed to try the merits and either party may ask the master to try the issue himself. This he generally does at the earliest possible opportunity, for the sheriff being in possession, costs are mounting up. Otherwise the "issue" is reported for trial to the High Court or county court, the claimant being directed to bring the amount of the sheriff's valuation into court. That money being in court, the sheriff withdraws. After seizure the sheriff must retain possession, and, in default of payment by the execution debtor, proceed to sell. Where the judgment debt, including legal expenses, exceeds £20, the sale must be by public auction, unless the court otherwise orders, and must be publicly advertised. The proceeds of sale, after deduction of the sheriff's fees and expenses, become the property of the execution creditor to the extent of his claim.

Under the law of bankruptcy, the sheriff, in case of sale under a judgment for a sum exceeding £20 is required to hold the proceeds for 14 days in case notice of bankruptcy proceedings should be served upon him. (See BANKRUPTCY.) Imprisonment for debt in execution of civil judgment is now abolished except in cases of default in the nature of contempt, unsatisfied by judgments for penalties, defaults by persons in a fiduciary character, and defaults by judgment debtors.

Writ of *Elegit*.—The writ of *elegit* is a process enabling the creditor to satisfy his judgment debt out of the lands of the debtor. It derives its name from the election of the creditor in favour of this mode of recovery. It is founded on the Statute of Westminster (1285, 13 Ed. I. c. 18), under which the sheriff was required to deliver to the creditor all the chattels (except oxen and beasts of the plough) and half the lands of the debtor until the debt was satisfied. By the Judgments Act 1838 the remedy was extended to all the debtor's lands, and by the Bankruptcy Act 1883 (now replaced by the Bankruptcy Act 1914) the writ no longer extends to the debtor's goods. The writ is enforceable against legal interests whether in possession or remainder but not against equitable interests in land. When the debtor's interest is equitable recourse is had to equitable execution by the appointment of a receiver or to bankruptcy proceedings. (See R.S.C., O. 43.)

Writs of Possession and Delivery. — Judgments for the recovery or for the delivery of the possession of land are enforceable by writ of possession. The recovery of specific chattels is obtained by writ of delivery (R.S.C., O. 47, 48).

Writ of *Sequestration*.—Where a judgment directing the payment of money into court, or the performance by the defendant of any act within a limited time, has not been complied with, or where a corporation has wilfully disobeyed a judgment, a writ of sequestration is issued, to not less than four sequestrators, ordering them to enter upon the real estate of the party in default, and "sequester" the rents and profits until the judgment has been obeyed (R S.C., O. 43, r. 6).

Equitable Execution. — Where a judgment creditor is otherwise unable to reach the property of his debtor he may obtain equitable execution, usually by the appointment of a receiver, who collects the rents and profits of the debtor's land for the benefit of the creditor (R.S.C., O. 1, rr. 15A–22). But receivers may be appointed of interests in personal property belonging to the debtor by virtue of the Judicature Act 1873, s. 25 (8). The plaintiff may apply ex parte, for leave to issue a summons for the appointment of a receiver and for an injunction to restrain the defendant from parting with his property pending the hearing of the summons. Such an application may be heard by a master.

Attachment.—A judgment creditor may "attach" debts due by third parties to his debtor by what are known as garnishee proceedings. A garnishee order *nisi* may be made by a master of the king's bench on the application of the judgment creditor. It must be supported by an affidavit in which the judgment creditor or his solicitor swears positively that there is a debt owing by the garnishee to the judgment debtor—a debitzim in *praesenti,* which may however be *solvendum* in futuro. Enormous sums of money are "garnisheed" in the course of the year to answer judgments from the king's bench division. Stock and shares belonging to a judgment debtor may be charged by a charging order, so as, in the first instance, prevent transfer of the stock or payment of the dividends, and ultimately to enable the judgment creditor to realize his charge. A writ of attachment of the person of a defaulting debtor or party may be obtained in a variety of cases akin to contempt (*e.g.,* against a person failing to comply with an order to answer interrogatories, or against a solicitor not entering an appearance in an action, in breach of his written undertaking to do so), and in the cases where imprisonment for debt is still preserved by the Debtors Act 1869 (R S.C., O. xliv.). *Contempt* of *Court* (*q.v.*) in its ordinary forms is also punishable by summary committal.

Another form of execution analogous to the attachment of a debt is a charging order. This directs that any stock, funds or shares of a public company in England, standing in the name of a debtor in his own right or in the name of any person in his trust for him, shall stand charged with the payment of the judgment debt and interest. The charge cannot be enforced for six calendar months after the order (0. 46, r. 1).

Interpleader.— This in English law is the form of action by which a person who is sued at law by two or more parties claiming adversely to each other for the recovery of money or goods wherein he has no interest, obtains relief by procuring the rival claimants to try their rights between or among themselves only. Originally the only relief available to the possessor against such adverse claims was by means of a bill of interpleader in equity. The Interpleader Act 1831 enabled the defendant in such cases, on application to the court, to have the original action stayed and converted into a trial between the two claimants. The Common Law Procedure Act of 1860 further extended the power of the common law courts in interpleader; and the Judicature Act 1875 (repealed and re-enacted by the Judicature Act 192j) provides that the practice and procedure under these two statutes should apply to all divisions of the High Court of Justice. The Judicature Act also extended the remedy of interpleader to a debtor or other person liable in respect of a debt alleged to be assigned, when the assignment was disputed. In 1883 the Acts of 1831 and 1860 were embodied in the form of rules by the *Rules* of the *Supreme Courts* (1883), O. 47, by reference to which all questions of interpleader in the High Court of Justice are now determined. Interpleader is the equivalent of multiplepoinding in Scots law.

Costs.—When giving judgment in England, the judge usually deals with the costs of the action. The term "costs" denotes the expenses incurred (1) in employing a lawyer in his professional capacity for purposes other than litigation; (2) in instituting and carrying on litigation whether with or without the aid of a lawyer.

The retainer of a solicitor implies a contract to pay to him his proper charges and disbursements with respect to the work done by him as a solicitor. In cases of conveyancing his remuneration is now for the most part regulated by scales ad valorenz on the value of the property dealt with (Solicitors' Remuneration Order 1882), and clients are free to make written agreements for the conduct of any class of non-litigious business, fixing the costs by a percentage on the value of the amount involved. So far as litigious business is concerned, the arrangement known as "no cure no pay" is objected to by the courts and the profession as leading to speculative actions, and stipulations as to a share of the proceeds of a successful action are champertous and illegal. An English solicitor's bill drawn in the old form is a voluminous itemized narrative of every act done by him in the cause or matter with a charge set against each entry and often against each letter written. Before the solicitor can recover from his client the amount of his charges, he must deliver a signed bill of costs and wait a month before suing.

The High Court has a threefold jurisdiction to deal with solicitors' costs:—(I) by virtue of its jurisdiction over them as its officers; (2) statutory, under the Solicitors Act 1843 and other legislation; (3) ordinary, to ascertain the reasonableness of charges made the subject of a claim.

The client can, as a matter of course, get an order for taxation within a month of the delivery of the solicitor's bill, and either client or solicitor can get such an order as of course within 12 months of delivery. After expiry of that time the court may order taxation if the special circumstances call for it, and even so late as up to 12 months after actual payment.

Costs as between solicitor and client are taxed in the same office as litigious costs, and objections to the decisions of the taxing officer, if properly made, can be taken for review to a judge of the High Court and to the court of appeal.

The expenses of litigation fall in the first instance on the person who undertakes the proceedings or retains and employs the lawyer. It is in accordance with the ordinary ideas of justice that the expenses of the successful party to litigation should be defrayed by the unsuccessful party, a notion expressed in the phrase that "costs follow the event." But there are many special circumstances which interfere to modify the application of this rule. The action, though successful, may be in its nature frivolous or vexatious, or it may have been brought in a higher court where a lower court would have been competent to deal with it. On the other hand the defendant, although he has escaped a judgment against him, may by his conduct have rendered the action necessary or otherwise justifiable. In such cases the rule that costs should follow the event would be felt to work an injustice, and exceptions to its operation have therefore been devised. In the law of England the provisions as to litigious costs, though now simpler than of old, are still elaborate and complicated, and the costs themselves are on a higher scale than is known in most other countries.

Except as regards appeals to the House of Lords and suits in equity, the right to recover costs from the opposite party in litigation has always depended on statute law or on rules made under statutory authority. "Costs are the creature of statute." The House of Lords has declared its competence to grant costs on appeals independently of statute.

In the judicial committee of the privy council the power to award, in its discretion, costs on appeals from the colonies or other matters referred to it, is given by s. 15 of the Judicial Committee Act 1833; and the costs are taxed by the registrar of the council.

The general rule now in force in the Supreme Court of Judicature is as follows:—"Subject to the provisions of the Judicature Acts and the rules of the court made thereunder, and to the express provision of any statute whether passed before or after Aug. 14, 1890, the costs of and incident to all proceedings in the Supreme Court, including the administration of estates and trusts, shall be in the discretion of the court or judge, and the court or judge shall have full power to determine by whom and to what extent such costs are to be paid. Provided (1) that nothing herein contained shall deprive an executor, administrator, trustee or mortgagee who has not unreasonably carried on or resisted any proceedings of any right to costs out of a particular estate or fund to which he would be entitled under the rules hitherto (*i.e.,* before 1883) acted upon in the chancery division as successor of the court of chancery; (2) that where an action, cause, matter or issue is tried with a jury, the costs shall follow the event unless the judge who tried the case or the court shall for good cause otherwise order." (R.S.C., O. 65, r 1.)

The rule above stated applies to civil proceedings on the Crown side of the king's bench division, including mandamus, prohibition *quo warranto,* and certiorari (*R.* v. *Woodhouse,* 1906, 2 K.B. 502, 540); and to proceedings on the revenue side of that division (0. 68, r. 1); but it does not apply to criminal proceedings in the High Court, which are regulated by the Crown office rules of 1906, or by statutes dealing with particular breaches of the law, and as to procedure in taxing costs by O. 65, r. 27, of the Rules of the Supreme Court.

The rule is also subject to specific provision empowering the courts to limit the costs to be adjudged against the unsuccessful party in proceedings in the High Court, which could and should have been instituted in a county court, *e.g.*, actions of contract under £100 or actions of tort in which less than £10 is recovered, unless the plaintiff, claiming a liquidated sum, has taken proceedings under O. 14 in the High Court, in which case he *may* get High Court costs if he recover over £20.

Costs of interlocutory proceedings in the course of a litigation are sometimes said to be "costs in the cause," that is, they abide the results of the principal issue. A party succeeding in interlocutory proceedings, and paying the costs therein made "costs in the cause," would recover the amount of such costs if he had a judgment for costs on the result of the whole trial, but not otherwise. But it is usual now not to tax the costs of interlocutory proceedings till after final judgment.

When an order to pay the costs of litigation is made the costs are taxed in the central office of the High Court, unless the court when making the order fixes the amount to be paid (R.S.C., O. 65, r. 23). Recent changes in the organization for taxing have tended to create a uniformity of system and method which had long been needed.

The taxation is effected, under an elaborate set of regulations, by reference to the prescribed scales, and on what is known as the lower scale, unless the court has specially ordered taxation on the higher scale (R.S.C., O. 65, rr. 8, 9, appendix N).

In the taxation of litigious costs two methods are still adopted, known as "between party and party" and "between solicitor and client." Unless a special order is made the first of the two methods is adopted. Until very recently "party and party" costs were found to be a very imperfect indemnity to the successful litigant; because many items which his solicitor would be entitled to charge against him for the purposes of the litigation were not recoverable from his unsuccessful opponent. The High Court can now, in exercise of the equitable jurisdiction derived from the court of chancery, make orders on the losing party to pay the costs of the winner as between solicitor and client. These orders are not often made except in the chancery division. But even where party and party costs only are ordered to be paid under the present practice (dating from 1902), the taxing office allows against the unsuccessful party all costs, charges and expenses necessary or proper for the attainment of justice or defending the rights of the successful party, but not costs incurred through over-caution, negligence, or by paying special fees to counsel or special fees to witnesses or other persons, or by any other unusual expenses (R.S.C., O. 65, rr. 27, 29). This practice tends to give an approximate indemnity, while preventing oppression of the losing party by making him pay for lavish expenditure by his opponent. The taxation is subject to review by a judge on formal objections carried on, and an appeal lies to the Court of Appeal.

See ADMIRALTY; APPEAL; ARBITRATION; EVIDENCE; COUNTY COURT. (W. V. B.)

THE UNITED STATES

The practice and procedure of the courts in the varous jurisdictions of the United States is derived, in the main, from the English common law system of court administration. But since each State or Territory and the Federal Government, in addition, has its own system of courts and its own procedure, a considerable diversity exists. In general, a reform of the common law procedure has occurred in many ways similar to the English reforms of the 19th century. The extent of the reform varies in the different jurisdictions. The most important change is that of the so-called code reform of procedure inaugurated by the code of civil procedure adopted in New York in 1848 and now in force in 30 American jurisdictions.

The Code Reform. — In 1847 the New York legislature instructed a commission "to provide for the abolition of the present forms of actions and pleadings in cases at common law; for a uniform course of proceeding in all cases whether of legal or equitable cognizance, and for the abandonment of all Latin and other foreign tongues, so far as the same shall by them be deemed practicable, and of any form and proceeding not necessary to ascertain or preserve the rights of the parties" (N.Y. Laws, 1847, C. 59 § 8). During the following year, the commission reported a code which was adopted on April 12, 1848. This measure, which has served as the model for other codes in the United States, was largely the work of David Dudley Field, a member of the commission. It is often called the "Field Code."

The chief characteristic and most fundamental part of the code is its single form of action for all cases. The distinctions of the common law actions and *of their forms* were abolished; the separation in procedure of equitable from legal relief was abandoned. As a substitute, the codifiers planned a blended system of law and equity with only one form of action to be known as the *civil action.* In effect, this is the same step taken in England a generation later in the Supreme Court of Judicature Act (1873). The full benefits of this reform have not been attained in all the States, for many courts considered the ancient forms of action to rest upon distinctions fundamental in the law. Furthermore, some courts have taken a hostile attitude towards the attempted union of actions at law and suits in equity. Here the history and tradition of the separate systems of law and equity have proved strong obstacles to a complete amalgamation. It has therefore often been held that the theory of the action, whether legal or equitable, must be pointed out in the pleadings. In fact, however, the difference between law and equity actions to-day is chiefly in the remedy to be granted and this should not be an objection to the single action or the simpler forms of pleading.

Perhaps the obstacle which has seemed greatest to the courts in preventing a complete union of law and equity is the requirement common to the State Constitutions that the right of trial by jury shall remain inviolate. This is construed to mean a preservation of the jury trial right substantially as it was at the time of the original adoption of the Constitutions. In view of the historical practice of jury trials in courts of law, this means in effect that in modern substitutes for action at law, jury trial is a matter of right, while in equitable claims no such right exists. Many courts in protecting the constitutional right continue to force a division of all actions into "law actions" and "equity actions." A more convenient rule and one more in keeping with the code principle is followed in some States, where the question of the form of trial is not allowed to affect the pleading in advance of the trial. If an issue arises at the trial as to the existence of a right to jury trial in either party, it is then determined by the nature of the issues developed in the pleadings in the light of the historical method of trying such issues.

Another important characteristic of the code is its emphasis upon pleading facts, not conclusions of law or evidence. *Fact pleading* was to be substituted for the *issue pleading* of the common law. This part of the code reform has been comparatively unsuccessful, because no clear line of demarcation exists between statements of fact and statements of law. An additional change wrought by the code is the adoption of the equity principles of greater freedom of joining parties and of rendering judgments in part for or against the various parties, as the justice of the case may require (the *split judgment* of equity). In spite of the fact that the code reform has not met with the same degree of success in all the States, it seems in general to have been in accord with the desires of the people for simpler judicial procedure. Modern plans for further reform are all in the direction of a greater simplification of practice.

The system inaugurated by the New York Code of 1848 has been adopted in the following jurisdictions: Alaska (1900); Arizona (1864); Arkansas (1868); California (1850); Colorado (1877); Connecticut (1879); Indiana (1852); Iowa (1851); Idaho (1864); Kansas (1859); Kentucky (1851); Minnesota (1851); Missouri (1849); Montana (1865); Nebraska (1855); Nevada (1860); New Mexico (1897); New York (1848); North

Carolina (1868); Korth Dakota (1862); Ohio (1853); Oklahoma (1890); Oregon (1854); Porto Rico (1904); South Carolina (1870); South Dakota (1862); Utah (1870); Washington (1854); Wyoming (1869); Wisconsin (1856); a total of 28 States and two Territories. Of the above States four — Arkansas, Iowa, Kentucky and Oregon — still retain a formal distinction between actions at law and suits in equity, although both are heard in the same court and by the same judge or judges. The code was adopted in Florida in the reconstruction days following the Civil War, but on restoration of the former Government it was supplanted by a modified common-law system. This is the only case where code pleading, once adopted, has been repudiated.

The non-code States are generally classified as common-law States and as "quasi code" or "quasi common law" States according to their nearness of resemblance to the common-law system or to the code system. But in no jurisdiction is the common-law system in force in its entirety. All the States have made some approach to the code principles. In the non-code States in general, the formal distinctions between law and equity actions are maintained, although considerably broken down, especially by the presence of statutes allowing "equitable defences" in actions at law. Often, in these States some distinctions between the forms of action are maintained. as between tort and contract; but even here the minute distinctions of the common law as between trespass and trespass on the case have been abolished.[1] The following may be treated as the "quasi code" or "quasi common-law" States: Massachusetts, Mississippi, Alabama, Maryland, Tennessee, Georgia, Texas and Michigan. The following may be treated as common-law States: Delaware, District of Columbia, Florida, Illinois, Maine, New Hampshire, New Jersey, Rhode Island, Vermont, Virginia and West Virginia. In New Jersey where the equity and law courts are entirely distinct, a practice act was adopted in 1912 for the law courts, which was an advanced system based on the English practice (N.J. Laws, 1912, p. 377). This act has had a salutory effect on a recent New York revision of the code (1920). The code of practice in Louisiana is based upon the civil law of that State.

Federal Procedure. — In the Federal courts, jurisdiction at law and in equity, though administered by the same court, has not been blended, partly because of a belief that under the Federal Constitution the separation of the two systems is necessary. This belief, in the light of the decisions, does not seem well founded. A statute passed in 1915 allows equitable defences in actions at law, and to some extent lessens the difficulties due to the divided system.

A uniform simplified procedure in equity for the Federal courts throughout the country has been established under statutes which enact that "the forms and modes of proceeding in suits of equity and of admiralty and maritime jurisdiction in the district courts shall be according to the principles, rules and usages which belong to courts of equity and of admiralty respectively," and which also authorizes the U.S. Supreme Court to establish rules of practice. U.S. Rev. St. § 913 (28 U.S.C.A. § 723 [U.S. Comp. St. § 1536]); U.S. Rev. St. § 917 (28 U.S.C.A. § 730 [U.S. Comp. St. §1543]). In 1912, by use of this rule-making power the Court succeeded in greatly simplifying the equity practice of the lower Federal courts.

On the law side of the Federal courts, difficulties arise because the controlling "Conformity Act" (originally passed in 1872) provides that "the practice, pleadings, and forms and modes of proceeding in civil causes, other than equity and admiralty causes, in the (federal) district courts shall conform as near as may be, to the practice, pleadings and forms and modes of proceeding existing at the time in like causes in courts of record of the state within which such district courts are held" (U.S. Rev. St. § 914 [28 U.S.C.A. § 724; U.S. Comp. St. § 1537] [not applicable to the circuit courts of appeal or to the U.S. Supreme Court]; Camp v. *Gress*, 250 U.S. 308, 39 Sup. Ct. 478, 1919). The question when conformity is to be had presents a difficult problem. As the Federal courts constitute an entirely independent judiciary system, there can be no conformity in conflict with positive Federal legislation; in any event, the conformity is only "as near as may be." Another difficulty is the lack of a unified practice for all the Federal courts as in Federal equity procedure. In attempting to apply all the differing rules followed in the various States, the conformity practice has served to emphasize the discord. To remedy the situation the American Bar Association has urged the passage of an act by Congress establishing a uniform system of Federal practice in law and equity under rules made by the Supreme Court, similar to the procedure adopted in 1912 as to equity.[2]

Revisions and Future Pleading Reform. — General revisions of the code have been infrequent. In New York, however, prior to 1920 some changes were made resulting in an increase of the bulk of the code. In 1920 the New York Civil Practice Act was adopted, incorporating certain provisions, such as those fur joinder of parties, from the English practice, but retaining many of the undesirable features of the old procedure (N.Y. Laws, 1920, C. 925). While the Practice Act materially reduced the bulk of the code, it continued the policy of legislative control of the details of practice. Authorities generally agree that procedural law requires constant revision and that a fundamental step in procedural reform is the placing of power in the judges to make and alter rules of practice, as under the English system.[3] This should be accompanied by a centralized system of court administration with the chief justice or other official as directing executive head. Among desirable incidental reforms of practice may be noted freer joinder of parties and of claims in a single action, greater facility in waiving jury trial, as by failure of a party affirmatively to claim it, pleading in the alternative, clearer provisions as to when jury trial may be had, abolishment of the demurrer, freer amendment of pleadings, procedure for entering judgments summarily in the absence of a *bona fide* defence (the summary judgment) and procedure for declaring the rights of the parties even though no wrong has actually been committed (the declaratory judgment).

The Function of Pleading. — In pleadings under the code. emphasis was originally placed upon stating the facts rather than conclusions of law on the one hand or mere evidence on the other. It has been urged that this system of *fact pleading* should now give way to a plan of *notice pleading,* a very brief statement designed merely to give notice of the plaintiff's claim to the opponent and to the court (C. B. Whittier, "Notice Pleading," 31 *Harv.* L. *Rev.* 501). Notice pleading differs from fact pleading in the main in the degree of generality of statement permitted. Thus, instead of describing the particulars of an accident, only the time and fact of the accident are alleged. While brevity to this extent is not generally followed in courts of general jurisdiction in the United States, the modem tendency is to place increasing emphasis upon the notice function of all pleadings. This is desirable not only because of the great difficulty in distinguishing facts from law and evidence, but because it comports more with modern ideas of the place of pleading in the judicial system. The legal profession to-day recognizes to an increasingly greater degree that pleading is not an end in itself but only a means to an end, and that end the administration of justice between litigants. The office of pleading and practice is only as an aid in bringing out the substantive legal relations of the parties.

Course of Proceedings in a Legal Action. — Notice to the defendant at the institution of suit and an opportunity to present his side of the case are essential to the American, as to any system of justice. In many of the States (some of which have

[1] This is true even in Illinois, whose "pleading and practice are not only derived from the common-law system, but they are in fact that system, modified, however, by some legislation, which still leaves them the nearest approach to the English law of procedure, as it existed before the passage of the Judicature acts, now remaining anywhere in the world" (35 N.Y. State Bar Assn. Rep. 850). Some States provide merely for the joining of counts in trespass and case (Ala. Code, 1907, § 5,329; R.I. Gen. Laws, 1923, § 4,874).

[2] For the history of the movement and copy of the bill see Rep. of Committee on Uniform Judicial Procedure of Am. Bar Assn., 5 A.B.A.J. 468 (1919); 6 *ibid.*, 509 (1920); 48 A.B.A. Rep. 343 (1923); and later reports of the Association to date.

[3] *See* authorities collected in Clark, Code Pleading, 33, note 103 (1928).

adopted the code procedure), the traditional practice of issuing a writ in the name of the State directing the sheriff to make the summons is followed. In others, however, the writ of the sovereign is supplanted by a simple written summons to appear, signed by the plaintiff or his attorney and served upon the defendant by anyone not a party—usually by a clerk in the office of the plaintiff's attorney. Even in these jurisdictions, when the plaintiff claims some extraordinary or provisional remedy, such as attachment of the defendant's property, arrest of the defendant or an injunction, notice is given in the form of a court order served by some public officer, such as the sheriff. It is necessary that proper *service* of the summons be had, for unless the defendant is legally notified of the action, no *jurisdiction* is acquired over his person. Moreover, unless the action is brought to the proper court, *jurisdiction over the subject matter* does not exist. Next come the pleadings, the first step being the filing by the plaintiff of his *complaint* or *petition* (the *declaration* or *count* of the common law). This contains the names of the parties and the court, a statement of the facts constituting the plaintiff's cause of action and a demand for the judgment to which he thinks himself entitled. The complaint is served upon the defendant with the summons or after the parties are in court or else is supplied to the defendant by the court clerk. If the defendant desires to defend, his first move is to enter an *appearance* which may be done, without his presence in court, by a written notice of appearance by his attorney, or by filing an *answer* to the complaint. By *demurring,* the defendant may question the legal sufficiency of the complaint. But if the demurrer is abolished as in New Jersey and New York, he moves for judgment and thus raises the same issue. In the defendant's *answer* he may deny the plaintiff's allegations or he may admit them and allege new matter in his defence or as a basis for a *counterclaim* against the plaintiff. To this the plaintiff under most codes may file a *reply* (corresponding to the common-law *replication)* and at this stage the pleadings are generally required by the statute to come to an end. Thereafter follows the actual trial with the production of evidence by the parties, followed by the verdict, if a jury is present, and judgment. If the defeated party so desires he may then take an appeal to some appellate tribunal. *(See* APPEAL: *In the United States.)* When the judgment is finally effective, extensive proceedings are available to secure its enforcement.

Criminal Procedure.—Here again the English practice is the source. Indictment by a grand jury is still an essential step in a criminal prosecution in many jurisdictions for capital and many other serious crimes. This body varies in number in the different jurisdictions but usually consists of not less than 12 and not more than 23 persons, at least 12 of whom must concur in presenting an indictment. It may act upon its own knowledge, upon an information of the prosecutor or upon a complaint made under oath by a private person before a committing magistrate. The indictment, which is usually prepared beforehand by the prosecutor and given to the grand jury for its consideration, serves as the prosecution's complaint at the trial. A number of technical rules apply to the indictment, making criminal procedure very rigid. Thus in many jurisdictions unless the indictment describe the offence with great particularity, including its time and place of occurrence and the accused's name, it may be quashed. Such technicalities are a relic of ancient common-law times when the accused was favoured because of the serious penalties imposed for minor offences. But as the reason for these rules is now gone, authorities to-day advocate a procedure requiring only that reasonable notice of the ground of complaint be given the accused. In a considerable number of States an information by the prosecutor has been substituted for the indictment by the grand jury. An information suffices in the Federal courts except in offences punishable by more than one year's imprisonment. Trial by jury is usually a constitutional guarantee except in minor offences. But in Maryland and Connecticut the accused may elect a trial to the court if he so chooses. The American Law Institute, an organization of judges, lawyers and law teachers with headquarters in Philadelphia, Pa., is now engaged as a part of its activities in preparing a model code of criminal procedure. Its first tentative draft, dated April 9, 1928, indicates that a noteworthy attempt is being made by it to simplify the administration of the criminal law.

BIBLIOGRAPHY.—C. M. Hepburn, *Development of Code Pleading* (St. Paul, 1897); Charles E. Clark, *Code Pleading* (St. Paul, 1928); J. N. Pomeroy, *Code Remedies* (5th ed., Boston, 1929); J. M. Kerr, *Pleading and Practice in the Western States* (San Francisco, 1919); W. A. Sutherland, *Code Pleading* (San Francisco, 1910); Bancroft, *Code Pleading in the Western States* (San Francisco, 1926) and *Code Practice and Remedies* (San Francisco, 1927–); W. L. Clark, *Criminal Procedure* (St. Paul, 1895); *First Tentative Draft, Code of Criminal Procedure, with Commentaries,* by W. E. Mikell, E. R. Keedy, reporters, American Law Institute (Philadelphia, 1928); J. H. Beale, *Criminal Pleading and Practice* (Boston, 1899); F. Wharton, *Criminal Procedure,* 10th ed. (San Francisco, 1918); *Encyclopedia of Pleading and Practice* (Northport, 1895–1902). (C. E. CL.)

PRADIER, JAMES (1792–1852), French sculptor, was born at Geneva. He was a member of the French Academy, and a popular sculptor of the pre-Romantic period, representing in France the drawing-room classicism which Canova illustrated at Rome. His chief works are the Niobe group (1822), "Atalanta" (1850), "Psyche" (1824), "Sappho" (1852) (all in the Louvre), "Prometheus" (Tuileries Gardens), a bas-relief on the triumphal arch of the Carrousel, the figures of "Fame" on the Arc de l'Etoile, and a statue of J. J. Rousseau for Geneva. Beside the above noted works mention should be made of his "Three Graces" (1821).

PRADILLA, FRANCISCO (1848–1921), Spanish painter, was born at Villanueva da Gallago (Saragossa). He studied first at the Fernando academy, and then at the Spanish academy in Rome, of which he was afterwards director, and became the leading historical painter of modern Spain. In 1896 he was appointed director of the Madrid museum. Though he is best known for such large historical compositions as "Joan the Mad" (gold medal, Paris, 1878), and "The Surrender of Granada" (gold medal, Munich, 1883), in which he discarded the heavy colouring of Laurens for a lighter and more atmospheric key, he has painted many excellent genre pictures in the manner of Fortuny, and some decorative compositions in which he follows the example of Tiepolo. The best of these are his decorations in the Murgo Palace in Madrid. Among his best known works are "Elopement," "Strand at Vigo," "Procession in Venice," "La Fiorella," "Reading on the Balcony," "Don Alfonso the Warrior," and "Don Alfonso the Scholar." He became member of the Berlin academy and died in Madrid on Oct. 30, 1921.

PRAED, WINTHROP MACKWORTH (1802–1839), English poet, was born in London on July 26, 1802, son of William Mackworth Praed, serjeant-at-law. His mother belonged to the New England family of Winthrop. At Eton Praed founded a ms. periodical *Apis matina,* which was followed by *The Etonian* (1820–21). After a brilliant career at Trinity college, Cambridge, he joined the Middle Temple, was called to the bar in 1829, and went to the Norfolk circuit. He entered parliament in 1830, and was a member of the short Peel administration in 1834. He died on July 15, 1839, in London.

Praed's lighter poetry was the perfection of ease. Austin Dobson has justly praised his "sparkling wit, the clearness and finish of his style, and the flexibility and unflagging vivacity of his rhythm" (Ward's *English Poets).* It abounded in happy allusions to the characters and follies of the day. His humorous verse found numerous imitators.

His poems were first edited by R. W. Griswold (New York, 1844); another American edition, by W. A. Whitmore, appeared in 1859; an authorized edition with a memoir by Derwent Coleridge appeared in 1864; *The Political and Occasional Poems of W. M. Praed* (1888).

PRAEFECT, the title of various Roman officials, civil and military *(praefectus).* A praefect was not a magistrate proper; he was the deputy of a superior magistrate.

City **Praefect.**—The city praefect *(praefectus urbis)* acted at Rome as the deputy of the chief magistrate or magistrates during his or their absence from the city. He represented the consul or consuls when he or they were absent on a campaign or on other public duties, such as the celebration of the annual Latin festival on the Alban Mount. The absence of all the chief magistrates for more than a single day rendered the appointment of a praefect obligatory; after the institution of the praetorship (367 B.C.) the necessity only arose exceptionally, as it rarely happened that both the consuls and the praetor were absent simultaneously. But a praefect was appointed during the enforced absence of all the higher magistrates at the Latin festival. The right of appointing a praefect belonged to the magistrate whose deputy he was. No formalities in the appointment and no legal qualifications on the part of the praefect were required. The praefect had all the powers of the magistrate whose deputy he was, but his office expired on the return of his superior.

Under the empire a new city prefecture was introduced. Augustus occasionally appointed a city praefect to represent him in his absence from Italy, although the praetors, or even consuls, remained in the capital. In the absence of Tiberius at Capreae during the last 11 years of his reign (A.D. 26–37), the city prefecture, hitherto temporary, became a permanent magistracy; henceforth the praefect held office even during the presence of the emperor in Rome. He was chosen by the emperor; his office might be held for years or for life. The praefect was not allowed to quit the city for more than a day at a time. His duty was the preservation of peace in the capital; he was, in fact, the chief of the police, with the superintendence of the streets, markets and public buildings. He was entrusted by Augustus with a summary criminal jurisdiction over slaves and rioters, which was gradually extended until it embraced all offences by whomsoever committed. In the 3rd century A.D., appeals to the emperor in civil cases were handed over to the praefect. An appeal lay from the praefect to the emperor. The praefect commanded the city cohorts (cohortes urbanae), which formed part of the garrison of Rome and ranked above the line regiments, though below the guards (see PRAETORIANS). The military power thus placed in the hands of the chief of the police was one of the most sorely-felt innovations of the empire. The changes of Diocletian and Constantine extended the power of the praefect, in whom, after the removal from R'ome of the highest officials, the whole military, administrative and judicial powers were centred.

Judicial Praefects.—Under the republic judicial praefects (praefecti *iuri* dicendo) were sent annually from Rome as deputies of the praetors to administer justice in certain towns of the Italian allies. These towns were called prefectures (*praefecturae*). After the social war (90–89 B.C.), when all Italy had received the Roman franchise, such prefectures ceased to exist.

Praetorian Praefects.—Under the empire the praetorians or imperial guards were commanded by praefects (praefecti *praetorio*), who were chosen by the emperor and held office at his pleasure. In course of time the command seems to have been enlarged so as to include all the troops in Italy except the corps commanded by the city praefect (cohortes urbanae). Further, the praetorian praefect acquired a criminal jurisdiction which he exercised as the representative of the emperor. A similar jurisdiction in civil cases was acquired by him not later than the time of Severus. Hence a knowledge of law became a qualification for the post, which was held by the first jurists of the age (*e.g.*, Papinian), while the military qualification fell into the background. Under Constantine the institution of the *magistri militum* deprived the praetorian prefecture of its military character, but left it the highest civil office of the empire.

Various Other Praefects.—The title of "praefect" was borne by various other Roman officials, of whom we may mention the following:—

(1) Praefectus *Aegypti* (afterwards Praefectus *augustalis*).—The government of Egypt was entrusted to a viceroy with the title of "praefect" and was surrounded by royal pomp instead of the usual insignia of a Roman magistrate. He was under the immediate orders of the emperor. The exceptional position thus accorded to Egypt was due to its peculiar character and status as an imperial domain and to its very high importance as the granary of Rome.

(2) *Praefectus Vigilum,* the commander of the cohortes *vigilum,* a night police force instituted by Augustus (A.D. 6). One of the principal duties of this force was that of serving as a fire brigade. The *praefectus vigilum* besides commanding the cohortes *vigilum* exercised criminal jurisdiction in cases of incendiarism and offences committed during the night.

BIBLIOGRAPHY.—The different praefects are fully discussed in Mommsen, *Römisches Staatsrecht* (1887), vols. II., III.; see also T. M. Taylor, Constitutional and Political History of Rome **(1899)**; **A.** H. J. Greenidge, Roman Public Life (1901); J. E. Sandys, Companion to Latin Studies (1921).

For the French pre'fet see **PREFECT.**

PRAEMUNIRE, in English law an offence so called from the introductory words of the writ of summons issued to the defendant to answer the charge, "Praemunire facias A.B.," etc., *i.e.*, "cause A.B. to be forewarned." From this the word came to be used to denote the offences, usually ecclesiastical, prosecuted by means of such a writ, and also the penalties they incurred. From the beginning of the 14th century papal aggression had been particularly active, more especially in two forms. The one, the disposal of ecclesiastical benefices, before the same became vacant, to men of the pope's own choosing; the other, the encouragement of resort to himself and his curia rather than to the courts of the country. The Statute of Provisors (1306), passed in the reign of Edward I., was, according to Coke, the foundation of all subsequent statutes of praemunire. This statute enacted "that no tax imposed by any religious persons should be sent out of the country whether under the name of rent, tallage, tribute or any kind of imposition." A much greater check on the freedom of action of the popes was imposed by the Statute of Provisors (1350–51) and the Statute of Praemunire passed in the reign of Edward III. The former ordained the free election of all dignities and benefices elective in the manner as they were granted by the king's progenitors. The Statute of Praemunire (the first statute so called), 1353, enacts "that all the people of the king's ligeance of what condition that they be, which shall draw any out of the realm in plea" or any matter of which the cognizance properly belongs to the king's court shall be allowed two months in which to answer for their contempt of the king's rights in transferring their pleas abroad. Many other statutes followed that of 1353, but that passed in the 16th year of Richard II.'s reign is usually referred to as the Statute of Praemunire. The Royal Marriage Act, 1772, is the last which subjects anyone to the penalties of a praemunire. A peer charged with praemunire is not entitled to trial by his peers, but is to be tried by a jury. The most famous historical instance of a prosecution of the Statute of Praemunire was that of Cardinal Wolsey in 1529.

See E. Coke, Institutes **(1628,** etc.); **J.** Reeves, History of English Law (1783–84); **H.** Hallam, Middle Ages **(1818)**; T. **E.** Tomlin, Law Dictionary (1838); H. J. Stephen, Commentaries on the Laws *of* England (1841–45); W. Stubbs, Constitutional History **(1866)**; J. **F.** Stephen, History oj Criminal Law of *England* **(1883).**

PRAENESTE (mod. Palestrina), a very ancient city of Latium, lies 23 m. E. of Rome by the Via Praenestina (see below), on a spur of the Apennines facing the Alban hills. To the natural strength of the place and its commanding situation Praeneste owed in large measure its historical importance. Objects in metal and ivory discovered in the earliest graves prove that as early as the 8th or 7th century B.C. Praeneste had reached a considerable degree of civilization and stood in commercial relations not only with Etruria but with the East. In 499 B.C., according to Livy, it formed an alliance with Rome. After Rome had been weakened by the Gallic invasion (390) Praeneste joinec in a long struggle with Rome which culminated in the great Latin War (340–338), in which the Romans were victorious, and Praeneste was punished by the loss of part of its territory. It continued in the position of a city in alliance with Rome down to the Social War, when it received the Roman franchise.

As an allied city it furnished contingents to the Roman army and possessed the right of exile (ius *exilii*), *i.e.*, persons banished from Rome were allowed to reside at Praeneste. The nuts of Praeneste were famous and its roses were amongst the finest in Italy. The Latin spoken at Praeneste was somewhat peculiar, and was ridiculed by the Romans, *e.g.*, by Plautus. In the civil wars the younger Marius was blockaded in the town by the Sullans (82 B.C.); and on its capture Marius slew himself, the male inhabitants were massacred in cold blood, and a military colony was settled on part of its territory, while the city was removed from the hill-side to the lower ground at the Madonna dell' Aquila, and the temple of Fortune enlarged so as to include the space occupied by the older city. Under the empire Praeneste, from its elevated situation and cool salubrious air, became a favourite summer resort of the wealthy Romans, whose villas studded the neighbourhood. Horace ranked it with Tibur and Baiae, though as a fact it never became so fashionable a residence as Tibur or the Alban hills. Still, Augustus resorted thither; here Tiberius recovered from a dangerous illness, and here Hadrian and Marcus Aurelius had villas. Amongst private owners were Pliny the younger and Symmachus.

But Praeneste was chiefly famed for its great temple of Fortune and for its oracle, in connection with the temple, known as the "Praenestine lots" (sortes *praenestinae*). The oldest portion of the sanctuary was, however, that situated on the lowest terrace but one. Here is a grotto in the natural rock, containing a beautiful coloured mosaic pavement, representing a sea-scene — a temple of Poseidon on the shore, with various fish swimming in the sea. To the east of this was a basilica in two storeys. As extended by Sulla the sanctuary of Fortune occupied a series of five vast terraces, which, resting on gigantic substructions of masonry and connected with each other by grand staircases, rose one above the other on the hill in the form of the side of a pyramid, crowned on the highest terrace by the small round temple of Fortune. This immense complex, probably by far the largest sanctuary in Italy, must have presented a most imposing aspect, visible as it was from a great part of Latium, from Rome, and even from the sea.

The modern town of Palestrina, a collection of narrow alleys, stands on the terraces once occupied by the temple of Fortune. On the summit of the hill (2,471 ft.), nearly a mile from the town, stood the ancient citadel, the site of which is now occupied by a few poor houses (Castel San Pietro) and a ruined mediaeval castle of the Colonna. Considerable portions of the southern wall of the ancient citadel, built in very massive Cyclopean masonry of blocks of limestone, are still to be seen; and the two walls, also polygonal, which formerly united the citadel with the town, can still be traced. The calendar set up by the grammarian M. Verrius Flaccus in the forum of Praeneste was discovered in 1771. Excavations made in the ancient necropolis, which lay on a plateau surrounded by valleys at the foot of the hill, have yielded important results for the history of the art and manufactures of Praeneste. The famous Ficoroni casket, engraved with pictures of the arrival of the Argonauts in Bithynia and the victory of Pollux over Amycus, was found in 1738. Most of the objects discovered in the necropolis are preserved in the Roman collections, especially in the Villa Giulia, the Museo Pigorini (Collegio Romano) and the Vatican.

See E. Fernique, *Préneste* (Bibliothèque des Écoles Françaises, *fasc.* 17, 1880); *Corp.* inscr. etrusc. vol. ii.; R. S. Conway, Italic Dialects, i. 311 seq. (1897); T. Ashby in Papers of the British School at Rome, i. 132 seq.; H. C. Bradshaw, *ibid.* ix. 257 seq.; R. Delbrück, Hellenistische Bauten in Latium, p. 47 seq. (1907); R. van Deman Magoffin, Topography *and* Municipal History of Praeneste (Johns Hopkins University Studies, xsvi. 9, 10; Baltimore, 1908); D. Randall-MacIver, Iron Age in Italy (1927). (J. G. Fr.; R. S. Co.; T.A.)

PRAENESTINA, VIA, an ancient road of Italy, leading from Rome east by south to Praeneste, a distance of 23 m., Gabii being situated almost exactly half-way. At the ninth mile the road crosses a ravine by the well-preserved and lofty Ponte di Nona, with seven arches, the finest ancient bridge in the neighbourhood of Rome. In the stretch, for a few miles beyond Gabii it is now only used as a track, and well preserved.

See T. Ashby in Papers of the British School at Rome, i. 149 sqq.

PRAESEPE, a loose star-cluster in the constellation Cancer having a "bee-hive" shape. It is a favourite object for telescopes of low power.

PRAETOR, originally a military title (a leader; Lat. prae . . . ire), was the designation of the highest magistrates in the Latin towns.

Under the republic the Roman consuls were at first called praetors; by the Licinian law of 367 B.C., a new magistrate was created who was to be a colleague of the consuls, though with lesser powers. This new magistrate was entrusted with the jurisdiction in civil cases; in other respects his powers resembled those of the consuls. His title was the city praetor (praetor urbanus), and when the number of praetors was increased, the city praetor always ranked first. To this new magistrate the title of "praetor" was thenceforward restricted. About 242 B.C. the increase of a foreign population in Rome necessitated the creation of a second praetor for the decision of suits between foreigners (*peregrini*) or between citizens and foreigners (praetor *peregrinus*). About 227 two more praetors were added to administer the provinces of Sicily and Sardinia. The conquest of Spain occasioned the appointment of two more in 197. The number of praetors remained stationary until Sulla's time (82 B.C.). Eut in the interval their duties multiplied. On the one hand, five new provinces were added to the Roman dominions; on the other new and permanent jury courts (quaestiones perpetuae) were instituted at Rome, over which the praetors were called on to preside. To meet this increase of business the tenure of office of the praetors and also of the consuls was practically prolonged from one to two years, with the distinction that in their second year of office they bore the titles of propraetor and proconsul instead of praetor and consul. The prolongation of office formed the basis of Sulla's arrangements. He increased the number of the praetors from six to eight, and ordained that henceforward all the eight should in their first year administer justice at Rome and in their second should as propraetors undertake the government of provinces. The courts over which the praetors presided, in addition to those of the city praetor and the foreign praetor, dealt with the following offences: oppression of the provincials by governors (repetundarum), bribery (ambitus), embezzlement (*peculatus*), treason (maiestatis), murder (de *sicariis* et *veneficis*), and forgery (falsi). Later, more provinces were added and more courts constituted, including that of *Gallia Cisalpina.* Iulius Caesar increased the number of praetors.

The praetors were elected, like the consuls by the *comitia* centuriata (see COMITIA) and with the same formalities. They held office for a year. The insignia of the praetor were those of the higher Roman magistrates — the purple-edged robe (toga praetexta) and the ivory chair (sella *curulis*); in Rome he was attended by two lictors, in the provinces by six. The praetors elect cast lots to determine the department which each of them should administer. A praetor as a civil judge at or before his entry on office published an edict setting forth the rules and law procedure by which he intended to be guided. These rules were often accepted by his successors, and corrected and amplified from year to year, became, under the title of the "perpetual" edicts, one of the most important factors in moulding Roman law. Their tendency was to smooth away the anomalies of the civil law by substituting rules of equity for the letter of the law.

Under the Empire. — Under the empire various special functions were assigned to certain praetors, such as the two treasury praetors (*praetores* aerarii), appointed by Augustus in 23 B.C.; the ward praetor (praetor *tutelaris*), appointed by Marcus Aurelius to deal with the affairs of minors; and the liberation praetor (praetor de *liberalibus causis*), who tried cases turning on the liberation of slaves. Of the praetorships with special jurisdiction (especially the ward praetorship and the liberation praetorship) some lasted into the 4th century and were copied in the constitution of Constantinople.

Besides their judicial functions, the praetors as colleagues of the consuls, possessed the consular powers, which they exercised in the absence of the consuls; but in the presence of a consul they exercised them only at the command either of the consul or the senate. (For the praetor as provincial governor see PROVINCE.)

BIBLIOGRAPHY.—A full account of the praetorship will be found in Mommsen, Romisches staatsrecht (1887); T. M. Taylor's Constitutional and Political History of Rome (1899) will also be found useful. See also A. H. J. Greenidge, Roman Public Life (1901); J. E. Sandys, Companion to Latin Studies (1921); W. E. Heitland, The Roman Republic (1923).

PRAETORIANS. In the early Roman republic, praetor (*q.v.*) meant commander of the army: later praetor and propraetor were the usual titles for provincial governors with military powers. Accordingly, the general's quarters in a camp came to be called *praetorium*, and one of the gates *porta* praetoria, and the general's bodyguard *cohors* praetoria. Under the empire cohortes pvaetoriae formed the imperial bodyguard. This, as founded by Augustus, consisted of nine cohorts, each 1,000 strong, some part of which was always with the emperor, whether in Rome or elsewhere. Tiberius concentrated this force on the eastern edge of Rome in fortified barracks. The men were recruited voluntarily, in Italy or Italianized districts, and enjoyed better pay and shorter service than the regular army; they were commanded by *praefecti prae*torio. This force was the only body of troops in Rome (save a few *cohortes urbanae* and some non-Roman personal guards of the emperor), or, indeed, anywhere near the capital. Accordingly it could make or unmake emperors in crises—at the accession of Claudius in A.D. 41, in 68–69, and again late in the second century.

See J. E. Sandys, Companion to Latin Studies (1921).

PRAETORHUS, MICHAEL (1571–1621), German musical historian, theorist and composer, was born at Kreuzberg, Thuringia, on Feb. 1j, 1571. His father's name was Michael Schultze, and the name was latinized as Praetorius. He studied philosophy at Frankfort-on-Oder, and on the death of his brother, on whose support he relied, he was given a post as organist in the town. He was organist and later kapellmeister and secretary to the duke of Brunswick-Wolfenbüttel, and was rewarded for his services with the priory of Ringelheim, near Goslar. He died at Wolfenbüttel on Feb. 1j, 1621. The most important of his compositions are: *Polyhymnia* (15 vols.), *Musae Sioniae* (16 vols.), and *Musa* Aonia (9 vols.), all written partly to Latin and partly to German words. But more precious than all these is the Syntagma *musicum* (3 vols. and a cahier of plates. 4to, Wittenberg and Wolfenbuttel, 1615–20).

For a full description of the work see Grove's Dictionary *of* Music (3rd ed., 1927).

PRAETUTTII, also called Πραιτεττιοί, a tribe of ancient Italy inhabiting the south of Picenum (*q.v.*). Their territory lay between the rivers Vomanum and Tessinnus (Pliny iii. §110), and therefore included Castrum Novum, Interamnia and the Truentus, as well as probably the original of Hadria.

PRAGMATIC SANCTION, originally a term of the later Roman law, is found in the Theodosian and Justinian codes (Lat. *pragmatica* sancfio, from the Gr. πρᾶγμα, business). It was a decision of the state dealing with some interest greater than a question in dispute between private persons, and was given for some community (*universitas hominum*) and for a public cause. In more recent times it was adopted by those countries which followed the Roman law, and in particular by despotically governed countries, to signify an expression of the will of the sovereign defining the limits of his own power or regulating the succession. Justinian regulated the government of Italy by pragmatic sanctions after it had been reconquered from the Ostrogoths. In after ages the king of France, Charles VII., imposed limits on the claims of the popes to exercise jurisdiction in his dominions by the pragmatic sanction of Bourges in 1438. The emperor Charles VI. settled the law of succession for the dominions of the house of Habsburg by pragmatic sanction that was first published on April 19, 1713 (see AUSTRIA). Philip V., the first of the Bourbon kings of Spain, introduced the Salic law by a pragmatic sanction, and his descendant, Ferdinand VII., revoked it by another. The term was not used in England.

PRAGMATISM, in philosophy, a theory or method of dealing with real things (Gr. πράγματα: cf. πραγματικός versed in affairs). "Pragmatic," as here employed is not used in the common colloquial sense of "pragmatical," *i.e.*, "fussy and positive," nor in the historical sense, as in "Pragmatic Sanction," of "relating to affairs of state," but in the sense of practical or efficient. Pragmatism, as a general philosophic doctrine or mental attitude, can only be understood as part of a reaction against the intellectualistic speculation which has characterized most of modern metaphysics. It arises from a general awakening to the fact that the growth of our psychological and biological knowledge must profoundly transform the traditional epistemology. It follows that "pragmatic" lines of thought may originate from a multiplicity of considerations and in a variety of contexts. These, however, may be conveniently classified under four main heads—psychological, logical, ethical and religious—and the history of the subject shows that all these have contributed to the development of pragmatism.

1. Psychologically, pragmatism starts from the efficacy and all-pervasiveness of mental activity, and points out that interest, attention, selection, purpose, bias, desire, emotion, satisfaction, etc., colour and control all our cognitive processes. It insists that all thought is personal and purposive and that "pure" thought is a figment. A judgment which is not prompted by motives and inspired by interest, which has not for its aim the satisfaction of a cognitive purpose, is psychologically impossible, and it is, therefore, mistaken to construct a logic which abstracts from all these facts. Nor is the presence of such non-intellectual factors in thinking necessarily deleterious: at any rate they are ineradicable.

2. In its logical aspect pragmatism originates in a criticism of fundamental conceptions like "truth," "error," "fact" and "reality," the current accounts of which it finds untenable or unmeaning. "Truth," for example, cannot be defined as the agreement or correspondence of thought with "reality," for how can thought determine whether it correctly "copies" what transcends it? Nor can our truth be a copy of a transcendent and absolute truth (Dewey). If it be asked, therefore, what such phrases mean, it is found that their meaning is really defined by their use. The real difference between two conceptions lies in their application, in the different consequences for the purposes of life which their acceptance carries. When no such "practical" difference can be found, conceptions are identical; when they will not "work," *i.e.*, when'they thwart the purpose which demanded them, they are false; when they are inapplicable they are unmeaning (A. Sidgwick). Hence the "principle of Peirce" may be formulated as being that "every truth has practical consequences, and these are the test of its truth." It is clear that this (1) implicitly considers truth as a value, and so connects it with the conception of good, and (2) openly raises the question—What is truth, and how is it to be distinguished from error? This accordingly becomes the central problem of pragmatism. This same issue also arises independently out of the breakdown of rationalistic theories of knowledge (F. H. Bradley, H. H. Joachim). Logical analysis, after assuming that truth is independent and not of our making, has to confess that all logical operations involve an apparently arbitrary interference with their data (Bradley).

3. The ethical affinities of pragmatism spring from the perception that all knowing is referred to a purpose. This at once renders it "useful," *i.e.*, a means to an end or "good." Completely "useless" knowledge becomes impossible, though the uses of knowledge may still vary greatly in character, in directness, and in the extent and force of their appeal to different minds. This relation to a "good" must not, however, be construed as a doctrine of ethics in the narrower sense; nor is its "utilitarianism" to be confused with the hedonism of the British associationists. "Useful" means "good for an (any) end," and the "good" which the "true" claims must be understood as cognitive. But cognitive "good" and moral "good" are brought into close connection, as species of teleological "good" and contributory to "the Good." Thus only the generic, not the specific, difference between them is abolished. The "true" becomes a sort of value, like the beautiful and the (moral) good. Moreover, since the "real" is the object of the "true," and can be distinguished from the "unreal" only by developing superior value in the process of cognition which arrives at it, the notions of "reality" and "fact" also turn out to be disguised forms of value. Thus the dualism between judgments of fact and judgments of value disappears: whatever "facts" we recognize are seen to be relative to the complex of human purposes to which they are revealed. It should further be noted that pragmatism conceives "practice" very widely: it includes everything related to the control of experience. The dualism, therefore, between "practice" and "theory" also vanishes; a "theory" unrelated to practice (however,

indirectly) is simply an illusion.

4. Pragmatism has very distinctly a connection with religion, because it explains, and to some extent justifies, the faith-attitude or will to believe, and those who study the psychology of religion cannot but be impressed with the pragmatic nature of this attitude. If the whole of a man's personality goes to the making of the truth he accepts, it is clear that his beliefs are not matters of "pure reason," and that his passional and volitional nature must contribute to them and cannot validly be excluded. His religion also is ultimately a vital attitude which rests on his interests and on his choices between alternatives which are real for him. It is not however asserted that his mere willing to believe is a proof of the truth of what he wishes to believe, any more than a will to disbelieve justifies disbelief. His will to believe merely recognizes that choice is necessary and implies risk, and puts him in a position to obtain verification (or disproof). The pragmatic claim for religion, therefore, is that to those who will take the first step and will to believe an encouraging amount of the appropriate verifications accrues. It is further pointed out that this procedure is quite consonant with the practice of science with regard to its axioms. Originally these are always postulates which have to be assumed before they can be proved, and thus in a way "make" the evidence which confirms them. Scientific and religious verification therefore, though superficially distinct, are alike in kind.

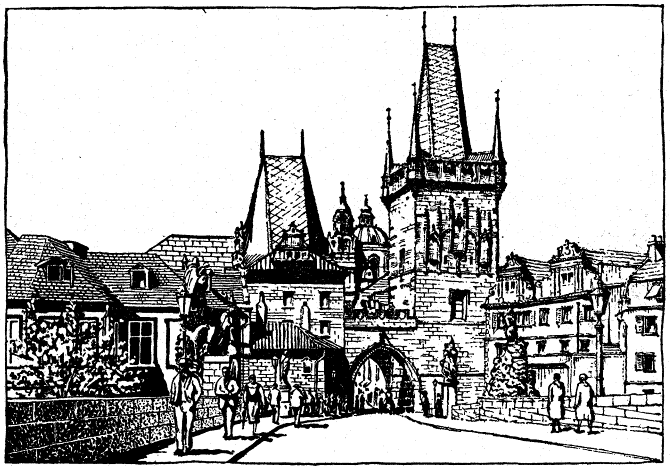
The *pragmatic doctrine of truth*, which it is now possible to outline, results from a convergence of the above lines of argument. Because truth is a value and vitally valuable, and all meaning depends on its context and its relation to us, there cannot be any abstract "absolute" truth disconnected from all human purposes. Because all truth is primarily a claim which may turn out to be false, it has to be tested. To test it is to try to distinguish between truth and falsity, and to answer the question—What renders the claim of a judgment to be true, really true? Now such testing, though it varies greatly in different departments of knowledge, is always effected by the consequences to which the claim leads when acted on. Only if they are "good" is the claim validated and the reasoning judged to be "right": only if they are tested does the theory of truth become intelligible and that of error explicable. If, therefore, a logic fails to employ the pragmatic test, it is doomed to remain purely formal, and the possibility of applying its doctrines to actual knowing, and their real validity, remain in doubt. By applying the pragmatic test on the other hand, it is possible to describe how truths are developed and errors corrected, and how in general old truths are adjusted to new situations. This "making of truth" is conceived as making for greater satisfaction and greater control of experience. It renders the truth of any time relative to the knowledge of the time, and precludes the notion of any rigid, static or incorrigible truth. Thus truth is continually being made and re-made. If the new truth seems to be such that our cognitive purposes would have been better served by it than they were by the truth we had at the time, it is antedated and said to have been "true all along." If an old truth is improved upon, it is revalued as "false." To this double process there is no actual end, but ideally an "absolute" truth (or system of truths) would be a truth which would be adequate to every purpose.

BIBLIOGRAPHY.—C. S. Peirce, *Chance, Love and Logic* (1923); W. James, *Will to Believe* (1896), *Pragmatism* (1907), *The Meaning of Truth* (1909); J. Dewey, *Studies in Logical Theory* (1903), *Essays in Experimental Logic* (1916), *Creative Intelligence* (1917), *Nature and Experience* (1925); F. C. S. Schiller, *Humanism* (1903), *Studies in Humanism* (1907), *Plato and Protagoras* (1908), *Problems of Belief* (1924); S. Hook, *The Metaphysics of Pragmatism* (1927); A. W. Moore, *Pragmatism and its Critics* (1911); D. L. Murray, *Pragmatism* (1925); W. Caldwell, *Pragmatism and Idealism* (1913); J. T. Driscoll, *Pragmatism and the Problem of the Idea* (1915); V. Lee, *Vital Lies* (1912); J. B. Pratt, *What is Pragmatism?* (1909); W. P. Montague, *The Ways of Knowing* (1925); B. Russell, *Philosophical Essays* (1910); A. Schinz, *Anti-Pragmatism* (1909); L. J. Walker, *Theories of Knowledge, Absolutism, Pragntatism, Realism* (1910).

(F. C. S. S.)

PRAGUE (prāg; Czech *Praha;* Ger. *Prag),* capital of Bohemia and Czechoslovakia, situated on both banks of a large meander of the Vltava. There is ample evidence that the site has been continuously inhabited since Palaeolithic times but its fixed population dates from the Neolithic period, when the advantages of a more open plant association in the valley slopes were exploited by an agricultural people. A fertile soil, mild climate, the shelter of surrounding heights and terraced valley slopes contributed to establish a strong and flourishing settlement which avoided the floor of the valley, subject to inundations.

History.—The early history of the town is obscure and legendary but the site was doubtless selected by Slav chieftains as a



BY COURTESY OF G. K. GEERLING

THE WEST END OF CHARLES BRIDGE, IN PRAGUE. CZECHOSLOVAKIA

convenient central position from which to govern their dominions. Historical records after the 10th century indicate a large settlement protected by two castles, one on a hill of the right bank—the Vyšehrad, and a later one on the Hradčany hill of the opposite bank. Geographically the town has never formed a perfect route centre and its supremacy as a political centre is largely the artificial creation of the successive rulers of Bohemia, who systematically furthered its growth. German colonists, invited to settle by King Vratislav during the 11th century, founded a settlement on the right bank at a place known as Pořič, now forming part of the "New Town" (Prague II.), and later a second settlement, the "Old Town" (Prague I.), was built and walled in by them. About the same period the Jews had a separate settlement first under the shadow of the Vyšehrad but later between the Old Town and the river, and now known as Prague V. or Josef's Town.

In the early part of the 19th century Prague, which had become almost a German city, felt the stirrings of a movement to revive the Czech nationality. At first purely literary and fostered by the "Society of the Bohemian Museum," founded 1822, it gradually assumed a political character. In 1848 a Slav congress was held in Prague. Trouble and conflict occurred between students and soldiers of the garrison, and barricades were erected but the town surrendered after a short bombardment. From that time on the history of Prague was the history of the rebirth of the Czechoslovak nation. Once more it was occupied by the Prussians in 1866, this time without resistance, and here the treaty of peace between Austria and Prussia was signed. Czech feeling and cultural life in Prague grew rapidly until its triumph resulted in the establishment of the republic of Czechoslovakia in 1918, with Prague as the capital. But in March 1939 Prague was occupied by Germans, and Hitler established a protectorate.

Topography!—The larger part of the modern town lies on the east or right bank of the Vltava, the houses spreading up the terraced slopes, often interrupted by parks, and overflowing into side-valleys. This is predominantly the commercial and industrial side of the town, though the "Old Town" and the adjacent parts of the "New Town" retain their ancient appearance. The former is remarkable for several features. Here is the "Ring" or market place with the fine old 14th century town hall, faced by the Týn church (14th–15th centuries) memorable as the religious centre of the Hussite movement and for its tomb of Tycho Brahe, the astronomer. Leading from the town hall to the limit of the old town is the Celetna ulice, at the extremity of which is the so-called powder tower, an elaborate building occupying the site of one of the old gates, at the corner of the Piikopy, which, with its continuations, is on the site of a trench that once encircled the fortifications of the old town. These and the fortifications around the new town are now laid out as parks. The new town lacks the crooked streets and quaint relics of the old, which surpasses it in romantic beauty and interest, but has much that is worth notice, *e.g.,* the National museum (1891) at the head of the Wenceslas place, and the 14th century Karlov church, restored in the 18th century.

The districts on the western bank of the river are mainly residential, with the exception of Holešovice-Bubna, and are dominated by Hradčany hill, on the summit of which lies the vast fortified palace of the ancient kings of Bohemia, now the headquarters of the government and the residence of the president. In the centre of the palace area stands the cathedral of St. Vitus, founded in 930 by the prince-saint Wenceslas, rebuilt by Charles IV and restored in recent times; castle and cathedral epitomize the history of the Czech state.

Industries, Education, **etc.**—Prague is pre-eminently the financial centre and the first manufacturing town of Czechoslovakia, including in its varied industries flour-milling, sugar-refining, brewing, tanning, the preparation of fertilizers and chemicals and the manufacture of furniture, foodstuffs and all types of heavy machinery, notably agricultural implements, rolling stock and river-barges. The re-orientation of the railways in Czechoslovakia has centralized traffic upon the capital, where electrification and enlargement are in progress, while it is also the terminus of Elbe-Vltava shipping; rapid progress is also being made in the direction of making it a centre of commercial aviation. The trade of the city was stimulated in 1920 by the establishment of a sample fair held twice a year and through which it is recovering much of its early importance as a leading centre of European trade.

Culturally too Prague is recovering its ancient leadership through its Czech and German universities and technical schools, while the charm of its numerous handsome buildings and monuments with historical associations, and the attraction of their architecture, even of the many flamboyant examples of Baroque style, are responsible for a growing number of foreign visitors.

The population numbered 676,657 in 1921, 94·2% Czech and 4·6% German. Of the total 468,375 live on the right, the remainder on the left bank of the river, 395,119 are Roman Catholics, 30,961 Protestants, 85.960 belong to the Czechoslovak church, 31,751 are of the Jewish faith and 127,676 are without any confession. In 1930 the total population was 848,823.

See also under CZECHOSLOVAKIA and BOHEMIA, and Count Lützow, *Prague* in "Mediaeval Towns" Series (1902); H. Rudolphi, *Lage, Entwickelung und Bedeutung von Prag,* Geog. Zeitschrift (Leipzig, 1916); J. Moscheles, *Prague,* Geografiska Annaler (Stockholm, 1920); for a complete demographic study (in Czech and French) *see* Dr. A. Boháč, *Hlvavní Město Praha* (Prague, 1923). (W. S. L.)

Battle of Prague, May *6,* **1757.**—This, the first great victory of Frederick the Great over the Austrians in the SEVEN YEARS' WAR, is described under the latter heading. The town also gives its name to other battles, notably that of 1620, the first important battle in the THIRTY YEARS' WAR (*q.v.*).

PRAGUERIE, THE, a revolt of the French nobility against King Charles VII, in 1440. It was so named because a similar rising had recently taken place in Prague, Bohemia, at that time closely associated with France through the house of Luxemburg, kings of Bohemia, and it was caused by the reforms of Charles VII. at the close of the Hundred Years' War, by which he sought to lessen the anarchy in France. The instigator was Charles I., duke of Bourbon, who three years before had attempted an unsuccessful rising. He and his bastard brother, Alexander, were joined by the former favourite, Georges de la Trémoille, John V., duke of Brittany, who allied himself with the English, the duke of Alençon, the count of Vendôme, and captains of mercenaries like Antoine de Chabannes, or Jean de la Roche. The duke of Bourbon gained over to their side the dauphin Louis — afterwards Louis XI. — then sixteen years old, and proposed to set aside the king in his favour, making him regent. Louis was readily induced to rebel; but the country was saved from a serious civil war by the energy of the king's officers and the solid loyalty of his "good cities." The constable de Richemont marched with the king's troops into Poitou, his old battleground with Georges de la Trémoille, and in two months he had subdued the whole country. Charles VII. then attempted to ensure the loyalty of the duke of Bourbon by the gift of a large pension, forgave all the rebellious gentry, and installed his son in Dauphin6 (see LOUIS XI.).

PRAIRIE, a level tract of grassy and generally treeless country, generally restricted to tracts so characterized in the central parts of North America (adopted from the Fr. prairie, a meadow-tract). In the United States the prairies may roughly be taken to extend from southern Michigan and western Ohio over Illinois (especially designated the Prairie State), Indiana, Missouri, Iowa, Wisconsin and Minnesota, and west of the Missouri to the foothills of the Rocky mountains. In Canada they extend from the same mountains to a line somewhat to the east of Winnipeg. The word prairie is used in a large number of compound names referring to natural and other features, flora, fauna, etc., characteristic of the prairies. Examples are: prairie-chicken or prairie-hen, a name for the pinnated grouse, also applied to the sharp-tailed grouse; prairie-dog, a rodent of the squirre! family.

For detailed description of the prairie scenery and its distinctive types of life *see* D. A. Dondore, ***The*** *Prairie and the Making* of *Middle America: Four Centuries* of *Description* (1927); *B.* Shimek, *Papers on the Prairie* (Iowa City, 1925).

PRAIRIE CHICKEN or **PRAIRIE HEN** (*Tympanuchus americanus*), **a** North American grouse inhabiting the prairies of the Mississippi valley north to Manitoba and south to Louisiana and Texas. The male has a neck-tuft cf ten or more rounded feathers, much reduced in the female. The lesser prairie hen (T. *pallidicinctus*) is smaller and has more buff above. It is confined to south-west Kansas and western Texas The Attwater prairie hen (T. a. attwateri) inhabits the coast districts of Louisiana and Texas.

PRAIRIE-DOG, a North American burrowing rodent allied to the marmots. There are several species in the western United States, ranging as far south as Mexico. The common prairie-dog (Cynomys *ludovicianus*) of the Great Plains region is a plump, short-tailed, squirrel-like animal of social habits. It makes a raised funnel-shaped entrance to its burrows, and congregates in colonies, sometimes many miles in extent and containing many thousands or even millions of individuals. Prairie-dogs feed chiefly upon grass. Rattlesnakes, burrowing owls and weasels are also found in the burrows but this does not indicate a "happy family" arrangement, as these animals prey on the young "dogs," and the prairie-dogs destroy the young owls and sometimes bury the rattlesnakes alive. (See MARMOT; RODENTIA.)

PRAIRIE DU CHIEN, a city of southwestern Wisconsin, U.S.A., on the Mississippi river, 3 mi. above the mouth of the Wisconsin; the county seat of Crawford county. It is on federal highway 18, and is served by the Burlington route and the Chicago, Milwaukee, St. Paul and Pacific railways. Pop. (1930) 3,943; in 1940, 4,622. It is the seat of St. Mary's academy for women (Roman Catholic; 1872) and has various manufacturing industries. Historically it is one of the most interesting spots in the state. In 1680 it was visited successively by Father Hennepin and the trader Du Lhut. In 1685 the French built a fort (St. Nicholas) of which the British assumed possession after the close of the French and Indian war. In 1816, Ft. Crawford was erected, and in 1820 Joseph Rolette established a permanent depot of the American Fur company. The first U.S. court in what is now Wisconsin was opened there in 1823 by Judge James Duane Doty. The "Milwaukee" railroad reached this point in 1857. The city was chartered in 1872.

PRAKRIT LANGUAGES, term applied to the vernacular (*prakṛta,* natural) languages of India as opposed to the literary Sanskrit (*saṁskṛta,* purified). There were two main groups of ancient Indo-Aryan dialects, or Primary Pkakrits; viz., the language of the Midland or Āryāvarta, and that of what is called the Outer Band. The language of the Midland was crystallized in the shape of literary Sanskrit before 300 B.C. Beside it, all the Primary Prakrits continued to develop under the usual laws of phonetics, and, as vernaculars, reached a secondary stage marked by a tendency to simplify harsh combinations of consonants and the broader diphthongs, the synthetic processes of declension and conjugation remaining as a whole unaltered. Although the literary dialect of the Midland became fixed, the vernacular of the same tract continued to develop along with the other Primary Prakrits, but owing to the existence of a literary standard by its side its development was to a certain extent retarded.

The Secondary Prakrits, in their turn, received literary culture. In their earliest stage one of them became the sacred language of Buddhism, under the name of Pali (*q.v.*). In a still later stage several Secondary Prakrits became generally employed for a new literature, both sacred and profane. Three of them were used for the propagation of the Jaina religion (see JAINS), and they were also vehicles for independent secular works, and largely employed in the Indian drama, in which Brahmans, heroes and people of high rank spoke in Sanskrit, while the other characters expressed themselves in some Secondary Prakrit according to nationality or profession. This later stage of the Secondary Prakrits is known as the Prakrit par excellence. In its turn it was fixed by grammarians, and as a literary language ceased to grow, while as a vernacular it went on in its own course. This further development was looked upon as corruption, and its result hence received the name of *Apabhraṁśa*. Again in their turn the *Apabhraṁśas* received literary cultivation and a stereotyped form, while as vernaculars they went on into the stage of the Tertiary Prakrits and become the modern Indo-Aryan languages.

In the Prakrit stage of the Secondary Prakrits we see as before —a Midland language, and the dialects of the Outer Band. The Prakrit of the Midland was known as ŚaurasEni, from Sūrasēna, the name of the country round Mathurā (Muttra). It was the language of the territories having the Gangetic Doab for their centre. To the west it probably extended as far as the modern Lahore and to the east as far as the confluence of the Jumna and the Ganges. Conquests carried the language to Rajputana and Gujarat. The development of SaurasEni was retarded by the influence of its great neighbour Sanskrit. Moreover, both being sprung from the same original—the Primary Prakrit of the Midland—its vocabulary, making allowances for phonetic changes, is the same as in that language.

The Prakrits of the Outer Band, all more closely connected with each other than any one of them was to SaurasEni, were Māgadhī, Ardhamāgadhī, Māhārāṣṭrī, and an unknown Prakrit of the North-west. Māgadhī was spoken in the eastern half of the Gangetic plain. Its proper home was Māgadha, the modern South Bihar, but it extended far beyond these limits at very early times. Judging from the modern vernaculars, its western limit must have been about the longitude of the city of Benares. Between it and Saurasēnī (*i.e.*, in the modern Oudh and the country to its south) lay Ardhamāgadhīmī "half Magādhī." Māhārāṣṭrī was the language of Māhārāṣṭra, the great kingdom extending southwards from the river Nerbudda to the Kistna and sometimes including the southern part of the modern Bombay Presidency and Hyderabad. Its language therefore lay south of SaurasEni. West of SaurasEni, in the Western Punjab, there must have been another Prakrit of which we have no record, although we know a little about its later *Apabhraṁśa* form. Here there were also speakers of Dardic (see INDO-ARYAN LANGUAGES), and the local Prakrit, to judge from the modern Tertiary vernacular, was a mixed form of speech. We have a detailed description of only one *Apabhraṁśa*—the Nāgara—the *Apabhraṁśa* of the Śaurasēnī spoken in the neighbourhood of Gujarat, and therefore somewhat mixed with Māhārāṣṭrī. We may, however, conclude that there was an *Apabhraṁśa* corresponding to each Prakrit, so that we have, in addition to Śaurasēna, a Māgadha, an Ardhamāgadha and a Māhārāṣṭra *Apabhraṁśa*. Native writers describe more than one local *Apabhraṁśa*, such as Vrācaḍa, the ancient dialect of Sind. There were numerous Prakrit subdialects to which it is not necessary to refer. These *Apabhraṁśas* are the direct parents of the modern vernacular.

Māhāraṣṭrī is the Prakrit best known to us. It early obtained literary pre-eminence, was the subject of long treatises by native grammarians, and became the language of lyric poetry and of the formal epic (kavya). Dramatic works have been written in it, and it was also the vehicle of many later scriptures of the Jaina religion. The older Jaina writings were composed in Ardhamāgadhī. The Māgadhī we have brief accounts by native grammarians and short sentences scattered through the plays. Saurasēnī is the usual prose dialect of the plays, and is also employed for the sacred writings of one of the Jaina sects.

The following is a list of the Indo-Aryan vernaculars, showing, when known, the names of the *Apabhraṁśas* from which they are sprung:—

Apabhraṁśa.	Modern language.
	A. Language of *the* Midland.
Śaurasēna . .	Western Hindi
	B. Intermediate Languages.
Āvanta . .	Rājasthānī
" . .	Pahārī Languages
Gaurjaia . .	Gujarātī
Śaurasēna . .	Pañjābī
Ardhamāgadha	Eastern Hindi
	C. Outer *Languages.*
	(a) *North-Western Group.*
Unknown . .	Kāshmīrī (with a Dardic basis)
" . .	Kōhistānī (with a Dardic basis)
" . .	Lahndii or Western Pañjābī
Vracada . .	Sindhi
	(*b*) Southern Language.
Māhārāṣṭra .	Marāṭhī
	(c) Eastern Group.
Māgadha . .	Bihārī
" . .	Oriyā
" . .	Bengali
" . .	Assamese

Language.—Originally real vernaculars with tendencies towards certain phonetic changes, the dialects were taken in hand by grammatical systematizers.

Subsequent writers followed these rules and not the living speech, even though they were writing in what was meant to be a vernacular. Moreover, at an early date, the Prakrits, qua literary languages, began to lose their characteristics as local forms of speech. A writer composed in Māhārāṣṭrī because it was the particular Prakrit employed for lyrics and in formal epics. In dramatic literature, SaurasEni and Miigadhi were put into the mouths of characters in particular walks in life, whatever the nationality of the dramatist might have been.

(Contractions: Skr.=Sanskrit. Pr.=Prakrit. S.= SaurasEni. Mg.=Māgadhī. AMg.=Ardhamāgadhī. M.=Māhāraṣṭrī. Ap.= Nāgara Apabhraṁśa.)

Vocabulary.—The vocabulary of S. is to all intents and purposes the same as that of Skr. In the languages of the Outer Band there are numerous provincial words (dēśī or dēśya), the originals of which belonged to Primary Prakrits other than those of the Midland. In the Outer Band there is also a rich variety of grammatical forms, many of which are found in the Veda and not in classical Sanskrit, and some which cannot be traced to any known Primary Prakrit form, but which must have existed in that stage and preceding it, far back into ancient Indo-European times.

An elaborate system of phonetics was developed by the grammarians. They are of interest as showing the tendencies at work and bring out especially in the case of compound consonants the substitution, mainly by a process of assimilation, of a slurred for a distinct pronunciation.

Declension.—Pr. has preserved the three genders of Skr., but has lost the dual number. As a rule, the gender of a noun follows that of the Skr. original, though in AMg. there is already a tendency to substitute the masculine for the neuter, and in Ap. these two genders are frequently confused, if the distinction is not altogether neglected. In the formation of cases, the phonetic rules just given are fully applied, but there are also other deviations from the Skr. original. The consonantal stems of Skr. declension are frequently given vocalic endings, and there is a general tendency to assimilate their declension to that of *a*-bases, which is helped by the free use of pleonastic suffixes ending in *a,* which are added to the base without affecting its meaning. Of these the most common are *-ka-*, *-ḍa-*, and *-alla-*, *-illa-* or *-ulla-*. The first of these was also very common in Skr., but its use was much extended in Pr. In accordance with the general rule, the *k* is liable to elision. It may even be doubled. *-Ḍa-* is confined to Ap., and may be used alone or together with the other two. *-Illa-* is most common in the Outer languages, and especially so in AMg. and M.

All the Skr. cases are preserved except the dative which has altogether disappeared in the Midland, but has survived in the singular number in the Outer languages. Everywhere the genitive can be employed in its place. Most of the case-forms are derived from Sanskrit according to the phonetic rules, but Ap. has a number of dialectic forms which cannot be referred to that language (*cf.* the remarks above about *-hi* = *θĭ*). It also rarely distinguishes between the nominative and the accusative.

The declension of neuter *a*-bases closely resembles the above, differing only in the nominative and accusative singular and plural. Ap. has almost lost the neuter termination in the singular. Feminine *a*-stems are declined on the same lines, but the cases have run more into each other, the instrumental, genitive and locative singular being identical in form. Very similarly are declined the bases ending in other vowels. The few still ending in consonants and which have not become merged in the *a*-declension, present numerous apparent irregularities.

All the Skr. pronouns appear in Pr., but often in extremely abraded shapes. There is also a most luxuriant growth of by-forms, the genitive plural of the pronoun of the second person being, *e.g.,* represented by no less than 25 different words in M. alone. We also find forms which have no original in classical Skr.

Conjugation.—The Pr. verb shows even more decay than does the noun. With a few isolated exceptions, all trace of the second, or consonantal, conjugation of Skr. has disappeared, and all verbs are now conjugated after the analogy of the *a*-conjugation, which falls into two classes, the first being the *a*-conjugation proper, and the second the *ē*-conjugation, in which the *ē* represents the *aya* of the Skr. 10th class and of causal and denominative verbs. The present participle is the only form which has everywhere survived. All the past tenses (imperfect, perfect and aorists) have fallen into disuse, leaving only a few sporadic remains, their place being supplied, as in the case of the tertiary vernaculars, by the participles, with or without auxiliary verbs. The present tense of the verb substantive has survived from Skr., but it is usual to employ *atthi* (= Skr. *asti*) for both numbers and all persons of the present, and *āsī* (= *āsīt*) for both numbers and all persons of the past. The latter has survived in the modern Punjabi *sī*, was. Another verb substantive (Skr. √ *bhū*) has also survived, generally in the form *hōi* or *huvaï* for *bhavati.* Its usual past participle is *hūa-*, or Mg. *hūda-*, S. *bhūda.* The forms given here are important when the history of the Tertiary Prakrits comes under consideration. These two verbs substantive make periphrastic tenses with other participles, and, in the case of the past participles and gerundives of transitive verbs (both of which are passive in signification), the agent or subject is put into the instrumental case, the participle being used either personally or impersonally, as in the tertiary languages. The gerundive, or future passive participle, is also used impersonally in the case of intransitive verbs.

Besides the participles, the infinitive and the indeclinable participle (gerund) have also survived. So also the passive voice, conjugated in the same tenses as the active. The causal has been already mentioned. There are also numerous denominative verbs (many of them onomatopoeic), and a good supply of examples of frequentative and desiderative bases, mostly formed, with the necessary phonetic modifications, as in Skr. Many direct representatives of Skr. participles in *-ta-* (without the *i*) and *-na-* also appear. As usual there is a tendency to simplification, and the termination *ia* is commonly added to the Pr. present base, instead of following Skr. analogy. All the three forms of the future passive participle or gerundive in *-tavya-*, *-anīya-* and *-ya-* have survived. The infinitive has survived, not only with the form corresponding to the classical Sanskrit termination *-tum,* but also with several old Vedic forms. The same is the case with the gerund, in which both the classical forms in *-tvā* and *-(t)ya* have survived, but with the loss of the distinctive use which obtained in Sanskrit. Besides these there are also survivals of Vedic forms, and even of Primary Prakrit forms not found in the Veda. The passive is generally formed by adding *-jja* or, in S. and Mg., *-īa-* to the root or, more often, to the present stem.

The only tenses which are fully conjugated in Pr. are the present, the imperative, the future and the optative. Except in Ap., the personal terminations in general correspond to the Skr. ones, but in Ap. there are some forms which probably go back to unrecorded Primary Prakrits. The imperative similarly follows the Skr. imperative. The base of the optative is generally formed by adding *-ejja-* in the Outer languages and *-ēa-* in S. The Skr. future termination *-isya-* is represented by *-issa-* or *-ihi-*.

Prakrit Literature.—The great mass of Prakrit literature is devoted to the Jaina religion. The oldest Jaina *sūtras* were in Ardhamāgadhī, while the non-canonical books of the Svētāmbara sect were in a form of Māhārāṣṭri, and the canon of the Digambaras appears to have been in a form of Saurasēnī. Prakrit also appears in secular literature. In artificial lyric poetry it is pre-eminent. The *Sattasaī* (*Saptaśaptikā*) was compiled at some time between the 3rd and 7th centuries A.D. by Hāla. It has had numerous imitators, both in Sanskrit and in the modern vernaculars, such as the Satsaī of Bihārī Lāl (17th century A.D.). Hāla's work is important as showing the existence of a large Prakrit literature at the time when it was compiled. Most of this is lost. In Prakrit we have the *Rāvaṇavaha* or *Sētubandha* (attributed to Pravarasēna, before A.D. 700), dealing with the subject of the *Rāmāyaṇa;* the *Gaüḍavaha* of Vākpati (7th–8th century A.D.), celebrating the conquests of Bengal by Yásōvarman, king of Kanauj, and the *Kumārapālacarita,* or the last eight cantos of the huge *Dvyāśraya Mahākāvya* written by Hēmacandra (A.D. 1150), to serve as a series of illustrations to the author's Sanskrit and Prakrit grammar, the *Sidda-hēmacandra.* The cantos are in Prakrit, and illustrate the rules of that portion of his work. Dramatic literature has also an example in the *Karpūra-mañjarī* ("Camphor-cluster," the name of the heroine) by Rāja-śēkhara (A.D. 900), a comedy of intrigue. An important source of our knowledge of Prakrit, and especially of dialectic Prakrit, is the Sanskrit drama. In works of this class many of the characters speak in Prakrit, different dialects being employed for different purposes. Generally speaking, Śaurasēnī is employed for prose and Māhārastri (the language of lyric poetry) for the songs, but special characters also speak special dialects according to their supposed nationality or profession. The result is that in the Sanskrit drama we have a valuable reflection of the local dialects.

BIBLIOGRAPHY.—*See* R. Pischel's *Grammatik der Prākritsprachen* (Strasbourg, 1900). As an introduction to the study of the language, the best work is H. Jacobi's *Ausgewählte Erzählungen in Mâhârashṭrî zur Einführung in das Studium des Prâkrit, Grammatik, Text, Wörterbuch* (Leipzig, 1886). The best editions of the grammars are E. B. Cowell's of Vararuci's *Prākṛta-Prakāśa* (1868), R. Pischel's of Hēmacandra (Halle, 1877, 1889), and E. Hultzsch's of Śiṁharāja's *Prākṛtarūpāvatāra* (1909). For *Dēśya* words, *see* Pischel's *The Dēśînâmamâlâ of Hemachandra* (Bombay, 1880). For *Apabhraṁśa,* in addition to his edition of Hēmacandra's grammar, *see* the same author's *Materialen zur Kenntnis des Apabhraṁśa* (1902). For *Apabhraṁśa* texts published in Europe, mention may be made of Dhanavāla's *Bhavisatta Kaha* (Munich, 1918), and Haribhadra's *Sanatkumāsacaritom* (Munich, 1921), both edited by H. Jacobi with valuable introductory essays, dealing with the whole question of Prakrit. For the mutual relationship of the various Prakrits, *see* S. Konow, "Mâhârâshṭrî and Mârâthî," in the *Indian Antiquary* (1903), xxxii., 180 *sqq.* For Jaina Prakrit, *see* under JAINS. In the secular texts the best editions are: A. Weber, *Das Saptataçatakam des Hāla* (Leipzig, 1881); another edition by Durgāprasād and Kāśīnáth Pāṇḍurang Parab under the title of *The Gâthasapataśatî of Śâtavâhana* (Bombay, 1889) [a good commentary]; S. Goldschmidt, *Rāvaṇavaha oder Setubandha* (Strasbourg, 1880–83) [text and translation]; Sivadatta and Parab, *The Setubandha of Pravarasena* (Bombay, 1895); Shaṅkar Pāṇḍurang Pandit, *The Gaüḍavaho, a Historical Poem in Prâkrit, by Vâkpati* (Bombay, 1887); the same editor, *The Kumârapâla-charita* (Bombay, 1900); *Rajaçekhara's Karpūramañjari,* edited by S. Konow,

translated by C. R. Lanman (Cambridge, Mass., 1901).

The literature of the Sanskrit drama is given under SANSKRIT.

PRAM, the name of a flat-bottomed boat or barge used as a "lighter" for discharging and loading cargo in the ports of the Baltic and North Sea. The word, which is common in various forms to all the languages bordering on those seas, is Slavonic.

PRANTL, KARL VON (1820–1888), German philosopher, was born at Landsberg on the Lech on Jan. 28, 1820, and died on Sept. 14, 1888, at Oberstdorf. In 1843 he became doctor of philosophy at Munich Observatory, where he was made professor. His best known work is the Geschichte der Logik *im Abendland* (Leipzig, 1855–70).

PRASEODYMIUM, a metallic element (symbol Pr, atomic number 59, atomic weight 140·9), of the rare-earth group, was discovered in 1885 by von Welsbach when he separated "didymium" into praseodymium and neodymium. This metal occurs along with lanthanum, cerium, neodymium, etc., in monazite, cerite and allanite. It is usually separated by fractional crystallization, employing first the double magnesium nitrate, and finally the double ammonium nitrate. The oxide is an almost black powder, the composition of which varies according to the method of preparation. It is usually considered to be Pr_4O_7; reduction in hydrogen gives Pr_2O_3. The oxides are soluble in acids giving green salts such as $Pr_2(SO_4)_3,8H_2O$, which show a strong characteristic absorption spectrum. The metal is prepared by the electrolysis of the fused chloride. It melts at 940° C. (See RARE EARTHS.)

(C. J.)

PRATI, GIOVANNI (1815–1884), Italian poet, was born at Dasindo and studied law at Padua. An ardent partisan of the house of Savoy, in 1862 he was elected a deputy to the Italian parliament, and in 1876 a senator. He died at Rome on May 9, 1884. Prati's work ranged from his romantic narrative *Ermenegarda* (1841) to the 500 sonnets collected in Psiche (187;) and the poems entitled *Iside* (1878). His *Opere varie* were published in five volumes in 1875, and a selection in one volume in 1892.

PRATINAS, a tragic poet of Athens, was a native of Phlius in Peloponnesus. About 500 B.C. he competed with Choerilus and Aeschylus, when the latter made his first appearance as a writer for the stage. Pratinas was also the introducer of satyric dramas as a species of entertainment distinct from tragedy. Pratinas was also a writer of dithyrambs and the choral odes called *hyporchemata* (a considerable fragment of one of these is preserved in Athenaeus xiv. 617).

See Pausanias ii. *13;* Suidas (*q.v.*) ; fragments in T. Bergk, Poetae *lyrici graeci,* vol. iii.

PRATINCOLE, a name for the bird Glareola *pratincola,* forming the type of a genus belonging to the order Limicolae. The pratincoles, of which eight or nine species have been described, are small birds, slenderly built and delicately coloured, with a short stout bill, a wide gape, long pointed wings and a forked tail. In some of their habits they are thoroughly plover-like, running swiftly and breeding on the ground, but on the wing they have much the appearance of swallows and, like them, feed, at least partly, while flying. The pratincole of Europe, G. pratincola, breeds in many parts of Spain, Barbary and Sicily, along the valley of the Danube and in southern Russia. In the south-east of Europe a second and closely allied species, G. nord*manni,* which has black instead of chestnut inner wing-coverts, accompanies or, farther east, replaces it; other species occur in Asia, Africa and Australia.

PRATO IN TOSCANA, a town and episcopal see of Tuscany, Italy, in the province of Florence, 11 m. by rail N.W. of Florence, 207 ft. above sea-level. Pop. (1936), 28,646, town; 70,206, commune. It is situated on the Bisenzio, and was dominated by a castle built by Frederick II. (c. 1250). The cathedral was begun in the 12th century; to this period belongs the narrow nave with its wide arches; the raised transepts and the chapels were added by Giovanni Pisano in 1317–1320; the campanile dates from 1340, while the façade, also of alternate white sandstone and green serpentine, belongs to 1413. It has a fine doorway with a bas-relief by Andrea della Robbia over it and a lovely open-air pulpit, erected in 1439 by Donatello and Michelozzo for displaying the Virgin's girdle, brought from the Holy Land by a knight of Prato in 1130. The pulpit itself has beautiful reliefs of dancing children; beneath it is a splendid bronze capital. The Chapel of the Girdle has a statue of the Virgin by Giovanni Pisano, and a handsome bronze open-work screen. The frescoes in the choir, with scenes from the life of St. John the Baptist and St. Stephen, are by Fra Filippo Lippi (1456–1466) and are his best work.

The massive old Palazzo Pretorio (13th century) contains a small but good picture gallery. A beautiful Madonna by Filippino Lippi (1498) is in a small street shrine at the corner of the Via S. Margherita. The Madonna del Buon Consiglio has some good reliefs by Andrea della Robbia, by whom is also the beautiful frieze in the Madonna delle Carceri. This church, by Giuliano da Sangallo (1485–1491), is a Greek cross, with barrel vaults over the arms, and a dome; it is a fine work, and the decoration of the exterior in marble of different colours (unfinished) is of a noble simplicity. The industries of Prato embrace the manufacture of woollens (174 establishments in the Val Bisenzio), straw-plaiting, etc.

See E. Corradini, *Prato* (Bergamo, 1905) ; R. Papini, *Prato* in *Toscana, 1910.*

PRATT, a city of southern Kansas, U.S.A., on the headwaters of the Ninnescah river, at an altitude of 1,916 ft.; the county seat of Pratt county; on federal highways 54 and 281; served by Rock Island and Santa Fe railways. Pop. (1940) 6,591. Pratt is a well built, well kept city, surrounded by a highly developed agricultural region of gently rolling land. It has a commission form of government, a city-planning commission and zoning regulations. Founded in 1884, Pratt was chosen as the county seat in 1886. It is the home of the Kansas State Fish hatchery.

PRAWN, a name applied to the larger shrimp-like Crustacea, in Great Britain usually to Leander *serratus.* (See SHRIMP.)

PRAXITELES, of Athens, the son of Cephissodotus, the greatest of the Attic sculptors of the 4th century B.C., who has left an imperishable mark on the history of art.

Though Praxiteles may be considered as in some ways well known to us, yet we have no means for fixing his date accurately. It seems clear that he was no longer working in the time of Alexander the Great, or that king would have employed him. Pliny's date, 364 B.C., is probably that of one of his most noted works. We possess one undisputed original work of Praxiteles, that of the marble statue of Hermes carrying the infant Dionysus (GREEK ART, Plate VI., fig. 3). The young child can hardly be regarded as a success; he is not really childlike. But the figure of the Hermes, full and solid without being fleshy, at once strong and active, is a masterpiece, and the play of surface is astonishing. In the head we have a remarkably rounded and intelligent shape, and the face expresses the perfection of health.

This statue is our best evidence for the style of Praxiteles. It altogether confirms and interprets the statements as to Praxiteles made by Pliny and other ancient critics. Gracefulness in repose, and an indefinable charm are also the attributes of works in our museums which appear to be copies of statues by Praxiteles. Perhaps the most notable of these are the Apollo Sauroctonus, or the lizard-slayer, a youth leaning against a tree and idly striking with an arrow at a lizard, and the Aphrodite at the bath (GREEK ART, Plate VI., figs. 5, 6) of the Vatican, a copy of the statue made by Praxiteles for the people of Cnidus. There is a story that Phryne, who was supposed to have been Praxiteles' model, induced him to name his two finest works by telling him his studio was on fire. He named the Eros and the Satyr. The "Capitoline Faun" at Rome has been identified as a copy of this, and a torso in the Louvre may even be the original.

Excavations at Mantineia in Arcadia have brought to light the basis of a group of Leto, Apollo and Artemis by Praxiteles. This basis was doubtless not the work of the great sculptor himself, but of one of his assistants. Nevertheless it is pleasing and historically valuable. Pausanias (viii. 9, 1) thus describes the base, "on the base which supports the statues there are sculptured the Muses and Marsyas playing the flutes." Three slabs which have survived represent Apollo, Marsyas, a slave and six of the Muses, the slab which held the other three having disappeared.

Four points of composition may be mentioned, which appear to be in origin Praxitelean: (1) a very flexible line divides the figures if drawn down the midst from top to bottom; they all tend to lounging; (2) they are adapted to front and back view rather than to being seen from one side or the other; (3) trees, drapery and the like are used for supports to the marble figures, and included in the design, instead of being extraneous to it; (4) the faces are presented in three-quarter view.

The subjects chosen by Praxiteles were either human beings or the less elderly and dignified deities. It is Apollo, Hermes and Aphrodite who attract him rather than Zeus, Poseidon or Athena. And in his hands the deities sink to the human level, or, indeed, sometimes almost below it. They have grace and charm in a supreme degree, but the element of awe and reverence is wanting. Between them Scopas with his gift for expressing emotion, and Praxiteles, with his delicacy and grace, changed the whole aspect of such sculpture, and the development of later ages derives largely from these two.

See Klein, *Praxiteles* (Leipzig, 1838); Perrot, *Praxitèle* (Paris, 1905).

PRAYER, a term used generally for any humble petition, but more technically, in religion, for that mode of addressing a divine or sacred power in which there predominates the mood and intention of reverent entreaty (from Lat. *precari*, entreat; Ital. *pregaria;* Fr. *prière*).

Prayer and its Congeners.—Prayer in the latter sense is a characteristic feature of the higher religions, and we might even say that Christianity or Mohammedanism, ritually viewed, is in its inmost essence a service of prayer. At all stages of religious development, however, and more especially in the case of the more primitive types of cult, prayer as thus understood occurs together with, and shades off into, other varieties of observance that bear obvious marks of belonging to the same family.

Confining ourselves for the moment to forms of explicit address, we may group these under three categories according as the power addressed is conceived by the applicant to be on a higher, or on much the same, or on a lower plane of dignity and authority as compared with himself. (1) Only if the deity be regarded as altogether superior is there room for prayer proper, that is, reverent entreaty. Of this we may perhaps roughly distinguish a higher and a lower type, according as there is either complete confidence in the divine benevolence and justice, or a disposition to suppose a certain arbitrariness or, at any rate, conditionality to attach to the granting of requests. In the first case prayer will be accompanied with disinterested homage, praise, and thanksgiving, and tends to lose its distinctive character of entreaty or petition, passing into a mystic communing or converse with God. In the second case it will be supported by pleading, involving on the one hand self-abasement, with confession of sins and promises of repentance and reform, or on the other hand self-justification, in the shape of the expression of faith and recitation of past services, together with reminders of previous favour shown. (2) If the worshipper place his god on a level with himself, so as to make him to some extent dependent on the service man contracts to render him, then genuine prayer tends to be replaced by a mere bargaining, often conjoined with flattery and with insincere promises. This spirit of do *ut* des will be found to go closely with the gift-theory of sacrifice (*q.v.*) and to be especially characteristic of those religions of middle grade that are given over to sacrificial worship as conducted in temples and by means of organized priesthoods. So when the high gods are kind for a consideration, the lower deities will likewise be found addicted to such commerce; thus in India the hedge-priest and his familiar will bandy conditions in spirited dialogue audible to the multitude (cf. W. Crooke, Things Indian, *s.v.* "Demonology," pp. 132, 134). (3) Lastly, the degree of dependency on human goodwill attributed to the power addressed may be so great that, instead of diplomatic politeness, there is positive hectoring, with dictation, threats, and abuse. Even the Italian peasant is said occasionally to offer both abuse and physical violence to the image of a recalcitrant saint; and antiquity wondered at the bullying manner of the Egyptians towards their gods (cf. Iamblichus, *De* mysteriis, vi. 5–7). Westermarck supplies many instances from Morocco of *'âr* the "conditional curse," applied to saints in order to make them attend, on pain of disaster if they are recalcitrant (History and Development of the Moral Ideas, passim). This frame of mind, however, is mainly symptomatic of the lower levels of cult. Thus the Zulu says to the ancestral ghost, "Help me or you will feed on nettles"; whilst the still more primitive Australian exclaims to the "dead hand" that he carries about with him as a kind of divining-rod, "Guide me aright, or I throw you to the dogs."

So far the forms of address are explicitly directed towards a power that, one might naturally conclude, has personality, since it is apparently expected to hear and answer. At the primitive stage, however, the degree of personification is, probably, often far slighter than the words used would seem to suggest. The verbal employment of vocatives and of the second person may have little or no personifying force, serving primarily but to make the speaker's wish and idea intelligible to himself. When the rustic talks in the vernacular to his horse he is not much concerned to know whether he is heard and understood; still less when he mutters threats against an absent rival, or kicks the stool that has tripped him up with a vicious "Take that!"

These considerations may help towards the understanding of a second class of cases, namely, forms of implicit address shading off into unaddressed formulas. Wishings, blessings, cursings, oaths, vows, exorcisms, and so on, are uttered aloud, partly that they may be heard by the human parties to the rite, but in many cases that they may be heard, or at least overheard, by a consentient deity, perhaps represented visibly by an idol or other cult-object.

From Suggestion to Prayer.—To address and entreat a fellow-being is a faculty as old as that of speech, and, as soon as it occurred to man to treat sacred powers as fellow-beings, assuredly there was a beginning of prayer. We are not likely to know how religion first arose, and the probability is that many springs went to feed that immense river. Thus care for the dead may well have been one amongst such separate sources. It is natural for sorrow to cry to the newly dead "Come back!" and for bereavement to add "Come back and help!" Another source is mythologic fancy, which, in answer to child-like questions: "Who made the world?" "Who made our laws?" and so on, creates "magnified non-natural men," who presently made their appearance in ritual (for to think a thing the savage must dance it); whereupon personal intercourse becomes possible between such a being and the tribesmen, the more so because the supporters of law and order, the elders, associate themselves as closely as possible with the supreme law-giver. From Australia comes a certain amount of evidence showing that, in the two ways just mentioned, some inchoate prayer is being evolved. On the whole, the absence of prayer from the magico-religious ritual of the Australians is conspicuous. Uttered formulas abound; yet they are not forms of address, but rather self-sufficient pronouncements charged with *mana* (*q.v.*). They involve a wonder-working recognized as such, the core of the mystery consisting in the supposed transformation of suggested idea into accomplished fact by means of that suggestion itself. To the man endowed in the opinion of his fellows (and doubtless of himself) with this wonderful power of effective suggestion, the output of such power naturally represents itself as a kind of unconditional willing. When he cries "Rain, rain," or otherwise makes vivid to himself and his hearers the idea of rain, expecting that the rain will thereby be forced to come, it is as if he had said "Rain, now you must come," or simply "Rain, come!" and we find that suggestional formulas mostly assume the tone of an actual or virtual imperative, "As I do this, so let the like happen," "I do this in order that the like may happen," and so on. Now it is easy to "call spirits from the vasty deep," but they do not always come. Hence such imperatives have a tendency to dwindle into optatives. "Let the demon of small-pox depart!" is replaced by the more humble "Grandfather Smallpox, go away!" where the affectionate appellative (employed, however, in all likelihood merely to cajole) signalizes an approach to the genuine spirit of prayer. Again, the user of suggestion conscious of his limitations will seek to supplement his *mana* by tapping, so to speak, whatever sources of similar power lie round about him. A notable method of borrowing power from another agency involving *mana* is simply to breathe its name in connection with the spell that stands in need of reinforcement; as the name suggests its owner, so it comes to stand for his real presence. Even the more highly developed forms of liturgical prayer tend, in the recitation of divine titles, attributes and the like to present a survival of this formalist use of potent names. *(See* NAME.)

Prayer as a Part of Ritual. — By an exactly converse process prayer actually generates formalism, instead of growing out of it. In advanced religion, indeed, prayer is the chosen vehicle of the free spirit of worship. Its mechanism is not unduly rigid, and it is largely autonomous, being rid of subservience to other ritual factors. In more primitive ritual, however, set forms of prayer are the rule, and their function is mainly to accompany and support a ceremony the nerve of which consists in action rather than speech. Hence, suppose genuine prayer to have come into being, it is apt to degenerate into a mere piece of formalism; and yet, whereas its intrinsic meaning is dulled by repetition according to a well-known psychological law, its virtue is thereby hardly lessened for the undeveloped religious consciousness, which holds the saving grace to lie mainly in the repetition itself. But a formula that depends for its efficacy on being uttered rather than on being heard is virtually indistinguishable from the purely suggestional type of utterance, though its origin is different. A good example of a degenerated prayer-ritual comes from the Todas *(see* W. H. R. Rivers, *The Todas,* ch. x.). The prayer itself tends to be slurred over, or even omitted. On the other hand, great stress is laid on a preliminary citation of names of power followed by the word *idith.* This at one time seems to have meant "for the sake of," carrying with it some idea of supplication; but it has now lost this connotation, seeing that it can be used not merely after the name of a god, but after that of any sacred object or incident held capable of imparting efficacy to the formula. Even the higher religions have to fight against the tendency to "vain repetitions" (often embodying a certain sacred number, *e.g.* three), as well as to the use of prayers as amulets, medicinal charms, and so on. Throughout we must carefully distinguish in theory, though hard in practice, between legitimate ritual understood as such, whether integral to prayer, such as its verbal forms, or accessory, such as gestures, postures, incense, oil or what not, and the formalism of religious-decay, such as generally betrays itself by its meaninglessness, by its gibberish phrases, sing-song intonation and so forth.

Silent Prayer. — A small point in the history of prayer, bearing on the subject of its relation to magic, is concerned with the custom of praying silently. Charms and words of power being supposed to possess efficacy in themselves are guarded with great secrecy by their owners, and hence, in so far as prayer verges on spell, there will be a disposition to mutter or otherwise conceal the sacred formula. Thus the prayers of the Todas already alluded to are in all cases uttered "in the throat," although these are public prayers, each village having a form of its own. At a later stage, when the distinction between magic and religion is more clearly recognized and an anti-social character definitely assigned to the former, on the ground that it subserves the sinister interests of individuals, the overt and, as it were, congregational nature of the praying comes to be insisted on as a guarantee that no magic is being employed, a notion that suffers easy translation into the view that there are more or less disreputable gods with whom private trafficking may be done on the sly. Thus, in accordance with the outlook of the classical period, Plato in his *Laws* (909–910) prohibits all possession of private shrines or performance of private rites; "Let a man go to a temple to pray, and let anyone who pleases join with him in the prayer." Nevertheless, instances are not wanting amongst the Greeks of private prayers of the loftiest and the most disinterested tone *(cf.* L. R. Farnell, *The Evolution of Religion,* p. 202 *seq.).* Finally, in advanced religion, at the point at which prayer is coming to be conceived as communion, silent adoration is sometimes thought to bring man nearest to God.

The Moralization of Prayer.——As to the moral quality of the act of prayer, this contrast between the spirit of public and private religion is fundamental for all but the most advanced forms of cult. In its public rites the community becomes conscious of common ends and a common edification. Even a very primitive people such as the Arunta of Australia behaves with the greatest solemnity at its ceremonies, and professes to be made "glad" and "strong" thereby. Of his countrymen, whom he would not trust to pray in private, Plato testifies that in the temples during the sacrificial prayers "they show an intense earnestness and with eager interest talk to the gods and beseech them" *(Laws,* 887). In acts of public worship at any rate, therefore, prayer and its magico-religious congeners are at all stages resorted to as a "means of grace," even though such grace does not constitute the expressed object of petition. Poverty of expression is apt to cloak the real spirit of primitive prayer, and the formula under which its aspirations may be summed up, namely, "Blessings come, evils go," covers all sorts of confused notions about a grace to be acquired and an impurity to be wiped away, which, as far back as our clues take us, invite interpretations of a decidedly spiritualistic and ethical order. To explicate, however, and purge the meaning of that "strong heart" and "clean" which the savage after his fashion can wish and ask for, remained the task of the higher and more self-conscious types of religion. A favourite contrast for which there is more to be said is that drawn between the magico-religious spell-ritual, that says in effect, "My will be done," and the spirit of "Thy will be done" that breathes through the highest forms of worship. Such resignation in the face of the divine will and providence is, however, not altogether beyond the horizon of primitive faith, as witness the following prayer of the Khonds of Orissa: "We are ignorant of what it is good to ask for. You know what is good for us. Give it to us." (Tylor, *Prim. Culture,* 4. 369). At this point prayer by a supreme paradox virtually extinguishes itself, since in becoming an end in itself, a means of contemplative devotion and of mystic communing with God, it ceases to have logical need for the petitionary form. Thus on the face of it there is something like a return to the self-sufficient utterance of antique religion; but, in reality, there is all the difference in the world between a suggestion directed outwardly in the fruitless attempt to conjure nature without first obeying her, and one directed towards the inner man so as to establish the peace of God within the heart.

BIBLIOGRAPHY.—For prayer from the comparative standpoint: E. B. Tylor, *Primitive Culture,* ch. xviii. (1903); C. Tiele, *Elements of the Science of Religion* (Gifford lectures, lect. 6) (1897); F. Max Miiller, "On Ancient Prayers," in *Semitic Studies in Memory of Rev. Dr. Alexander Kohut* (1897); L. R. Farnell, *The Evolution of Religion,* lect. 4 (1905). For prayer in relation to magic: R. R. Marett, "From Spell to Prayer," in *Folk-Lore* (June 1904); W. W. Skeat, *Malay Magic* (1900). Degeneration of prayer: W. H. R. Rivers, *The Todas,* ch. x. (1906). Use of the name of power; F. Giesebrecht, *Die alttestamentliche Schätzung des Gottesnamens* (1901); W. Heitmüller, *Im Namen Jesu* (1903). Silent prayer: S. Sudhaus, "Lautes und leises Beten" in *Archiv fur Religionswissenschaft,* 185 *seq.* (1906). Beginnings of prayer in Australia: A. W. Howitt, *The Native Tribes of South-East Australia,* 394, *cf.* 546 (1904); K. Langloh Parker, *The Euahlayi Tribe,* 79 *seq.* (1905): the evidence discussed in *Man.* 2, 42, 72 (1907). Prayer and spell in North American religion: W. Matthews, "The Prayer of a Navajo Shaman," in *American Anthropologist,* i.; *idem,* "The Mountain Chant; a Navajo Ceremony," in *Fifth Report of Bureau of American Ethnology.* Greek prayer: C. Ausfeld, *De graecorum precationibus quaestiones* (1903). Christian prayer: E. von der Goltz, *Das Gebet in der altesten Christenheit* (1901); *id., Tischgebete und Abendmahlsgebete* (1905); O. Dibelius, *Das Vaterunser: Umrisse zu einer Geschichte des Gebets in der alten und mittleren Kirche* (1903); T. K. Cheyne, "Prayer," in *Ency. Bib.* (1902); W. G. Procter, *The Principles and Practice of Prayer* (1927); W. H. Frere, *The Principles of Religious Ceremonial* (2nd ed., 1928). *(See* also SPELL, MANA, RITUAL.) (R. R. M.)

PRAYER, BOOK OF COMMON, the title of the official service book of the Church of England. One of the most important steps taken at the Reformation was the compilation and provision of a comprehensive service book for general and compulsory use in public worship throughout the Church of England. The following main advantages were achieved.

(1) The substitution of the English language for the Latin language, in which all the old service books were written.

(2) Unification and simplification. The Prayer Book represents in a much condensed and abbreviated form the four chief ancient service books, viz.: the Missal, Breviary, Manual and Pontifical. In addition to a multiplicity of books there was much variety of use. Although the Sarum Use prevailed far the most widely, yet there were separate Uses of York and Hereford, and also to a less degree of other dioceses and cathedral churches as well. Cranmer's preface "Concerning the Service of the Church" expressly mentions the abolition of this variety as one of the things to be achieved by a book of Common Prayer. It says: "And whereas heretofore there hath been great diversity in saying and singing in Churches within this Realm; some following Salisbury Use, some Hereford Use, and some the Use of Bangor, some of York, some of Lincoln; now from henceforth all the whole Realm shall have but one Use." On the sources from which the Prayer Book was compiled, *see* F. Procter and W. H. Frere, *New History of the Book of Common Prayer* (2nd ed. 1902), and the works mentioned below.

Of changes preceding the first Prayer Book we may note: (a) The compiling and publishing of the Litany in English by Cranmer in 1544. (b) Royal injunctions in Aug. 1547 ordering the Epistle and Gospel to be read in English at High Mass. (c) A royal proclamation, dated March 8, 1548, imposing for use at the coming Easter *The* Order *of the Communion.* This was an order or form of service in English for the communion of the people in both kinds. It was to be inserted into the service after the communion of the priest, without making any other alteration in the Latin Mass. It comprised the long exhortation or notice to be given on Sunday, or on some other day, previous to the Communion, the longer exhortation, and the shorter invitation, the confession, absolution, comfortable words, prayer of humble access, formulae of administration and the concluding peace, much as they exist at present.

The First Complete Prayer Book.—The first complete vernacular Book of Common Prayer was issued in Jan, 1549. An Act of Uniformity made its use compulsory on and after the following Whit-Sunday. Some of the chief points of difference between this and subsequent Prayer Books were the following: Matins and Evensong began with the Lord's Prayer, and ended with the third collect; the Athanasian Creed was introduced after the Benedictus on six festivals only, and in addition to the Apostles' Creed; to the Communion service an alternative title was given, viz.: "commonly called the Mass." Introits were provided for use on every Sunday and Holy-Day; in the prayer for the whole state of Christ's church, the blessed Virgin Mary was commemorated by name; prayer for the dead was explicitly retained; also an invocation of the Holy Spirit before the words of institution, the prayer of oblation immediately following them; the mixed chalice was ordered to be used, and the Agnus Dei to be sung during the Communion of the people; unleavened bread was to be used and placed in the mouth of the communicant; the sign of the cross was frequently to be made; reservation for the sick and unction of the sick were retained; and exorcism, unction, trine immersion and the chrisom were included in the baptismal service. As to vestments, at Holy Communion the officiating priest was to wear "a white albe plain with a vestment or cope," and the assistant clergy were to wear "albes with tunicles." Whenever a bishop was celebrant he was to wear, "beside his rochette, a surplice or albe, and a cope or vestment"; the mitre was not mentioned.

The ordinal was added to this Prayer Book in 1550 by another act of parliament. It included the deliverance to the newly ordained priest of the chalice or cup, with the bread.

Second Prayer Book.—In 1552 a new and revised edition was introduced by an act of parliament which ordered that it should come into use on All Saints' Day (Nov. 1). This represents the most Protestant position ever reached in the Prayer Book. The chief alterations were: (1) the introductory sentences, exhortation, confession and absolution were to be read at the beginning of the order for morning and evening prayer; (2) in the order for Holy Communion the alternative title "commonly called the Mass" was left out; the introits were omitted, the Gloria in Excelsis was transferred from near the beginning to near the end of the service; the ten commandments with an expanded Kyrie eleison were introduced; the long new English canon of 1549 was split up into three parts—the prayer for the church militant, the prayer of consecration and prayer of oblation, becoming a post-Communion collect; the epiklesis or invocation of the Holy Ghost upon the elements was entirely omitted; the mixed chalice, the use of the sign of the cross in the consecration prayer; the coinmemoration of the blessed Virgin Mary and of various classes of saints were omitted; the words of administration in the 1549 book were abolished, viz.: "The body of our Lord Jesus Christ which was given for thee, preserve thy body and soul unto everlasting life," and "The blood of our Lord Jesus Christ which was shed for thee preserve thy body and soul unto everlasting life," and the following words were substituted: "Take and eat this in remembrance that Christ died for thee, and feed on him in thy heart by faith, with thanksgiving," and "Drink this in remembrance that Christ's blood was shed for thee, and be thankful;" a long rubric was added at the end of the service explanatory of the attitude of kneeling at the reception of Holy Communion, in which it was stated that "it is not meant hereby that any adoration is done, or ought to be done, either unto the sacramental bread and wine there bodily received, or to any real and essential presence there being of Christ's natural flesh and blood," etc.; exorcism, unction, trine immersion and the chrisom were omitted from the baptismal service; unction and communion with the reserved sacrament were removed from the services for the visitation and the communion of the sick; prayers for the dead and provision for a celebration of Holy Communion at a funeral were removed from the burial service; the vestments retained and ordered under the Prayer Book of 1549 were abolished by a new rubric which directed that both at the time of Communion and at all other times of ministration a bishop should wear a rochet and that a priest or deacon should have and wear a surplice only; on the other hand, the directions as to daily service were extended to all clergy and made much stricter, and the number of days on which the Athanasian Creed was to be used was raised from six to thirteen.

The main objects of these drastic alterations have been thought to have been two-fold: to abolish all ritual for which there was not scriptural warrant; and to make the services as unlike the pre-Reformation services as possible. The alterations were violent enough to alarm and offend the Catholic party, but they were not violent enough to satisfy the extreme Puritan party, who would no doubt have agitated for and would probably have obtained still further reformation and revision. This Prayer Book only lived for eight months. It came into use on All Saints' Day (Kov. 1) 1552, and on July 6, 1553, Edward VI. died and was succeeded by his sister Mary, under whom the Prayer Book was abolished and the old Latin services and service books resumed their place.

Act of Uniformity.---On the death of Queen Mary and the accession of her sister Elizabeth (Nov. 17, 1558) all was reversed, and the Book of Common Prayer was restored into use again. The Act of Uniformity, which obtained final parliamentary authority on April 28, 1559, ordered that the Prayer Book should come again into use on St. John the Baptist's Day (June 24, 1559). This was the second Prayer Book of King Edward VI., with few but important alterations, which, like all the alterations introduced at subsequent dates into the Prayer Book, were in a Catholic rather than in a Protestant direction. Morning and Evening Prayer were directed to be "used in the accustomed place of the church, chapel or chancel," instead of "in such place as the people may best hear"; the eucharistic vestments ordered in the first Prayer Book of Edward VI. were brought back by a new rubric which directed that "the minister at the time of the communion and at all other times in his ministration, shall use such vestments in the church as were in use by authority of parliament in the second year of the reign of Ring Edward the VI. according to the act of parliament set in the beginning of this book; in the Litany the following petition found in both the Edmarclian Prayer Books was omitted "from the tyranny of the bishop of Rome and all his detestable enormities, good Lord deliver us;" in the Communion service the two clauses of administration found in the first and second Prayer Books of King Edward's reign were combined; the rubric explanatory of "kneeling for reception," commonly known as "the Black Rubric" was omitted; in the Ordinal in the rubric before the oath of the queen's sovereignty the words "against the power and authority of all foreign potentates" were substituted for "against the usurped power and authority of the Bishop of Rome," and in the oath itself four references to the bishop of Rome, by name, were omitted.

A smouldering and growing Puritan discontent with the Prayer Book, suppressed with a firm hand under Queen Elizabeth, burst out into a flame on the accession of King James I. in 1603. A petition called the millenary petition, because signed by no less than 1,000 ministers, was soon presented to him, asking, among other things, for various alterations in the Prayer Book and specifying the alterations desired. As a result the king summoned a conference of leading Puritan divines, and of bishops and other leading Anglican divines, which met under his presidency at Hampton Court in Jan. 1604. After both sides had been heard, certain alterations were determined upon and were ordered by royal authority, with the general assent of Convocation. These alterations were not very numerous nor of great importance, but such as they were they all went in the direction of catholicizing rather than of puritanizing the Prayer Book; the one exception being the substitution of some chapters of the canonical scriptures for some chapters of the Apocrypha, especially of the book of Tobit. Alterations were introduced into the service for the private baptism of children in houses, with the object of doing away with lay baptism and securing the administration by the minister of the parish, or some other lawful minister; and the concluding portion of the Catechism, consisting of 11 questions on the sacraments, was now added.

The next important stage in the history of the Prayer Book was its total suppression in 1645 for a period of 15 years, "the Directory for the Public Worship of God in the Three Kingdoms" being established in its place. The restoration of King Charles II. in 1660 brought with it toleration at once. Nonconformists pressed upon the king, either that the Prayer Book should not be re-introduced, or that if it were re-introduced, features which they objected to might be removed. The result was that a conference was held in 1661, known from its place of meeting as the Savoy Conference. The objections raised from the Nonconformist point of view were numerous and varied, but they were thoroughly discussed between the first meeting on April 15 and the last on July 24, 1661; the bishops agreeing to meet the Puritan wishes on a few minor points but on none of fundamental importance. Later in the year, between Nov. 20 and Dec. 20, Convocation assembled and undertook the revision of the Prayer Book. In the earlier part of the following year the book so revised came before parliament. No amendment was made in it in either house and it finally received the royal assent on May 19, 1662, being annexed to an Act of Uniformity which provided for its coming into general and compulsory use on St. Bartholomew's Day (Aug. 24).

The alterations thus introduced were very numerous, amounting to many hundreds and many of them were more important than sny which had been introduced into the Prayer Book since 1552. Their general tendency was distinctly in a Catholic as opposed to a Puritan direction, and the 2,000 Puritan incumbents who vacated their benefices on St. Bartholomew's Day rather than accept the altered Prayer Book bear eloquent testimony to that fact. Among the important alterations, the following may be named as of special interest.

(a) The preface "It hath been the wisdom of the Church of England," etc., composed by Sanderson, bishop of Lincoln, was prefixed to the Prayer Book. (b) The authorized version of the Bible of 1611 was taken into use, except in the case of the Psalms, where the great Bible of 1539–1540 was retained as much smoother for singing, and in parts of the Communion service. (*c*) The rubric preceding the absolution in Morning and Evening Prayer, viz.: "The absolution to be pronounced by the minister alone," was altered into "The Absolution, or Remission of Sins, to be pronounced by the priest alone, standing; the people still kneeling." (d) In the Litany the phrase "Bishops, Pastors and Ministers of the Church," was altered into "Bishops, Priests and Deacons," and in the clause commencing "From all sedition and privy conspiracy," etc., the words "rebellion" and "schism" were added. (e) In the Communion service two rubrics were prefixed to the prayer "for the whole state of Christ's Church militant here in earth" ordering the humble presentation and placing of the alms upon the Holy Table, and the placing thereon then of so much Bread and Wine as the priest shall think sufficient; and the commemoration of the departed was added to the prayer itself. (f) The rubric explanatory of the posture of kneeling for reception, known as the Black Rubric, which had been added in 1562, but omitted in 1559 and 1604, was re-introduced; but the words "to any real and essential presence there being of Christ's natural flesh and blood" were altered to "unto any Corporal Presence of Christ's natural Flesh and Blood"—a very important and significant alteration which affected the meaning of the whole rubric. (g) A new office was added for the Ministration of Baptism to such as are of riper years. (*h*) A rubric was prefixed to the Order for the Burial of the Dead, forbidding that order to be used "for any that die unbaptized, or excommunicate, or have laid violent hands upon themselves." (i) In the "Ordering of Priests," and "the Consecration of Bishops," in the formula for ordination, after the words, "Receive the Holy Ghost," these words were added "for the Office and Work of a Priest (or Bishop) in the Church of God, now committed unto thee by the Imposition of our hands."

No substantial alteration has been made in the Prayer Book since 1662. But in 1859 the special services prescribed for Nov. 5, Jan. 30 and May 29 (which had an essential political significance) were abolished by royal warrant, chronicled as having obtained the sanction of the Convocations of Canterbury and York, and also legal force by act of parliament. In 1871 a revised Lectionary was substituted for the previously existing one, into the merits and demerits of which it is not possible to enter here; and in 1872, by the Act of Uniformity Amendment Act, a shortened form of service was provided instead of the present form of Morning and Evening Prayer for optional use in other than cathedral churches on all days except Sunday, Christmas Day, Ash Wednesday, Good Friday and Ascension Day; provision was also statutably made for the separation of services, and for additional services, to be taken, however, except so far as anthems and hymns are concerned, entirely out of the Bible and the Book of Common Prayer. In 1901 new forms of prayer, with Thanksgiving, were prepared by Convocation and authorized by royal warrant, and in 1922 a new Lectionary was issued for use in morning and evening prayer throughout the year.

Movements **for** Revision.—Since 1910 there has been a great movement for the revision of the Prayer Book in almost all branches of the Anglican Church. In Scotland some suggestions were made in the Synod of 1911, when a schedule of permissible variations to, and deviations from, the Prayer Book was drawn up, and a revised text of the Scottish liturgy was authorized. In 1919 a more complete revision was undertaken by the consultative council on Church legislation, a body consisting of bishops, clergy and laity sitting together without legislative power. The result of its labours from 1919 to 1924 was contained in a series of reports. In America revision was inaugurated in 1913 by the appointment of a Revision Commission of the General Convention, consisting of seven bishops, seven presbyters and seven laymen. The work had been going on continuously since then until, in 1925, the last stages were reached. A considerable number of the changes have been already ratified, and, after the ratification of the changes, approved in Oct. 1925, at New Orleans by the General Convention, in 1928 a Prayer Book according to the standard of 1928 will be published. In *South* Africa two tentative alternative uses for the Communion Office were put forward. This was followed by the definite issue of an alternative liturgy, which was sanctioned for use in the province at a provincial synod held in 1924, to be used when desired by the priest and people in the parish. In Canada a new Prayer Book has betn issued. It carefully avoids making any changes in the Communion Office or any changes involving doctrine, but adds a large number of services adapting the worship of the Church to the needs of the day. In *Ireland* a new revision is being undertaken for which a committee was appointed in 1909.

Proposals were made for a revision of the English Prayer Book on the accession of William III. in 1689, but they came to nothing. The subject was much to the fore between 1857 and 1863. Revision proposals were made in 1879, but came to nothing. The later movement for revision dates from the Royal Commission which was appointed on April 23, 1904, to inquire into "the alleged prevalence of breaches or neglect of the law relating to the conduct of Divine Service in the Church of England." This reference inevitably led to the consideration of a general revision of the book; and Convocation took up this task in 1906, though it was stated that it is not desirable at present to introduce into the text of the Prayer Book any changes, but they should be embodied in another volume to be sanctioned for optional use for a determined period. The work of revision went on for many years. The whole matter went through the hands of each House of Convocation separately, of the Joint Committee of both Provinces and then of each House again.

The result of this work was taken up by the Church Assembly when it was formed. A committee was appointed and the report of the Assembly on the revision of the Prayer Book was ultimately published under the auspices of the National Assembly (N.A.84). But when the moderate and somewhat conservative proposals which had been put forward by Convocation appeared in the fuller light of the Assembly many new factors came into consideration and different groups or parties in the Church took the matter of revision up with great keenness, so there was issued a series of new proposals. These were contained in the Green Book, issued by the English Church Union, the Grey Book, issued by a committee which was supposed to represent the Life and Liberty Movement, the Yellow Book, issued under the auspices of the Alcuin Club, an attempt to embody these suggestions in one book, and some white papers, representing a still more extreme view.

Reasons for Revision. — It may be convenient to sum up the reasons for the amendment of the Prayer Book. Speaking generally, they are the desire to adapt a book which dates from 1662 to the needs of the time. (1) A desire to do away with old-fashioned expressions, phrases unsuitable to the taste of the time, and statements inconsistent with modern thought. On this point there is considerable variation of opinion, many being attached even to the archaisms of the Prayer Book, others finding them difficult or even offensive. (2) A desire to adapt the Prayer Book to the changed usages of the Church which have gradually grown up, to accommodate law to custom. (3) Some desire that the Prayer Book should be revised so as to make the restoration of law and order in the Church possible. It is recognized that the existing Prayer Book cannot reasonably be obeyed in various points. It is proposed that there should be a rule of worship adapted to the present time with a reasonable latitude in the way of variations allowed, and that this should be enforced on the clergy. (4) There is a great desire to adapt the Prayer Book to the far wider religious and social aspirations of the present day. There is a great demand that religious worship should be brought much more closely into touch with the life of the people. (5) A desire felt, particularly by one party in the Church, arising from the great growth among them of sacramental ideas of worship. It is desired to give far greater opportunity for this in the new Prayer Book, and to accommodate it more closely to the traditional liturgical customs of the Church.

The final proposals embodied in the revised Prayer Books submitted to parliament in 1927 and 1928, and the events which ensued, are dealt with in *The Church* in the Twentieth Century, under article ENGLAND, CHURCH OF.

BIBLIOGRAPHY.—The following additional references, on the history of the Book of Common Prayer to the end of the 19th century, may be given here. W. Palmer, *Originès* Liturgicae, 4th ed. (1845); J. H. Blunt, Annotated Book of Common Prayer (1866); H. B. Swete, Church Services and Service Books before the Reformation (1896); L. Pullan, *History* of the Book of Common Prayer (1900); F. E. Brightman, The English Rite (1915); and *The* Prayer Book Dictionary (1912).
(F.E. WA.; A. C. HE.; X.)

PRAYERS FOR THE DEAD. Wherever there is a belief in continued existence through and after death, religion naturally concerns itself with the relations between the living and the dead. In the ancient practices and doctrines of the Judaeo-Christian tradition prayers for the dead have an important place. The practice of the Old Testament Jews is expressed in II Mac. xii:43–44, where it is related that Judas sent "twelve thousand drachmas of silver to Jerusalem for sacrifice to be offered for the sins of the dead. . . . It is a holy and a wholesome thing to pray for the dead that they may be loosed from sin." The Gospels are not explicit in the matter but indications of early Christian practice are found in the letters of St. Paul. In I Cor. xv:29, he refers to the custom of Christians being baptized for those who had died without baptism. This at least bears witness to their belief in the efficacy of works for the dead. In II Tim. i:16–18 Paul seems to pray for Onesiphorus, then dead. Outside the Bible, early use of prayers for the dead is found in the inscription on the tomb of Abercius of Hieropolis in Phrygia (see Lightfoot, Apostolic Fathers, vol. i): "Let every friend who observeth this pray for me," *i.e., Abercius,* who died in the latter part of the second century. The inscriptions in the Roman catacombs bear similar witness to the practice, by the occurrence of such phrases as "Mayest thou live amongst the saints" (3rd century); "May God refresh the soul of . . ."; "Peace be with them." Among Church writers Tertullian is the first to mention prayers for the dead: "The widow who does not pray for her dead husband has as good as divorced him" (beginning of the 3rd century). Subsequent writers similarly make incidental mention of the practice as prevalent, but not as unlawful or even as disputed (until Aerius challenged it towards the end of the 4th century). The most famous instance is St. Augustine's prayer for his mother, Monnica, *Confessions* (Bk. ix).

An important element in the liturgies of the various churches consisted of the diptychs or lists of names of living and dead who were to be commemorated at the Eucharist. To be inserted in these lists was an honour, and it was out of this practice that the canonization of saints grew. In the third century we find Cyprian enjoining that there should be no oblation or public prayer made for a deceased layman who had broken a Church rule by appointing a cleric trustee under his will: "He ought not to be named in the priest's prayer who has done his best to detain the clergy from the altar." The universal occurrence of these diptychs and of definite prayers for the dead in all parts of the Church in the 4th and 5th centuries tend to show how primitive such prayers were. The language used in the prayers reflects the Old Testament, suggesting the continuance of an ancient Jewish tradition. We may cite from the so-called liturgy of St. James: —

> "Remember, O Lord, the God of spirits and of all flesh, those whom we have remembered and those whom we have not remembered, men of the true faith, from righteous Abel unto to-day; do thou thyself give them rest there in the land of the living, in thy kingdom, in the delight of Paradise, in the bosom of Abraham, Isaac and Jacob, our holy fathers, from whence pain and sorrow and sighing have fled away, where the light of thy countenance visiteth them and always shineth upon them."

Public prayers were offered only for those who were believed to have died as faithful members of Christ. This restriction on public prayers is still enforced by the laws of the Roman Catholic Church. But where there is no danger of scandal, permission is explicitly given to offer prayers and the sacrifice of the mass privately for heretics and schismatics (Coder *Juris Canonici,* 809; 2262). Theologians commonly teach that this permission extends also to the case of mass, and a fortiori prayers, offered for infidels (cf. Cappello, De Sacramentis (1928), vol. i, n. 619).

With the development of doctrine in the Catholic Church the foundations for the practice of prayers for the dead became more clearly defined. It is seen as the consequence of (a) the doctrine that purification from sin requires, beyond divine forgiveness, a satisfaction on man's part that is offered by good works in life or by a period of suffering after death; and (b) the doctrine that the prayers and good works of the living can benefit the souls of the dead who have not offered complete satisfaction for the sins whose guilt has been remitted. The authoritative statement of the Catholic Church's doctrine is in the *Decree for the Greeks* from the Council of Florence: "Likewise, if those who have truly repented of their sins have died in the charity of God before they have satisfied with fruits worthy of penance for their sins . . . , their souls are cleansed after death by purifying pains; of great benefit to them for relief from these pains are the suffrages of the faithful still alive, *i.e.*, the sacrifice of the mass, prayers and alms-deeds and other good works. . . ." (Denzinger, *Enchiridion Symbolorum,* 693). These doctrines on the existence of purgatory and the related doctrine on indulgences (*q.v.*) were opposed by the leaders of the Protestant reformation; consequently, they were inclined to disuse all prayers for the dead.

In the English communion service of 1549, after the offering of praise and thanks for all the saints, came the following: "We commend into thy mercy all other thy servants, which are departed hence from us with the sign of faith and now do rest in the sleep of peace: grant unto them, we beseech thee, thy mercy and everlasting peace." The burial service of the same date also contained explicit prayers for the deceased. In 1552 all mention of the dead, whether commemorative or intercessory, was cut out of the Eucharist; the prayers in the burial service were brought into their present form; and the provision for holy communion at a burial was omitted. The thankful commemoration of the dead in the Eucharist was restored in 1662, but prayers for them remained, if they remained at all, veiled in ambiguous phrases

The Church of England has, however, never forbidden prayers for the dead. It was proposed in 1552 to condemn the Roman doctrine *de precatione pro defunctis* in what is now the nand of the Thirtv-Nine articles, but the proposal was rejected. And these intercessions have been used in private by a long list of English divines, *e.g.,* Andrewes, Cosin, Ken, Wesley and Keble. In a suit (1838) as to the lawfulness of an inscription "Pray for the soul of . . .," the Court held that "no authority or canon has been pointed out by which the practice of praying for the dead has been expressly prohibited."

See H. M. Luckock, *After Death* (1886); E. H. Plumptre, *The Spirits in Prison* (1886); H. B. Swete, "Prayers for the Departed in the First Four Centuries," *Jour. Theol. Stud,* viii.; Arts. "Prayers for the Departed" in Hastings' *Encyc. Rel. Etk.* and "Dead, Prayers for the" in *Catk. Encyc.*

BRAYING WHEEL, used by the Buddhists of Tibet as a means of offering invocations. The smallest kind consists of a cylinder of metal or other substance turning on a handle as pivot. Outside it and on strips of paper within is inscribed the invocation to Avalokiteśvara or his consort, *Oṃ Maṇipadme hūṃ.* A weight hangs at the side, and with a slight movement of the hand the cylinder revolves. Larger wheels are made to revolve by means of wind or water.

PREACHING, the proclamation of a Divine message, and the regular instruction of the converted in the doctrines and duties of the faith, is a distinctive though not a peculiar feature of the Christian religion. The Mohammedans exercise it freely, and it is not unknown among the Buddhists. The history of Christian preaching with which alone this article is concerned has its roots (1) in the activity of the Hebrew prophets and scribes, the former representing the broader appeal, the latter the edification of the faithful, (2) in the ministry of Jesus Christ and His apostles, where again we have both the evangelical invitation and the teaching of truth and duty. Whichever element is emphasized in preaching, the preacher is one who believes himself to be the ambassador of God, charged with a message which it is his duty to deliver.

The Patristic **Age,** to the Death of St. Augustine, **430.**—From the Acts of the Apostles we gather something as to the methods adopted by St. Peter and St. Paul, and these we may believe were more or less general. The Apostles who had known the Lord would naturally recall the facts of His life, and the story of His words and works would form a great deal of their preaching. It is not until we come to Origen (d. 254) that we find preaching as an explanation and application of definite texts, a usage that Christianity adopted from Greek rhetoricians. The fourth century marks the culmination of early Christian preaching. In an age of doctrinal controversy, the intellectual presentation of the Christian position was thus developed. Preaching flourished chiefly in the East; especially noteworthy are the three Cappadocians, Basil (*q.v.*) of Caesarea, cultured, devout and practical; his brother Gregory (*q.v.*) of Nyssa, more inclined to the speculative and metaphysical; and Gregory (*q.v.*) of Nazianzus, richly endowed with poetic and oratorical gifts, the finest preacher of the three. Foremost of all stands John of Antioch, Chrysostom (q v.), who in 386 began his 12 years' ministry in his native city, and in 398 the six memorable years in Constantinople, where he loved the poor, withstood tyranny and preached with amazing power. In the West the allegorical method of Alexandria had more influence than the historical exegesis cultivated at Antioch. This is seen in Ambrose of Milan and in Hilary of Poitiers. But the only name of first rank in preaching is that of Augustine, and even he is curiously unequal. His fondness for the allegorical and his manifest carelessness of preparation disappoint as often as his profundity, his devout mysticism and his practical application attract and satisfy. Augustine's De *doctrina Christiana,* bk. iv., is the first attempt to formulate the principles of homiletics.

The Middle Ages.—After the days of Chrysostom and Augustine there was a great decline of preaching. The West did better than the East: at Rome Leo the Great and Gregory the Great could preach, and the missionaries Patrick, Columba, Columbanus, Augustine, Wilfrid, Willibrord, Gall and Boniface are known by their fruits. Then came the age when the papacy was growing out of the ruins of the old Roman empire, and the best talents were devoted to the organization of ecclesiasticism rather than to the preaching of the Word. But certain forces were at work which were destined to bring about a great revival, *e.g.,* the rise of the scholastic theology, the reforms of Pope Hildebrand and the preaching of the First Crusade by Pope Urban II. (d. 1099) and Peter the Hermit. In the 12th century the significant feature is the growing use of the various national languages in competition with the hitherto universal Latin. The most eminent preachers of the century were Bernard of Clairvaux (1091–1153), the two mystics of St. Victor, Hugo and Richard, and Peter Waldo of Lyons, who preached a plain message to the poor and lowly. The 13th century saw the culmination of mediaeval preaching, especially in the rise of the two great mendicant orders of Francis and Dominic. Representative Franciscan names are Antony of Padua (d. 1231), who travelled and preached through southern Europe; Berthpld of Regensburg (d. 1272), who, with his wit and pathos, imagination and insight, drew huge crowds all over Germany; and Francis Bonaventura, the schoolman and mystic, who wrote a little book on The *Art* of *Preaching.* Of the Dominicans Thomas Aquinas (d. 1274), the theologian, was perhaps also the greatest preacher. With the 14th century a new note, that of reformation, is struck; but on the whole there was a drop from the high level of the 13th. Among the popular preachers vigour was often blended with coarseness and vulgarity. Mysticism is represented by Suso, Meister Eckhart, above all Johann Tauler (*q.v.*) of Strasbourg (d. 1461), a true prophet in an age of degeneration. Towards the close of the century comes John Wycliffe (*q.v.*) and his English travelling preachers, who passed the torch to Hus and the Bohemians, and in the next age Savonarola.

The Reformation Period, 1500–1700.—The Reformers gave the sermon a higher place in the ordinary service than it had previously held, and they laid special stress upon the interpretation and application of scripture. The controversy with Rome, and the appeal to the reason and conscience of the individual, together with the spread of the New Learning, gave preaching a new force and influence which reacted upon the old faith. Most of the Reformation preachers read their sermons, in contrast to the practice of earlier ages. The English Book of Homilies (see HOMILY) was compiled because competent preachers were comparatively rare.

The 17th-century preaching was, generally speaking, a continuation of that of the 16th century, the pattern having been set by the Council of Trent and by the principles and practice of the Reformers. In Spain and Germany, however, there was a decline of power, in marked contrast to the vigour manifested in France and England. In France, indeed, the Catholic pulpit now came to its perfection, stimulated, no doubt, by the toleration accorded to the Huguenots up to 1685 and by the patronage of Louis XIV. The names of Bossuet, Fléchier, Bourdaloue, Fénelon and Massillon, all supreme preachers, despite a certain artificial pompousness, belong here, and on the reformed side are Jean Claude (d. 1687) and Jacques Saurin (d. 1730). In England, among Anglicans, are Andrewes, Hall, Chillingworth, Jeremy Taylor, Barrow and South; among Puritans and Nonconformists, Baxter, Calamy, the Goodwins, Howe, Owen and Bunyan. The sermons of these men were largely scriptural, the cardinal evangelical truths being emphasized with reality and vigour, but with a tendency to abstract theology rather than concrete religion.

The early years of the 18th century were a time of torpor as regards preaching. Generally speaking, sermons were unimpassioned, stilted and formal presentations of ethics and apologetics, seldom delivered extempore.

The Modern Period.—This dates from 1738, the year in which John Wesley began his memorable work. The example and stimulus given by him and by Whitefield were almost immeasurably productive. In their train came the great field preachers of Wales, like John Elias and Christmas Evans, and later the Primitive Methodists, who by their camp meetings and itinerancies kept religious enthusiasm alive when Wesleyan Methodism was in peril of hardening. Mean hile. in America the Puritan tradition, adapted to the new conditions, is represented by Cotton Mather, and later by Jonathan Edwards, the greatest preacher of his time and country. Whitefield's visits raised a band of pioneer preachers, cultured and uncultured, men who knew their Bibles but often interpreted them awry.

Preaching, in modern times, has been so varied, depending, as it largely does, on the personality of the preacher, that it is not possible to speak of its characteristics. Nor can one do more than enumerate a few outstanding modern names, exclusive of living preachers. In the Roman Catholic Church are the Italians Ventura and Curci, the Germans Diepenbrock and Foerster, the French Lacordaire, Dupanloup, Loyson (Pkre Hyacinthe) and Henri Didon. Of Protestants, Germany produced Schleiermacher, Claus Harms, Tholuck and F. W. Krummacher; France, Vinet and the Monods. In England representative Anglican preachers were: Newman (whose best preaching preceded his obedience to Rome), T. Arnold, F. W. Robertson, Liddon, Farrar, Magee; of Free Churchmen, T. Binney, R. W. Dale, Joseph Parker and J. H. Jowett (Congregationalist); Robert Hall, C. H. Spurgeon, Alexander Maclaren and John Clifford (Baptists); W. M. Punshon, Hugh Price Hughes, Peter Mackenzie and W. L. Watkinson (Wesleyan); James Martineau (Unitarian). The Scottish churches gave Edward Irving, Thomas Chalmers, R. S. Candlish, R. M. McCheyne and John Caird. In America, honoured names are those of W. E. Channing, Henry Ward Beecher, Horace Bushnell, Phillips Brooks, Harry Emerson Fosdick (1878–), to mention only a few.

See A. E. Garvie, The Christian Preacher (1920), a comprehensive survey with full bibliography. (A. J. G.)

PREADAMITES, a term signifying either (1) human races existent before Adam or (2) a 17th century Christian sect that professed belief in such races. The sect was inspired by Isaac La Peyrkre's Prae-Adanzitae (1655), which interpreted Paul's Epistle to the Romans (v. 12–14) to mean that, since "sin was in the world" before the law (that given to Adam), then there must have been human beings to sin. These were the Gentiles, whose creation is described in Genesis i., while Adam ("man") the first of the Jews, is not mentioned until Genesis ii.

PREAMBLE, a term particularly applied to the opening paragraph of a statute which summarizes the intention of the legislature in passing the measure. The procedure in the British parliament differs in regard to the preambles of public and private bills. The second reading of a public bill affirms the principle, and therefore in committee the preamble stands postponed till after the consideration of the clauses, when it is considered in reference to those clauses as amended and altered if need be (Standing Order 35). On the other hand, the preamble of a private bill, if opposed, is considered first in committee, and counsel for the bill deals with the expediency of the bill, calls witnesses for the allegation in the preamble, and petitions against the bill are then heard; if the preamble is negatived the bill is dropped, if affirmed it is gone through clause by clause. On unopposed private bills the preamble has also to be proved, more especially with regard to whether the clauses required by the standing orders are inserted (see May, Parliamentary Practice).

PREANGER (PRIANGAN), a district in the southwest of Java, Netherlands Indies, part of the province of West Java. Formerly one residency—the Preanger Regencies—it was divided into two residencies, Buitenzorg and Preanger. They are bounded north by Cheribon and Batavia, west by Bantam, east by Banjumas and Cheribon and south by the Indian ocean. Pop. (1930): Buitenzorg 2,212,997, Preanger 3,448,796. The natives are Sundanese. The whole district is mountainous, and contains a large number of both active and inactive volcanoes, including the well-known Salak and Gedeh in the north, and bunched together at the eastern end the Chikorai, Papandayan, Wayang, Malabar, Guntur, etc., ranging from 6,000 to 10,000 ft.

The greatest rivers are the Chi Manuk and the Chi Tarum, both rising in the eastern end of the province and flowing northeast and northwest respectively to the Java sea, and the Chi Tandui, flowing southeast to the Indian ocean. Crater lakes are Telaga (lake) Budas, in the crater of the volcano of the same name in the southeast, and Telaga Warna, on the slopes of the Gedeh, famous for its beautiful tinting. There are also other small lakes—Bagendit, Leles, Penjalee, etc. On the side of the Gedeh is the health resort of Sindanglaya (3,500 ft.), with a mineral spring containing salt.

Numerous warm springs are scattered about this volcanic region. The soil is in general very fertile, the principal products being rice, maize, cassava and pulse (kachang) and rubber in the lower grounds, and cinchona, coffee and tea. as well as cocoa, coca, tobacco and fibrous plants in the hills. The coffee cultivation has, however, diminished considerably. Irrigation works have been carried out in various parts. The principal towns are Bandung, the capital of Preanger; Buitenzorg, the site of world-famous botanical gardens; Sukabumi (34,191); Tasikmalaja (25,605) with its native wicker industry and Chianjur (20,812), Sumedang, Chibatu, Chichalengka, Garut and Manon Java; all with the exception of Sumedang connected by railway. The Preanger became Dutch in 1704, after the trouble with Susuhunan, Amangku Rat II. From the time of the British reform of the administration in Java by Sir Stamford Raffles (1811–16), it was known generally as the Preanger Regencies.

The district of Preanger was occupied by the Japanese in March 1942.

PRE-CAMBRIAN. Pre-Cambrian and Archaean, in geology, are used synonymously by certain authors and are so employed in this article. The term Archaean, however, is often used in a restricted sense to include only the oldest rocks, the Keewatin and Laurentian, for example, in North America.

Age and Features.—The pre-Cambrian includes all formations below the beds containing *Olenellus* fauna. A great unconformity, or time break, generally separates the Cambrian from the pre-Cambrian, although in a few regions there seems to be no unconformity, and the Olenellus beds appear to pass downwards conformably into underlying beds holding a few fossils older than the *Olenellus*.

The pre-Cambrian rocks are believed to underlie everywhere the Palaeozoic and all later formations; and wherever erosion has penetrated deeply enough the pre-Cambrian formations have been brought to light. They are the most ancient of any exposed on the crust of the earth, and may have required more than half of all geological time for their formation. Their age can be only approximately estimated, the estimate varying within wide range —48,000,000 to 1,710,000,000 years. These venerable formations, which are now exposed over one-fifth of the land surface of the earth, consist dominantly of granitic rocks, massive gneissoid, or banded in texture. Sediments and lava flows, while occurring in great thickness in some regions, are subordinate. In many parts of the world the rocks have been tremendously altered, and now consist of schists and gneisses of almost infinite variety.

Fossils are exceedingly rare and poorly preserved. Indeed, certain geologists consider that the evidence for the occurrence of fossils is hardly conclusive. This sparsity of fossils is the main feature which distinguishes the pre-Cambrian from Palaeozoic and later eras. On the whole, too, the rocks are more altered and metamorphosed than are those of later formations. On account of their generally metamorphosed state their structural and age relationships are complex and difficult to unravel, and much work remains to be done. Owing to the almost total absence of fossils no satisfactory way has been discovered of definitely correlating pre-Cambrian formations of one continent with another. Nevertheless it may be pointed out that the very oldest known rocks possess pronounced similarities, chief of which is the fact that they consist in many regions of lava flows of basic and intermediate composition. Moreover, the flows are interbanded in many areas with very striking beds of brilliant red jaspilite and banded hematite-magnetite-quartz rock commonly called iron formation. In Canada these lava flows have been named Keewatin. Certain writers have cautiously suggested that the Keewatin might, be correlated, tentatively, with similar rocks in South Africa, India and West Australia.

For much of pre-Cambrian time conditions on the surface of the earth appear to have been similar, in some respects at least, to conditions in later eras. Water played the same role then as it does to-day; rocks were deeply eroded, and conglomerates, sandstones and other sediments were deposited in the same manner as at the present time. It is believed, too, by certain geologists that ice ages occurred in north-eastern Ontario, China, India, Australia, and elsewhere; but in the first mentioned this has not yet been definitely established. Volcanic activity was intense, and lava flows in enormous thickness were poured out. Indeed, in the earliest (Keewatin) epoch of geological history volcanic activity as indicated by lava flows appears to have reached an intensity possibly never afterwards rivalled. The base on which these old flows were laid down has not been discovered.

Economic Importance. — The pre-Cambrian is economically of much importance on account of the valuable mineral deposits which it contains. The greatest gold mines in the world, those of the Transvaal, occur in these rocks, as do also the gold mines of India, Ontario, West Australia, Southern Rhodesia, Brazil and South Dakota. The pre-Cambrian, too, contains the greatest iron and nickel mines in the world, the latter at Sudbury, Canada, the former in the Lake Superior region of the United States. Copper is found in immense deposits. A variety of useful, non-metallic products also occur, including mica, talc, graphite, corundum, felspar, marble and other materials. The mineral production from the pre-Cambrian throughout the world is increasing, and our knowledge of these ancient complex rocks is advancing.

Canada. — The most extensive region of pre-Cambrian rocks is exposed in Canada, over a stretch of country estimated at 1,800,000 sq. miles. This great expanse surrounds Hudson Bay on the E., S. and W., and from its shape has been named the Canadian Shield; its southern fringe extends into the United States mainly around Lake Superior. Canada was the first country in which the pre-Cambrian formations were systematically studied and subdivided, the pioneer work having been accomplished during the middle of the last century by Sir William Logan, the father of pre-Cambrian geology, and owing to the great importance of the gold, silver, nickel, copper and cobalt mines, detailed geological mapping has been done, particularly since 1900 in the province of Ontario. The result has been that the pre-Cambrian formations of this region have been more closely studied and mapped than has any other of similar magnitude, and the classification so laboriously worked out in Ontario may be used as a guide or standard by geologists working on similar rocks elsewhere.

Though the rocks of Ontario have been studied in much detail practically only the southern fringe of the pre-Cambrian of Canada has been touched, and it will probably be many years before the vast inland regions will be mapped and the stratigraphy worked out. In N.-E. Ontario the rocks have been divided into three major divisions, upper, middle, and lower, based on two major periods of erosion. A great unconformity alike separates the upper from the middle and the middle from the lower. Granites of at least three ages have been recognized, viz., commencing with the oldest, the Laurentian, Algoman and Killarnean. On account of their similarity it has not been found possible to separate these three granites over large areas.

The following classification has been adapted by the Ontario Department of Mines, the youngest rocks being shown at the top of the column:—

Classification of Pre-Cambrian Rocks at Cobalt and Lake Timiskaming, in North-Eastern Ontario, Canada

Upper	KEWEENAWAN Nipissing diabase, etc. ANIMIKEAN Cobalt series—conglomerate, etc.
	GREAT UNCONFORMITY
Middle	MATACHEWAN Diabase, etc. ALGOMAN Lorrain granite. HAILEYBURIAN Lamprophyre, diabase, ctc. TIMISKAMIAN Conglomerate, etc.
	GREAT UNCONFORMITY
Lower	LAURENTIAN Represented by granite pebbles in Timiskamian conglomerate. LOGANIAN Grenville—iron formation, etc., in minor quantity; elsewhere much crystalline limestone, etc. Keewatin—Basic lavas, etc.

The classic name Huronian is not used in this classification, confusion having arisen owing to its employment in different senses.

The most ancient rocks in N.-E. Ontario, the Keewatin series, constitute one of the greatest outpouring of lavas in the history of the earth's crust, and are of immense thickness. The flows, which are in part at least of submarine origin, are composed dominantly of basalts and andesites in which pillow structure is commonly developed. Dacites and rhyolites are subordinate. Interbedded with the flows are subordinate bands of volcanic ashes and brilliant red jaspilites. In S.-E. Ontario crystalline limestones, known as the Grenville series, occur in great volume; this series is believed to have been deposited mainly towards the close of the Keewatin, there being no unconformity between the two. The basement on which the lava originally rested has nowhere been positively recognized. In W. Ontario there is a highly altered sedimentary series, known as the Coutchiching, which is believed by certain workers to be older than the Keewatin lava flows, but its stratigraphic position has not been generally agreed on, and the subject is still controversial.

The Keewatin occupies many isolated areas in the Canadian shield varying from a few to about 10,000 sq. miles. These isolated masses are surrounded and, apparently, supported by granite, which occurs in by far the greater volume. Wherever the contacts with the Keewatin and granites have been closely studied the granites have been found to be intrusive, and therefore younger than the Keewatin. The Laurentian includes only those granites which rest unconformably below the Timiskamian sediments. As detailed work progressed it was found that the Laurentian granites were difficult to recognize, 'and, indeed, in N.-E. Ontario have not as yet been discovered. The Timiskamian sediments, which occur in narrow sharply folded synclines, contain many granite pebbles and boulders. In N.-E. Ontario the granite (Laurentian) from which these granite fragments were derived has not as yet been recognized. The unconformity at the base of the Timiskamian is profound. The Timiskamian sediments are intruded by the basic Haileyburian rocks, and both Haileyburian and Timiskamian have been intruded by widespread masses of granites known as Algoman. The Matachewan basic intrusives, which cut the Algoman, are found in small volume. Above the Algoman and all the other rocks mentioned rest the Animikean sediments, of which the Cobalt series at Cobalt, Ontario, forms a part. These sediments rest in horizontal or gently inclined positions, and differ in this respect from the closely folded Timiskamian. The unconformity at the base of the Cobalt series is, like that at the base of the Timiskamian, very great.

On the north shore of Lake Huron there is a thick series of sediments to which the name Huronian was given by Sir Wm. Logan. These have not as yet been satisfactorily correlated with the Timiskamian or Cobalt series; unconformities have been found within them but these are of minor importance compared with that at the base of the Timiskamian or that at the base of the Cobalt series.

The Keweenawan in N.-E. Ontario is represented by the Nipissing diabase at Cobalt and by the nickel eruptive (norite-micropegmatite) at Sudbury. On the shores of Lake Superior the Keweenawan consists of a great thickness of sediments and lava flows. A minor unconformity has been found to exist between the Keweenawan and the Animikean. Granites are found in the Sudbury area, Ontario, cutting the Keweenawan nickel eruptive, and they belong to the third period of granitic intrusion, named the Killarnean. The pre-Cambrian era in North-Eastern Ontario was closed by the intrusion of fresh olivine diabase dikes which intersect all the older rocks and which in certain regions may be traced for many miles.

In that almost unexplored region of the Canadian Shield between the Atlantic on the E. and Great Slave and Great Bear lakes on the W. there is very little known regarding the rocks. They appear to consist largely of granites and gneisses; and a few isolated areas may correspond to the Keewatin and Timiskamian series. Late pre-Cambrian sediments relatively undisturbed occur along the Labrador coast, inland to the South of Ungava Bay, on the E. coast of Hudson Bay, on the Belcher Islands of that coast, on the S. side of Athabaska Lake, and in the Coppermine River area—where the rocks attain the thickness of over g miles and are known as the Coppermine River series. They resemble the Keweenawan series on the S. shore of Lake Superior, and like that series the Coppermine River group also contains deposits of native copper.

In the western part of Canada, including British Columbia and the Yukon, there are areas of pre-Cambrian rocks. In southern British Columbia the pre-Cambrian sediments attain great thickness, the Purcell series consisting of more than 20,000 ft. of sediments, mostly argillaceous quartzites.

United States.—In the Lake Superior region, where the pre-Cambrian rocks have been intensively studied by Leith and Van Hise, they have been sub-divided as follows, commencing with the youngest:

Algonkian	Keweenawan	w Proterozoic
	Huronian	
Archaean	Laurentian	
	Keewatin	

There have been, as in Ontario, three periods of granitic intrusions, namely, at the close of the Archaean, at the close of the Lower—Middle Huronian, and in Keweenawan times. The first has been called the Laurentian. The other t o are not specifically named, but in general correspond respectively to what has been called Algoman and Killarnean in Ontario. The Huronian is divided into three unconformable series, lower, middle and upper. The lower appears to correspond, in certain areas, with the Timiskamian of Ontario. Two major unconformities are recognized, one at the base of the upper, and one at the base of the lower (Knife Lake Series). Two others, at the base of the Keweenawan and at the base of the middle Huronian, are distinct but not conspicuous. The two major unconformities appear to correspond with those in Ontario at the base of the Animikean and of the Timiskamian respectively.

In Montana and northern Idaho there is a very thick series, consisting largely of sandstones and shales, known as the Beltian series; the pre-Cambrian sediments in the Grand Canyon of Arizona—the Grand Canyon series—are magnificently exposed; in the Adirondacks (New York State) the Grenville sediments are found; and in Pennsylvania, Maryland and Northern Virginia the Glenarm series of metamorphosed pre-Cambrian sediments.

British Isles.—In the British Isles the pre-Cambrian rocks have their greatest development in Scotland, but isolated areas of considerable interest and importance are also known in the Isle of Anglesey, N. Wales, S. Wales, the Welsh Borderland and the English Midlands.

Taken as a whole they fall into two main groups, an older group composed mainly of highly crystalline Schists and Gneisses, separated by a great unconformity from a younger relatively unaltered group of sediments and volcanic rocks. The older group of Schists and Gneisses has its most extensive development in the Highlands of Scotland of which it forms by far the larger part; here it includes the Glen Elg Schists, the Lewisian Gneisses, a highly altered plutonic complex, the Moinian, and the Dalradian Schists. The Glen Elg Schists, like the Moinian and Dalradian, consist in the main of a series of highly metamorphosed sediments of various kinds, though the Dalradian also contains schists of volcanic and hypolysed origin. The relative ages of these Schist Groups has afforded a matter for considerable controversy, and the matter cannot yet be regarded as definitely settled.

Crystalline Schists are also developed in the Isle of Anglesey, and on the coasts of Devon (Start), and Cornwall (Lizard).

The younger group of pre-Cambrian rocks is represented in N.W. Scotland by the Torridonian rocks, red felspathic sandstones and conglomerates, usually held to have accumulated under arid conditions, and believed to show considerable resemblance to the Keweenawan sandstones of America and the Jotnian sandstones of Fennoscandia.

In southern Britain a wider range of rock types is found; in W. Shropshire rocks of Torridonian type are found overlying with apparent unconformity a series of sandstones, grits, flags and shales predominantly grey in colour, the whole being referred to the Longmyndian Series. Elsewhere the pre-Cambrian rocks are mainly volcanic in origin, and include a series of lavas and tuffs of varied composition referred collectively to the Uriconian Series.

The relation of the Uriconian to the Longmyndian is difficult of determination; it possibly intervenes between the "red" and the "grey" Longmyndian.

Fennoscandia.—J. J. Sederholm bases his classification of pre-Cambrian rocks in Fennoscandia (*i.e.,* Scandinavia and Finland regarded as a geological unit) on the relations of sedimentary and other rocks to four great intrusions of granites, named (commencing with the youngest) Rapakivi, post-Kalevian, post-Bothnian and Katarchean. The oldest rocks, called Svionian, consist in part of schisted lavas, tuffs and crystalline limestones and are penetrated by the Katarchean granites. Unconformably overlying the Svionian and Katarchean granites is the Bothnian, the coarse conglomerates of which are reminiscent of the Timiskamian conglomerates of Ontario. The Bothnian is penetrated by the post-Bothnian granites. The Jatulian-Kalevian formations, which resemble the Huronian in Ontario, rest with great unconformity on the older rocks referred to above. The Jatulian-Kalevian sediments have been metamorphosed by post-Kalevian granites which are said to be analogous to the Algoman granites of Ontario. The Rapakivi granites are younger than all of the rocks just described. The youngest series of pre-Cambrian sediments belong to the Jotnian, the beds of which rest unconformably and generally almost horizontally on the older rocks. The Jotnian red sandstones have been compared with the Keweenawan of N. America.

South Africa.—Cambrian fauna have not as yet been recognized in South Africa; but, although the oldest fossils known are Devonian, it is believed that the pre-Devonian rocks are certainly largely pre-Cambrian. The pre-Devonian formations occupy an enormous stretch of country but in the central part they are almost entirely covered by vast areas of sand. Du Toit classifies them as follows:—

WATERBERG SYSTEM	Waterberg, Matsap and Umkondo Systems
ROOIBERG SERIES	Felsites and Sediments
TRANSVAAL SYSTEM	Pretoria and Griquatown Series Black Reef, Dolomite and Campbell Rand Series and Lomagundi System
NAMA SYSTEM	Fish River and Ibiquas Series Kuibis, Nieuwerust, Schwarzkalk, Otavi Dolomite and Malmesbury Series
VENTERSDORP SYSTEM	Zoetlief and Pniel Series.
WITWATERSRAND SYSTEM	Upper and Lower WWR.
PRIMITIVE SYSTEMS	Rhodesian Schists, Eldorado, Moodies, Pongola, Kheis, Kraaipan, Chanse, etc.

The oldest rocks have been named Primitive by Du Toit, and they are also known as the Swaziland system. In Rhodesia, the basal rocks—the Rhodesian schists—of the Primitive system are altered basic lava flows, commonly showing pillow structure, associated with bands of brilliant red jaspilite and banded ironstones; they are intruded by "old granite," and resting unconformably on them and "old granite" is a series of folded sediments known as the Eldorado series. The latter is intruded by younger granite. In Barberton and neighbouring portions of Swaziland the Jamestown and Onverwacht series of the Primitive system consists of basic lavas with subordinate cherty bands. The Moodies series of sediments is apparently 20,000 to 30,000 ft. thick; its age relation to the lavas is not definitely known. The Jamestown, Onverwacht and Moodies series are intruded by the "old granite."

In the Transvaal the Witwatersrand series rests with marked unconformity on the Primitive system. The Witwatersrand has a maximum thickness of almost 25,000 ft. and consists of quartzites, slates, and conglomerates. Certain conglomerate beds, regarded as placer in origin, contain gold, and these constitute the greatest known gold deposits in the world.

The Ventersdorp system, made up of lavas and minor amounts of sediments, rests unconformably on the Witwatersrand system; the Transvaal-Nama system of sediments, including a great dolomite formation, overlies this unconformably. The felsites of the Rooiberg series are regarded as the upper part of the Transvaal system.

The Waterberg system is the youngest of the pre-Cambrian. The rocks are mainly of sandstones and rest unconformably on the Transvaal. The Torridonian of Scotland compares with it.

India.—The pre-Cambrian of India consists of two main groups (a) a great mass of gneisses, crystalline schists, and plutonic rocks, named by T. H. Holland the Vedic, and (b) a group of unfossiliferous sedimentary rocks named by Holland the Purana group and suggestive of the Animikean and Keweenawan of Canada. Group (b) includes many isolated areas of sediments, of great thickness, little disturbed and resting with great unconformity on the Vedic group. Holland has tentatively classified the Vedic rocks as follows, commencing with the youngest:—5, Post-Dharwar, eruptives; 4, Dharwar systems; 3, Bundelkhand type of deformed eruptives; 2, Bengal type of Schists; 1, oldest gneisses.

There appear to be at least two periods of granitic intrusions, one (the Bundelkhand) cutting the Bengal schists, and the younger (post-Dharwar eruptives) cutting the Dhanvar system. It has been cautiously suggested that the Bundelkhand granites may be comparable with the Laurentian of Canada, and the post-Dharwar eruptives with the Algoman of Canada. The Bengal Schists are thought to be comparable with the Keewatin of Canada. The Dharwar system is much altered and folded, and contains lava flows, and banded jaspers characteristic of the Keewatin iron formation of Canada; sediments possibly corresponding to the Timiskamian may be recognized when further work is accomplished. The chief gold mines in India, those of the Kolar gold field, occur in rocks belonging to the Dharwar system. The post-Dharwar eruptives include granites and the elaeolite-syenites of Coimbatore.

Western Australia.—In the pre-Cambrian rocks of Western Australia no general sequence has yet been established, although in restricted areas the age relationships have been worked out. The rocks consist dominantly of gneisses, schists and granites; amphibolites everywhere play an important part, and bands of chert and brilliantly coloured jaspers constitute noticeable features and are identical with those in India, Rhodesia and East Transvaal.

The crystalline schists, some of which bear a close resemblance to the Keewatin of N. America, are divided into two groups: (a) an older group made up of mica-quartz-schist and marble associated with basic rocks which have in certain localities been converted into greenstone-schists, and (b) a younger group of conglomerates, arkoses, quartzites, slates and phyllites (the Mosquito Creek and other series). They have been intruded by great batholiths of granite covering some hundreds of sq. miles.

A younger series of little altered rocks, known as the Nullagine formation, consists of sandstones, quartzites, conglomerates, and dolomitic limestones, together with a series of lavas, ashes and agglomerates. The beds generally repose at horizontal or inclined angles, and rest with great uncomformity on the older rocks.

Brazil.—The pre-Cambrian covers large areas in Brazil, but little detailed work has been done. The oldest rocks have been named Archaean and consist of gneiss, granite and schist. There are also metamorphosed sediments, classed as Algonkian, made up of quartzites, iron formation, argillaceous schists and limestones. These Algonkian sediments contain great deposits of iron ores. One of the deepest gold mines, the Morro Velho mine of the St. John Del Rey Mining Company, occurs in pre-Cambrian calcareous schists and slates.

China.—In China there is a basal group of rocks consisting of gneisses and schists, including green schists, to which the name T'ai-shan complex has been given and which may correspond, in part, with the Keewatin of the N. American continent. The T'ai-shan complex is intruded by granites. Resting with great unconformity on these rocks is a highly altered, folded series of sediments known as the Wu-T'ai system, the conglomerates of which contain granite pebbles, proving the existence of granite older than this system. There are believed to be unconformities within the Wu-T'ai system; and granites are intruded into it. Some of the more altered sediments of the Wu-T'ai are suggestive of Lower Huronian rocks of the Lake Superior region.

Overlying the Wu-T'ai rocks with marked unconformity is the little altered Hu-t'o system, consisting of conglomerate, quartzite, shale and limestone. The Wu-T'ai and Hu-t'o systems have been classified by Bailey Willis as Proterozoic. (C. W. K.)

BIBLIOGRAPHY.—General. L. V. Pirsson and C. Schuchert, *Textbook of Geology* (2nd ed. 1919, vol. ii.); F. R. C. Reed, *Geology of the British Empire* (1921); Sir A. Geikie, *Textbook of Geology* (4th ed. 1923); "Pre-cambrian rocks of the world" (Br. Ass. Ad. Sc., Toronto, 1924), *Journal;* "Symposium on pre-Cambrian Geology" (*Bull.* Geol. Soc. Am., vol. 38, Nos. 1 and 4).

Canada. W. G. Miller and C. W. Knight, "Revision of pre-Cambrian in Ontario," *Journal,* vol. 23 (1915); F. D. Adams, *Problems of the Canadian Shield* (1915); W. G. Miller and C. W. Knight, *Pre-Cambrian geology of south eastern Ontario,* vol. 22 (1924); A. C. Coleman and W. A. Parks, *Elementary Geology* (1922); *W.* G. Miller, "Pre-Cambrian rocks of Canada" (Br. Ass. Ad. Sc., Toronto, 1924), *Journal,* pp. 32–33; G. A. Young, "Geology and economic minerals of Canada" (Geol. Sur. Can., 1926).

United States. M. G. Wilmarth, "Geologic Time Classification of the United States Geological Survey compared with other Classifications" (U.S. Geol. Sur., *Bull.* 769, 1925); C. K. Leith, "Lake Superior Pre-cambrian" (*Bull.* Geol. Soc. Am., vol. 38, Nos. 1 and 4, 1927).

British Isles. W. G. Miller, "A geological trip to Scotland; pre-Cambrian of north-west Highlands compared with that of Ontario" (Ont. Dept. Mines; vol. 20, pt. 1, pp. 259–269, 1911); A. Strahan, "Subdivisions and correlation of the pre-Cambrian rocks of the British Isles" (Int. Geol. Cong. XII., 1913; *Compte Rendu,* pp. 339–347); P. Lake and R. H. Rastall, *Tertbook of Geology* (4th ed., 1927).

Fennoscandia. J. J. Sederholm, "Pre-Cambrian Geology of Fennoscandia, with special reference to Finland" (*Bull.* Geol. Soc. Am., vol. 38, Nos. 1 and 4, 1927).

S. Africa. F. R. C. Reed, *Geology of the British Empire* (1921); Alex. L. Du Toit, Geology of S. Africa (1926); A. W. Rogers, "Pre-Cambrian rocks of the Union of S. Africa" (*Bull.* Geol. Soc. Am., vol. 38, Nos. 1 and 4, 1927).

India. F. R. C. Reed, *Geology of the British Empire* (1921); Sir T. Holland, "Pre-Cambrian rocks of India" (Br. Ass. Ad. Sc., Toronto,

1924); *D. N.* Wadia, *Geology of India (1926)*.
W. Australia. A. G. Maitland and A. Montgomery, "Geology and Mineral Industry of W. Australia" *(Bull. 89,* Geol. Sur. W. Australia); F. R. C. Reed, *Geology of the British Empire* (1921).
Brazil. E. C. Harder and R. T. Chamberlin, "Geology of Central Minas Geraes, Brazil" (*Jour. Geology,* vol. *23, 1915); J. C.* Branner, "Outlines of the geology of Brazil to accompany the geological map of Brazil" *(Bull.* Geol. Soc. Am., vol. 30, no. 2, 1919).
S. America. B. L. Miller and J. T. Singewald, *Mineral* Deposits of *S. America.*
China. *B.* Willis, "Research in China" (Carnegie Inst. of Washington; vols. i. and ii., 1907).

PRECEDENCE. This word in the sense in which it is here employed means priority of place, or superiority of rank. In Great Britain the crown is the fountain of honour, and has the undoubted prerogative to confer such rank and place as to it may seem convenient. In the old time all questions of precedence came in the ordinary course of things within the jurisdiction of the court of chivalry.

In 1539 an Act "for the placing of the Lords in Parliament" (31 Hen. VIII. c. 10) was passed at the instance of the king, and by it the relative rank of the members of the royal family, of the great officers of State and the household, and of the hierarchy and the peerage was definitely and definitively ascertained. Subsequent modifications were enacted in 1563 (5 Eliz. c. 18), and in 1689 (1 Will. and Mary c. 21). The Acts of Union with Scotland (1707) and Ireland (1800) laid down rules of precedence for the Scottish and Irish peers. At different times too, statutes for the reform and extension of the judicial organization have affected the precedence of the judges, more especially the Judicature Act of 1873. But the statute of Henry VIII. "for the placing of the Lords" remains the only measure dealing with any large section of the scale of general precedence; and the law, so far as it relates to the ranking of the sovereign's immediate kindred, the principal ministers of the Crown and court, and both the spiritual and temporal members of the House of Lords, is to all practical intents what it was made by that statute.

General Precedence of Men.—The sovereign; (1) prince of Wales; (2) younger sons of the sovereign; (3) grandsons of the sovereign; (4) brothers of the sovereign; (5) uncles of the sovereign; (6) nephews of the sovereign; (7) archbishop of Canterbury, primate of all England; (8) lord high chancellor of Great Britain or lord keeper of the great seal; (9) archbishop of York, primate of England; (10) prime minister; (11) lord high treasurer of Great Britain; (12) lord president of the privy council; (13) speaker of the House of Commons; (14) lord keeper of the privy seal; (15) lord great chamberlain of England, (16) lord high constable of England, (17) earl marshal, (18) lord high admiral, (19) lord steward of the household, (20) lord chamberlain of the household, (21) master of the horse, above peers of their own degree; (22) dukes; (23) eldest sons of dukes of the blood royal; (24) marquesses; (25) dukes' eldest sons; (26) earls; (27) younger sons of dukes of the blood royal; (28) marquesses' eldest sons; (29) dukes' younger sons; (30) viscounts; (31) earls'eldest sons; (32) marquesses' younger sons; (33) bishops; (34) secretaries of State of baronial rank; (35) barons; (36) lords commissioners of the great seal; (37) treasurer of the household; (38) comptroller of the household; (39) vice-chamberlain of the household; (40) secretaries of State; (41) high commissioners in London; (42) viscounts' eldest sons; (43) earls' younger sons; (44) barons' eldest sons; (45) knights of the Garter; (46) privy councillors; (47) chancellor of the Exchequer; (48) chancellor of the duchy of Lancaster; (49) lord chief justice of England; (50) master of the rolls; (51) president of the probate, divorce and admiralty division; (52) lords justices of appeal; (53) judges of the High Court of Justice; (54) viscounts' younger sons; (55) barons' younger sons; (56) sons of lords of appeal; (57) baronets; (58) knights grand cross of the Bath, Grand Commanders of the Star of India, grand cross of St. Michael and St. George, grand commanders of the Indian Empire, grand cross of the Royal Victorian Order, and of the Order of the British Empire; (59) knights commanders of the Bath, the Star of India, etc.; (60) knights bachelors; (61) judges of the county court direct; (62) serjeants-at-law; (63) masters in chancery; (64) masters in lunacy; (65) companions of the Bath, of the Star of India, of St. Michael and St. George, of the Indian Empire, commanders of the Royal Victorian Order, and of the Order of the British Empire; (66) companions of the Distinguished Service Order; (67) members of the Royal Victorian Order (4th class); (68) officers of the Order of the British Empire; (69) companions of the Imperial Service Order; (70) gentlemen of the privy chamber; (71) eldest sons of the younger sons of peers; (72) eldest sons of the baronets; (73) eldest sons of the knights of the Garter; (74) eldest sons of the knights of the Bath, of the Star of India, etc., (eldest sons of the knights grand cross taking precedence of eldest sons of knights of the second degree); (75) members of the Royal Victorian Order (5th class); (76) members of the Order of the British Empire; (77) younger sons of baronets; (78) younger sons of knights; (79) esquires; (80) gentlemen.

General Precedence of Women.—The Queen; (1) the queen dowager; (2) the princess of Wales; (3) daughters of the sovereign; (4) wives of the sovereign's younger sons; (5) granddaughters of the sovereign (with style of Royal Highness); (6) wives of the sovereign's grandsons; (7) sisters of the sovereign; (8) wives of the sovereign's brothers; (9) aunts of the sovereign; (10) wives of the sovereign's uncles; (11) nieces of the sovereign; (12) wives of the sovereign's nephews; (13) granddaughters of the sovereign (without style of Royal Highness); (14) wives of dukes of the blood royal; (1j) duchesses; (16) wives of sons of dukes of the blood royal; (17) marchionesses; (18) wives of the eldest sons of dukes; (19) dukes' daughters; (20) countesses; (21) wives of the younger sons of dukes of the blood royal; (22) wives of the eldest sons of marquesses; (23) marquesses' daughters; (24) wives of the younger sons of dukes; (25) viscountesses; (26) wives of the eldest sons of earls; (27) earls' daughters; (28) wives of the younger sons of marquesses; (29) baronesses; (30) wives of the eldest sons of viscounts; (31) viscounts' daughters; (32) wives of the younger sons of earls; (33) wives of the eldest sons of barons; (34) baron's daughters; (35) maids of honor to the Queen; (36) wives of knights of the Garter; (37) wives of the younger sons of viscounts; (38) wives of younger sons of barons; (39) daughters of life barons; (40) wives of the sons of life barons; (41) baronets' wives; (42) dames grand cross of the Order of the British Empire; (43) wives of the knights grand crosses of the Bath, grand commanders of the Star of India, grand crosses of St. Michael and St. George, grand commanders of the Indian Empire, grand crosses of the Royal Victorian Order, and of the order of the British Empire; (44) dames commanders of the Order of the British Empire; (45) wives of knights commanders of the Bath, Star of India, etc.; (46) wives of knights bachelors; (47) commanders of the Order of the British Empire; (48) wives of the companions of the Bath, of the Star of India, of St. Michael and St. George, of the Indian Empire, of commanders of the Royal Victorian Order, and commanders of the Order of the British Empire; (49) wives of companions of the Distinguished Service Order; (50) wives of serjeants-at-law; (51) officers of the Order of the British Empire; (52) wives of members of the Royal Victorian Order (4th class); (53) wives of officers of the Order of the British Empire; (54) companions of the Imperial Service Order; (55) wives of companions of the Imperial Service Order; (56) wives of the eldest sons of the younger sons of peers; (57) daughters of the younger sons of peers; (58) wives of the eldest sons of baronets; (59) baronets' daughters; (60) wives of the eldest sons of knights; (61) knights' daughters; (62) members of the Order of the British Empire; (63) wives of members of the Royal Victorian Order (5th class); (64) wives of members of the Order of the British Empire; (65) wives of the younger sons of the younger sons of peers; (66) wives of the younger sons of baronets; (67) wives of the younger sons of knights; (68) wives of esquires; (69) wives of gentlemen.

A special table of precedence in Scotland is regulated by a royal warrant dated March 16. 1905, and a special table of precedence in Ireland was set forth by authority of the lord lieutenant (Jan. 2, 1895). Both contain errors and will probably be revised.

Personal precedence belongs to the royal family, the peerage and certain specified classes of the commonalty. Official precedence belongs to such dignitaries of the church and such ministers of State and the household as have had rank and place accorded to them by parliament or the Crown, to the speaker of the House of Commons and to the privy council and the judicature. Substantive precedence, which may be either personal or official, belongs to all those whose rank and place are independent of their connection with anybody else, as by the archbishop of Canterbury, the iord high chancellor or the lord great chamberlain, peers and peeresses, baronets, knights and some esquires. Derivative precedence, which can only be personal, belongs to all whose rank and place are determined by their consanguinity with or affinity to somebody else, as the lineal and collateral relations of the sovereign, the sons, daughters and daughters-in-law of peers and peeresses in their own right, and the wives, sons, daughters and daughters-in-law of baronets, knights and some esquires. The precedence of the sovereign is at once official and personal, the precedence of peeresses by marriage is at once derivative and substantive. In the case of the sovereign it is his or her actual tenure of the office of king or queen which regulates the rank and place of members of the royal family, and in the case of peeresses by marriage, although their rank and place are derivative in origin.

What are termed "titles of courtesy" are borne by all the sons and daughters of peers and peeresses in their own right. The eldest sons of dukes, marquesses and earls are designated by the names of one or other of the inferior peerages of their fathers, usually a marquessate or an earldom in the first, an earldom or a viscounty in the second and a viscounty or barony in the third case. The rule applicable in former times, still adhered to by the older English dignities, was that a duke's eldest son was styled earl, the son of a marquess, viscount, the son of an earl, baron. No such rule obtained in Scotland. But, whatever it may be, it is without effect on the rank and place of the bearer, which are those belonging to him as the eldest son of his father. The younger sons of dukes and marquesses are styled "lords," followed by both their Christian names and surnames. The younger sons of earls and both the eldest and the younger sons of viscounts and barons are described as "honourable" before both their Christian names and surnames. The daughters of dukes, marquesses and earls are styled "ladies" before both their Christian names and surnames. The daughters of viscounts and barons are described as "honourable" before both their Christian names and surnames. If the eldest son of a marquess or an earl marries a woman of rank equal or inferior to his own, she takes his title and precedence; but if she is of superior rank she retains, with her own precedence, the prefix "lady" before her Christian name followed by the name of her husband's title of courtesy. Again, if the younger son of a duke or a marquess marries a woman of rank equal or inferior to his own, she is called "lady," with his Christian and surname following, and is placed in his precedence, but, if she is of superior rank, she retains, with her own precedence, the prefix "lady" before her Christian name and his surname. If the daughter of a duke, a marquess or an earl marries the younger son of an earl, the eldest or younger son of a viscount or baron, a baronet, a knight or an esquire, etc., she retains, with her own precedence, the prefix "lady" before her Christian name and her husband's surname. If the daughter of a viscount marries the younger son of an earl or anybody of inferior rank to him, or the daughter of a baron marries the younger son of a viscount or anybody of inferior rank to him, she retains her own precedence with the prefix "honourable" before the addition "Mrs." and his surname or Christian name and surname. But, if her husband is a baronet or a knight, she is called the Honourable Lady Smith or the Honourable Lady Jones, as the case may be. The wives of the younger sons of earls and of the eldest and younger sons of viscounts and barons, if they are of inferior rank to their husbands, take their precedence and are described as the Honourable Mrs., with the surnames or Christian names and surnames of their husbands following. The judges were placed by James I. before the younger sons of viscounts and barons and accorded the title of "honourable" (*q.v.*). But this does not apply to their wives.

Some Criticisms. — It is manifest on even a cursory examination of the tables we have given that they are in many respects very imperfectly fitted to meet the circumstances and requirements of the present day. In both of them the limits prescribed to the royal family are inconveniently narrow, in contrast to the ample bounds through which the operation of the Royal Marriage Act (12 Geo. III. c. 11) extends the disabilities but not the privileges of the sovereign's kindred. Otherwise the scale of general precedence for women compares favourably with the scale of general precedence for men, which is now in nearly the same condition as that in which it has been for between two and three centuries, and the political, to say nothing of the social, arrangements to which it was framed to apply have undergone an almost complete transformation. It is true that in the professional classes definite systems of subordination are established by either authority or usage, which are carefully observed and enforced in the particular areas and spheres to which they have reference. As an example of precedence, major-generals and rear-admirals are of equal rank, and with them are placed commissaries-general and inspectors-general of hospitals and fleets; in India along with civilians of 31 years' standing they immediately follow the vice-chancellors of the Indian universities, and in relation to the consular service they immediately precede agents-general and consuls-general. But there is nothing to aid us in determining whether in England they should be ranked with, before or after deans, king's counsel or doctors in divinity, who likewise are destitute of any recognized general precedence, and, as matters now stand, would certainly have to give place to the younger sons of baronets and knights and the companions of the knightly orders

No foreigner has any legal precedence in Great Britain, but it is suggested that it being proper courtesy to accord to guests the precedence due to the rank they bear in their own countries, they should rank in society with and immediately before those of the relative rank in England. It should, however, be remembered that the younger sons of counts and other nobles bear the title of count with the addition of the Christian name, and they should be ranked with younger sons of British earls, etc., whatever title they bear.

It has now become usual to recognize ecclesiastical rank derived from the pope, even when held by subjects of the king. Cardinals, therefore, rank by international usage above archbishops, as princes of the blood royal, and in Ireland, Roman Catholic and Protestant bishops rank as such by warrants there in force.

An order respecting precedence was sent by the secretary of State for the colonies to the governor-general of Canada (July 24, 1868). Precedence in India is regulated by a Royal Warrant dated May 6, 1871.

See the peerages of Burke, Debrett etc.

THE UNITED STATES

Since there is no hereditary ranking in the United States precedence in official functions and ceremonies is purely according to official position. No statutes determine the order, so courtesy is the only law which rules. Custom, however, has set an order generally as follows: The President, Vice-President, Ambassadors in order (*i.e.,* according to the date when their credentials were presented), Chief Justice, Justices, Ministers in order, Speaker of the House of Representatives, The Cabinet in order (Secretary of State, Secretary of the Treasury, Secretary of War, Attorney General, Postmaster General, Secretary of the Navy, Secretary of the Interior, Secretary of Agriculture, Secretary of Commerce, and Secretary of Labor), Senators, Chief of Staff of the Army, Chief of Operations of the Navy, Representatives, Chargé d'Affaires, major-generals and rear-admirals, counsellors and military and naval attaches, Solicitor General, foreign first secretaries, American under-secretaries and first-assistant secretaries, Federal Reserve Board members, Interstate Commerce Commission members, members of other quasi-independent boards and commissions, Secretary of the Smithsonian Institution and heads of other quasi-independent bureaus and institutions, foreign second and third secretaries, second and third secretaries of the United States.

PRECESSION OF THE EQUINOXES, in astronomy, an effect connected mainly with a gradual change of the direction of the earth's axis of rotation. There is a general resemblance between the motion of the earth and that of a spinning top. It is well-known that when a top is slightly disturbed its axis precesses round the vertical so that it traces out a cone; the earth's axis similarly describes a cone at the rate of one revolution in about 26,000 years. In applying this analogy we must take the ecliptic (*i.e.,* the plane of the orbit of the earth round the sun) to correspond to the horizontal; the axis about which the earth spins is inclined at $23\frac{1}{2}°$ to the "vertical," and keeping this inclination it turns slowly round the "vertical." It must be emphasized, however, that this correspondence between the earth and a top is superficial, the cause of the precessional motion being upon different principles.

In this way the north pole of the celestial sphere describes among the constellations a circle of $23\frac{1}{2}°$ radius, making a revolution in 26,000 years. At present it is near the star *a* Ursae Minoris, which is therefore called the Pole Star; but it has travelled a considerable distance within historic times. About 3000 B.C. the star *a* Draconis would have served as pole star; in 13000 B C., also in AD. 13000 Vega would be near enough to the pole to mark roughly its position. By this displacement the part of the sky visible from a particular terrestrial station gradually changes; certain constellations cease to rise above the horizon and others appear for the first time. In the time of the early Chaldean astronomers it was not necessary to travel so far south to see the Southern Cross as it is now.

Cause of Precession.—This was first explained by Isaac Newton. It is due to the attraction of the sun and moon on the equatorial protuberance of the earth, the moon being responsible for about $\frac{2}{3}$ and the sun for $\frac{1}{3}$ of the motion—the same proportion as the lunar and solar tides. Treating the equatorial bulge as an extra ring of matter surrounding a spherical earth, the attraction of the sun and moon on this ring gives a couple tending to turn the ring into the plane of the ecliptic, since both disturbing agents are in or near the ecliptic. If the earth were not spinning this would turn the earth over until the equator coincided with the ecliptic, but the spinning earth behaves like a gyrostat, so that its axis moves at right angles to the plane of the couple—just as the couple which would upset a top at rest gives the axis of the spinning top a conical motion.

The moon's orbit is inclined at about 5° to the ecliptic, but it does not remain still; its nodes travel round the ecliptic in 18·6 years. Averaged over a long period of time the deviations of the moon from the ecliptic cancel out; but at any moment the precession caused by the moon may be greater or less than the average, according to the position at the time of the lunar orbit. In fact the path of the pole among the stars is a slightly sinuous curve. Astronomers distinguish the average secular motion as precession and the periodic fluctuations or sinuosities as *nutation* (*q.v.*).

As the pole (corresponding to the equator) moves round the pole of the ecliptic, so the equinox or intersection of the equator and ecliptic moves round the ecliptic once in 26,000 years. Both right ascensions and longitudes are reckoned from the equinox as zero-point; stellar longitudes on this account iccrease steadily by nearly a minute of arc every year; the effect on the right ascensions is more complicated, but these also continually increase. The vernal equinox is commonly called the First Point of Aries, but it has already moved away from that constellation and is now in Pisces. It should be understood that the precession of the equinoxes has no effect on the seasons, and, for example, has no connection with the gradual departure of the spring equinox from March 21 which occurred in the old Julian calendar.

Planetary Precession.—Besides the foregoing luni-solar precession, a phenomenon of much smaller magnitude, known as planetary precession, is recognized. It is due to perturbations by the planets which cause slow changes in the plane of the earth's orbit. Planetary precession changes the position of the ecliptic, whereas luni-solar precession changes the position of the equator; either change affects the equinox, which is the intersection of the two planes. Corrections for precession and nutation are of great importance in most branches of positional astronomy, and their computation is very burdensome. For details of the theory of the precessional motions see Newcomb's *Spherical* Astronomy, ch. ix.

PRECIPITATION, in chemistry, is the separation of a solid in a condition to be insoluble in the solution from which it is removed. Precipitation is an important step in many chemical processes. It may be accomplished by the concentration of the solution to the point where it is supersaturated, when, upon cooling, a part of the solid separates out, though this process is usually described as crystallization (*q.v.*). It may also be accomplished by the addition of reagents which may combine with the material to form an insoluble compound, or which may displace the material from the original solution. The application of heat may cause coagulation, as with certain proteins, and the removal of gas may also alter conditions sufficiently to cause precipitation. A change of temperature is another method. The salting out process as employed in the soap industry is a familiar example of precipitation. The formation of the fibre from a solution of cellulose by causing it to pass into a setting bath is a case of precipitation used in the artificial silk industry.

PRECISION GAUGES AND COMPARATORS. The World War was responsible for a considerable development and improvement of apparatus intended for the measurement of engineers' gauges and products.

Whitworth and Johansson's Gauges.—Improvement in accuracy of measurement necessarily goes hand in hand with improvement in accuracy and perfection of manufacture of the articles to be measured. The original measuring machine of Sir Joseph Whitworth would have been of little value apart from the system of accurate standards (both end gauges and cylindrical gauges) which he produced for use with it. The next great advance was the introduction by the Swedish firm of Johansson, in 1908, of flat parallel faced slip and block gauges, of such perfection of workmanship that any two of them, when cleaned, would "wring" together. (See METROLOGY.) The gauges were made in series differing by definite small amounts, so chosen that by wringing together a suitable combination of pieces, any desired size, to the nearest 0·0001 in., could be produced. To ensure this accuracy, it is necessary that the individual pieces should each have a guaranteed accuracy of (say) 0·00001 in., in order that the cumulated error of a group of four or'five should not exceed 0·00005 inch. And in order to assert with confidence that this degree of accuracy is, or is not, in fact attained in an individual piece it is necessary to be able to measure with an accuracy of the order of 0·000001 inch. When the Johansson gauges were first introduced no appliances were available which could be relied on to give measurements of an accuracy of the order of 0·000001 inch. Three entirely different methods have since been developed, however, which enable it to be done, and which, with due precautions, give mutually consistent results. These are:—

Tilting Level Comparator.—The "tilting level" comparator, due to A. J. C. Brookes, in which the two gauges, or groups of gauges, to be compared are stood side by side on a level surface plate, and the difference in their heights is determined by the reading of a highly sensitive level, which rests by point contact upon their upper surfaces, through two ball feet.

Millionth *Comparator.*—The "millionth" comparator, due to J. E. Sears, jun., wherein measurements are made between two flat parallel anvils, giving a local surface contact, the one anvil being fixed, and the other connected, through a series of spring suspensions designed to eliminate all frictional effects, with a sensitive tilting mirror which causes a spot of light to move across a scale, giving a magnified image of the displacement of the anvil on a scale of about 30,000 to 1.

Optical Interference.—The method of optical interference developed at the Bureau of Standards, Washington, wherein the whole surfaces of the gauges under comparison may be inspected, being marked out into contours of approximately 0·00001 in. difference in height by the alternate light and dark bands forming the interference pattern.

Measurement of Internal Dimensions.— The method of transference from external to internal measurement constituted a considerable difficulty, and the sizes of such objects as ring gauges, either plain or screwed, were usually estimated by the nature of their fit upon corresponding plug gauges. As the fit depends to a very marked extent upon the amount and nature of the lubricant used, considerable uncertainty existed as to the correct interpretation of the observed results. If well finished and liberally lubricated with thick grease, a cylindrical plug gauge will enter and pass through a ring gauge definitely smaller than itself without damage to either. Two instruments have now been produced for the measurement of internal diameters of either plain or screwed rings, which give results mutually consistent, if due care is taken, and the work being measured is sufficiently uniform in its dimensions, to the order of 0·00001 inch.

In the *chord contact* machine, due to G. A. Tomlinson, the diameter of the ring is deduced by calculation from the measured displacement, in a direction perpendicular to its length, of a double ball-ended distance piece of known length, which is allowed to make contact inside the ring, first on one side, and then on the other side of the diameter.

In the *displacement* type of internal measuring machine, due to J. E. Sears, the position of the ring is so adjusted that measurements are made exactly across the diameter. The ring is mounted on a carriage, which can be moved bodily in the direction of the diameter being measured by means of suitable micrometers. Contact is made first on one side of the ring, and then on the other, with a double-ended stylus attached to a sensitive indicating mechanism, and the micrometer readings are taken when the indicator reads zero. The same is done in turn with a standard plug substituted for the ring, provision being made for withdrawing the stylus temporarily as the plug passes across. If $x_1\ y_1\ x_2\ y_2$ are the four micrometer readings, the displacements d_1 and d_2 are equal to x_2-x_1 and y_1-y_2 respectively, and it is to be noticed that the pressure on the stylus is in the same direction when both x readings are taken, and also when both y readings are taken, so that any possible errors due to backlash or flexure in the indicating mechanism are eliminated. The transition from external to internal measurement is thus directly accomplished, and the final result is given by the equation

$$\mathrm{R}=d_1+d_2-\mathrm{P}=(x_2-x_1)+(y_1-y_2)-\mathrm{P}$$

where R and P are the diameters of the ring and plug, respectively.

MODERN PRACTICE

Scientific Principles. — The question of the general geometrical principles underlying the correct design of instruments intended to give the highest accuracy of measurement has received greater attention in recent years. Questions of the proper application of the theory of kinematic constraint to ensure definite and repeatable registration of parts, of eliminating backlash and friction effects, of preventing components of errors due to inevitable imperfections of workmanship (*e.g.*, in sliding ways) from becoming effective in the actual direction of measurement, of the design and relationing of parts so that elastic deformations due to changing distributions of load do not affect the results, and so on, are all involved here.

These various points have been fully considered in the travelling *microscope comparator* designed by J. E. Sears, jun., for the Metrology Department of the National Physical Laboratory. The long leg of an L-shaped carriage, which bears two microscopes, is supported on two wheels running in a V-guide along the upper side of the machine bed, so that whatever position is taken up by the carriage its form is undisturbed. The focal points of the two microscopes are arranged to lie in the extension of the axis of the micrometer screw, and the object to be measured is supported on an independent carriage which, by means of a small weight attached to a cord passing over a pulley, is held permanently in contact with a stud at the end of the screw abutment. Thus errors of straightness in the V-groove are non-effective, and so is any distortion of the base of the machine proper, due to the movement of the microscope carriage. Advantage is taken of the simple ratio 1 in. = 25·4 mm. (which is correct to within 2 parts in 1,000,000) to obtain simultaneous readings of equal accuracy in either British or the metric system, by means of suitable gearing in the compound micrometer head. The verniers read to 0·00001 in. and 0·0001 mm. respectively. The instrument can be used either with one microscope for making direct measurements against its own calibrated micrometer screw, or, using the two microscopes as a comparator, for determining the values of the sub-divisions of short scales.

Screw Gauges and Projection Gauges. — In the course of the War the necessity for rapid measurement of large numbers of screw gauges led to the development of special machines for the measurement of both pitch and effective diameter of screw threads. E. M. Eden, then of the National Physical Laboratory, was largely instrumental in this work and in the development of the optical projection method of examining profiles of gauges, both screws and flat templets. For the latter, he found lens combinations capable of giving an undistorted magnification of 50 times over a field of initial diameter approaching two inches. These combinations were incorporated in the now well-known "horizontal projector." For screw gauges the "vertical projector" was designed, in which the path of the light is vertical, and the image-forming rays are reflected back from an optically flat mirror overhead on to a specially prepared thread-form diagram placed on the table of the machine. The screw in this case is mounted in a carriage provided with two horizontal micrometer traverses in directions parallel and perpendicular to its axis, respectively, so that measurements of pitch and diameter can be made at the same time as the accuracy of the thread form is examined. Mention should also be made of the *Wilson* projection *gauge,* in which the optical system is duplicated, so that the two opposite sides of a screw can be projected simultaneously on to the screen, in such a manner that the two images of the thread intermesh, and if the screw is of direct form and size, and the apparatus correctly adjusted, exactly meet. If the screw is small a space is left between the images of its two sides; if large they overlap.

The projection method has naturally proved of great value in a number of other ways. In particular, it has been used in connection with the measurement of gear wheels and gear cutting hobs. Machines for this purpose have been designed by G. A. Tomlinson, and depend for their use on the accurate reproduction of the profiles of the teeth of the gear or hob, in the form of traces made on smoked glass, by a needle point attached to a specially designed pantograph. One of the machines is also fitted with a device for recording, in a similar manner, the relative velocities of rotation of two gear wheels when in mesh. In both cases the smoked glass, bearing the record, is put into the projection apparatus and magnified 50 times at the screen. It is found that the traces are quite sharp in the magnified image, and measurements can be made corresponding to an accuracy of about 0·0001 or 0·0002 inch on the original.

BIBLIOGRAPHY.—*Annual* Reports of the *National* Physical Laboratory, Stationery Office, London; R. T. Glazebrook, Dictionary of Applied Physics, vol. 3. Articles on "Design of Scientific Instruments," "Gauges," "Meters," "Metrology"; E. A. Griffiths, Engineering *Instruments* and Meters (1921); R. S. Whipple, "Design and Construction of Scientific Instruments," Trans. Opt. *Soc.*, 22, No. 2, 1920–21; C. G. Peters and H. S. Boyd, "Interference Methods for Standardizing and Testing Precision Gauge Blocks," Bureau of Standards, Scientific Papers, No. 436; A. F. C. Pollard, "The Mechanical Design of Scientific Instruments," Cantor Lectures, Royal Society of Arts, 1922; J. E. Sears, jun., "Precise Length Measurements," Cantor Lectures, Royal Society of Arts, 1923. (J. E. s.)

PREDESTINATION, as a theological term is used in three senses: (1) God's unchangeable decision from eternity of all that is to be; (2) God's destination of men to everlasting happiness or misery; (3) God's appointment unto life or "election" (the appointment unto death being called "reprobation." and the term "foreordination" being preferred to "predestination" in regard to it). In the first sense the conception is similar to that of fate; this assumes a moral character as nemesis, or the inevitable penalty of transgression. Sophocles represents man's life as woven with a "shuttle of adamant" (Antigone, 622–624). Stoicism formulated a doctrine of providence or necessity. Epicurus denied a divine superintendence of human affairs. A powerful influence in Scandinavian religion was exercised by the belief in "the *nornir*, or Fates, usually thought of as three sisters." In Brahmanic thought Karma, the consequences of action, necessitates rebirth in a lower or higher mode of existence, according to guilt or merit. With some modifications this conception is taken over by Buddhism. The Chinese tao, the order of heaven, which should be the order for earth as well, may also be compared. According to Josephus (Antiq. xviii. 1, 3, 4; xiii. 5, 9) the Sadducees denied fate altogether, and placed good and evil wholly in man's choice; the Pharisees, while recognizing man's freedom, laid emphasis on fate; the Essenes insisted on an absolute fate. This statement is exposed to the suspicion of attempting to assimilate the Jewish sects to the Greek schools. In Islam the orthodox theology teaches an absolute predestination, and yet some teachers hold men responsible for the moral character of their acts. The freethinking school of the Mo'tazilites insisted that the righteousness of God in rewarding or punishing men for their actions could be vindicated only by the recognition of human freedom.

The question of the relation of divine and human wiii has been the subject of two controversies in the Christian Church, the Augustinian-Pelagian and the Calvinistic-Arminian. Pelagius maintained the free-will of man and regarded grace as only an aid to freedom. Augustine held that God's grace alone is effectual and irresistible; He chooses whom He will have (election) and whom He will leave to perish (reprobation or praeterition).

At the Reformation the Augustinian position was accepted by both Luther and Calvin. Melanchthon modified his earlier view in the direction of synergism, the theory of a co-operation of divine grace and human freedom. Calvin wavered between the *supralapsarian* view that the fall was decreed in order to give effect to the previous decree of election and reprobation, and the *sublapsarian* of a "permissive decree—a volitive permission." This view repelled Arminius. According to Calvinism God's election unto salvation is absolute, determined by His own inscrutable will; according to Arminianism it is conditional, dependent on man's use of grace. The Synod of Dort (1618–1619) which affirmed the sublapsarian without excluding the supralapsarian form of Calvinism, condemned the views of Arminius and his followers, who were known as Remonstrants from the remonstrance "which in four articles repudiates supralapsarianism and infralapsarianism (which regarded the Fall as foreseen, but not decreed), and the doctrines of irresistibility of grace, and of the impossibility of the elect finally falling away from it, and boldly asserts the universality of grace."

In the Church of Rome the Dominicans favoured Augustinianism, the Jesuits Semi-Pelagianism; the work of Molina on the agreement of free-will with the gifts of grace provoked a controversy, which the Pope silenced without deciding; but it broke out again a generation later when Jansen tried to revive the decaying Augustinianism. The Church of England has passed through several disputes regarding the question whether the Thirty-Nine Articles are Calvinistic or not; while there is some ambigmty in the language, it seems to favour Calvinism. At the Evangelical Revival the old questions came up, as Wesley favoured Arminianism and George Whitefield Calvinism. In Scotland Calvinism was repudiated by James Morison, the founder of the Evangelical Union, who declared the three universalities, God's love for all, Christ's death for all, the Holy Spirit's working for all.

While retained in the creeds of several denominations, in the public teaching of the churches the doctrine of predestination is less emphasized. The problem is the reconciliation of human freedom with divine foreknowledge. It has been argued that, if God allows His activity to be limited by human freedom, He may also so limit His foreknowledge as to know free acts as possible and not as actual.

BIBLIOGRAPHY.—W. A. Copinger, *A* Treatise in Predestination, *Election,* and *Grace* (1889) with a full bibliography in the Appendix; Augustine's Anti-Pelagian Treatises; Calvin's Institutes; Jonathan Edwards, *Works* (1869); Histories of Doctrine, and works on Systematic Theology. (A. E. G.)

PREDICABLES, in logic, are the main types of predicates, or the principal ways in which the predicate of a proposition can be related to its subject. The oldest known doctrine of predicables is that of Aristotle, but the one that had, and still has, the greatest vogue is that of Porphyry, which is not essentially different from that of Aristotle. According to Porphyry there are five predicables, namely, genus, species, differentia, *proprium,* accident. These five predicables are obtained as follows. When a predicate is affirmed of a subject it must either express something that is essential to the subject (that is, something in the absence of which the subject would not be called by that name) or not. If the predicate is not essential to the subject it is described as an accident. *E.g.,* "Many Prime Ministers of England are Scotsmen" (or "Oxford men," or "wealthy," etc.); but they need not be. If the predicate is essential, then there are four possibilities. The predicate may state the including class in which the subject is included—*e.g.,* "Prime Ministers are Cabinet Ministers" (or "Rectangles are parallelograms," etc.). In this case the predicate is described as a genus of the subject; and the subject (if a class-name) is called a species of the predicate. The predicate is called a species in relation to the subject, if the subject is a singular term and the predicate represents this class (*e.g.,* "Mr. Kellogg is a statesman"), or if the subject is a class-name restricted by "Some" and the predicate denotes an included class (*e.g.,* "Some members of Parliament are Cabinet Ministers," or "Some rectangles are squares"). Again the predicate may assert of the subject some character, or group of characteristics, which distinguishes (or differentiates) one species of a genus from the other species (*e.g.,* "Squares are equilateral," whereas other rectangles are not). In this case the predicate is called a differentia (or "difference") of the subject term. Lastly, the predicate may assert of the subject something essential, but different from either its genus or *differentia,* though derivable from these (*e.g.,* "Equilateral triangles and equiangular"). In this case it is called a *proprium* (or "property") of the subject. The predicables are applicable readily enough to ideal objects like those of geometry, but cannot be applied very satisfactorily or usefully to empirical objects. Although they mark distinctions which are very important and useful in connection with many ordinary problems, they play no very important part in modern science, which needs more precise and more numerous distinctions than they mark. See LOGIC, HISTORY OF.

See also H. W. B. Joseph, *Introduction* to Logic (1916).

PREECE, SIR WILLIAM HENRY (1834–1913), British electrical engineer, was born in Wales on Feb. 15, 1834, and educated at King's College, London. He became a civil engineer, but in 1853 joined the Electric and International Telegraph Co. In 1869 he returned to the civil service, and in 1877 was appointed electrician to the Post Office, in 1899 engineer-in-chief, and, after his retirement, consulting engineer. He was a pioneer of wireless telegraphy (*see* TELEGRAPH; *Part II.,* Wireless Telegraphy). He died at Penrhos, Carnarvon, on Nov. 6, 1913.

PRE-ESTABLISHED HARMONY, in philosophy, denotes the relationship between body and mind as conceived by Leibnitz. According to the interaction theory body and mind act upon each other, so that the body does what the mind wants done, and the mind is affected by the condition of the body. Cartesian dualism excluded the possibility of such interaction, by its conception of an absolute difference and opposition between mental and material substances. To account for the appearance of such interaction some of the Cartesians introduced the theory of "occasionalism," namely, that the mind does not influence the body nor *vice versa,* but that on every occasion that anything happens to the one, God produces a certain change in the other. This implied God's constant interference with everything. Leibnitz suggested that body and mind have been harmonized by God once for all, so that their changes correspond or synchronize without either influencing the other, and without needing God's incessant intervention. He compares the relation between body and mind to that between two clocks which have been synchronized once for all. and so keep step without mutual interaction and without the constant intervention of anybody. This is the theory of pre-established harmony, which Leibnitz applied to his system of monads. For Leibnitz reality consists of monads or spirits of different degrees of development. Their active side is their spiritual side, and matter is simply the appearance of their passivity or deficiency. As their activity is entirely immanent, the monads do not interact (they "have no windows"), but there is a pre-established harmony between them inasmuch as they all mirror the same universe, though each "from its own point of view." *See* LEIBNITZ.

PRE-EXISTENCE, DOCTRINE OF, in theology, the doctrine that Jesus Christ had a human soul which existed before the creation of the world — the first and most perfect of created things — and subsisted, prior to His human birth, in union with the Second Person of the Godhead. It was this human soul which suffered the pain and sorrow described in the Gospels. The chief exposition of this doctrine is that of Dr. Watts *(Works,* v. 274, etc.) ; it has received little support. In a wider form the doctrine has been applied to men in general — namely, that in the beginning of Creation God created the souls of all men, which were subsequently as a punishment for ill-doing incarnated in physical bodies till discipline should render them fit for spiritual existence. Supporters of this doctrine, the Pre-existants or Pre-existiani, are found as early as the 2nd century, among them being Justin Martyr and Origen (*q.v.*), and the idea not only belongs to metempsychosis and mysticism generally, but is widely prevalent in Oriental thought. It was condemned by the Council of Constantinople in 540, but has frequently reappeared in modern thought *(cf.* Wordsworth's *Intimations of Immortality)* being in fact the natural correlative of a belief in immortality.

PREFECT, in France, the title of a high official (*préfet*). The prefects of the department were created by a law of the 28th Pluviose in the year VIII. (Feb. 17, 1800). They were intended to be the chief officers of internal administration, and have, in fact, discharged this function, especially under the First and Second Empire, surviving, under the other forms of government which modern France has seen.

The prefect has a double character and two series of functions. First, he is the general representative of the Government, whose duty it is to ensure execution of the Government's decisions, the exercise of the law, and the regular working of all branches of the public service in the department. Thus far the rôle of the prefect is essentially political; he guarantees the direct and legal action of the Government in his department. He has the supervision of all the State services in his department, which procures the necessary uniformity in the working of the services, each of which is specialized within a narrow sphere. He serves as a local source of information to the Government, and transmits to it representations from those under his administration.

In the name of the State he exercises a certain administrative control over the local authorities, such as the *conseil ge'ne'ral,* the mayors, and the municipal councils. This control, though considerably restricted by the laws of Aug. 10, 1871, and April 5, 1884, still holds good in some important respects. The prefect can still annul certain decisions of the *conseil ge'ne'ral.* He can suspend for a month a municipal council, mayor, or deputy-mayor; certain decisions of the municipal councils require his approval; and he may annul such of their regulations as are *extra vires.* He can annul or suspend the *maire's* decrees and he has also considerable control over public institutions, charitable and otherwise. He may make regulations both on special points and for the general administration of the police.

Secondly, the prefect is not only the general representative of the Government, but the representative of the department in the management of its local interests. But his unfettered powers in this respect were reduced under the Third Republic, chiefly by the law of Aug. 10, 1871, which led to decentralization, by increasing the powers of the *conseils généraux.*

The *sous-préfets,* having very limited powers of deciding questions, serve as intermediaries between the prefect and the persons under his administration. This function was most useful in the year VIII., when communications were difficult, even within a department. At the present time their chief service to the administration lies in keeping up good relations with the *maires* of the communes in their *arrondissement,* and thus acquiring a certain amount of influence over them.

The National Assembly of 1871 proposed to suppress the *sous-préfets,* but the president, M. Thiers, persuaded them to reconsider their decision. The question has been raised from time to time, since that date, in the Chamber of Deputies, and finally, by the decree of Sept. 6, 1926, the *Conseils de Préfecture* were suppressed and the *Conseils de Préfecture interdépartementaux* created. The suppression of a certain number of the *sous-préfectures* was effected by the decree of Sept. 10, 1926.

See *Journal Officiel,* Sept. 9, 14, and 30, 1926, and June 3, 1927.

PREFERENCE, IMPERIAL: *see* IMPERIAL PREFERENCE.

PREFERENCE SHARES. In a joint-stock company, the name given to shares entitled to a dividend at a fixed rate before any dividend is paid on other shares. If the arrears of preference dividend have to be paid before any profits are divided amongst other shareholders, the shares are called "cumulative preference shares." Sometimes a company issues "first preference" and "second preference" shares, the latter ranking after the former. For further details *see* INVESTMENT.

PREFERRED STOCK, stock of a corporation which possesses the same rights and privileges as common stock and which has in addition certain more or less valuable and desirable preferences. Such stock may be *preferred as to assets,* or *preferred as to dividends,* or as to both. Being preferred as to assets means that in case of dissolution of the company, the holders of the stock will receive their portion of the proceeds before holders of other stock not preferred as to assets will participate. This preference is, of course, of no service to the stockholder as long as his company is prosperous and in no danger of dissolution, but in case of weak companies the preference tends to give his stock a higher market value than stock not so preferred. And in case of actual dissolution where the assets are not sufficient to satisfy all claims, the preference will prove most valuable.

The expression *preferred as to dividends* means that this stock is entitled to a specified rate of dividend out of the earnings before any dividend is given to the stock not so preferred. It does not mean that a certain dividend is guaranteed but merely that if any amount of the earnings is declared as a dividend, then the amount necessary to pay the specified rate of dividend on the preferred stock, or such part of such dividend as possible, must be used for this purpose before any is allocated to pay a dividend on non-preferred stock. If the entire amount declared as a dividend is absorbed by the dividend on the preferred stock, it means simply that the non-preferred or common stock gets nothing. In prosperous companies, however, it is usually possible to pay the stipulated rate to the preferred stock and still have sufficient money left to pay an equal or even larger rate to the comman stock. It is ordinarily only fair that the common stock should get more in view of the fact that it takes a risk by permitting the preferred stock to take out its share of dividend first. It is sometimes deemed advisable to have several issues of preferred stock, one taking precedence over the next, just as ordinary preferred stock takes precedence over common. These several issues are then usually classified as 1st preferred, and preferred, etc.; or sometimes as preferred A, preferred B, preferred C.

Preferred stock is also sometimes made participating. Participating preferred stock is that which is to receive first its preferential dividend at the stipulated rate and after that is to participate or share with the other stock in the remainder of the funds declared as dividend. This participation or sharing may be done in one of a number of ways, but regardless of the manner of participation, if the preferred stock shares in any way in the dividend over and above its stipulated rate it is participating stock. Dividends on preferred stock may be either cumulative or non-cumulative. (J. H B.)

PREHNITE, a mineral of the composition $H_2Ca_2Al_2Si_3O_{12}$, but containing also small amounts of Fe_2O_3, and traces of Mn, Mg and alkalis; so called after Col. Prehn, who first brought it to Europe from Cradock, in Cape Colony. It crystallizes in the hemimorphic class of the rhombic system, but the hemimorphic character is often obscured by twinning. Crystals are pyroelectric. The habit is that of flat tables on 001 or elongated along the crystallographic axis *a*. Crystals, however, rarely occur singly, most frequently being aggregated together in divergent groups to form fan-shaped, or globular masses. Prehnite has a dominant 001 cleavage and is usually white or pale green. Though often classed with the zeolites, the contained water is only expelled at a red heat. Optical anomalies are not uncommon, this characteristic being ascribed to twinning on a fine scale. The hardness is 6–6.5 and specific gravity 2·80–2·95. Prehnite occurs in association with zeolites in amygdales of basic igneous rocks such as basalt and dolerite, as well as a purely secondary mineral in veins. In contact-altered limestones the mineral is not uncommon. Here it appears to represent a late hydrothermal stage of alteration, being found in veins and replacing such minerals as labradorite, vesuvianite and scapolite. In the crystalline schists it is sparingly developed in amphibolites, and metamorphosed carbonate sediments. (C. E. T.)

PREJUDICE. In law "without prejudice," means without detriment to a person's rights or claims. When two parties are negotiating for the settlement of an existing dispute, statements or admissions made by or on behalf of either, with a stipulation, expressed or implied, that the statements are made "without prejudice" to the party's claims in the dispute, cannot be put in evidence in litigation to settle the dispute. But a letter which by its nature may prejudice the person to whom it is written may be put in evidence, *e.g.,* if it contain threats. *(See* EVIDENCE.)

PREL, KARL, FREIHERR VON (1839–1899), German philosopher, was born at Landshut on April 3, 1839, and died on Aug. 4, 1899. After studying at the University of Munich he served in the Bavarian army from 1859 to 1872, when he retired with the rank of captain. He then gave himself up to philosophical work, especially in connection with the phenomena of hypnotism and occultism from the modern psychological standpoint. He attempted to deduce the existence of spirit, apart from, and yet entering from time to time into connection with, the phenomena of the senses, by an examination of the relation between the ego of thought and the age of sensible experience as understood by Kant. In *Der Kampf ums Dasein am Himmel* (1874), republished in 1882 under the title *Entwickelungsgeschichte des Weltalls.* Prel endeavoured to apply the Darwinian doctrine of organic evolution not only to the sphere of consciousness but also even more widely as the philosophical principle of the world. He was one of a large number of German thinkers who during the latter half of the 19th century endeavoured to treat the mind as a mechanism. *See* EVOLUTION; *in Philosophy.*

PRELATE, ecclesiastical dignitary of high rank. In the early middle ages the title *prelate* was applied to secular persons in high positions and thence it passed to persons having ecclesiastical authority. The *De prelatis* of Valerian is concerned with secular princes, and even as late as the 14th century the title was occasionally applied to secular magistrates. In mediaeval ecclesiastical usage the term might be applied to almost any person having ecclesiastical authority. The term occurs very frequently in the Rule of St. Benedict and other early monastic rules.

In more modern usage in the Roman Catholic Church prelates, properly so-called, are those who have jurisdiction *in foro externo,* but a liberal interpretation has given the title a more general significance. Prelacy is defined by the canonists as "pre-eminence with jurisdiction" and the idea supposes an episcopal or quasi-episcopal jurisdiction. But gradually the title was extended to ecclesiastical persons having a prominent office even without jurisdiction, and later still it has come to be applied to ecclesiastical persons marked by some special honour though without any definite office or jurisdiction.

We may therefore distinguish "true" from "titular" prelates. The true prelacy is composed of the persons who constitute the ecclesiastical hierarchy; jurisdiction is inherent in their office and gives pre-eminence, as with patriarchs, archbishops and bishops. The true, no less than the titular, prelates have their various ranks, differing as regards title, precedence, clothing and other insignia. The distinguishing colour of a prelate's clothing is violet; the form, like the greater or less use of violet, depends on the rank of the prelate. Four classes may be distinguished: (1) Great prelates, *e.g.,* cardinals, archbishops and bishops. (2) Exempt prelates, *i.e.,* abbots and religious superiors, who are withdrawn from the ordinary diocesan jurisdiction and themselves possess episcopal jurisdiction. (3) Roman prelates, *(a)* active and *(b)* honorary. The title is applied to numerous ecclesiastics attached by some dignity, active or honorary, to the Roman court *(see* CURIA ROMANA).

In the Reformed churches the title was retained in England, Sweden, Denmark and Germany. The cathedral chapter of Brandenburg consists of two prelates, the dean and the senior, besides eight other members. The chapter of Merseburg contains five prelates, viz., the dean, senior, provost, custos and scholasticus. In Baden the general synod is presided over by the prelate (*prelat*), *i.e.,* the principal "superintendent." In the Church of England the term prelate has been since the Reformation applied only to archbishops and bishops.

BIBLIOGRAPHY.—See Du Cange, *Glossarium mediae et infimae latinitatis* (new ed., *by* L. Favre, Niort, 1883) ; Paul Hinschius, *Kirchenrecht* (Berlin, 1869) ; F. H. Vering, professor of law at Prague, *Lehrbuch des katholischen, orientalischen und protestantischen Kirchenrechts (1893).*

PRELLER, LUDWIG (1809–1861), German philologist and antiquarian, was born at Hamburg on Sept. 15, 1809. He taught at Dorpat and Jena, and was head librarian at Weimar, where he died on June 21, 1861. His chief works are: *Demeter u. Persephone* (1837) ; *Griechische Mythologie* (1854–55); and *Romische Mythologie* (1858); with H. Ritter he produced the valuable *Historia philosophiae graecae et romanae ex fontium locis contexta* (1838). He contributed to Ersch and Gruber's *Allgemeine Encyklopadie* and Pauly's *Realencyklopadie der classischen Altertumswissenschaft.* A complete list of his works will be found in *Ausgewahlte Aufsätze aus dem Gebiete der klassischen Altertumswissenschaft* (ed. R. Kohler, 1864).

See G. T. Stichling, *Ludwig Preller. Eine Gedächtnissrede (1863).*

PREMONITION, an impression relating to a future event. In modern times the best attested premonitions are those relating to events about to occur in the subject's own organism. The power of prediction possessed by the subject in such cases may be explained in two ways: (1) As due to an abnormal power of perception possessed by certain persons, when in the hypnotic trance, of the working of their own pathological processes; or (2) more probably, as the result of self-suggestion.

Apart from these cases there are two types of alleged premonitions. (1) The future event may be foreshadowed by a symbol. Amongst the best known of these symbolic impressions are banshees, corpse lights, phantom funeral processions, ominous animals or sounds and symbolic dreams (*e.g.,* of teeth falling out). Of all such cases it is enough to say that it is impossible for the serious inquirer to establish any causal connection between the omen and the event which it is presumed to foreshadow. (2) There are many instances, recorded by educated witnesses, of dreams, visions, warning voices, etc., giving precise information as to coming events. In some of these cases, where the dream, etc., has been put on record before its "fulfilment" is known, chance is sufficient to explain the coincidence, as in the recorded cases of dreams foretelling the winner of the Derby or the death of a crowned head. In cases where such an explanation is precluded by the nature of the details foreshadowed, contemporaneous documentary evidence is usually lacking. The persistent belief on the part of the narrators in the genuineness of their previsions indicates that in some cases there may be a hallucination of memory, analogous to the well known feeling of "false recognition."

PREMONSTRATENSIANS, also called Norbertines, and in England White Canons, from the colour of the habit: an order of Augustinian Canons founded in 1120 by St. Norbert, afterwards archbishop of Magdeburg. He had made various efforts to introduce a strict form of canonical life in various communities of canons in Germany; in 1120 he was working in the diocese of Laon, and there in a desert place, called Prémontré, in Aisne, he and thirteen companions established a monastery to be the cradle of a new order. They were canons regular and followed the so-called Rule of St. Augustine (see AUGUSTINIANS), but with supplementary statutes that made the life one of great austerity. St. Norbert was a friend of St. Bernard of Clairvaux—and he was largely influenced by the Cistercian ideals as to both the manner of life and the government of his order. But as the Premonstratensians were not monks but canons regular, their work was preaching and the exercise of the pastoral office, and they served a large number of parishes incorporated in their monasteries. The strength of the order now lies in Belgium, where at Tongerloo is a great Premonstratensian abbey that still maintains a semblance of its mediaeval state.

BIBLIOGRAPHY.—*See* Max Heimbucher, *Orden* u. Kongregationen (1907); ii. § 56; articles in Wetzer u. Welte, Kirchenlexikon (2nd ed.); Herzog-Hauck, *Realencyklopädie* (3rd ed.) and Catholic Encyclopaedia, art. "Premonstratensians." The best special study is F. Winter, *Die* Pramonstratensev des *12.* Jahrh. *und* ihre Bedeutung fur *das nordöstliche Deutschland* (1865).

PŘEMYSL, the reputed ancestor of the line of dukes and kings which ruled in Bohemia from 873 or earlier until the murder of Wenceslaus III. in 1306, and which was known as the Pfemyslide dynasty. According to legend Pfemysl was a peasant of Staditz who attracted the notice of Libussa, daughter of a certain Krok, who ruled over a large part of Bohemia, and is said to have been descended from Samo. Přemysl married Libussa, the traditional foundress of Prague, and during the 8th century became prince of the Bohemian Czechs. His family became extinct when Wenceslaus III. died, but through females the title to Bohemia passed from the Přemyslides to the house of Luxembourg and later to the house of Habsburg.

See F. Palacky, Geschichte von *Böhmen,* Bd. I. (Prague, 1844).

PRENZLAU or **PRENZLOW,** a town in the Prussian province of Brandenburg, Germany, on the lower Ucker See, 30 mi. W. by S. of Stettin by rail. Pop. (1939) 26,562. Prenzlau is first mentioned at the close of the 12th century, and received its municipal charter in 1235. As the capital of the old Uckermark it was a frequent object of dispute between Pomerania and Brandenburg until incorporated with the latter about 1480. The Gothic church of St. Mary dates from 1340, and the remains of the town gates, walls and towers are also interesting. The industries include machine building, iron-founding, brewing and sugar-refining. Tobacco is grown in the neighbourhood, and cigars, margarine and leather are manufactured in the town.

PREPARATORY SCHOOLS form part of what is known as the public school system. (In the United States the term is used for those schools which prepare for higher education, and they are discussed in articles SECONDARY EDUCATION and EDUCATION, *United* States sections.) In Great Britain before Thomas Arnold, in the 'thirties of last century, excluded boys of under twelve years of age from Rugby, there were exceedingly few of these schools, but they now number some 700. It has for many years been exceptional for a boy to enter a public school otherwise than from a preparatory school. These schools are privately owned and are free of Government control; the majority are, however, linked together by membership in an incorporated association. They cater, for the most part, for boys between the ages of six and fourteen years, and, outside the large towns and cities, the great bulk of the pupils are boarders, with only a few day scholars.

BIBLIOGRAPHY.—*See* The Board of Education Report on Preparatory *Schools,* ed. Michael Sadler (1900); The Preparatory *Schools'* Review issued by the Incorporated Association of Preparatory Schools; S. S. Harris, The Master and his Boys; J. Alan Rannie, The Schools of England (1928).

PREROGATIVE, in English law, means the powers, privileges and immunities peculiar to the King. In the early Middle Ages the word occurs as an adjective meaning "exceptional," as in the sentence "The King is prerogative."

A distinction has to be made at the outset between prerogatives peculiar to the King in his "natural" capacity and confined to him, such as the rule that he is personally exempt from all jurisdiction, criminal or civil, and cannot be sued for debt, and prerogatives which belong to his "politic" capacity and as such extend to the whole Government carried on in his name, such as the immunity of "the Crown" from being sued by ordinary civil process. (See PETITION OF RIGHT.) English law has, however, never clearly distinguished between the two capacities; indeed Coke declared it "a damned and damnable opinion" to attempt such a distinction. The whole history of "constructive treason" is a witness to this dualism, as when the judge held that "every rebellion intendeth as its natural consequence the death of the King." In other words, a subject indicted for attempting to compel the King to change his counsellors was not allowed to plead that his "overt acts" were not directed against the life of the King but merely against his Government. The result was that the King was completely identified with the State and even to-day our constitutional law knows no such term as "The State." The State is the King. All writs run in his name. All indictable offences are offences "against the peace of our Lord the King, his Crown and dignity." All "public" property is legally vested in the King—"his" are the ships of war, the Government buildings; the courts of justice and all other governmental agencies.

All statutory powers conferred upon the Government are declared to be conferred on "His Majesty in Council." All money voted by Parliament is voted to "the King," even though it be appropriated by statute to public services from which the King is powerless to divert it. This identification of the State with the King is nothing but a survival of mediaeval times when the King was, indeed, "every inch a King," when he governed largely by his own will, did justice in person and chose his own servants.

The Crown.—The term "Crown" is occasionally used to mark the distinction between the King's Government and the King's person, but its use is intermittent and, strictly speaking, the Crown is, as has been prettily said, nothing but "a chattel in the Tower which has been entailed upon the Hanoverian dynasty." The common law, apart from statute, makes no distinction, for example, between debts due to the King's household and debts due to the Crown, so that, at common law, debts due to the King personally and taxes due to his Government enjoy, indifferently, the prerogative of priority over all other claims against the estate of a debtor, a bankrupt or a deceased person. In the same way a royal palace and a Post Office are equally exempt from the payment of rates, for it is one of the "prerogatives" that "the King" is not bound, in the absence of express words, by a taxing statute. We see the same identification of the "natural" King and the "politic" King in the rule that the King's Government can never, in any circumstances, be sued for wrongful, *i.e.,* tortious, acts. The immunity of the latter is based, historically, on the rule that the "King can do no wrong" which did not mean originally, *e.g.,* in the time of Bracton, the perfectibility of the King but the simple feudal fact that the King could not be tried or sued in his own courts any more than any other feudal lord in the court of that lord's jurisdiction.

As the King was, and is, the "Government," the rule found a new application in the principle that no governmental acts or defaults could be the subject of legal proceedings. Had this application been carried to its logical conclusion, it would have resulted in the immunity of all the King's officers from being sued for their wrongful acts. But English law was, and is, too practical a science to be logical and a consequence so disastrous to the rights of the subject was avoided by the evolution of the principle, laid down by the judges, that no servant of the Crown could be allowed to plead the command of the King, even where such a command had actually been issued, as a defence for an unlawful act, for to admit such a plea would, they held, be to impute wrong to the King. This theory reaches its triumphant climax in the dictum of Blackstone that the King not only can "do" no wrong but cannot even "think a wrong." The failure of the law to make any distinction between the natural and political capacity of the King led to some desperate fictions, of which the supreme example is the legal maxim that "the King never dies." This fiction, in the absence of such a distinction, was necessary because otherwise the death of the King would have dissolved the State in the interregnum between the decease of one King and the coronation of his successor. Indeed, this was actually the situation before the invention of the fiction.

A mediaeval chronicler records that on the death of one of the earlier Kings "every man did what was right in his own eyes." The King was dead, his "peace" died with him and, for the time being, offences ceased to be "crimes" for the legal essence of a crime, as we have seen, is an offence "against the King's peace." Here is the mystical doctrine, so mystically expressed by Allen when he says "When the King dies his politic body escapes from his natural body and by a sort of legal metempsychosis enters into the natural body of his successor; but whilst he is alive the two bodies are indissolubly united and consolidated into one." But the conquest of this fiction was not complete. Right down to 1867 the death of the King operated to dissolve Parliament; the King was, and is, a constitutional element in Parliament and the summons of a Parliament was regarded as an act so personal to him that when he died his Parliament died with him. It was reserved for the Demise of the Crown Act of 1867 to provide that the death of the King should not involve a dissolution. On the other hand the death of the King still operates to dissolve the whole Privy Council from the date of his death until his successor re-appoints the members.

Modern Kingly **Prerogative.**—The prerogative powers of the King, *i.e.,* powers original and inherent in the Kingship, as distinct from powers conferred on him by statute, have all of them one feature in common which is that they can no longer be exercised by the King in person but only on the advice of Ministers or, what amounts to the same thing, in particular forms and by the use of particular instruments. Long before "responsible government" made its appearance in England and at a time when the Commons even repudiated responsibility for the government of the country, Parliament, guided by a sound instinct, insisted that the royal prerogative in certain matters could only be exercised by the use of certain seals, notably the Great Seal and the Privy Seal, which were in the custody of certain great officers of State. There are innumerable mediaeval statutes to this effect. For the use or misuse of these seals their custodians could be brought to book by *impeachment* (*q.v.*) in Parliament. As early as the 16th century the judges held in Mildmay's Case that the King's order to issue "treasure" could only be executed by a warrant under the Great or Privy Seal—a principle now embodied in the Exchequer and Audit Act of 1866 which requires that the sign-manual, *i.e.,* the King's personal signature, must always be countersigned by two Lords of the Treasury before money can issue out of the national exchequer. In the same way the common law courts themselves laid down the rule, at the beginning of the 17th century, that, even in the Court of King's Bench, held *coram* rege and in which mediaeval Kings had presided in person, the King could no longer administer justice in person—"the King cannot speak by word of mouth but only by record." There still remained, it is true, the residuary jurisdiction of the King in Council which could be, and was, exercised by him in person, but with the abolition of the Star Chamber in 1641 this jurisdiction disappeared. By the same statute the King's personal command, *i.e.,* a warrant issued under his hand, was no longer, of itself, to be a decisive answer to an application for a writ of Habeas Corpus by a person arrested under such a warrant. (See WARRANT and HABEAS CORPUS.)

So long as it was in the power of the King to remove the judges for decisions adverse to the exercise of his personal will or to dismiss ministers who refused to carry out his wishes, he could, of course, bend them to exercise his prerogatives according to his pleasure, even when their exercise was subject to the formal rules described above. Parliament, however, gradually stopped up every earth in this respect. It refused to accept the King's command as a defence to the impeachment of one of his ministers, as in Danby's Case (1679), while by the Act of Settlement (section 3) it enacted that the King's prerogative of pardon under the Great Seal should not be pleadable to an impeachment. So long, however, as the King was not dependent on supplies for the ordinary expenses of the Government he could neglect to summon a Parliament for as many years as he pleased and impeachment was thereby made impossible. What was really decisive in securing the exercise of the King's prerogative by ministers in accordance with popular will was not so much the development of Cabinet Government as the transfer, principally as the result of Burke's reforms, of all governmental expenses from being a charge on the hereditary revenues of the Crown, or the Civil list, to the annual Estimates. In strict law the King can still appoint and dismiss ministers as he pleases, nor is he under any statutory obligation to summon Parliament. But if he did the one and omitted the other, he and his ministers would be without money to carry on the Government. Taxes might still be imposed, for much of our taxation is voted under permanent Acts, but none of the proceeds could be expended. Only the annual Appropriation Act can authorize the expenditure of the public money.

Decreasing Powers.—As with the King's ministers, so with "his" judges. In virtue of the Act of Settlement the King can no longer dismiss judges at his pleasure; they are removable only on an address by both Houses of Parliament. Even their appointment, although technically the act of the King, is the act of a minister, namely the Lord Chancellor who issues, in each case, a "patent" of appointment.

The prerogatives are thus no longer an instrument of arbitrary government. They have, constitutionally speaking, passed into the hands of the Cabinet. Hence Dicey's epigram that "the prerogatives of the Crown have become the principles of the people." Like all epigrams, this statement is, however, more pointed than true. Cabinets may be as arbitrary as Kings, and Prime Ministers as arbitrary as Cabinets. The prerogative of dissolution, for example, now operates, in virtue of the modern convention that the King is constitutionally bound to grant a dissolution to a Prime Minister, even when he has been defeated in the House of Commons, to make the former the master of the latter. So too a Government, faced by a hostile House of Lords, can in certain cases avail itself of the prerogative where it cannot be sure of getting its way by statute. Furthermore the prerogative interposes a shield between a Government department and a subject whose rights it has invaded. (See PETITION OF RIGHT.)

Pre-Cabinet Government.—Before the development of Cabinet Government, in other words while the exercise of the prerogative was exclusively in the hands of the King himself, or of ministers subservient to him, the efforts of Parliament were directed to depriving, subjugating or abolishing the prerogative The chief example is afforded by statutes such as the Petition of Right, the Bill of Rights and the Act for the Abolition of the Star Chamber, statutes abolishing respectively the prerogative of the King in taxation to supply his needs, in raising and keeping a standing army to enforce his will, and in exercising a jurisdiction to punish his opponents. Here Parliament went further than the courts were prepared to go. The courts did, indeed, in the famous "Case of Proclamations" lay down the important principle that "the King hath no prerogative except that which the law allows him," But the law itself, *i.e.,* the common law, was disposed, as in Bate's Case, 2 State Trials 371 (1606), and in the Ship Money Case, 3 State Trials 1090 (1638), to recognize an arbitrary power in the King by distinguishing an "absolute" prerogative in cases of emergency, of which the King must be the sole judge, and from the exercise of which no King, not even by statute, would contract himself out—at any rate so as to bind his successors. The answer to this doctrine was the pertinent challenge of Mr. Hakewill in the Commons debates, "Who then shall decide what is an emergency?". It was the Revolution of 1689 that really decided the issue by settling that the King has no power above and beyond the law and that the real sovereign is not the King but the King in Parliament.

Summary.—The chief prerogative powers may be summarised as follows:

(1) In foreign relations the King has the exclusive power of making war and of declaring peace. The power is usually exercised by a Proclamation and an Order in Council and, as such, it is binding on the courts who cannot go behind it but must accord it the same "judicial notice" as an Act of Parliament, *Esposito* v. *Bowden* 7 E. and B. 765. In practice, of course, the power is never exercised except with the approval of Parliament. The treaty-making power may be regarded as an exercise of the

same prerogative. The King can make what treaties he pleases, provided they do not impose a tax on the subject or derogate from common law rights. Whether he can, by the negotiation of such a treaty, cede British territory is more doubtful and has been much disputed; no King, in other words no English ministry, has ventured to exercise such a prerogative since 1894 without seeking the consent of Parliament in the form of a statute and it may be regarded as now settled usage that, as in the case of the Treaty of Versailles, the Crown will always, in the case of a Treaty of Peace involving cession or annexation, seek statutory powers, *ex magna cautela,* to do all such things as may be necessary to carry such a treaty into effect. The Crown has, however, often, as in the case of certain African Protectorates, annexed "foreign" territories by mere prerogative in the form of an Order in Council. Furthermore it rests with the Crown, and the Crown alone, to "recognize" the foreign Governments as *de jure* Governments: a recent case in point is the recognition of the Bolshevik Republic (see *Luther* v. *Sagor* [1921] 3 K.B. 533). Such recognition is binding on the courts and, by a logical sequence, so is a declaration by the Crown that a particular person is entitled to the status of a foreign sovereign and as such is immune from the jurisdiction of the courts—cf. *Mighell* v. *Sultan of Johore* (1880) *L.R.* 5 P.D. 197. So too with the status of an ambassador and the diplomatic immunity of himself and his "suite"—it has now been held that the courts cannot, in the presence of a Foreign Office certificate, even traverse that certificate in order to decide whether the person, in favour of whom diplomatic immunity from their jurisdiction is claimed, is, as a matter of fact, a member of the embassy or not—*Mussman* v. *Engelke* (1928) A.C.

(2) Defence.—The King is head of the naval and military forces of the country and can alone recruit them. It is a statutory offence for any other person to "recruit." The Bill of Rights has limited the exercise of this prerogative by making the raising and maintaining of a standing *army* in *time of peace* illegal. The words italicized are important; they do not prohibit the exercise of the power in time of war and they leave the prerogative unaffected as regards the navy. "The Crown is *not* precluded from raising a standing navy in time of peace nor from imposing a permanent discipline" and in time of war the King can impress sailors and ships by virtue of royal prerogative, R. v. *Broadfoot* (Foster, *Crown Cases* p. 154). There is considerable authority for the proposition that in time of war the King can conscript civilians for the defence of the realm although he cannot compel them to serve abroad. So, too, with certain limitations, he can requisition the subject's property and enter on the subject's land in time of war although this prerogative is now entirely regulated by statute *(see* the *De Keyser Case* below). The necessity of an annual statute to put in force the code of discipline known as the Army Act has, as it has been well said, made of the army "a statutory not a prerogative force." The fact also that all Army expenditure is subject to the annual vote of the Army Estimates has the same effect. And it is, in fact, impossible for the King to "make war," as distinct from declaring it, without the consent of Parliament. Not only would a vote of special supplies be necessary. but by the Reserve Forces Act of 1882, mobilization itself is subject to Parliamentary consent inasmuch as the Army Reserve cannot be called up for permanent service unless Parliament is summoned within 10 days. The same condition is attached to the embodiment of the Territorial Force. *(See* also MARTIAL LAW and MILITARY LAW.)

(3) Legislation.—The requirement of the King's assent to a bill passed by both Houses of Parliament before it can be "enacted" may be regarded as an aspect of the royal prerogative in that the King may, in law, withhold his assent. This prerogative is not dead—"time never runs against the King" so as to make a prerogative wholly obsolete by desuetude—but it has not been exercised since the reign of Queen Anne. But the King may legislate by prerogative, *i.e.,* by Proclamation or by Order in Council, as distinct from statute. But it was long ago laid down by Coke that the King cannot, by his prerogative, alter the common law or create a new offence. In the case of colonies acquired by conquest or cession the prerogative is, however, as absolute as in the time of the earlier statutes. In such cases the King may make what laws he pleases *(Campbell* v. *Hall,* 20 St. Tr. 239). And in the case of all colonies, even the self-governing Dominions, the King can "disallow" an Act to which his local representative, the Governor or Governor-General, has assented. This power is recognized in the constitution of the self-governing Dominions themselves, but it is therein made subject to a period of limitation, usually one or two years.

(4) Parliament.—It is the sole prerogative of the King to summon, prorogue and dissolve Parliament. This may properly be regarded as an executive, not a legislative, act and it is, of course, performed on the advice of ministers. As has been said above, it may be regarded as an accepted convention, at any rate since 1924, that the King cannot, under any circumstances, refuse to dissolve Parliament when a request to that effect is preferred by a Prime Minister. But he might still dissolve Parliament *ex proprio motu* and against the wishes of his Prime Minister under certain circumstances, as, for example, when a Prime Minister having been defeated on a direct Vote of Confidence in the Commons refused either to resign or to ask for a dissolution. Such a state of affairs is not likely nor would it, in any case, be durable, but it is not inconceivable.

(5) Executive.—The theory of the law is that the Government of the country is still entirely a matter of prerogative, although, of course, many, if not most, of the powers now exercised by the Crown have been conferred upon it by statute—in particular the power of making Statutory Rules and Orders *(q.v.)* to carry a statute into effect. All ministers are appointed by the King—on the nomination of the Prime Minister—and "Kiss hands" or, as in the case of Secretaries of State, receive their seals from the King himself. In law there is no such office as that of "Prime Minister." In the choice of a Prime Minister the King has, both in law and in fact, a discretion and he sends for whom he will, when the outgoing Prime Minister has resigned, but his choice is usually limited to the leader of the Opposition. All military and naval officers are appointed by a "commission" from the King. So too with the Governors of the Colonies. And as he appoints, so he dismisses. Every office under the Crown, except that of the judges and the Comptroller and Auditor General, is held "during pleasure." This doctrine has important legal consequences in that the King's ministers, exercising the prerogative, can terminate any commission or contract of service whenever they please and the servant of the Crown, civil or military, has no remedy. English law "imports into every agreement" for service with the Crown the term "that the Crown has power to dismiss at pleasure" and even that any term of agreement purporting to exclude this power would be void (Lord Watson in *De Dohse* v. *the King* quoted in *Dunn* v. *the Queen* [1896] 1 *Q.B.* at p. 118). This is a striking example of how the prerogative may operate to invest ministers with arbitrary power. No servant of the Crown has any legally enforceable right to pay, pension or security of tenure.

(6) General.—The less important prerogatives of the Crown may be dealt with generally. The King is the supreme landowner, a relic of feudal doctrines, which is only important in the case of a man dying intestate and without heirs in which case his land "escheats" to the Crown. The King also is the depositary of the prerogative of mercy, in other words he can pardon those who offend against his "peace"; the prerogative is now exercised exclusively on the advice of the Home Secretary. He is the "fountain of honour" and as such is the sole grantor of titles such as peerages, baronetcies and knighthoods; his power in this respect is subject to no limitations except those contained in peerage law but "honours" are rarely conferred by him except on the advice of Ministers. He is the "supreme governor" of the Church in virtue of the Acts of Supremacy and Uniformity. The prerogatives of the Crown in the courts are dealt with in the article on PETITION OF RIGHT.

Effect of Statutes on the Prerogative.—As has been seen Parliament has frequently intervened to abolish some particular prerogative, deemed to be oppressive, and since the Revolution of 1689 it has never been doubted that such a statute will bind not only the King who actually assented to it but all his successors. It has, however, until recently, been a matter of considerable doubt and speculation whether a statute can curtail a prerogative in the absence of express words to that effect. In a book of considerable authority in its day, Chitty (The Prerogative of the *Crown* [1820] p. 383) laid down that "Acts of Parliament which would divest or abridge the King of his prerogative, his interests or his remedies in the slightest degree do not in general extend to bind the King unless there be express words to that effect." This view was expressed more widely by a judge, Hobart, C. J., in 1624 in the quaint words "Everything [in a statute] for the benefit of the King shall he taken largely [*i.e.*, liberally], as everything against the King shall be taken strictly" —Sir Edward Coke's Case (1624), Godbee's Reports, p. 289. Thus it has been successfully contended that the Crown is not bound by the Statute of Limitations and it has obtained judgment in proceedings against a subject, by Information of Debt, on a claim thirty years old (*Brummell* v. *M'Pherson* 7 L.J. [O.W. Series] Ch. 1.). But the presumption in favour of the Crown, in the interpretation of a statute, is no longer as strong as it was. In this respect the great case of *Attorney-General* v. *De Keyser's* Hotel [1920] A.C. is decisive to the extent that when Parliament has by statute regulated "the whole field of the prerogative," that particular prerogative can be exercised in no other way than that prescribed by the statute. In that case the Defence Act of 1842 had laid down regulations for the payment of compensation by the Crown for lands taken for the purpose of national defence, and it was held that, though that Act had not expressly abolished the prerogative of taking land or premises in time of war, the prerogative itself could only be exercised in accordance with the terms laid down by the Act, namely the payment of compensation duly assessed by a jury. The Crown's contention that, as there was no direct mention of the prerogative in the Act of 1842, that prerogative was unaffected and unimpaired, was decisively rejected by the courts. The same principle has been followed by the courts in the more recent case of Food *Controller* v. Cork (1923) A.C. 647. (See also articles on ATTORNEY-GENERAL, COMMON LAW, CONSTITUTIONAL LAW, PETITION OF RIGHT.)

BIBLIOGRAPHY.—*See* W. Stanford, Exposition of the King's *Prerogatives* (1567); J. Comyns, Digest of the Laws of England (5 vols., 1762–67, 5th ed. 8 vols., 1822); J. Chitty, *A* Treatise of the Law of the Prerogatives of the Crown (1820); F. W. Maitland, Collected *Papers* vol. iii. (3 vols., 1911); J. H. Morgan, "Remedies against the Crown" in G. E. Robinson, Public Authorities and Legal Liability (1925); also A. V. Dicey, *Introduction* to the Study of *the* Law of the Constitution (8th ed. 1915); W. R. Anson, The Law and *Custom* of the Constitution (5th ed. M. L. Gwyer, 1922). (J. H. Mo.)

PREROGATIVE COURTS, the name given to the English provincial courts of Canterbury and York, as far as regarded their jurisdiction over the estates of deceased persons. They had jurisdiction to grant probate or administration where the diocesan courts could not entertain the case owing to the deceased having died possessed of goods above the value of £5 (bona notabilia) in each of two or more dioceses. The jurisdiction of the prerogative courts was transferred to the court of probate in 1857 by the Probate Court Act, and is now vested in the probate, divorce and admiralty division of the High Court of Justice by the Judicature Act 1875. In the State of New Jersey, United States, the court having jurisdiction over probate matters is called the prerogative court.

PRESBYTER, the title borne from very early times by certain officers or ministers of the Christian Church intermediate between "bishops" and "deacons." The word is the original form of priest (*q.v.*). The word is not found in pre-Christian writing: except in the Septuagint, though as Deissmann has shown it is found on the Papyri as an official title for the village magistrates of Egypt and the members of the γερουσία, or senate, of many towns in Asia Minor. The office is, however, closely analogous to, and perhaps founded on, a similar office in the Jewish synagogue organization among the officials of which were the *zekenim*, or elders, sometimes identified with the archi-synagogues. In the New Testament the Greek word is used both for the ancient Jewish official and for the Christian elder.

The history of presbyteral government as opposed to episcopacy and pure congregationalism is not known in detail. After the Reformation, however, it was adopted by Calvin and his followers, who created that system which has ever since been known as Presbyterianism (*q.v.*). During the last quarter of the 1st century, a threefold organization is found in the Church: (a) a spiritual organization composed of "apostles, prophets and teachers who had been awakened by the spirit and by the spirit endowed"; (b) an administrative organization, "For the care of the poor, for worship, for correspondence, the congregation needed controlling officials. These were the bishop and the deacons, the former for higher, the latter for inferior services"; (c) a patriarchal organization based upon the natural deference of the younger to the older members of the Church. The senior members of the community, by virtue of their age and experience, watched over the conduct and guided the action of the younger and less experienced portion of the Church, though they held no official position and were not appointed for any particular work like the bishops and deacons. In the and century the patriarchal element in the organization was merged in the administrative, and the presbyters became a definite order in the ministry. The time at which the change occurred cannot be definitely fixed. Although presbyters are not mentioned in the genuine Epistles of St. Paul, there are hints that similar officers existed in some of the churches founded by the apostle. There is a reference in 1 Thess. v. 12 to "those who rule over you" (προϊστάμενοι), and the same word occurs in Rom. xii. 8. The term "governments" (κυβερνήσεις) in 1 Cor. xii. 28 obviously refers to men who discharged the same functions as presbyters. If too, as seems most probable, bishops and presbyters were practically identical, there is of course a specific reference to them in Phil. i. 1. The "leaders" who are mentioned three times in Hebrews xiii. were also probably "presbyters" under another name. If the Church at Jerusalem had any officials, it is highly probable that those officials bore the name and took over the functions of the elders of the synagogue. The statement in Acts xiv. 23, that Paul and Barnabas appointed elders in the churches of South Galatia, is more open to objection perhaps, owing to the silence of the Epistle to the Galatians.

The conclusions which we seem to reach are as follows: (1) In the earliest stage (between 30 and 60) there is no uniform organization in the Christian Church. Presbyters are found in Jerusalem from primitive times. In the Pauline churches the name is not found except at Ephesus and possibly in south Galatia, though there are traces of the office, at any rate in germ, under different titles in other churches. (2) In the second stage (between 60 and 100) there is an increasing tendency towards uniformity. The office is found definitely mentioned in connection with the churches of Asia Minor (1 Pet. v. 1), Corinth (Epistle of Clement) and Crete (Titus). The officials were called by two names, "elders" and "bishops," the former denoting the office, the latter the function (exercising the oversight). The substantial identity of the two titles cannot be doubted in the light of such passages as Acts xx. 17, 28; 1 Pet. v. 1, 2; 1 Tim. iii. 1–7, v. 17–19 and Titus i. 5–7.

There is far less controversy with regard to the later history of the presbyters. The third stage of the development of the office is marked by the rise of the single *episcopus* as the head of the individual church (see BISHOP; EPISCOPACY). The first trace of this is to be found in the Epistles of Ignatius which prove that by the year 115 "the three orders" as they were afterwards called—bishops, presbyters and deacons—already existed, not indeed universally, but in a large proportion of the churches. The presbyters occupied an intermediate position between the bishop and the deacons. They constituted "the council of the bishop." It was some time before the threefold ministry became universal. The *Didache* knows nothing of the presbyters; bishops and deacons are mentioned, but there is no reference to the second order. The Shepherd of Hermas knows nothing of the single bishop; the churches are under the control of a body of presbyter-bishops. Before the close of the 2nd century however the three orders were established almost everywhere. The sources of the Apostolic Canons (which date between 140–180) lay down the rule that even the smallest community of Christians, though it contain only twelve members, must have its bishop and its presbyters. The original equality of bishops and presbyters was still however theoretically maintained. The presbyters formed the governing body of the church. It was their duty to maintain order, exercise discipline, and superintend the affairs of the Church. At the beginning of the 3rd century, if we are to believe Tertullian, they had no spiritual authority of their own, at any rate as far as the sacraments are concerned. The right to baptize and celebrate the communion was delegated to them by the bishop.

In the fourth stage we find the presbyters, like the bishops, becoming endowed with special sacerdotal powers and functions. It was not till the middle of the 3rd century that the priesthood was restricted to the clergy. Cyprian is largely responsible for the change, though traces of it are found during the previous half century. Cyprian bestows the highest sacerdotal terms upon the bishops of course, but his references to the priestly character of the office of presbyter are also most definite. Henceforth presbyters are recognized as the *secundum sacerdotium* in the Church.

With the rise of the diocesan bishops the position of the presbyters became more important. The charge of the individual church was entrusted to them and gradually they took the place of the local bishops of earlier days, so that in the 5th and 6th centuries an organization was reached which approximated in general outline to the system which prevails in the Anglican Church to-day.

BIBLIOGRAPHY.—See Hatch, *Organization of the Early Christian Churches* (2nd ed., 1882), and Harnack's *"excursus"* in the German edition of this work (1883); Harnack, *Die Lehre der zwölf Apostel* (1884); Loening, *Die Gemeindeverfassung des Urchristentums* (1889); Sohm, *Kirchenrecht* (1892); an article by Loofs, in *Studien und Kritiken*, for 1890 (pp. 619–658); Lindsay, *The Church and the Ministry in the Early Centuries* (1902); Schmiedel, article "Ministry," in *Enc. Bib.*

PRESBYTERIANISM, one of the three principal systems of church polity known to the Christian (Protestant) Church, and occupying an intermediate position between episcopacy and congregationalism.

I. THE SYSTEM DESCRIBED

As compared with the Church of England (Episcopal) in which there are three orders of clergy—bishops, priests and deacons, Presbyterianism recognizes but one spiritual order, viz., presbyters. These are ecclesiastically of equal rank, though differentiated, according to their duties, as ministers who preach and administer the sacraments, and as elders who are associated with the ministers in the oversight of the people. There are deacons, in Presbyterianism inferior in rank to presbyters, their duties being regarded as non-spiritual. The membership of a Presbyterian Church consists of all who are enrolled as communicants, together with their children. Others who worship regularly without becoming communicants are called adherents. Only communicants exercise the rights of membership. They elect the minister and other office-bearers. But, in contrast with Congregationalism, when they elect and "call" a minister their action has to be sustained by the presbytery, which judges of his fitness for that particular sphere, of the measure of the congregation's unanimity, and of the adequacy of financial support. When satisfied, the presbytery proceeds with the ordination and induction. The ordination and induction of ministers is always the act of a presbytery. The ordination and induction of elders in some branches of the Church is the act of the session; in others it is the act of the presbytery.

Church **Courts.**—(i.) The *session* is the first of a series of councils or church courts which are an essential feature of Presbyterianism. It consists of the ministers and ruling elders. The minister is *ex officio* president or moderator. Without his presence or the presence of his duly-appointed deputy the meeting would not be in order nor its proceedings valid. The moderator has not a deliberative, but only a casting vote. (This is true of the moderator in all the church courts.) Neither the session nor the congregation has jurisdiction over the minister. He holds his office *ad vitam aut culpam;* he cannot demit it or be deprived of it without consent of the presbytery. In this way his independence among the people to whom he ministers is to a large extent secured. The session has oversight of the congregation in regard to such matters as the hours of public worship, the arrangements for administration of the sacraments, the admission of new members and the exercise of church discipline. New members are either catechumens or members transferred from other churches. The former are received after special instruction and profession of faith; the latter on presenting a certificate of church membership from the church which they have left. Though the admission of new members is, strictly speaking, the act of the session, this duty usually devolves upon the minister, who reports his procedure to the session for approval and confirmation. Matters about which there is any doubt or difficulty, or division of opinion in the session, may be carried for settlement to the next higher court, the presbytery.

(ii.) The *presbytery* consists of all the ministers and a selection of the ruling elders from the congregations within a prescribed area. The presbytery chooses its moderator periodically from among its ministerial members. His duty is to see that business is transacted according to Presbyterian principle and procedure. The moderator has no special power or supremacy over his brethren, but is honoured and obeyed as *primus inter pares.* The work of the presbytery is episcopal. It has oversight of all the congregations within its bounds; hears references from kirk-sessions or appeals from individual members; sanctions the formation of new congregations; superintends the education of students for the ministry; stimulates and guides pastoral and evangelistic work; and exercises discipline over all within its bounds, including the ministers. Appeals and complaints may be taken from the presbytery to the synod.

(iii.) The *synod* is a provincial council which consists of the ministers and representative elders from all the congregations within a specified number of presbyteries, in the same way as the presbytery is representative of a specified number of congregations. Though higher in rank and larger than most presbyteries it is practically of less importance, not being, like the presbytery, a court of first instance, nor yet, like the general assembly, a court of final appeal. The synod hears appeals and references from presbyteries; and by its discussions and decisions business of various kinds, if not settled, is ripened for consideration and final settlement by the general assembly, the supreme court of the Church.

(iv.) The *general assembly* is representative of the whole Church, either, as in the Irish General Assembly, by a minister and elder sent direct to it from every congregation, or, as in the Scottish General Assemblies, by a proportion of delegates, ministers and elders from every presbytery. The general assembly annually at its first meeting chooses one of its ministerial members as moderator. He takes precedence, *primus inter pares,* of all themembers, and is recognized as the official head of the Church during his term of office. His position is one of great honour and influence, but he remains a simple presbyter, without any special rule or jurisdiction. The general assembly reviews all the work of the Church; settles controversies; makes administrative laws; directs and stimulates missionary and other spiritual work; appoints professors of theology; admits to the ministry applicants from other churches; hears and decides complaints, references and appeals which have come up through the inferior courts; and takes cognizance of all matters connected with the Church's interests or with the general welfare of the people. As a judicatory it is the final court of appeal; and by it alone can the graver censures of church discipline be reviewed and removed. The general assembly meets once a year at the time and place agreed upon and appointed by its predecessor.

The weak point in the system is that episcopal superintendence being exercised in every case by a plurality of individuals there is no one, moderator or senior member, whose special duty it is to take initial action when the unpleasant work of judicial investigation or ecclesiastical discipline becomes necessary. This has led in some quarters to a desire that the moderator should be clothed with greater responsibility and have his period of office prolonged;

should be made, in fact, more of a bishop in the Anglican sense of the word.

Divergent Views.—Though Presbyterians are unanimous in adopting the general system of church polity as here outlined, and in claiming New Testament authority for it, there are certain differences of view in regard to details which may be noticed. (See Lightfoot's exhaustive essay in his volume on the Epistle to the Philippians.) There is no doubt that considerable indefiniteness in regard to the precise status and rank of the "ruling elder" has prevailed. When ministers and elders are associated in the membership of a church court their equality is admitted; no such idea as voting by orders is ever entertained. Yet even in a church court a certain disparity is apparent between a minister and his elders. Practically the minister is regarded as of higher standing. The duty of teaching and of administering the sacraments and of always presiding in church courts being strictly reserved to him invests his office with a dignity and influence greater than that of the elder. The practice which is most characteristic of Presbyterianism is that which recognizes one order of presbyters but in this order two degrees or classes, known as teaching elders or "ministers" and ruling elders. In teaching, in dispensing the sacraments, in presiding over public worship, and in the private functions by which he ministers to the comfort, the instruction and the improvement of the people committed to his care, a pastor acts within his parish (or congregation) according to his own discretion; and for the discharge of all the duties of the pastoral office he is accountable only to the presbytery from whom he received the charge of the parish (or congregation). But in everything which concerns what is called discipline—the exercise of that jurisdiction over the people with which the office-bearers of the church are conceived to be invested, he is assisted by lay-elders. They are laymen in that they have no right to teach or to dispense the sacraments, and on this account they fill an office in the Presbyterian Church inferior in rank and power to that of the pastors. Their peculiar business is expressed by the term "ruling elders."

In the initial stages of the Apostolic Church it was no doubt sufficient to have a plurality of presbyters with absolutely similar duties and powers At first, indeed, this may have been the only possible course. But apparently it soon became desirable and perhaps necessary to specialize the work of teaching by setting apart for that duty one presbyter who should withdraw from secular occupation and devote his whole time to the work of the ministry. There seems to be evidence of this in the later writings of the New Testament. It is now held by all Presbyterian churches that one presbyter in every congregation should have specially committed to him the work of teaching, administering the sacraments, visiting the flock pastorally, and taking oversight, with his fellow elders, of all the interests of the church.

Another subject upon which there is a difference of opinion in the Presbyterian churches is the question of Church Establishments. The view, originally held by all Presbyterian churches in Great Britain and on the Continent, that union with and support by the civil government are not only lawful but also desirable, is now held only by a minority, and is practically exemplified among English-speaking Presbyterians only in the Church of Scotland (see SCOTLAND, CHURCH OF). The lawfulness of Church Establishments with due qualifications is perhaps generally recognized in theory, but there is a growing tendency to regard connection with the state as inexpedient, if not actually contrary to sound Presbyterian principle.

Those who favour state connection and those who oppose it agree in claiming spiritual independence as a fundamental principle of Presbyterianism. All Presbyterians admit the supremacy of the state in things secular, and they claim supremacy for the Church in things spiritual. Those who favour a Church Establishment hold that Church and state should each be supreme in its own sphere, and that on these terms a union between them is not only lawful but is the highest exemplification of Christian statesmanship. So long as these two spheres are at all points clearly distinct, and so long as there is a desire on the part of each to recognize the supremacy of the other, there is little danger of friction or collision. But when spiritual and secular interests come into unfriendly contact and entanglement; when controversy in regard to them becomes inevitable; from which sphere, the spiritual or the civil, is the final decision to come? Before the Reformation the Church would have had the last word; since that event the right and the duty of the civil power have been generally recognized.

Origin.—The origin of Presbyterianism is a question of historical interest. By most students of the subject it is regarded as of later Jewish origin, and as having come into existence in its present form simultaneously with the formation of the Christian Church. The last is Bishop Lightfoot's view. He connects the Christian ministry, not with the worship of the Temple, in which were priests and sacrificial ritual, but with that of the synagogue, which was a local institution providing spiritual edification by the reading and exposition of Scripture. The first Christians were regarded, even by themselves, as a Jewish sect. They were spoken of as "the way." They took with them, into the new communities which they formed, the Jewish polity or rule and oversight by elders. The appointment of these would be regarded as a matter of course, and would not seem to call for any special notice in such a narrative as the Acts of the Apostles.

But Presbyterianism was associated in the and century with a kind of episcopacy. This episcopacy was at first rather congregational than diocesan; but the tendency of its growth was undoubtedly towards the latter. Hence for proof that their church polity is apostolic Presbyterians are accustomed to appeal to the New Testament and to the time when the apostles were still living; and for proof of the apostolicity of prelacy Episcopalians appeal rather to the early Church fathers and to a time when the last of the Apostles had just passed away. (See Lightfoot's essay in his *Commentary* on the Epistle to *the* Philippians.) It is generally admitted that distinct traces of Presbyterian polity are to be found in unexpected quarters (*e.g.*, Ireland, Iona, the Culdees, etc.) from the early centuries of church history and throughout the mediaeval ages down to the Reformation of the 16th century. Only in a very modified sense, therefore, can it be correctly said to date from the Reformation.

At the Reformation the Bible was for the great mass of both priests and people a new discovery. The study of it shed floods of light upon all church questions. The leaders of the Reformation searched the New Testament not only for doctrinal truth but also to ascertain the polity of the primitive Church. This was specially true of the Reformers in Switzerland, France, Scotland, Holland and in some parts of Germany. Luther gave little attention to New Testament polity, though he believed in and clung passionately to the universal priesthood of all true Christians, and rejected the idea of a sacerdotal caste. He had no dream or vision of the Church's spiritual independence and prerogative. He was content that ecclesiastical supremacy should be with the civil power, and he believed that the work of the Reformation would in that way be best preserved and furthered. In no sense can his "consistorial" system of church government be regarded as Presbyterian.

It was different with the Reformers outside Germany. While Luther studied the Scriptures in search of true doctrine and Christian life and was indifferent to forms of church polity, they studied the New Testament not only in search of primitive church doctrine but also of primitive church polity. One is struck by the unanimity with which, working individually and often in lands far apart, they reached the same conclusions. They did not get their ideas of church polity from one another, but drew it directly from the New Testament. They were unanimous in rejecting the episcopacy of the Church of Rome, the sanctity of celibacy, the sacerdotal character of the ministry, the confessional, the propitiatory nature of the mass. They were unanimous in adopting the idea of a church in which all the members were priests under the Lord Jesus, the One High Priest and Ruler; the officers of which were not mediators between men and God, but preachers of One Mediator, Christ Jesus; not lords over God's heritage, but examples to the flock and ministers to render service. They were unanimous in regarding ministerial service as mainly pastoral;

preaching, administering the sacraments and visiting from house to house; and, further, in perceiving that Christian ministers must be also spiritual rulers, not in virtue of any magical influence transmitted from the Apostles, but in virtue of their election by the Church and of their appointment in the name of the Lord Jesus. When the conclusions thus reached by many independent investigators were at length reduced to a system by Calvin, in his famous Znstitutio, it became the definite ideal of church government for all the Reformed, in contradistinction to the Lutheran, churches.

Yet we do not find that the leaders of the Reformed Church succeeded in establishing at once a fully-developed Presbyterian polity. Powerful influences hindered them from realizing their ideal. In the first place, the people generally dreaded the recurrence of ecclesiastical tyranny. A second powerful influence was of a different kind, viz. municipal jealousy of church power. The municipal authority in those times claimed the right to exercise a censorship over the citizens' private life. Any attempt on the part of the Church to exercise discipline was resented as an intrusion. Hence friction, at times, between the Reformers and civic authorities friendly to the Reformation; not as to whether there should be "discipline" (that was never doubted) but as to whether it should be ecclesiastical or municipal. Even, therefore, where people desired the Reformation there were powerful influences opposed to the setting up of church government and to the exercise of church discipline after the manner of the Apostolic Church; and one ceases to wonder at the absence of complete Presbyterianism in the countries which were forward to embrace and adopt the Reformation. Indeed the more favourable the secular authorities were to the Reformation the less need was there to discriminate between civil and ecclesiastical power, and to define strictly how the latter should be exercised. We look in vain, therefore, for much more than the germs and principles of Presbyterianism in the churches of the first Reformers. Its evolution and the thorough application of its principles to actual church life came later, not in Saxony or Switzerland, but in France and Scotland; and through Scotland it has passed to all English-speaking lands.

Presbyterian Worship.—The form of worship associated with Presbyterianism has been marked by extreme simplicity. It consists of reading of Holy Scripture, psalmody, non-liturgical prayer and preaching. There is nothing in the standards of the Presbyterian Church against liturgical worship. In some of the early books of order a few forms of prayer were given, but their use was not compulsory. On the whole, the preponderating preference has always been in favour of so-called extemporaneous, or free prayer; and the Westminster Directory of Public Worship has to a large extent stereotyped the form and order of the service in most Presbyterian churches. Within certain broad outlines much, perhaps too much, is left to the choice of individual congregations. It used to be customary among Presbyterians to stand during public prayer, and to remain seated during the acts of praise, but this peculiarity is no longer maintained. The psalms rendered into metre were formerly the only vehicle of the Church's public praise, but hymns are now also used in most Presbyterian churches. Rous's version of the Psalms is the best known and most widely used. It is an English work. Somewhat reluctantly it was accepted by Scottish Presbyterianism as a substitute for an older version with a greater variety of metre and music. "Old Hundred" and "Old 124th" mean the 100th and 124th Psalms in that old book. Organs used to be regarded as contrary to New Testament example, but their use is now all but universal. The public praise used to be led by an individual called the "precentor," who occupied a box in front of, and a little lower than, the pulpit. Choirs of male and female voices now lead the church praise.

Presbyterianism has two sacraments, baptism and the Lord's Supper. Baptism is administered both to infants and adults by pouring or sprinkling, but the mode is considered immaterial. The Lord's Supper, as generally observed throughout the various Presbyterian churches, is a close imitation of the New Testament practice; and where it is not marred by undue prolixity commends itself to most Christian people as a solemn and impressive service. The old plan of coming out and taking one's place at the communion table in the body of the church is unhappily seen no more; communicants now receive the sacred elements seated in their pews. The dispensing of this rite is strictly reserved to an ordained minister, who is assisted by elders in handing the bread and the cup to the people. The administration of private communion to the sick and dying is extremely rare in Presbyterian churches, but there is less objection to it than formerly, and in some churches it is even encouraged.

Discipline.—Presbyterian discipline is now entirely confined to exclusion from membership or from office. Though it is the duty of a minister to warn against irreverent or profane participation in the Lord's Supper, he himself has no right to exclude any one from communion; that can only be done as the act of himself and the elders duly assembled in session. A code of instructions for the guidance of church courts when engaged in cases of discipline is in general use, and bears witness to the extreme care taken not only to have things done decently and in order, but also to prevent hasty, impulsive and illogical procedure in the investigation of charges of heresy or immorality. Cases of discipline are now comparatively rare, and, when they do occur, are not characterized by the bigoted severity which prevailed in former times and was rightly denounced as unchristian.

The extent to which the Presbyterian form of church government prevails throughout the world has been made more manifest in recent years by the formation of the "General Council of the Alliance of Reformed Churches holding the Presbyterian System," the object of which is to promote unity and fellowship among the numerous branches of Presbyterianism throughout the world. Since 1910 the Presbyterian churches have encountered, in common with others, the obstacles and the impetus created by the World War. The gains have outweighed the losses upon the whole: Numerically, to judge from the statistics presented to the general council held at Cardiff in July 1925 the total membership of the Presbyterian churches had increased between 1913 and that date by well over 2,000,000. The precise figures are, for 100 organised churches which it has been possible to reach, 8,670,500 souls; so that, on the usual scale of estimating people under the direct influence of a Church, there are over 40,000,000 who are Presbyterians.

II. HISTORY IN DIFFERENT COUNTRIES

From this general outline of Presbyterianism we now turn to consider its evolution and history in some of the countries with which it is or has been specially associated. We omit, however, one of the most important, viz., Scotland, as the history is fully covered under the separate headings of SCOTLAND, CHURCH OF, and allied articles.

Switzerland.—The Swiss, owing to their peculiar geographical position and to certain political circumstances, early manifested independence in ecclesiastical matters, and became accustomed to the management of their church affairs. The work of Zwingli as a Reformer, important and thorough though it was, did not concern itself mainly with church polity. Ecclesiastical affairs were, as a matter of course, wholly under the management of the cantonal and municipal authorities, and Zwingli was content that it should be so. The work of Farel, previous to his coming to Geneva, was almost entirely evangelistic, and his first work in Geneva was of a similar character. It was the town council which made arrangements for religious disputations, and provided for the housing and maintenance of the preacher. When Calvin, at Farel's invitation, settled in Geneva (1536) the work of reformation became more constructive. "The need of the hour was organization and familiar instruction, and Calvin set himself to work at once." The first reforms he wished to see introduced concerned the Lord's Supper, church praise, religious instruction of youth and the regulation of marriage. In connection with the first he desired that the discipline de l'excommunication should be exercised. His plan was partly Presbyterian and partly consistorial. Owing to certain circumstances in its past history, Geneva was notoriously immoral. "The rule of dissolute bishops, and the example of a turbulent and immoral clergy, had poisoned the morals of the city. Even the nuns of Geneva were notorious for their conduct." Calvin suggested that men of known worth should be appointed in different quarters of the city to report to the ministers those persons in their district who lived in open sin; that the ministers should then warn such persons not to come to the communion; and that, if their warnings were unheeded, discipline should be enforced. It was on this subject of keeping pure the Lord's Table that the controversy arose between the ministers and the town councillors which ended in the banishment of Calvin, Farel and Conrad from Geneva. In 1538 the ministers took upon themselves to refuse to administer the Lord's Supper in Geneva because the city, as represented by its council, declined to submit to church discipline. The storm then broke out, and the ministers were banished.

Calvin's refusal to administer the sacrament, for which he was banished from Geneva, is important as a matter of ecclesiastical history, because it is the essence of the whole system which he subsequently introduced. It rests on the principles that the Church has the right to exclude those who are unworthy, and that she is in no way subject to the civil power in spiritual matters. During the three years of his banishment Calvin was at Strassburg, where he had been carrying out his ideas. His recall was greatly to his honour. The town had become a prey to anarchy. One party threatened to return to Romanism; another threatened to sacrifice the independence of Geneva and submit to Berne. It was felt to be a *political* necessity that he should return, and in 1541, somewhat reluctantly, he returned on his own terms. These were the recognition of the Church's spiritual independence, the division of the town into parishes, and the appointment (by the municipal authority) of a consistory or council of elders in each parish for the exercise of discipline. The arrangement was, however, a compromise. The state retained control of the ecclesiastical organization, and Calvin secured his much-needed system of discipline. Fourteen years of friction and struggle followed, and if there came after them a period of comparative triumph and repose for the great reformer it must still be remembered that he was never able to have his ideal ecclesiastical organization fully realized in the city of his adoption.

The early Presbyterianism of Switzerland was defective in the following respects: (1) It started from a wrong definition of the Church, which, instead of being conceived as an organized community of believers in the Lord Jesus Christ, was made to depend upon the preaching of the gospel and the administration of the sacraments. As these implied a duly appointed minister, the existence of the Church was made to depend upon an organized ministry rather than an organized membership. It calls to mind the Romish formula: *"Ubi episcopus ibi ecclesia."* (2) It did not maintain the scriptural right of the people to choose their minister and other office-bearers. (3) Its independence of civil control was very imperfect. (4) And it did not by means of church courts provide for the manifestation of the Church's unity and for the concentration of the Church's influence.

"Calvin," says Principal Lindsay, "did three things for Geneva all of which went far beyond its walls. He gave its Church a trained ministry, its homes an educated people who could give a reason for their faith, and the whole city an heroic soul which enabled the little town to stand forth as the citadel and city of refuge for the oppressed Protestants of Europe."

France. — It is pathetic and yet inspiring to study the development of Presbyterianism in France; pathetic because it was in a time of fierce persecution that the French Protestants organized themselves into churches, and inspiring, because it showed the power which scriptural organization gave them to withstand incessant, unrelenting hostility. It would be difficult to exaggerate the influence of Calvin upon French Protestanism. His *Christianae religionis institutio* became a standard round which his countrymen rallied in the work and battle of the Reformation. Though under thirty years of age, he became all over Europe, and in an exceptional degree in France, the leader, organizer and consolidator of the Reformation. The work which the young Frenchman did for his countrymen was immense.

The year 1555 may be taken as the date when French Protestantism began to be organized. A few churches had been organized earlier, at Meaux in 1546 and at Nimes in 1547, but their members had been dispersed by persecution. Prior to 1555 the Protestants of France had been for the most part solitary Bible students or little companies meeting together for worship without any organization. The first organized church was formed in that year in Paris; and from that date they began to spring up in all parts of the country.

In 1558 a further stage in the development of Presbyterian church polity was reached. Some doctrinal differences having arisen in the church at Poitiers, a synod was convened to meet in Paris the following year (1559). It was the first general synod of the French Protestant Church, and consisted of representatives from, some say sixty-six, others, twelve churches. It adopted a confession of faith and a book of order or discipline. The confession consisted of forty articles. It was based on a short confession drafted by Calvin in 1557, and may still be regarded, though once or twice revised, as the confession of the French Protestant Church. The book of order, *Discipline ecclésiastique des e'glises réformées de France*, regulated the organization and procedure of the churches. It contains this fundamental statement of Presbyterian parity, "Aucune église ne pourra prétendre primauté ni domination sur l'autre; ni pareillement, les ministres d'une église les uns sur les autres; ni les anciens ou diacres, les uns sur les autres"; and it explains various church courts, familiar to us now as Presbyterian. "It is interesting to see how in a country whose civil rule was becoming gradually more absolutist, this 'Church under the cross' framed for itself a government which reconciled, more thoroughly perhaps than has ever been done since, the two principles of popular rights and supreme control. Its constitution has spread to Holland, Scotland (Ireland, England), and to the great American (and Colonial) churches. Their ecclesiastical polity came much more from Paris than from Geneva."

To trace the history of Presbyterianism in France for the next thirty years would be to write the history of France itself during that period. We should have to tell of the great and rapid increase of the Church; of its powerful influence among the nobles and the *bourgeoisie;* of its direful persecutions; of its St. Bartholomew massacre with 70,000 victims; of its regrettable though perhaps inevitable entanglements in politics and war; and finally of its attaining not only tolerance but also honourable recognition and protection when Henry IV. in 1598 signed the famous Edict of Nantes. This secured complete liberty of conscience everywhere within the realm and the free right of public worship in all places in which it existed during the years 1596 and 1597, or where it had been granted by the edict of Poitiers (1577) interpreted by the convention of Nérac (1578) and the treaty of Fleix (1580)—in all some two hundred towns; in two places in every *bailliage* 'and *sénéchaussée*; in the castles of Protestant *seigneurs hauts justiciers* (some three thousand); and in the houses of lesser nobles, provided the audience did not consist of more than thirty persons over and above relations of the family. Protestants were granted full civil rights and protection, and were permitted to hold their ecclesiastical assemblies. Under the protection of the edict the Huguenot Church of France flourished. Theological colleges were established at Sedan, Montauban and Saumur, and French theology became a counterpoise to the narrow Reformed scholastic of Switzerland and Holland. The history of the Church from the passing of the edict of Nantes till its revocation in 1685 cannot be given here. That event was the climax of a long series of horrors. Under the persecution, a large number were killed and between four and five millions of Protestants left the country. From 1760 owing to the gradual spread of the sceptical spirit and the teaching of Voltaire more tolerant views prevailed. In 1787 the Edict of Tolerance was published. In 1789 all citizens were made equal before the law, and the position of Presbyterianism improved till 1791. In 1801 and 1802 Napoleon took into his own hands the independence of both Catholic and Protestant Churches, the national synod was abolished, and all active religious propaganda was rigorously forbidden. In 1848 an assembly representative of the *e'glises consistoriales* met at Paris. When it refused to discuss points of doctrine a secession took place under the name of the *Union des églises évangéliques de France.* This society held a synod at which a confession of faith and a book of order were drawn up. Meanwhile the national Protestant Church set itself to the work of reconstruction; and in 1852 a change took place in its constitution. The *églises consistoriales* were abolished, and in each parish a presbyterial council was appointed, the minister being president, with four to seven elders chosen by the people. In the large towns there were consistories composed of all the ministers and of delegates from the various parishes. Over all was the central provincial council consisting of the two senior ministers and fifteen members nominated by the state in the first instance. The vigour shown by the two groups of Presbyterian churches in France (whose members number nearly half the Protestant population) in the work of reorganization since the Great War, has helped to vitalize French Presbyterianism.

The Netherlands.— From the geographical position of the Netherlands, Presbyterianism there took its tone from France. In 1562 the *Confessio belgica* was publicly acknowledged, and in 1563 the church order was arranged. In 1574 the first provincial synod of Holland and Zealand was held, but William of Orange would not allow any action to be taken independently of the state. The Reformed churches had established themselves in independence of the state when that state was Catholic; when the government became Protestant the Church had protection and at the same time became dependent. It was a state church, and could not shake off the civil power in connection with the choice of church officers. Thus, although the congregations were Presbyterian, the civil government retained overwhelming influence. The Leiden magistrates said in 1581: "If we accept everything determined upon in the synod, we shall end by being vassals of the synod. We will not open to churchmen a door for a new mastership over government and subjects, wife and child." From 1618 a modified Presbyterian polity predominated. In 1795, of course, everything was upset, and it was not until after the restoration of the Netherland States that a new organization was formed in 1816. Its main features were strictly Presbyterian, but the minister was greatly superior to the elder, and the state had wide powers especially in the nomination of higher officers. In 1851 the system now in force was adopted. The congregation chooses all the officers, and these form a church council.

England.— Presbyterian principles and ideas were entertained by many of the leading ecclesiastics in England during the reign of Edward VI. Even the archbishop of Canterbury favoured a modification of episcopacy, and an approach to Presbyterian polity and discipline; but attention was mainly directed to the settlement of doctrine and worship. Cranmer wrote that bishops and priests were not different but the same in the beginning of Christ's religion. Thirteen bishops subscribed to the proposition that in the New Testament there is no mention made of any distinctions or degrees in orders but only deacons and "priests or bishops." As an indication of sympathy with Presbyterianism, it may be noted that Cranmer favoured a proposal for the formation of a council of presbyters in each diocese, and for provincial synods.

During 1567 and 1568 the persecutions in France and Holland drove thousands of Protestants, mostly Presbyterians, to England. In 1570 Presbyterian views found a distinguished exponent in Dr. Thomas Cartwright at Cambridge. In 1572 a formal manifesto was published, entitled an *Admonition to Parliament,* the leading ideas in which were: parity of ministers, appointment of elders and deacons; election of ministers by the congregation; objection to prescribed prayer and antiphonal chanting; preaching, the chief duty of a minister; and the power of the magistrates to root out superstition and idolatry. On the 20th of November 1572 the authors of the "Admonition" set up at Wandsworth what has been called the first presbytery in England. They adopted a purely Presbyterian system which was published as the *Orders of Wandsworth.* Similar associations or presbyteries were formed in London and in the midland and eastern counties; but the privy council was hostile. The temper of Parliament was shown by the introduction of bills to reduce the position of a bishop to well-nigh that of *primus inter pares;* to place the power of veto in the congregation; to abolish the canon law and to establish a presbytery in every parish. These proposals were rendered abortive by the unflinching use of the queen's prerogative.

In 1640 Henderson, Baillie, Blair and Gillespie came to London as commissioners from the General Assembly in Scotland, in response to a request from ministers in London who desired to see the Church of England more closely modelled after the Reformed type. They were able men, whose preaching drew great crowds, and increased the desire for the establishment of Presbyterianism. In 1642 the Long Parliament abolished Episcopacy (the act to come into force on the 5th of November 1643); and summoned an assembly of divines to meet at Westminster in June 1643 to advise parliament as to the new form of Church government. The Westminster Assembly, through its *Confession, Directory* and *Catechism,* has become so associated with the Presbyterian Church that it is difficult to realize that it was not a church court at all, much less a creation of Presbyterianism.

It was a council created by parliament to give advice in church matters at a great crisis in the nation's history; but its acts, though from the high character and great learning of its members worthy of deepest respect, did not *per se* bind parliament or indeed anyone. It was, in a very real sense, representative of the whole country, as two members were chosen by parliament from each county. The number summoned was 151, viz., ten lords, twenty members of the House of Commons, and one hundred and twenty-one ministers. The ministers were mostly Puritans; by their ordination, etc., Episcopalian; and for the most part strongly impressed with the desirability of nearer agreement with the Church of Scotland, and other branches of the Reformed Church on the Continent. About one-half of the members attended regularly. Those who were out-and-out Episcopalians did not attend at all. Apart from these, there were three well-defined parties: (1) those with Presbyterian ideas and sympathies, a great majority; (2) Erastians, ably represented and led by Selden, Lightfoot and Coleman; (3) Independents, ten or eleven in number, led by Philip Nye, and assured of Cromwell's support. Then there were the Scottish commissioners who, though without votes, took a leading part in the proceedings. Judged by the objects for which it was summoned the Westminster Assembly was a failure, a remarkable failure. Episcopacy, Erastianism and Independency, though of little account in the assembly, were to bulk largely in England's future; while the church polity which the assembly favoured and recommended was to be almost unknown. Judged in other ways, however, the influence of the assembly's labours has been very great. *The Confession of Faith* and the *Larger* and *Shorter Catechisms* are recognized and venerated standards in all the lands where British Presbyterianism, with its sturdy characteristics, has taken root. And the *Directory of Public Worship* has shaped and coloured, perhaps too thoroughly, the ritual and atmosphere of every group of Protestant Anglo-Saxon worshippers throughout the world, except Episcopalians.

In June 1646 the ordinance establishing presbyteries was ratified by both houses of parliament, and a few days afterwards it was ordered to be put into execution. But the system never took root. Not only were there well-known adverse influences, but the soil seems to have been uncongenial. During the Commonwealth Independency gained ground. Then with the Restoration came Episcopacy, and the persecution of all who were not Episcopalians; and the dream and vision of a truly Reformed English Church practically passed away. From the beginning of the 18th century the greater number of the Presbyterian congregations became practically independent in polity and Unitarian in doctrine. Indigenous Presbyterianism became almost unknown. The Presbyterianism now visible in England is of Scottish origin and Scottish type, and beyond the fact of embracing a few congregations which date from, or before, the Act of Uniformity and the Five Mile Act, has little in common with the Presbyterianism which was for a brief period by law established. In 1876 the union of the Presbyterian Church in England with the English congregations of the United Presbyterian Church of Scotland gathered all English Presbyterians (with some exceptions) into one church, "The Presbyterian Church of England." Following the lead of the Independents, who set up Mansfield College at Oxford, the Presbyterian Church has founded Westminster College at Cambridge as a substitute for its Theological Hall in London. It was opened in 1899 with the view of securing a home-bred ministry more conversant with English academic life and thought.

Ireland.—Presbyterianism in Ireland, in modern times at least, dates from the plantation of Ulster in the reign of James I. The infusion of a considerable Scottish element into the population necessitated the formation of a congenial church. The immigrants from England took with them, in like manner, their attachment to the Episcopal Church. But these two sections of Protestantism, in their common exile and in presence of the preponderating Roman Catholicism of the country, seemed at first inclined to draw closer together than had been thought possible in Great Britain. A confession of faith, drawn up by Archbishop Usher at the Convocation of 1615, implicitly admitted the validity of Presbyterian ordination, and denied the distinction between bishop and presbyter. Within the Episcopal Church and supported by its endowments, Robert Blair, John Livingstone and other ministers maintained a Scottish Presbyterian communion.

From 1625 to 1638 the history of Irish Presbyterians is one of bare existence. Their ministers, silenced by Wentworth, after an ineffectual attempt to reach New England, fled to Scotland, and there took a leading part in the great movement of 1638. After the Irish rebellion of 1641 the Protestant interest for a time was ruined. A majority of the Ulster Protestants were Presbyterians, and in a great religious revival which took place the ministers of the Scottish regiments stationed in Ireland took a leading part. Kirk-sessions were formed in four regiments, and the first regular presbytery was held at Carrickfergus on the 10th of June 1642, attended by five ministers and by ruling elders from the regimental sessions. This presbytery supplied ministers to as many congregations as possible; and for the remainder ministers were sent from Scotland. By the end of 1643 the Ulster Church was fairly established. Notwithstanding intervening reverses there were by 1647 nearly thirty ordained ministers in fixed charges in Ulster besides the chaplains of the Scottish regiments. After the Restoration the determination of the government to put down Presbyterianism was speedily felt in Ireland. In 1661 the lords justices forbade all unlawful assemblies, and in these they included meetings of presbytery as exercising ecclesiastical jurisdiction not warranted by the law. Bishop Jeremy Taylor was forward in this work of persecution. The ministers refused tb take the Oath of Supremacy without the qualifications suggested by Usher. Their parishes were declared vacant, and episcopal clergy appointed to them. The ejected ministers were forbidden to preach or administer the sacraments. Under Ormonde, in 1665, ministers were again permitted to revive Presbyterian worship and discipline, and for several years the Church prospered not only in Ulster but also in the south and west. In 1672 she received a yearly grant from Charles II. of £600 (*regium* donum), and under William III. the amount was considerably increased. Trouble arose again over the policy of James II., to which the Irish Presbyterians were opposed, though they had benefited by his Declaration of Indulgence, and they were the first to congratulate the Prince of Orange on his arrival in England. The defence of Londonderry owed much to them, as they were a majority of the population, and some of their ministers rendered conspicuous service. There were then in Ireland about a hundred congregations, seventy-five with settled ministers, under five presbyteries.

The Presbyterian Church in Ireland is the most conservative of the great Presbyterian churches in the United Kingdom. Her attitude is one of sturdy adherence to the old paths of evangelical doctrine and Presbyterian polity. She has been a zealous supporter of Irish national education, which is theoretically "united secular and separate religious instruction." The Church Act of 1869 which disestablished and disendowed the Irish Episcopal Church took away the Presbyterian *regium* donum. The ministers, with all but absolute unanimity, decided to commute their life-interest and form therewith a great fund for the support of the Church. The commutation fund thus formed is a permanent memorial of a generous and disinterested act on the part of her ministry. The interest accruing from it is added to the yearly sustentation contributions, and forms a central fund for ministerial support. Since the state endowment ceased the average income of ministers from their congregations has considerably increased.

Wales.—The Presbyterian Church of Wales, commonly known as the "Calvinistic Methodist," had its origin in the great evangelical revival of the 18th century. Its polity has been of gradual growth, and still retains some features peculiar to itself. In 1811 its preachers were first presbyterially ordained and authorized to administer the sacraments. In 1823 a Confession of Faith was adopted. In 1864 the two associations or synods of North and South Wales were united in a general assembly. Great attention is given to the education of the ministry, a considerable number of whom, in recent years, have taken arts degrees at Oxford and Cambridge. As far as the difference in language will permit, there is cordial fellowship and co-operation with the Presbyterian Church of England. The appetite of the Welsh people for sermons is enormous, and the preachers are characterized by an exceptionally high order of pulpit power.

Other European Countries.—In Germany the disestablishment of the churches, which followed the Revolution, has moved the Reformed section of the Church, tlie "Reformierte Bund," to stress its distinctively Presbyterian principles, and as its membership numbers over 600,000 souls, it is destined to exercise a powerful influence in the future reorganisation of the Evangelical churches in that country. The rise of the new state of *Czechoslovakia* in 1918 led to an extraordinary break-away from the Roman Church; the united Evangelical Church of Czech Brethren now numbers over 250,000 adherents, one of its members being President Masaryk. A similar movement is reported from Ukrainia, further east, where over 1,000,000 inhabitants have left the Roman and the Orthodox churches, and are being consolidated in a Presbyterian Church, largely under the mission work of Ukrainians who came back from Canada to carry on the movement. In Transylvania, on the other hand, the Presbyterians, like the rest of the religious minorities have suffered and are still suffering under oppressive legislation at the hands of the Rumanian Government. The Magyar Reformed Church, with 800 ministers and about 720,000 souls under its charge, has to encounter the Rumanian prejudice against Magyars and the Greek Orthodox dislike of Protestants. The rights guaranteed by the Peace Treaty of 1918 to religious minorities are imperfectly observed by the Rumanian Govt. and no remonstrances from outside have yet availed to check the persecution of the Church. Hungarian Presbyterians in Transylvania thus suffer heavy damage by the War-settlement which brought relief and advance to their Bohemian brethren. In Hungary, although the partition of the country brought about untoward religious results, the Reformed Church is still powerful both in numbers and in prestige, with over 1,000 congregations and 1,500,000 adherents. The Magyar racial problem emerges again in the position of the Magyar Reformed Church in Czechoslovakia, where about 40,000 members still keep apart from the larger Church of the country, and in the Reformed Church of Yugoslavia, where the members, two-thirds of whom (in all, about 23,000) are Magyars, lie exposed to hardships like those of their brethren in Transylvania. Possibly the racial prejudices and religious rivalries which make the situation in Transylvania and Yugoslavia so bitter at present may die down in the course of years; meantime the redeeming feature is the tenacity with which the oppressed Presbyterians maintain their faith amid a struggle in which, unfortunately, their outside brethren are unable to afford them very much practical sympathy. The four Presbyterian churches in Switzerland have formed a Federation of Evangelical Churches, representing 2,250,000 souls. Switzerland has felt, like most other countries, the call to re-union in organised religion, and the rise of this Federation is a first proof of the Swiss interest in unity. Since 1919 efforts have been made to bring together the Evangelical Church of Neuchatel and the mother church from which it broke away under Godet in 1873, but the local difficulties are still insurmountable. In Belgium the two small Presbyterian churches, the Union of Reformed Churches and the Missionary Church in Belgium. suffered heavily during the War. Together they now number 50 congregations, with 22,000 members. An even smaller group is the Reformed Helvetic Church in *Austria,* with its centre at Vienna, which numbers 25,000 souls, out of a total Protestant population of 260,000. The Waldensian Evangelical Church in *Italy* numbers only 22,633 members in 112 congregations, but its sturdy spirit is unabated; indeed since the War it has asserted itself more definitely than ever in Italian life, actually holding an Evangelical Congress at Rome itself, in 1920. Its theological college is now transferred from Florence to Rome. The *Spanish* Evangelical Church has but 1,000 members, a tenth of the total Protestant population in Spain, with 26 ministers and 32 congregations. Still fewer, though for no such reasons as in Italy and Spain and Belgium, are the Presbyterians in *Denmark and Sweden,* with three congregations between them and barely 400 communicants. The History of these countries seems to have marked the Lutheran form of organisation as native to their genius, as is the case with Norway. In *Russia* the Bolshevik persecution has reduced the Reformed Church from 25 to two congregations, which still survive in Moscow and Odessa. In *Poland* the Reformed Synod of Warsaw is now reduced to seven congregations, with barely 11,000 people; however, the transfer of Galicia from Austria has added a Reformed Church of three congregations and 7,000 souls. In *Lithuania,* which was mangled by the Peace settlement, the ancient Reformed Church numbers only nine congregations, with 17,527 members, but the land is politically free, and, though it is still predominantly Roman Catholic, the first national Cabinet was half Protestant in its membership.

Canada, Australia, Africa.—The United Church of Canada came formally into existence at Toronto on June 10, 1925. This remarkable union of Congregationalists, Methodists and Presbyterians is the outcome of negotiations which have been proceeding since 1908, in order to cope effectively with the religious needs of the Dominion, where (especially in the west) the ecclesiastical divisions were felt to be a serious weakness. The legislation required to make the union effective was carried through the Canadian Parliament in 1924. The polity of the united church is admittedly Presbyterian. A minority of the Presbyterian Churches (714 out of 4,531 congregations) declined to follow the lead. In *Australia* a movement for re-union similar to the Canadian enterprise has been wrecked in the meantime. Both in Australia and in New Zealand the shortage of ministers is being acutely felt, in face of the increasing number of immigrants and the scattered population. Australasia reckons 127,305 communicants (including the Missionary Synod of Tahiti, New Hebrides, etc.) with 967 ministers, but the latter are insufficient for the needs of the situation. Another failure of Presbyterianism to unite with other branches of the Church has to be chronicled in *South Africa.* In 1917 the Presbyterian Church inaugurated a movement for union with the Congregationalists, but the project had to be abandoned in 1921, partly on account of the colour question. Within the Presbyterian Church herself the colour question has had to be solved by the creation of the Bantu Presbyterian Church, composed of purely African natives, independent but allied. On the other hand, the Church of Central Africa came into being on Sept. 17, 1924, a very fine example of union between the Church of Scotland's Blantyre Presbytery, the United Free Church's Livingstonia Presbytery and the Dutch Reformed Church's Nyassaland (Mission) Presbytery. The Dutch Reformed Church in South Africa with a membership embracing 840,000 white adherents, brings up the total of Presbyterians in Africa at present to a large number, proportionately; there are in all 1,768 congregations, including the various missions and 532,085 communicants. A growing spirit of co-operation is also manifest.

Asia.—In *India* the South United Church was formed of Presbyterians and Congregationalists in 1908; the community numbers over 240,000, and proposals have even been made for union between this Church and the Southern Indian section of the Church of England. The North United Church, also on a Presbyterian basis, arose in Dec. 1924, from the Presbyterian Church, which had received 53,000 Welsh Calvinistic Methodists from Assam in 1921, and the local Congregationalists. On a smaller scale the genesis of the United Church of Christ in *China* resembles that of the Indian and the Canadian communities. It arose in 1921 from the Presbyterians and the Congregationalists, the former numbering 87,332 members, the latter 29,000. This had been rendered possible by a previous reunion among the Presbyterians themselves; in 1918, after 11 years' negotiations, 10 different missions came together to form the Presbyterian Church in China. The combined community is now the largest Protestant Church in China. In *Korea* the Church, originally founded by American missionaries, has prospered rapidly, and displays a true missionary spirit; it numbers 1,266 congregations, with a Christian community of over 200,000. (W. Y.; J. MoF.; X.)

BIBLIOGRAPHY.—J. S. Reid, *History of the Presbyterian Church in Ireland* (3 vols., 1867); P. Hume Brown, *John Knox: a Biography* (2 vols., 1895), and "Scotland from the Restoration to the Union" in *Cambridge Modern History,* vol. v. (1908); A. Wright, *The Presbyterian Church* (1895); A. T. Innes, *Law of Creeds in Scotland* (1902); W. T. Latimer, *History of the Irish Presbyterians* (1902); T. M. Lindsay, *The Church and the Ministry in the Early Centuries* (1902), and *The History of the Reformation* (2 vols., 2nd ed. 1906–07); G. M. McCrie, *The Church of Scotland* (1903); R. L. Orr (ed. by), *The Free Church of Scotland Appeals* (Edinburgh, 1904), and *The Practical Procedure of the United Free Church of Scotland* (Edinburgh, 1905); K. M. Black, *The Scots Churches in England* (1906); W. McPhail, *The Presbyterian Church* (1908); J V. Stephens, *The Presbyterian Churches in Scotland, Ireland, Canada and America* (Philadelphia, 1910); Balfour of Burleigh, *A Historical Account of the Development of Presbyterianism in Scotland* (1911); C. W. Gordon, *The Presbyterian Church and its Missions* (1913); J. N. Ogilvie, *Presbyterian Churches of Christendom* (1925); J. G. MacGregor, *The Scottish Presbyterian Polity* (1926); J. R. Fleming, *History of the Church in Scotland* (Edinburgh, 1927); J. Moffatt, *The Presbyterian Churches* (1928); *see* also J. Dall's "Presbyterianism" in Hastings' *Encyc. of Religion and Ethics,* and *Presbyterian Church of England, Official Handbook* (pubd. annually).

UNITED STATES

Presbyterianism in the United States is a reproduction and further development of Presbyterianism in Europe. Excluding the "Reformed" Churches—which also maintain, with minor modifications, the Presbyterian form of church government (*see* REFORMED CHURCH IN THE UNITED STATES and REFORMED CHURCH IN AMERICA), there are some ten Presbyterian denominations in the United States. In what follows, attention will be devoted mainly, but not exclusively, to the largest and most influential of these bodies—the Presbyterian Church in the United States of America. The narrative naturally falls into three periods.

I. The Colonial Period.—The earliest Presbyterian emigration from Europe to America was that of French Huguenots who, under the auspices of Admiral Coligny, were led by Jean Ribaut to Port Royal, S.C., in 1562, and to Florida (near the present St. Augustine) by Laudonniere, in 1564. In the latter half of the 17th century there were Huguenot churches at Boston, New York city, New Rochelle, N.Y., and Charleston, S.C.

English Puritanism under the auspices of the Virginia Company established itself in the Bermuda islands as early as 1612; and in 1617 a Presbyterian church, governed by ministers and four elders, was organized by the Rev. Lewis Hughes, who used the liturgy of the isles of Guernsey and Jersey. A considerable number of the Puritans who settled in Massachusetts were Presbyterians, and their churches in Connecticut were commonly spoken of as Presbyterian. The early New England churches have been aptly described as representing, in general, "a Congregationalized Presbyterianism, or a Presbyterianized Congregationalism." Later the Congregational elements predominated in these regions, and in the main only those Puritans who drifted west and south of New England became a permanent part of the Presbyterian Church. In New York city, Francis Doughty preached to Puritan Presbyterians in 1643, though there was no organized Presbyterian church there before 1717. In 1650 he was succeeded by Richard Denton, who returned to England in 1659. The oldest church on Long Island—of those now under the care of the General Assembly of the Presbyterian Church in the U.S.A.—is that of Southold, established in 1640 by the Rev. John Young. The first Presbyterian churches in North and South Jersey—Newark (1667), Elizabeth (1668), Woodbridge (1680) and Fairfield (1692)—were due to Puritan migrations from Connecticut and Long Island.

After leaving New York, Francis Doughty laboured in Virginia and Maryland from 1650 to 1659, becoming the pioneer of British Presbyterianism in the Middle Colonies. Likewise, other Presbyterian ministers, chiefly from Great Britain and Ireland, began to labour in the Middle Colonies and in the Carolinas during the latter half of the 17th century—Matthew Hill, William Trail, Joseph Lord and Archibald Stobo.

The tap-root of American Presbyterianism is to be found in Maryland, the chief field of the apostolic labours of Francis Makemie, the foremost representative of the Irish Presbyterians and the virtual founder of the American Presbyterian Church. He was born in Ireland, educated in Scotland, ordained and commissioned by the Presbytery of Laggan, in Ireland, to be a missionary to the Barbadoes and other American colonies. He organized several churches in Maryland, including those at Snow Hill and Rehoboth, the latter probably as early as 1683. He itinerated from New York to the Carolinas, preaching and establishing churches. He did much to encourage that notable immigration of Presbyterians from Scotland and Ireland who, to escape the prelatic oppressions under the Stuarts, crossed the sea and ere iong made Presbyterianism the dominant religious force in New Jersey, eastern Pennsylvania and Delaware. In 1706, he secured the establishment of the first presbytery. popularly known, from its customary place of meeting, as the Presbytery of Philadelphia. He was chosen to be its first moderator. Of the eight ministers composing the judicatory at the close of that year, all were foreign-born excepting Jedediah Andrews, a native of Massachusetts and a graduate of Harvard college. He began his ministry in Philadelphia in 1698, and in 1701 was ordained and installed in what is now the First Church. All but two of the eight were ordained in Scotland or Ireland.

In 1716 the presbytery had 17 ministers on the roll, the number having more than doubled in a single decade. In view of the difficulties of travel and the wide territory represented, the presbytery resolved in that year to transform itself into a synod, with four presbyteries under its jurisdiction (Philadelphia, New Castle, Snow Hill and Long Island). The first meeting of the synod was held on Sept. 17, 1717. In 1729 the synod passed what is called the Adopting act, by which it was agreed that "all the ministers of this synod, or that shall hereafter be admitted into this synod, shall declare their agreement in, and approbation of, the Confession of Faith, with the Larger and Shorter Catechisms of the Assembly of Divines at Westminster, as being in all essential and necessary articles good forms of sound words and systems of Christian doctrine." The act allowed scruples about "articles not essential and necessary in doctrine, worship, or government," the court, not the individual, being the judge of the issue raised.

The religious revival known as the Great Awakening profoundly affected most of the Protestant Churches, stimulating their evangelistic, missionary and educational enterprises, and proving itself a decisive factor even in the political sphere by breaking down some of the barriers of sectarian isolation, and promoting the sense of the growing national unity. But the revival also brought discord. The zealous evangelists severely criticized all who questioned the wisdom and propriety of their methods. Gilbert Tennent was especially censorious, and his sermon on "An Unconverted Ministry" was aimed at the opponents of the revival. He and his three brothers—sons of the William Tennent who in 1727 established the celebrated "Log College" at Neshaminy, Pa,, as a training school for the ministry—were prominent leaders of the "new side," while Robert Cross and Jedediah Andrews were foremost in charging the Tennents with heresy and disorder. The consequence was the first division of the Church (1741). The synod of Philadelphia represented the "old side"; and the synod of New York, the "new side." The latter body was the more enterprising and prosperous, making provision for the training of its ministers by the establishment at Elizabeth, in 1747, of the College of New Jersey, subsequently removed to Newark, and in 1756 to Princeton (now known as Princeton university). In 1758 a reunion of the two Synods was effected under the name of the "synod of New York and Philadelphia," upon the basis of the same Westminster standards of doctrine, polity and worship which both sides had maintained after their separation.

The Presbyterians from the Scots established Church, when they came to the Colonies, commonly joined the main body of American Presbyterians; but the seceding Churches of Scotland organized independent bodies. The Reformed Presbyterian Church (Covenanters) sent the Rev. John Cuthbertson in 1751. After labouring alone for many years in the interests of his denomination, with the aid of two fellow labourers from Scotland, Rev. Matthew Lind and Rev. Alexander Dobbin, he organized in 1774 the Reformed Presbytery of America. The Anti-Burgher Synod of Scotland sent two ministers, Alexander Gellatly and Andrew Arnot, to represent their cause, and thus were organized the Associate Presbytery of Pennsylvania (1753) and that of New York (1776). These two presbyteries joined with the Covenanters in 1780 and 1782 to make the Associate Reformed Church of America; but opposing minorities in both presbyteries kept up the separate denominations.

During the American Revolution the Presbyterian churches throughout the Colonies suffered severely. The devotion of their members, especially the Scotch-Irish, to the cause of national independence was equalled by that of no other denomination. No racial or religious group was superior to them in intelligence, love of freedom, moral firmness and capacity for political achievement. At the time of the Revolutionary War almost 2,000,000 of the 3,000,000 inhabitants of the 13 Colonies were of Calvinistic stock. The form of government of our nation is practically the form of government of the Presbyterian Church with such modifications as the civil sphere requires. The public-school system of America has grown out of the parish schools established in a multitude of Presbyterian parishes by their pastors. Many of the ministers served as chaplains or combatants. John Witherspoon, president of the College of New Jersey, was the only clerical member of the Continental Congress in 1776, and in many lines of activity, civil and military, he rendered distinguished service to his adopted country. John Murray, of the Presbytery at the Eastward, had as high a price set on his head by the Tories as did Samuel Adams or John Hancock. The testimony of the historian Bancroft to the patriotic fidelity of the Presbyterians is too familiar to be quoted. At the close of the war, the Synod of New York and Philadelphia, sharing in the general movement towards organization of nation-wide churches, soon made good the losses sustained during the struggle for independence, and in 1788 took steps to divide itself into four synods, with a General Assembly, consisting of representative delegates, both ministers and laymen, to serve as the supreme legislative, judicial and executive agency of the whole church. The Synod adopted as the constitution for the re-organized church the Westminster Confession of Faith, amended in Chapter xxiii., in regard to the relation of the civil power to the church; the Larger Catechism, with an amendment as to the toleration; the Shorter Catechism; the Directory of Worship, much revised; and the Form of Government and the Book of Discipline, with many alterations. It was also provided that thereafter the standards could be amended only by a two-thirds vote of the presbyteries, and subsequent enactment by the Assembly.

In 1801 this body entered into a Plan of Union with the General Association of Connecticut, for the purpose of a more efficient joint performance of their home missionary duties. This scheme, did, indeed, promote aggressive missionary work, and in the next half-century most of the existing theological seminaries of the Presbyterian Church were established to furnish ministers for the ever-expanding task: Princeton, 1811; Auburn, 1818; Union at Hampden-Sidney, later at Richmond, Va., 1824; Allegheny, 1827; Columbia, S.C., 1828; Lane, at Cincinnati, 1829; McCormick at Chicago, 1830; Union at New York, 1836; Dubuque, Ia., 1856. But while most of the Puritan migration from New England to the west was identified with the Presbyterian Church, these great gains in number were to a large extent offset by troublesome irregularities in polity, laxity in discipline and novelties in theology, all of which presently led to another division of the main Presbyterian body. To increase the embarrassments that grew out of the plan of union, there was the administrative question as to the best method of conducting the general benevolent and missionary work of the church. The supporters of the old order ("Old School"), deeply alarmed, charged their opponents ("New School") with doctrinal aberrations in 16 counts; with errors in church order in ten; and with mistakes in discipline in four.

After several years of bitter controversy, culminating in repeated but vain efforts to remove offending ministers by due process of law, the Old School Assembly of 1837, realizing that it once more had a majority—only the second time in seven years—abrogated the Plan of Union and then exscinded the Synod of Western Reserve in Ohio, and the Synods of Utica, Geneva and Genesee, in New York. The New School met in convention at Auburn, N.Y., in Aug., 1837, and adopted a "Declaration" setting forth the "True Doctrines" of their party as against the "Errors" charged on them by their opponents. When the Assembly met in 1838, the New School commissioners were denied legal standing in the court; whereupon they withdrew, organized their own Assembly, with the same title as the other body, and brought suits in the civil courts of Pennsylvania to determine the property issues involved. The first decision favoured the New School (1839); but the court en *banc* set aside this verdict on grounds that made another trial useless. After the division was completed the New School embraced about four-ninths of the ministry and membership of the Church, but in spite of its being almost as large as the other body, its growth was slow. It continued to co-operate with the Congregationalists for some time, but in 1852 it decided, in view of the ever-increasing doctrinal defection among the Congregationalists, to accept the proposal of the latter for the abolition of the Plan of Union. In the course of a few years, moreover, the strong anti-slavery sentiment among New School leaders led to the voluntary withdrawal of nearly all the Southern churches connected with this Assembly and to their organization as the United Synod of tht Presbyterian Church. The Old School Assembly also was rent asunder during the Civil War. The occasion was the adoption of the "Spring Resolutions" (1861), which declared it the duty of the church "to promote and perpetuate . . . the integrity of the United States, and to strengthen, uphold and encourage the Federal Government in the exercise of all its functions. . . ." During the summer of 1861, 47 Southern presbyteries of the Old School renounced their General Assembly and formed the Presbyterian Church in the Confederate States of America.

Another important division in the main body of Presbyterians during this period was that of the Cumberland Presbyterians. Kentucky and Tennessee, at the beginning of the 19th century, were particularly affected by the revival of religion which spread over most of the Eastern States. To accommodate the large crowds that wanted to hear the Gospel, "camp meetings" were much used in these frontier regions. The religious excitement became intense. Even children again and again preached with powerful effect. The demand for ministers far exceeded the supply. Under these circumstances the Presbytery of Transylvania, and then the Cumberland Presbytery—set off from the former in 1802—began ordaining a number of zealous young men who, in the judgment of the Synod of Kentucky, had not had an adequate training for the office and were unsound in doctrine. The Synod, in 1806, dissolved the Cumberland Presbytery, which in a few years organized itself into a new denomination (1810). It grew rapidly in numbers, as well as in its respect for, and its insistence upon, an educated ministry. The Synod of Cumberland, established in 1813, adopted as its standard the Westminster Confession, but in revised form, the alterations being designed to eliminate what was called the "fatalism" of this symbol. In 1829 a General Assembly was formed.

In 1822, under the influence of John M. Mason, the Associate Reformed Synod undertook a union with the General Assembly of the Presbyterian Church, but most of the ministers opposed the project and organized three independent presbyteries. In 1858 the Associate Synod and the General Synod of the Associate Reformed Church effected a union under the style of the "United Presbyterian Church." the basis being the Westminster Confession (slightly altered) and a "Testimony" in 18 articles, the last of which declared that "it is the will of God that the songs contained in the Book of Psalms be sung in His worship, both public and private, to the end of the world; and that in singing God's praise, these songs should be employed to the exclusion of the devotional compositions of uninspired men"—a requirement now left to the discretion of the individual church.

In 1833 the Reformed Presbyterian Church divided into New and Old Lights on the question as to whether their members may properly exercise the rights of citizenship under the U.S. Constitution.

III. The Modern Period (Since the Civil War).—Several important church unions mark this period. In the South, under the stress of the Civil War, the two branches that had seceded from the Old and the New School Assemblies, namely, the Presbyterian Church in the Confederate States of America and the United Synod of the Presbyterian Church, united in 1865, and at the close of the war adopted the name of the Presbyterian Church in the United States. In the North also, after several years of friendly negotiations, the Old School and the New School united in 1869 on the basis of "the standards pure and simple," and commemorated the happy event by raising a memorial fund of over $7,000,000. In 1906 the Presbyterian Church in the U.S.A. united with the Cumberland Presbyterian Church, and in 1920 with the Welsh Calvinistic Methodists.

In 1902 the General Assembly of the Presbyterian Church in the U.S.A. adopted a "Brief Statement of the Reformed Faith," not as an addition to its standards, but rather for popular use as an interpretation of its Confession, and the next year it made several amendments to this Confession, adopted a "Declaratory Statement" as to Chapters iii. and x., and added two new chapters, entitled "Of the Holy Spirit" and "Of the Love of God and Missions."

The Presbyterian Church in the U.S.A. administers its national and international affairs, other than those committed by its General Assembly to its four benevolent boards, to which reference will be made below, through the office of the General Assembly (five departments—administration, vacancy and supply, publicity, church co-operation and union, and historical) which has as its permanent executive head the stated clerk of the General Assembly; and through the General Council (23 members) of which the moderator of the General Assembly is, ex-officio, chairman (one year term) and the stated clerk secretary by election.

The Presbyterian Church in the U.S.A. has, under the supervision of the board of foreign missions, important missions in Africa, Mesopotamia, Persia, Syria, India, Siam, China, Japan, Chosen, Laos, Latin America and the Philippine Islands. Besides this board, it has, since the consolidations (1923) of its many agencies, three other boards, those for national missions (six divisions), Christian education (eight departments), and ministerial pensions ($15,000,000 fund raised, 1927), each of which boards carries on a work comparable in importance with that conducted by the board of foreign missions.

The Presbyterian Church in the U.S. (Southern) unlike the Presbyterian Church in the U.S.A., works not through "boards," but through executive committees, which were formerly more loosely organized, and which left to the presbyteries the more direct control of their activities, but which now differ little from the boards of the Presbyterian Church in the U.S.A. The Presbyterian Church in the U.S. has executive committees on foreign missions, home missions, publication and Sabbath school work, Christian education and ministerial relief, men's work, advisory committee on education, Protestant relief in Europe, Bible cause, reformation day and a permanent judicial committee, which report to the General Assembly annually.

The United Presbyterian Church of North America has a board of foreign missions, a board of home missions, a board of publication and Bible school work, a board of education and a board of ministerial pensions and relief, and a woman's guild and missionary society.

In 1928 the Presbyterian bodies, nine in number, reported 2,800,000 communicant members while other closely related bodies reported 550,000 additional communicants. The Presbyterian

Church in the United States of America, the largest of the Presbyterian bodies, reported 1,962,838 communicant members; 9,432 churches; 10,013 ministers; 1,614,013 Sabbath school members; total benevolences $15,642,508; total congregational expenses $48,956,022. The next largest body, the Presbyterian Church in the United States (Southern), reported 444,657 communicant members; 3,596 churches; 2,342 ministers; 431,065 Sabbath school members; total benevolences $5,520,285; congregational expenses $10,306,188. The United Presbyterian Church of North America reported 238,240 communicant members; 898 churches; 927 ministers; 182,304 Sabbath schoolmembers; $1,683,212 total benevolences; $4,254,717 congregational expenses.

BIBLIOGRAPHY.—On American Presbyterianism *see* C. Hodge, *Constitutional History of the Presbyterian Church in the United States of America 1706–1788* (Philadelphia, 1839), *Records of the Presbytertan Church in the United States of America from 1706 to 1788* (Philadelphia, 1841) ; R. Webster, *History of the Presbyterian Church in Amerzca (ibid.,* 1858) ; *E. H.* Gillett, *History of the Presbyterian Church in the United States of America* (2nd ed., *ibid.,* 1873); C. *A.* Briggs, *American Presbyterianism* (1885) ; R. E. Thompson, "History of the Presbyterian Churches in the United States" in *American Church History Series,* vol. vi. (189;; a good bibliography, pp. 11–31) ; in the same series vol. xi., "The United Presbyterians" by J. B. Scouller, "The Cumberland Presbyterians" by R. N. Foster and "The Southern Presbyterians" by T. C. Johnson; R. C. Reed, *History of the Presbyterian Churches of the World* (Philadelphia, 1905) ; E. B. Crisman, *Origin and Doctrines of the Cumberland Presbyterian Church* (St. Louis, 1877) ; W. M. Glasgow, *History of the Reformed Presbyterian Church in America* (Baltimore, 1888) ; *A.* Blaikie, *A History of Presbyterianism in New England* (Boston, 1882), on the Reunion of 1869, *Presbyterian Reunion, A Memorial Volume* (1871) ; on church law, *The Presbyterian Digest,* 2 vol. and sup. (Philadelphia, 1928).
(L. S. M.)

PRESBYTERY, in architecture, that portion of the choir of a church in which the high altar is placed, and which is generally raised a few steps above the rest of the church. It is reserved for the priests and differs from the choir, the stalls in which are occasionally occupied by the laity. In Westminster Abbey the space east of the transept is the presbytery, and the same arrangement is found in Canterbury cathedral. In S. Clemente at Rome the presbytery is enclosed with a marble balustrade or screen. For the use of the word in Church government *see* PRESBYTER and PRESBYTERIANISM.

PRESCOT, urban district, Lancashire, England, 8 mi. E. of Liverpool by the L.M.S.R. Pop. (est. 1938) 11,510. Area 1.4 sq.mi. It is of considerable antiquity and received a grant for a market and fair by Edward III. A church existed in the 13th century. The present church of St. Mary is in various styles, with a lofty tower and spire and carved timber roof. Since John Miller brought the industry from Yorkshire (1730) the town has been famed for watches, watch movements and tools. Electric cables are also manufactured. To the north is Knowsley Park, seat of the earls of Derby, containing a fine collection of pictures.

PRESCOTT, WILLIAM HICKLING (1796–1859), American historian, was born in Salem (Mass.), on May 4, 1796, his grandfather being Colonel William Prescott (1726–95), who commanded at the battle of Bunker Hill, and his father, a well known lawyer. Although he was blinded in one eye by a crust of bread flung in the Harvard Commons, he graduated with honour in 1814 and entered his father's office. The verdict of physicians abroad, however, that the injured eye was hopelessly paralysed, and that the preservation of the sight of the other depended upon the maintenance of his general health, caused him to abandon further pursuit of the legal profession and to devote his life to literature. A review of Byron's *Letters on Pope* in 1821 constituted his first contribution to the *North American Review,* to which he continued for many years to send the results of his slighter researches.

Although his early essays were distinctly literary, history had always been a favourite study with him, and Mably's *Observations sur l'histoire* appears to have influenced him. After prolonged hesitation, he recorded in Jan. 1826 his decision "to embrace the gift of the Spanish subject." The choice was certainly a bold one, but he was happy in the possession of ample means and admirable friends. His method of work is an excellent illustration of his resourcefulness and perseverance. Seated in a darkened study, he kept his writing apparatus (a noctograph) before him, and his ivory stylus in his hand to jot down notes as his assistant read aloud. These notes were in turn read over to him until he had completely mastered them, when they were worked up in his memory to their final shape. So proficient did he become that he was able to retain the equivalent of 60 pages of printed matter in his memory, turning and returning them as he walked or drove. On Oct. 6, 1829 he began the actual work of composition of his *History of the Reign of Ferdinand and Zsabella,* the concluding note being written June 25, 1836. Another year, during which his essay on *Cervantes* appeared, was spent in the final revision of the *History* for the press. Its success was immediate. From the position of an obscure reviewer Prescott suddenly found himself elevated to the first rank of contemporary historians.

After coquetting for a short time with the project of a life of Molière he decided to follow in the track of his first work with a *History of the Conquest of Mexico.* Washington Irving, who had already made preparations to occupy the same field, generously withdrew in his favour. Prescott's five years of labour on this second book were broken by the composition of various reviews and by the preparation of an abridgment of his *Ferdinand and Zsabella.* In Dec. 1843 the *Conquest of Mexico* was published with a success proportionate to the wide reputation he had won. The careful methods of work which he had adopted from the outset had borne admirable fruit. While the consultation of authorities had been no less thorough, his style had become more free and less self-conscious; and the epic qualities of the theme were such as to call forth in the highest degree his powers of picturesque narration. It was only a step from his great work on Mexico to that on Peru, and scarcely three months elapsed before he began to break ground on the latter subject. In Feb. 1845 he received the announcement of his election as corresponding member of the French Institute in place of the Spanish historian Navarrete, and also of the Royal Society of Berlin. The winter found him arranging for the publication in England of his *Critical and Historical Essays* (New York ed., *Biographical and Critical Miscellanies*). *The Conquest of Peru* was completed in Nov. 1846 and published in the following March. His misgivings as to its reception were at once set at rest, and it was speedily issued in translations into French, Spanish, German and Dutch, in addition to the English editions of New York, London and Paris. Prescott was now over 50 and his sight showed serious symptoms of enfeeblement. He had been for many years collecting materials for a history of Philip II., but he hesitated to attempt a work of such magnitude. Nevertheless in March 1848 he set himself with characteristic courage to its accomplishment. Through the aid of Don Pascual de Gayangos, then professor of Arabic literature at Madrid, he was enabled to obtain material not only from the public archives of Spain but from the muniment rooms of the great Spanish families. With an exceptional range of information thus afforded him, he wrote the opening of his history in July 1849; but, finding himself still unsettled in his work, he decided in the spring of the following year to carry out a long projected visit to England, where he was received with great honour. In Nov. 1855 the first two volumes of his uncompleted *History of Philip II.,* were issued from the press, their sale eclipsing that of any of his earlier books. This was his last great undertaking; but a year later he published in revised form Robertson's *Charles V.* A slight attack of apoplexy on Feb. 4, 1858 foretold the end, though he persevered with the preparation of the third volume of *Philip II.* for the press, and with the emendation and annotation of his *Conquest of Mexico.* On the morning of Jan. 28, 1859, a second attack occurred, and he died in the afternoon of the same day. Prescott's power lies chiefly in the clear grasp of fact, in selection and synthesis, in the vivid narration of incident. For extended analysis he had small liking and faculty; his critical insight was limited in range, and he confined himself almost wholly to the concrete elements of history. Moreover, the authorities on whom he relied have had to be corrected since in many points of detail in the light of later archaeological research. Few historians have had in a higher degree, however, that artistic feeling in the broad arrangement of materials which ensures popular interest.

BIBLIOGRAPHY.—The definitive or Montezuma ed. of Prescott's works was ed. by W. H. Munro (1904). His Life was written by George Ticknor (1864; rev. 1875). There are later lives by R. Ogden (1904) and H. T. Peck (1905). See also the chapters on Prescott and Motley in J. S. Bassett, The Middle Group of American *Historians* (1917) and The Cambridge History of American Literature (vol. 2, 1918); and sketch by M. A. D. Howe in American *Bookmen* (1898).

PRESCOTT, a city of central Arizona, U.S.A., on Federal highway 89 and the Santa Fe railway, at an altitude of 5,320 ft.; the county-seat of Yavapai county. Pop. (1920) 5,010 (82% native white); 6,018 in 1940 by the Federal census. It lies between the two divisions of the Prescott National Forest of 1,164,829 ac. in a region rich in mineral resources, flocks and herds, picturesque life (of Indians and ranchers), and natural beauty. The mines of the county produce copper, gold, silver, lead and zinc. Prescott is called "the cowboy capital" and the place "where the West remains."

It has held a Frontier Days' celebration annually since 1888, and the Smoki People of Prescott have since 1921 presented some of their ceremonial dances in an annual pageant of primitive Indian life. There are several "guest ranches" in the vicinity. Prescott was founded in 1864, to be the capital (1864–67) of the newly organized Territory of Arizona.

PRESCRIPTION, in the broadest sense, the acquisition or extinction of rights by lapse of time. The term is derived from the *praescriptio* of Roman law, originally a matter of procedure. It seems to have been introduced by the praetor to meet cases affecting aliens or lands out of Italy where the *usucapio* of the civil law (the original means of curing a defect of title by lapse of time) could not apply. The prescription of Roman law (and of modern systems based upon it) is both acquisitive and extinctive. It looks either to the length of time during which the defendant has been in possession, or to the length of time during which the plaintiff has been out of possession.

In English law prescription is used in a comparatively narrow sense. It is acquisitive only, and is very limited in its application. A title by prescription can be made only to incorporeal hereditaments—*i.e.,* in legal language, hereditaments that are or have been appendant or appurtenant to corporeal hereditaments — and to certain exemptions and privileges. The rights claimable by prescription for the most part consist of rights in alieno solo. The most important are advowsons, tithes, commons, ways, watercourses, lights, offices, dignities, franchises, pensions, annuities and rents. Land or movables cannot be claimed by prescription. The foundation of prescription is the presumption of law that a person found in undisturbed enjoyment of a right did not come into possession by an unlawful act. In the English courts this presumption was, perhaps still is, based upon the fiction of a lost grant. The enjoyment of the right must have been from a time whereof the memory of man runneth not to the contrary. After one or two previous enactments the date was finally fixed by the Statute of Westminster the First (3 Edw. I. c. 39) at the reign of Richard I., which was interpreted to mean the first year of the reign of Richard I. (1189). This is still the law with respect to claims not falling within the Prescription Act, 1832. By that act (extended to Ireland in 1858, but not to Scotland) claims to rights of common and other profits *à prendre* are not to be defeated after 30 years' enjoyment by any person claiming right thereto without interruption for 30 years by showing only the commencement of the right, and after 60 years' enjoyment the right is absolute and indefeasible unless had by consent or agreement by deed or writing (s. 1). In claims of rights of way or other easements the periods are 20 years and 40 years respectively (s. 2). The beforementioned periods are to be deemed those next before suits, and nothing is to be deemed to be an interruption unless acquiesced in for one year (s. 4). The time during which a person otherwise capable of resisting a claim is an infant, idiot, non *compos mentis,* feme covert or tenant for life, or during which an action or suit has been pending until abated by the death of a party, is to be excluded in the computation of the periods unless where the right or claim is declared to be absolute and indefeasible (s. 7). An act to define the period of prescription for a *modus decimandi,* or an exemption from tithes by composition, was passed the same year. The claim under the statute must be one which may be lawfully made at common law. The principal rules upon the subject are these: (1) The title is founded upon actual usage. The amount of actual usage and the evidence necessary to prove it vary according to the kind of claim. (2) The enjoyment must (except in the case of light) be as of right — that is to say, peaceable, openly used, and not by licence. (3) The prescription must be certain and reasonable. Inhabitants cannot, however, claim by prescription, as they are an uncertain and fluctuating body, unless under a grant from the Crown, which constitutes them a corporation for the purposes of the grant. (4) The prescription must be alleged in a *que* estate or in a man and his ancestors. Prescription in a que estate lies at common law by reason of continuous and immemorial enjoyment by the claimant, a person seised in fee, and all those whose estate he had. Prescription in a man and his ancestors is not of ordinary occurrence in practice. Corporations, however, occasionally claim by a prescription analogous to this, viz. in the corporation and its predecessors. Such claims by either a person or a corporation are not within the Prescription Act, which applies only where there are dominant and servient tenements. By 32 Hen. VIII. *c.* 2 (1540) no person can make any prescription by the seisin or possession of his ancestor unless such seisin or possession had been within three score years next before such prescription made. (5) A prescription cannot lie for a thing which cannot be granted, as it rests upon the presumption of a lost grant.

Prescription must be carefully distinguished from custom. Some rights may be claimed by custom which cannot be claimed by prescription, *e.g.,* a right of inhabitants to dance on a village green, for such a right is not connected with the enjoyment of land.

International Law uses the term "prescription" in its wider or Roman sense. "The general consent of mankind has established the principle that long and uninterrupted possession by one nation excludes the claim of every other" (Wheaton, *Int.* Law, s. 165). Historic instances of rights which were at one time claimed and exercised by prescription as against other nations are the sovereignty of Venice over the Adriatic and of Great Britain over the Narrow seas, and the right to the Sound dues long exacted by Denmark. But such claims were rejected by the highest authorities on international law (*e.g.,* Grotius), on the ground that they were defective both in *justus titulus* and in de facto possession. In private international law prescription is treated as part of the lex fori or law of procedure. (J. WIL.; X.)

Scotland. — In the law of Scotland "prescription" is a term of wider meaning than in England, being used as including both prescription and limitation of English law. In its most general sense it may be described as the effect which the law attaches to the lapse of time, and it involves the idea of possession held by one person adverse to the rights of another. Though having its basis in the common law, its operation was early defined by statute, and it is now in all respects statutory. Prescription in Scots law may be regarded (1) as a mode of acquiring rights — the positive prescription; (2) as a mode of extinguishing rights — the negative prescription; (3) as a mode of limiting rights of action — the shorter prescriptions. It must, however, be observed with reference to this division that the distinction between (1) and (2) is rather an accidental (due to a loose interpretation of the language of the act of 1617, c. 12) than a logically accurate one. It is, moreover, strictly confined to heritable rights, having no application in the case of movable property.

Positive Prescription. — The positive prescription was introduced by the Act of 1617, c. 12, which regulated the prescription of land rights till 1874. The provisions of the Act of 1874 are repealed as from Jan. 1, 1930, by the Conveyancing Act, 1924 (s. 16). As from that date the prescription will be 20 years without allowance for legal disability. The Acts of 1874 and 1924 provide that possession for 20 years upon "an ex facie valid irredeemable title recorded in the appropriate register of sasines" should in future give the same right as 40 years' possession upon charter and sasine under the earlier laws. These Acts also provide that the 20 years' prescription is not to apply to servitudes, rights of way and public rights generally.

Negative *Prescription.*—This prescription was introduced by the Act of 1469, c. 28, and was substantially re-enacted by the Act of 1474, c. 55. The negative prescription accordingly extinguishes *in toto* the right to demand performance of an obligation after 40 years, the years being reckoned from the day on which fulfilment of the obligation can be first demanded. Such a lapse of this period of time creates a conclusive presumption—one incapable of being reargued—that the debt or obligation has been paid or fulfilled. But it must be kept in view that the negative prescription does not per se—without the operation of the positive--establish a right to heritable property (Erskine, *Inst.* bk. iii. tit. 7. s. 8). The negative prescription of heritable debts (Act of 1617) is reduced to 20 years without allowance for legal disability as from Jan. 1, 1930, by the Conveyancing Act 1924 (s. 17). This reduction of period does not apply to the prescription of servitudes and public rights.

United States.—Prescription in the United States though often used synonymously with adverse possession is technically confined as at common law to the acquisition of rights to incorporeal hereditaments, chiefly easements. The common law doctrine of presuming a lost grant after a certain period of undisturbed enjoyment of the right prevailed in the States. Upon an analogy to the period of limitations prescribed by the Statute of James I., undisturbed enjoyment of the right for 20 years was deemed to raise the presumption of a lost grant. Some differences of opinion have prevailed as to whether the presumption is a matter only of fact and hence rebuttable or is conclusive as a matter of law, the latter view being the majority rule: Thus prescription has in many States been assimilated to the acquisition of title to land by adverse possession. Statutes have commonly dealt with prescription, abolishing the lost grant presumption and substituting the doctrine of acquisition of title through adverse possession. As at English common law the adverse use must be open and notorious and not under licence of the owner; it must be uninterrupted for the statutory period, and the right acquired is limited to the extent of the use and the enjoyment of it during the period of prescription: No easement can be acquired save as appendant to an absolute estate in land. No right to maintain a nuisance can be acquired by prescription nor can a right of user be acquired by prescription against the State.

PRESERVING AND BOTTLING, terms used for methods of saving perishable foods from moulds, yeasts and bacteria. (See FOOD PRESERVATION.) In the United States the term "canning," instead of "bottling," is used for the preservation of food in containers, whether of glass or tin, and the word "preserves" implies that sugar is added to the food material.

The application of heat in some form is one of the commonest means of destroying bacteria, yeasts and moulds, and is utilized in jam-making (see JAMS AND JELLIES), bottling, canning, pickle-making, drying and crystallizing. Pickle-making is a method of preserving in which heat, vinegar, sugar or salt, or both, are used to destroy the micro-organisms contained in fruit and vegetables. The acetic acid in the vinegar acts as an antiseptic and prevents further growth of bacteria, moulds or yeasts. Chutneys, pickles, catchups and sauces are examples of foods preserved with vinegar.

BOTTLING FRUIT

The aim when bottling is to sterilize the contents of the bottle, and having done so to prevent any germs from entering by sealing it. Bottling is one of the simplest, but most useful methods of preserving fruit and vegetables, for their character and flavour is unaltered, whereas in jam and pickle-making both taste and appearance are changed. Provided attention be paid to a few important points success is assured, and a lavish supply of peas, beans, cherries, currants, etc., is available for winter use at little cost beyond the initial expense of buying a supply of vacuum jars. These are not essential, however, for ordinary jam jars can be used, although special care and precautions must be taken to obtain an airtight seal. When bottling is done regularly it is advisable to purchase a supply of vacuum jars and a sterilizer.

Vacuum jars or bottles consist of (a) a glass container with wide neck. It should be without flaws and it is important that the rim should not be chipped; (b) a metal or glass lid; (c) a rubber band, which acts as a washer between the bottle and lid; (d) a metal screw band or clip. When bottling is carried out on a large scale special sterilizers are employed, but in the home a large zinc bath, fish kettle, bath or even a large clothes boiler or copper, can be used. As bottles are liable to crack if they are placed in immediate contact with the heated bottom of the pan some good non-conductor of heat must come between them. A simple slatted wood board to fit the copper, bath or fish kettle makes an excellent false bottom.

Selecting and Preparing the Fruit.—(I) Select sound fruit which is very slightly under-ripe, with the exception of pears, which are better bottled when fully ripe. (2) Wash to remove dust, grade according to degree of ripeness and pack neatly and firmly, using a smooth piece of wood or bone spatula. The bottle should be shaken from time to time to ensure a tight pack. Loose packing is responsible for the fruit rising when sterilized, leaving a space of one to two inches at the bottom of the jar. (3) Fill each jar with cold water and pour away. This is to rinse the fruit as it is handled during the packing process. (4) Fill the jars with syrup or water, taking care that the fruit is completely covered. The flavour is improved when syrup is used, but if sugar is scarce or unavailable water can be used. (5) Put the rubber rings, lids and screw bands or clips in position. When screw bands are used, they should be screwed down tightly and then unscrewed for rather less than a half turn to allow the steam and air to escape. (6) Stand the bottles in the sterilizer or bath, which should contain sufficient cold water to cover the bottles completely, and apply gentle heat until the correct temperature is reached. This varies according to the variety of fruit from 125° F for small soft fruit, such as raspberries and blackberries, to 185° F for fruit salad, plums, cherries and pears. The process must not be hurried and approximately $1\frac{1}{2}$ hours should be taken in bringing the water to the correct temperature. (7) Allow the bottles to remain at this temperature for from 10 to 30 minutes Most soft fruit requires about 15 minutes and pears and apples about 30 minutes. (8) When sterilizing is completed remove the bottles from the boiler, stand on a wooden table or some other good non-conductor, tighten the screw bands and leave until cold. (9) Next day examine the bottles to see if they are airtight. To do this, remove the screw bands and clips, hold the bottles by the lid and raise them. If the lid is firm and secure the seal is perfect. Should the lid show the slightest signs of movement or come off the seal is imperfect, and the bottle should be re-sterilized

To Make *the Syrup.*—Dissolve four to six pounds of sugar in a gallon of water—according to the sweetness of the fruit being bottled—bring to the boil and when cool fill the bottles.

BOTTLING VEGETABLES

Vegetables require rather more severe treatment than fruit, particularly peas and beans, as they contain nitrogen, which renders them favourable to the growth of certain micro-organisms Prepare brine of a suitable strength by dissolving 24 oz. salt in one gallon of water and adding 5 fluid oz. or $\frac{1}{4}$ pint lemon juice, when preserving peas and beans. Boil the water, add the salt and the exact quantity of lemon juice. When cold it is ready for use.

Peas must be cleaned thoroughly by washing, and as a precaution it is advisable to soak them for 15 minutes in a weak solution of permanganate of potash. Sufficient crystals should be added to the water to produce a deep magenta colour. Remove the pods and shell the peas. Put them loosely in muslin and dip in a saucepan of boiling water for 1–$1\frac{1}{2}$ minutes Then place in cold running water for about 10 minutes. Pack into the bottles and fill with acidified brine.

French and Runner Beans.—Wash the beans thoroughly, using a nail brush if necessary to remove soil from the pods; string (the runner beans will also require slicing); pack lengthways in the jars. After packing, rinse out the jars with water, cover with acidified brine and place the rubber ring, glass lid and screw band in position. (See detailed instructions for fruit bottling.) Put in the sterilizer or boiler, bring very slowly to the boil and boil for $1\frac{1}{2}$ hours. If, after the bottles have been boiling the brine has boiled away, remove the jars and fill up with boiling brine. Replace the rings and complete the cooking. Next day examine and test the seal as when fruit bottling.

CANNING

The same principles and methods are used in canning as bottling, the chief difference being that metal, and not glass, containers are used, and the method of sealing is therefore different.

Canning has the advantage that it occupies less time than bottling and less care is necessary as there is no risk of breakage. It has not been widely practised by housewives, chiefly owing to the fact that until recently soldering was necessary, a process which the majority of women found difficult. This drawback no longer exists, for a small hand sealing machine is now available which eliminates soldering. Numerous tests with the machine have been carried out and the results are invariably extremely satisfactory and reliable. In conjunction with the hand sealer, special straight sided sanitary cans with open ends must be used. The cans may be either plain or lacquered. The latter are preferable, as they prevent the acid fruit coming in contact with the tin. The outer rim of the lid has a groove which is treated with rubber solution and which acts in the same way as the flat rubber band used when fruit bottling.

Method of Canning.——(I) Wash the cans thoroughly in hot water before ase. Pack with prepared fruit or vegetables, and cover entirely with boiling syrup or brine. *(2)* Put the lids in position and with the aid of the sealing machine close the can. As the escape of steam exhausts the air it is important to seal the can whilst very hot; therefore only two or three should be filled with boiling syrup at one time, otherwise they cool down before there is time to seal them. (3) When all the cans have been sealed, place them in any large container, such as a clothes boiler, large pan or zinc bath containing sufficient boiling water to cover them completely. (4) Bring to the boil and boil gently for 15–40 minutes, according to the fruit. Small soft fruit requires 15 minutes only, and pears from 35 to 40 minutes. The time must be calculated from the moment the water boils again after all the cans have been put in. Small bubbles rising from the can whilst it is in the water indicates that it is not airtight, and has been sealed imperfectly. The contents must be removed, put into a new can and resealed. (5) When sterilizing is complete, cool the cans quickly by placing them in a bath or sink of cold water. When cold, dry and label. *(See* also Food Preservation.)

(D. D. C. T.)

In the United States processing is the term applied to the heating of the material to a temperature and for a length of time that will kill bacteria producing spoilage, and the following methods are used: (A) Water-bath canner, in which the containers are set far enough apart to allow free circulation of the water. This must be boiling when the sealed containers are set in (glass jars being preheated to avoid breakage) and must come over the top of the containers. (B) Steam-pressure canner, in which only enough water is put to come almost to the rack on which the containers are set.

The hot-pack method of canning is recommended by the United States Department of Agriculture. The food material is first heated to boiling point in a minimum of water, is packed while boiling hot into the containers, then processed. In the cold-pack method the material is packed cold into the container (often after first being blanched), then processed. (I. E. L.)

PRESIDENCY, an administrative unit of the Indian empire. The word is derived from the title of president or chief of the council of a principal factory under the East India Company—a title which lasted until governors were appointed under act of parliament in 1784. It thence came to be applied to the three original provinces of Bengal, Madras and Bombay. It is now restricted to Madras and' Bombay, in distinction to the lieutenant-governorships. In Anglo-Indian usage, "presidency" was also applied to the capital city as opposed to the country beyond, termed the "mofussil"; and this usage lingers in such phrases as "presidency town," and "presidency magistrate."

PRESIDENT, a style of title of one who presides. In classical Latin the title *praeses,* or president, was given to all governors of provinces, but was confined in the time of Diocletian to the procurators who, as lieutenants of the emperor, governed the smaller provinces. In this sense it survived in the middle ages. Du Cange gives instances from the capitularies of Charlemagne of the style *praeses provinciae* as applied to the count; and later examples of *praeses,* or *praesidens,* as used of royal seneschals and other officials having jurisdiction under the Crown.

In England the word survived late in this sense of royal lieutenant. Thus, John Cowell, in his *Interpreter of Words* (1607) defines "president" as "used in common law for the king's lieutenant in any province or function; as president of Wales, of York, of Berwick, president of the king's council." In some of the British North American colonies (New Hampshire, Pennsylvania, South Carolina) there was a president of the council, usually elected by the council; and when Pennsylvania and New Hampshire became States, one member of the executive council was called president. The chief (and single) executive head in Delaware, South Carolina and New Hampshire (1784–92) was called president.

During the revolutionary struggle in America from 1774 onwards, the presiding officer of the continental congress was styled "president" and when the present constitution of the United States was framed in 1787 (in effect 1789) the title of president was transferred to the head of the Federal Government. "President" thus became the accepted style for the elected chief of a modern republic.

In the simple sense of "one who presides" the word "president" preserved its meaning alongside the technical use implying royal delegation. In ecclesiastical terminology *praesidens* was sometimes used for the head of cathedral chapters, instead of dean or provost; and it was sometimes the title given to the principal visitor of monasteries. In Great Britain the heads of many colleges are styled "president," the title being of considerable antiquity in the case of one college at Cambridge (Queens', founded in 1448) and four at Oxford (St. John's, Magdalen, Corpus Christi, Trinity). At five Cambridge colleges (Pembroke, Gonville and Caius, St. Catherine's, St. John's, Magdalene) the title "president" is borne by the *second* in authority, being the equivalent of "vice-master." In the United States "president" is the usual style of the head of a college and also of a university wherever this has developed out of a single college. "President" is also the style of persons elected to preside over the meetings of learned, scientific, literary and artistic academies and societies, *e.g.,* the president of the Royal Academy (P.R.A.) in London; the title of the president of the Royal Society (P.R.S.) dates from its foundation in 1660. In the United States the style "president" is also given to the person who presides over the proceedings of financial, commercial and industrial corporations (banks, railways, etc.), in Great Britain usually styled "chairman," but in the Bank of England and certain other banks "governor."

In France, besides the president of the republic, there are presidents of the senate and of the chamber of deputies. In Germany the word *Priisident* is used in most of the English senses of "president," *e.g.,* of a corporation, assembly or political body.

PRESLAV, a village of Bulgaria, situated on the north edge of the Balkans, south of Shumen *(q.v.)*. Preslav was the second capital of the mediaeval Bulgarian tsars, and was raised to great splendour by Tsar Symeon (893–927). It was then compared to Constantinople, and described as "full of high palaces and churches, with countless stones, woods and paintings, so adorned with marble and copper, silver and gold, that the visitor knows not wherewith he shall compare it." It fell into decay on the fall of the first Bulgarian Empire, and was later plundered to adorn the new capital of Trnovo *(q.v.)*. It is now a heap of ruins.

PREŠOV, a town in eastern Slovakia, 25 m. north of Košice. Situated on the left bank of the river Tarcza, a tributary of the Theiss, it is a very old town but has been almost entirely rebuilt since a great fire in 1887. Following the foundation of the town by German colonists in the 12th century its history has been much affected by the nodal character of its site; today it is the seat of the District authorities, the centre of a Greek Catholic diocese and an important railway junction for the Carpathians and Poland. In the neighbourhood of the town is an opal mine and mineral springs, but importance rests on its administrative functions supplemented by small manufactures. Pop. (1930) 21,870.

PRESS. For the history of the liberty or freedom of the press see PRESS LAWS; also NEWSPAPERS and PERIODICALS. For the punishment of "pressirig" *see* PEINE FORTE *ET* DURE. For the "press gang" *see* IMPRESSMENT.

PRESS ASSOCIATION, THE, the oldest and largest news agency operating exclusively in Britain, was founded by provincial newspapers on a co-operative basis in 1868, and began active work on February 5, 1870, when the post office took over the private telegraph companies which had previously supplied the provincial papers with news. For 50 years the P.A. transmitted news by press telegrams, but in 1920 it leased private telegraph wires from the post office. Its private wire system embraces over 3,000 miles of telegraph circuits radiating from London and serving either direct or through centres at Birmingham, Bristol, Manchester, Leeds, and Glasgow, about 120 provincial morning and evening newspapers. It also operates a direct printer system to offices in London. The P.A. has always had the exclusive right to supply in the provinces Reuters' (*q.v.*) imperial and foreign news services. The two agencies are closely associated. With the Exchange Telegraph Company, the P.A. operates in the provinces a joint telephonic service for the rapid collection and distribution of racing results, etc., and cricket and football scores

The P.A. is governed by a board of seven directors. One new director is elected annually by the shareholders (the provincial newspapers). The Association's new headquarters' building, which it occupied in July, 1939, is at 85, Fleet Street, London. From this building it supplies news to all the London daily and Sunday newspapers, provincial newspapers, and trade journals and other periodicals. (H C. RO., X.)

PRESSBURG: see BRATISLAVA.

PRESSED METAL, a broad term which includes that class of merchandise made by the process of bending, shaping and forming sheets, strips, plates or bars of metal in either hydraulic or mechanically-driven presses. Steel so treated is referred to as "pressed steel" or "stampings." While brass, aluminium, zinc and various alloys are all formed in substantially the same manner as steel and with similar equipment, this article will be largely confined to pressed steel.

The greater portion of the work is done cold and pressed steel is generally assumed to mean the cold forming of sheet steel in power-driven presses. Castings and forgings constitute the classes of material that are most generally replaced by pressed steel. Pressed steel is different from both castings and forgings in that, while either a casting or a forging may have a solid section of varying degrees of thicknesses, except in rare cases, pressed steel is a flat or hollow form. such as a shell, the walls of which are of equal thickness throughout. While by special processes and by specially constructed tools it is possible to make a wall of varying thickness, it generally follows that if the sheet of steel which is used as raw material is $\frac{1}{8}$ in. thick, the walls of the finished pressed steel form will also be substantially $\frac{1}{8}$ in. thick. Cold forming of steel first became industrially important through its adoption by bicycle manufacturers. When bicycles became popular, pressed steel replaced forgings and castings because of the need of producing a lighter vehicle at a lower cost.

The next great advance in the use of pressed steel was by the automobile manufacturer. In 1929, apart from units such as the engine, front axle and a few minor parts, most automobiles were made almost entirely of pressed steel. (See MOTOR CAR BODIES.) Other manufacturers, perceiving the advantages of pressed metal over castings and forgings, changed their methods so that pressed steel now goes into many manufactured products. It is impossible here to give a complete list but a few of the better known products are beds, alarm clocks, cooking utensils, gas and electric ranges, lighting fixtures, electrical conduits, switch boxes, push button plates, office furniture, filing cabinets, concrete forms, car wheels, hot water heaters, gasolene pumps, washing machines and typewriters. Wherever a large number of individual units are demanded for mass production, pressed metal has, in the majority of cases, been utilized.

The equipment used for the manufacture of pressed steel carries the general term of presses. There are two general classes known as hydraulic and mechanically-driven. The majority, however, are belt-driven power presses of varying size. The press furnishes the power and the means of holding the "tools" or punches and dies that do the actual forming of the metal. These "tools" consist of an upper or male section, which is known as a punch, and the lower or female section, which is known as a die. A piece of steel is held over the lower section (the die) and the upper section (the punch) is brought down on this by the power press, thus cold forming the steel into the desired shape. The majority of pressed steel parts are made by several successive operations. A certain shape of flat blank receives the first operation in one set of tools, it is then passed along to a second press carrying a second set of tools and is further formed or drawn, and so on through various stages.

It is usually necessary to heat-treat the steel between these various operations as cold pressing makes steel harder and tougher and without heat-treating the steel would not withstand the strain to which it is subjected. Soft, well-annealed steel is ductile, while steel that has been worked in the tools is tough and hard. The tensile strength of a piece of steel can be increased as much as 30% by a single drawing operation. Holes are punched and edges trimmed smooth and round by specially designed tools. While forgings are heavy and castings are both brittle and heavy, a pressed steel part, when properly manufactured, is both lighter and stronger, has a smoother surface and requires less finishing or machining. It has replaced wood in many cases.

BIBLIOGRAPHY.—Georgi and Schubert, *Sheet Metal Working;* O. Smith, *Press-Working of Metals;* H. Hayes, *Drop Forging and Drop Stamping;* H. M. Boyeston, *Iron and Steel;* B. Saunders, *Forging, Stamping and General Smithing;* O. Fuchs, *Schmiedehammer; ein Leitfaden fur die Konstruktion und den Betrieb;* C. O. Bower, *Hydraulic Forging and the Plastic Deformation of Steel.* (W. G. A.)

PRESSENSÉ, FRANCIS DE (1853–1914), French politician and man of letters, was born in Paris on Sept. 30, 1853, being the son of Edmond de Pressensé, and was educated at the Lycée Bonaparte. He served on General Chanzy's staff in the war of 1870, and was taken prisoner at Le Mans, but after the war entered the public service. After a short period at the ministry of public instruction he entered the diplomatic service, and was appointed first secretary at Washington. In 1882 he returned to France and took up journalism, becoming in 1888, foreign editor of the Temps. At the time of the Dreyfus case (1895) de Pressensé identified himself with the cause of the prisoner. He wrote in support of General Picquart, and in consequence of his advocacy of Émile Zola's cause was struck off the roll of the Legion of Honour. This led to his resignation from the Temps, and he came forward as a socialist politician, being in 1902 elected socialist deputy for the Rhône. He took part in the debates on the question of the separation of church and state, and a bill brought in by him formed the basis of the one finally carried by Briand. He died in Paris on Jan. 19, 1914.

His works include *Le Cardinal Manning* (1896), and *L'Irlande et l'Angleterre depuis l'acte d'union jusqu'à nos jours, 1800–1888* (1889), besides many articles in the *Temps*, the *Revue des Deux Mondes, Aurore* and *Humanité*.

PRESSES AND PRESSWORK. The method of converting ingots of steel into forgings depends upon the size of the completed pieces and the number of these required. Hammer heads are formed in dies under a drop hammer. (*See* DROP FORGING.) Locomotive connecting rods would probably be forged under a steam hammer (*q.v.*). Ingots larger than 3 ft. in diameter, however, would usually be forged under a hydraulic press. The present article will confine itself to the latter type, although many hydraulic presses are used for the manufacture of seamless tubes, shells or flasks, and adapted to many forming operations in trades other than metal working. Machines for forming cold sheet metal and thin plate (*see* PRESSED METAL) are also called presses, although the dies are opened and closed by cam or eccentric-driven levers.

In a forging press the hot metal rests on a stationary anvil and is squeezed by a pallet forced downward by a hydraulic ram. Four heavy round columns act as tension members with both ends fixed into massive rectangular slabs called entablatures; the lower entablature rests directly on the foundation and supports the anvil; the upper entablature or cap carries the hydraulic cylinder. Fluid pressure in this cylinder forces a closely fitting ram downward; to the bottom of the ram is attached a cross head guided by four bushings sliding over the columns, and to this cross head is secured the upper working tool or pallet. Auxiliary cylinders are provided for lifting the cross head after the force has been exerted, and to move the ram up to its work. High pressure in the ram cylinder may be built up directly from a pump, from an accumulator *(see* STEAM ACCUMULATORS) or by a steam intensifier. .Frequently more than one pressure is available so that work of various sizes can be handled. Reliable valves and packing at all sliding joints are essential. The capacity of a press is rated by the total squeeze it can exert. The smaller sizes, which compete with steam hammers, are designed for rapid operation and economy of power and water; in the bigger ones these considerations are subordinated to the necessity for complete reliability.

So much improvement has been made in the art of casting and heat treating alloy steels that the large expense of forging is now justified only when the utmost of uniformity, soundness and toughness is essential. Castings and ingots are made up of interlocked fern-like crystals of metal, whose size depends upon the slowness of solidification. Long continued heat treatment may be able to refine this structure into an aggregate of microscopic crystals, but it is much more amenable to heat treatment if the hot ingot has been squeezed and the coarse crystals more or less broken up mechanically. Accidental internal cavities may also be closed up and welded shut. This kneading of metal, to be effective, should obviously extend to the very centre of the section. Hence large ingots need the slow, deliberate, irresistible squeeze of a hydraulic press. The sharp blow of the biggest hammer is cushioned by the outer layers of metal and fails to reach the centre of the slab. American railroad practice in 1929 calls for a 5 to 1 reduction from the ingot and a 4 to 1 from rolled billets. Recent investigations have shown, however, that fine grain can be obtained with even less than 3 to 1 reduction if proper precautions are taken. The irregularities caused by segregation (see IRON AND STEEL) can more than counteract the advantages of large reduction under the press. The carbon is lower in the bottom and sides of the ingot and higher in the centre and top; to counteract this in big ingots requiring the full capacity of several furnaces, metal containing less and less carbon is poured in the successive heats.

It is impossible to make absolutely clean steel. Tiny nonmetallic inclusions will be caught between the crystals throughout the ingot; soluble impurities like phosphorus will concentrate in the metal locked within the crystal branches. Forging tends to arrange these impurities into planes parallel to the pallet faces; the more the reduction the more pronounced would these "flow lines" become. Thus if tensile test pieces are cut from a thick forged slab in three directions (a) parallel to the main extension, (b) crosswise and (c) from front to back, the ultimate strength of all might be fairly close. However, the first or longitudinal piece would have satisfactory contraction of area and impact toughness; the second or tangential test piece would have markedly less toughness; the third, or transverse test piece would be the most brittle. Such "transverse weakness," as it is called, is a great danger to cylindrical objects which must withstand bursting pressure, because the greatest stress is in a tangential direction. Transverse weakness may be minimized by making ingots of cleanest steel, and also doing no more work in forging than is necessary. Hence the modern method of minimizing the size of ingots and degree of forging avoids undue trouble from segregation and transverse weakness. Tensile properties taken from representative large forgings are as follows:

Article	Steel	Size	Ultimate strength	Yield point	Elongation in 2 in.	Reduction in area
Hydraulic press column . . .	Kickel-chromium . .	24 in. dia. by 36 ft.	115,000	8j,000	21	55
40,000 lb. Intensifier	Nickel-chromium . .	18 in. dia.	148,500	110,000	15 (tangential)	50
47,000 lb. Extrusion press . . .	Chromium-vanadium .	32 in. dia.	..	110,000	..	..
Boiler drum	0·26% Carbon. . .	63 in. dia.	64,000	29,000 min.	2j in 3 in.	45

(See IRON AND STEEL.)

(E.E.T.)

PRESS GANG. The Press Gang was the name given to the naval parties who, until the beginning of the 19th century, were used forcibly to take or "impress" men for service in the British fleet. From mediaeval times the Crown claimed the power to impress able-bodied subjects for the defence of the realm, and as early as the time of Edward III. complaints are recorded in Parliament of the excessive use of this power. From the earliest time, England depended upon her professional seamen, the merchantmen, to man her fighting ships: but it was not until the end of the 16th century that fishermen, watermen and mariners were exempted by law from being "pressed" as soldiers: they remained liable to impressment for service in the Navy. The needs of Elizabeth's fighting fleet became so large that the Vagrancy Act was passed, rendering all "disreputable persons" liable for impressment for service in the fleet: the sheriffs and mayors being bound, upon the production of the warrant of the "takers" or "press gang," to produce the number of men required. This naturally led to jail clearance; the law remaining unaltered, throughout the 17th and 18th centuries there were constant complaints from naval officers of the quality of men supplied. In the 18th century certain exemptions were made, in the case of apprentices, a proportion of fishermen, seamen employed in the coastwise coal trade, but even at the height of Britain's maritime power, from 1780 to 1815, the press gang was the chief means of recruiting the fleet.

The action of English cruisers in pressing men from the merchant ships of the American colonies was one of the causes that led to the War of Independence. A favourite means of completing the complement of warships was by stopping homeward bound merchantmen and removing some of their seamen. Service became so unpopular that in 1795 the press gangs and the jails failed to provide sufficient men. An Act was passed directing each county to provide a "quota" of men, with the result that the authorities of each district handed all malcontents and agitators over to the press gangs, by whom they were taken to the guard ships stationed round the coast for drafting into the fleet. The introduction of this bad element into the Navy was one of the causes of the mutiny of 1797 which nearly brought disaster to the country. The insistence of the right to press British subjects in America was one of the chief causes of the war between Great Britain and the United States in 1812.

The press gangs were not used after the close of the Napoleonic Wars in 1815, although it is lawful to this day to impress men for service in the navy, though not in the army. By an Act of 1835 a "pressed" man is exempt after five years' service and seamen in the Merchant Service, fishermen and certain other persons are exempted from impressment. With the introduction of the long service system in 1853 all need for impressment disappeared and since that date there have always been more volunteers than could be accepted for service in the Royal Navy. (S. T. H. W.)

PRESSING: *see* PEINE FORTE ET DURE.

PRESS LAWS, the laws affecting the products of the printing-press and newspapers in particular. (See NEWSPAPERS.) In English-speaking countries the liberty of the press is nowadays taken for granted. It was not always so, but in 1784 Lord

Mansfield made the following pronouncement in *R.* v. Dean of St. Asaph (3 T.R. 431 n): "The liberty of the press consists in printing without any previous licence, subject to the consequences of the law." This liberty was a plant of slow growth in England, and in some Continental countries the State still exercises an authority over the newspaper press which in Anglo-American spheres would be considered intolerable in time of peace. (*See* also CENSORSHIP.)

In the middle ages the church kept a firm hand on the free expression of opinion, spoken or written, and when printing was discovered co-operated with the secular authority in keeping an even tighter hand on the printed word. The principle of the censorship over the products of the press, which is still maintained by the Roman Catholic Church (see INDEX LIBRORUM PROHIBITORUM), was initiated by a bull issued by Pope Alexander VI. in 1501 against unlicensed printing. In 1535 Francis I. issued an edict prescribing the death penalty for the unauthorized printing of books, and soon afterwards the Sorbonne became the licensing authority and remained so until the French Revolution.

England. — In England after the Reformation in Henry VIII.'s reign most of the rights of censorship passed from the ecclesiastical authorities to the Crown, which began to grant by letters patent the privilege of printing or selling books as a monopoly. Under Queen Mary the right of printing was limited to 97 members of the Stationers' company, founded by royal charter in 1556, and their successors by apprenticeship. Under Queen Elizabeth the Star Chamber limited the number of printers and presses, and ordained that printing should be carried on only in London, Oxford and Cambridge. In view of the increase in unlicensed printing-presses, the Star Chamber in 1637 decreed that all printed books must be submitted for licence and registered by the Stationers' company before publication, with the penalty of forfeiture of all presses belonging to disobedient printers, who were disabled thereafter from carrying on their trade. The old formula *imprimatur* (let it be printed) thenceforward denoted the authority to print the book. Law books had to be licensed by one of the chief justices or the chief baron of the Exchequer, certain other classes of books by special dignitaries, but most of the licensing devolved on the archbishop of Canterbury and his coadjutors and the chancellors or vice-chancellors of the universities. It was a similar ordinance made by the Long Parliament, after the Star Chamber had been abolished, that called forth John Milton's unlicensed essay, Areopagitica, a Speech for the Liberty of Unlicensed Printing. Under the Licensing Act of 1662 (in effect reproducing the Star Chamber order of 1637), practically the newspaper press was reduced to the London Gazette. In 1695 the Licensing Act lapsed and, to quote Macaulay, "English literature was emancipated for ever from the control of the Government." Lord Chief Justice Russell (of Killowen) said in R. v. Gray 1900, 2 Q.B. at p. 40: "The liberty of the press is no greater and no less than the liberty of every subject of the queen." (See CONTEMPT OF COURT.)

One effect of unlicensed printing was to lay authors open to the attacks of literary piracy, and in 1709 the first Copyright Act (8 Anne c. 19) was enacted for their protection. The old power of a secretary of State to issue a warrant, general or special, for the purpose of searching for and seizing the author of a libel, or seizing the libellous papers themselves, was not finally declared illegal until the case of *Entick* v. Carrington in 1765 (St Tr. xix. 1030). In 1776 the House of Commons passed a resolution in accordance with this decision. The compulsory stamp duty on newspapers was abandoned in 1855 (18 Vict. c. 27), the duty on paper in 1861 (24 Vict. c. 20), the optional duty on newspapers in 1870 (33 and 34 Vict. c. 38).

A declaration in favour of the liberty of the press is usually a prominent feature in the written constitutions of foreign States, but in England it rests upon a constitutional rather than a legal foundation. (Dicey's Introduction to the Law of the Constitution, 7th edition, chap. 6.)

The last relic of the censorship before publication is to be found in the licensing of stage plays. (See THEATRES, LAW RELATING TO.) The last relic of the monopoly of printing formerly granted to licensees of the Crown is found in the exclusive right of the king's printer and the universities of Oxford and Cambridge to print the Bible and the Book of Common Prayer, and of the king's printer to print Acts of parliament, statutory rules, and other State documents. This monopoly, so far as the Bible is concerned, extends only to the Authorized Version, and not to any accompanied by annotations or new marginal readings. In the case of re Red Letter New Testament (Authorized Version) in 1900, on the application of the queen's printers an order was made by a chancery judge expunging from the register of copyrights of the Stationers' company an entry whereby an American was registered as the owner of the copyright in that book (17 T. L.R. 1). The rights of the king's printers are protected by 8 and 9 Vict, c. 113 and 45 Vict. c. 9; the rights of the printers of the journals of either house of parliament are protected by 8 and 9 Vict. c. 113.

By 32 and 33 Vict. c. 24 the printer of any paper or book for profit is required under penalties to print thereon his name and address or the name of a university press, and is to keep a copy of everything printed, with a few exceptions. Penalties must be sued for within three months, and no proceeding for penalties can be begun uniess in the name of the attorney-general or solicitor-general of England or the lord advocate of Scotland.

Under the Copyright Acts a newspaper is a book, and the obligation imposed by the 1842 Act still remains of delivering (without request) to the British Museum a copy of any work published within the United Kingdom, and of delivering (on request) copies for the use of the university libraries at Oxford and Cambridge, the library of the faculty of advocates at Edinburgh, the library of Trinity college, Dublin, and the national library of Wales (1 and 2 Geo. V. c. 46, s. 15; see COPYRIGHT).

In the High Court a request by a judge that certain details be not published is equivalent to a command. By the Judicial Proceedings (Regulations of Reports) Act 1926 there is a declaration of the common law as to the offence of publishing indecent matter in reports of judicial proceedings and a special proviso limiting the reports of matrimonial causes. (See DIVORCE.) By the Children Act 1906 (8 Edw. VII. c. 67) reporters cannot be excluded from children's courts, subject to any powers that a police magistrate has of hearing proceedings in camera, but the normal practice is not to report the names and addresses of child offenders. By the Criminal Justice Act 1925 no photographs or sketches may be taken in court, or, if they are taken contrary to the law, published. Seditions, blasphemous, or obscene words in a newspaper may be punished as treason, treason felony, seditious libel, or misdemeanor. (W. LA.)

United States. — There is no body of law in America which with strict accuracy may be called "the law of the press." Except for a few statutes and peculiar rules of common law, journalists are not singled out for special legal favours or restrictions. Naturally, however, the press comes into more direct and frequent contact with certain branches of law than with others. These branches, touching content and distribution of newspapers, may, for convenience, be grouped under the above title.

The sources of press law are found in the Federal and State Constitutions, statutes and in decisions of Federal and State courts interpreting constitutional and statutory provisions and declaring the common law. Some branches are restrictive, others protective. Nearly all are relatively modern and all are in process of development, chiefly toward enlarged freedom for ethical journalism.

The restrictive laws are those thought necessary by legislatures or courts to serve three purposes: protection of Government and its processes, including judicial action, from violent disruption and unlawfully created disrespect; protection of individuals in good name, business reputation and right of privacy; and protection of the morals of the public and of its right not to be defrauded or deceived.

The chief instances of restriction for governmental protection are the statutes condemning publications constituting contempt of court, sedition (*e.g.,* the war-time Espionage Acts of Congress), criminal anarchy and syndicalism. Acts of Congress and State statutes generally deal with contempt of court and courts have repeatedly held certain publications to be contemptuous. Federal statutes prohibiting various forms of seditious publications have been common in war time, but ordinarily have been repealed on restoration of peace. Their constitutionality has been upheld with great uniformity. Many State statutes condemn criminal anarchy and syndicalism. The New York Criminal Anarchy statute (Penal Law, Sect. 160–161) is typical. These statutes are directed against advocacy of overthrow of Government and of destruction of property (sabotage) by violence or other unlawful means.

The chief instances of restriction for protection of individuals are the libel law and the prohibition of unauthorized publication of photographs and names of individuals for purposes of advertising or trade. This prohibition is statutory in two States (New York and California) and exists by judicial decision in others. It is destined to become general, if not universal.

Every State has libel law, usually expressed partly in statutes and partly in court decisions declaring common law rules. This is by far the most important phase of press law. It has its origin in the common law and many of its fundamental rules were laid down when the art and practice of printing were in their infancy. Even now the law for the most part is found, not in statutes or codes, but in court decisions. In general, the judicial tendency has been to abandon or relax common law rules thought too harsh for conditions of modern journalism. In the main, at least from the standpoint of importance, the statutes are relaxations of former harsh common law rules; in some instances the legislatures have codified liberal court decisions and in others they have advanced beyond the courts in enlarging the freedom of decent journalism.

Fundamentally, the libel law in the various States is 'substantially the same, though naturally there are variations in details, some of which are important, and in the application of underlying rules. Published matter is libellous if its natural tendency, in the opinion of a substantial number of right-thinking persons, is to induce an ill opinion of an individual or is to affect injuriously a person's standing in his business, profession or office or is to impugn the management or credit of a corporation in such manner as to be calculated to cause pecuniary loss. Libellous publications may be the subject of civil suits and criminal prosecutions but may not be restrained by injunction.

The generally recognized complete defences are that the published matter was true, that it was a fair and true report of legislative, judicial or other public and official proceedings published without malice, that it was fair comment or criticism concerning a matter of public interest, that it was published in good faith in defence of some attack upon the publisher or that it was published with the consent of the person named. Partial defences—those which mitigate or reduce damages—are also allowed. They consist generally of proof concerning the publisher's good faith and the reasons why he believed his publication to be true or otherwise justifiable.

The chief instances of restriction for the protection of public welfare are the statutes prohibiting publication of obscene matter; advertisements of such matter as lotteries, betting odds and other data useful in gambling; intoxicating liquor, abortifacient drugs and instruments, cures for venereal disease, procuration of divorce; false statements of circulation and false and misleading merchandise advertisements. Federal and some State statutes require that reading matter which is in fact paid advertising shall be plainly marked as advertising. A few States, in varying forms of phraseology, prohibit the publication and sale of newspapers "devoted to" or "principally made up" of stories of bloodshed, lust or crime.

The protective branches of newspaper law consist mainly of constitutional guaranties of freedom of the press, the copyright law and trade-mark law. Comment upon the latter two branches, each of which is a special body of law not peculiar to newspapers, is beyond the scope of this discussion, except to say that newspapers enjoy the same rights and privileges thereunder as do citizens generally.

The U.S. Constitution (1st amendment) provides that Congress shall pass no law abridging the freedom of the press and the State Constitutions, in varying phraseology, declare that citizens may freely speak, write and publish their sentiments on all subjects, being responsible for the abuse of that right, and that no law shall be passed to restrain or abridge the liberty of the press. Controversy concerning the proper interpretation of these guaranties rages endlessly and even now the subject is in doubt. Those favouring a narrow interpretation contend that the guaranties mean merely that there shall be no restraint in advance of publication or prevention of future publication, that Congress and the State legislatures are free to provide for punishment after the event for the publication of any sort of matter that they think objectionable and that the legislative conclusion of objectionableness is not subject to judicial scrutiny. Those favouring a broad construction contend—and sometimes with more emotion than logic—that the guaranties, properly interpreted, prevent any form of legal responsibility for any publications except those which are seditious, obscene or libellous. That contention has been rejected in a number of decisions of appellate courts. The truth lies, it is believed, between the two extremes. These guarantees do not protect a publisher from the consequences of a crime committed by the act of publication. They mean, however, more than that there shall be no restraint of future publications. They imply not only liberty to publish but complete immunity from legal punishment for the publication so long as it is not harmful in its character when tested by such standards as the law affords.

(H. L. Cr.)

The British Empire.—In the British dominions and possessions overseas the press is, generally speaking, as free as in England. In India the press laws are contained in a series of Acts of which the last and most important is No. XIV. of 1922, known as the Press Law Repeal and Amendment Act. The governor-general is given wide powers with regard to preventing a seditious use of newspapers, whether printed in English or in the vernacular, and there are elaborate provisions for the registration of printers and publishers, for the seizure and confiscation of seditious matter and for preventing its importation or circulation, and for the punishment of those responsible for its publication or distribution. Every copy of a newspaper must bear the name of the responsible editor.

Other Countries.—The press law in Austria is contained in the federal law of April 1922, which guarantees the freedom of the press subject to limitations set out in 51 articles. In Hungary the press law of 1914 (Act XIV.) is an elaborate set of regulations containing 64 articles, the first of which says: "It is open to every one to communicate and propagate his ideas by means of the press." Art. 14 of the Argentine Constitution provides that any inhabitant may publish his ideas in the press without any previous censorship. The only restrictions of the liberty of the press are contained in the penal code and social defence law dealing with defamation and other offences. By the Belgian Constitution of 1831 the liberty of the press is declared. In Bulgaria the press law of 1921 deals mainly with questions of responsibility and procedure, press offences being set out in the penal code. By the Constitution of Chile the liberty of the press is guaranteed, subject to ordinary restrictions. In China newspapers are governed by the press law of 1914, which follows the model of most European countries in its general outline, except for the important difference that in theory all leading articles have to be passed before publication by the police. The Czechoslovakian press law of May 1924 consists of 42 articles which amplify previous laws relating to the press passed when this country was part of the Austro-Hungarian empire. In the main the 1924 law deals with questions of procedure and responsibility and does not enact new offences. In Denmark press laws date from 1851, subject to amendments in the general civil penal law of 1866. As one of the new independent post-War States, Finland's press law dates from Jan. 1919.

In France the press is controlled by the law of July 1881, which declares the liberty of the press, subject to the prohibition of abuses. Is Germany, by the Constitution of Aug. 1919, Art, 118, "every German has the right, within the limits of the common law, to express his opinion by word of mouth, in writing, in print, or in any other way. A censorship will not be established, but certain regulations will be laid down dealing with cinematograph exhibitions. Legal measures are permissible for the prevention of immoral literature." For the rest the press is subject to the press law of May 1874.

Liberty of the press is provided in the Constitutions of Greece and Holland. In Holland it actually exists as in England, but the troublous political developments in Greece during and since the World War have resulted in a considerable limitation.

In Italy the press has become under Signor Mussolini's régime almost entirely, on its political side, an exponent of the Fascist idea. Nearly all professional journalists perforce belong to an organization under Government control, and by a decree of July 1924 the responsible editor of a newspaper must be approved by the prefect of the province. A prefect may warn the newspaper editor or manager who publishes false or tendencious news calculated to embarrass the country with foreign Governments, or to damage the national credit, or in any way to disturb public order, and may rcvokc his rccognition of the editor who has been so warned twice in a year. An appeal lies, not to a judicial tribunal, but to the minister of the interior. For breaches of these rules newspapers may be confiscated. In practice the Fascist press laws have, at any rate for the present, done away with the nominal liberty of the press expressed in the royal edict of 1848.

The press law of May 1901 in the main governs the activities of newspapers in Japan, other forms of print being dealt with in an earlier law of 1893. The various press laws under which partitioned Poland lived are being replaced by a uniform law based on the principle of freedom of opinion. In Portugal, Yugoslavia and Rumania there is a theoretical liberty for the press, liable to be waived during not infrequent periods of unrest. In other respects the press is subject to the usual restrictions against abuse of the printed word. In Russia by a decree of 1921 the Government of the Republic of Soviets has practically brought the newspaper press and all printed publications under State control, and there is no independent press. Unauthorized printing results in confiscation and the trial of those responsible. In Spain, since the abolition of parliamentary government, which was superseded by the régime of the Marques de Estella, the press has been in a political sense subject to Government control, but in other respects it is governed by laws passed since 1883 which are more or less in common with the press laws of other Roman Catholic countries. In Norway and Sweden there are voluminous press laws in operation, but they follow the usual order of things, freedom of opinion being allowed. The same applies to Switzerland. (W. La.)

PRESSURE CHEMISTRY. The influence of pressure on chemical transformations has long been recognized, but it is only within the 20th century that high pressures have been applied to industrial chemical processes. Haber's process for the direct synthesis of ammonia from its elements, which has been developed in Germany by the Badische Anilin und Soda Fabrik, has not only solved the problem of the world's supply of fixed nitrogen but has produced a technique in dealing with gases under conditions of high pressure and temperature, which is now being applied in the field of organic chemistry. Bergius's process for the production of oil from coal involves treatment of the latter with hydrogen at high temperatures and pressures. This process, after over 20 years' sustained research, has been placed on a manufacturing basis, and affords a solution of one of the greatest European problems, namely, the creation of an adequate oil supply.

Pressure and Chemical **Action.**—Le Chatelier's principle states, in effect, that if a system in equilibrium be subjected to a constraint, a change will take place in the system which is in opposition to the constraint. An increase of pressure favours the system formed with a decrease in volume, while a reduction of pressures favours the system formed with an increase in volume. Pressure may consequently be employed in gaseous reactions, which proceed with diminution in volume, to change the equilibrium in favour of the product desired. The attainment of this equilibrium or a close approach to it is brought about by the use of a catalyst, which may be defined as a substance which can accelerate a chemical change without itself undergoing permanent alteration. The development of ammonia synthesis has shown that a catalyst may be specially sensitive to the presence of certain substances which may either inhibit or enhance its activity. For example, the activity of iron as an ammonia catalyst is partially or totally destroyed by the presence of traces of sulphur, selenium, tellurium and other elements which act as poisons. Catalyst masses must consequently be prepared with great care, and the reacting gases need special purification. In contrast to the poisoning action of the elements mentioned above, the presence of a small proportion of certain substances called promoters, as for example the oxides of the alkalis and alkaline earths, greatly enhances the activity of the iron catalyst. Lowering the temperatures of reaction has the same effect on the ammonia equilibrium as raising the pressure. Haber has calculated that if the temperature of reaction could be reduced to 300° C, satisfactory yields of ammonia would result at ordinary pressures. No catalyst is known which will bring about reaction at so low a temperature, therefore the industrial procedure is to obtain a catalyst highly reactive at as low a temperature as possible, and to raise the pressure till adequate yields of ammonia result.

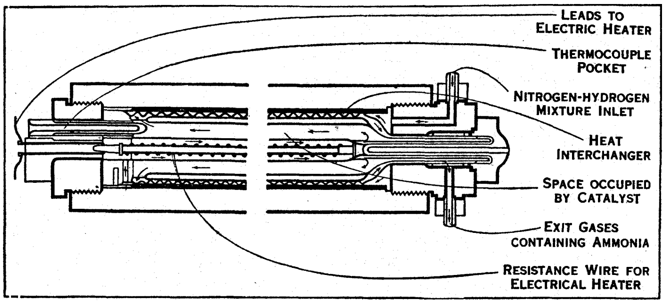
Synthetic Ammonia Processes.—Nitrogen and hydrogen subjected to high temperatures and pressures in the presence of a suitable catalyst unite to form ammonia, in accordance with the equation $N_2+3H_2\rightleftharpoons 2NH_3$. Variations in the different industrial processes lie principally in the pressures employed, the special form of catalyst, and in the method of preparing the nitrogen hydrogen mixture. The Haber-Rosch, Casale, and Claude processes operate at pressures of about 200, 800 and 900 atmospheres respectively. The first two processes employ circulatory forms of plant (figs. 1 and 2), where the nitrogen-hydrogen mixture is passed over the catalyst at a temperature of 500°–600° C. The partial pressure of ammonia in the gases leaving the converter amounts to about 12 atmospheres in the Haber-Bosch, and 160 atmospheres in the Casale process. Ammonia is removed in the former process by solution in water, and in the latter by condensation at ordinary temperatures. Unchanged gas is circulated by a pump over the catalyst together with fresh gas mixture added to maintain the pressure. A flow-through form of plant is employed in the Claude process. The catalyst is held in a battery of six converter tubes, one of which is shown in fig. 3. In the first of these, which contains the old catalyst, any carbon monoxide in the gas is converted to methane. The next two tubes are arranged in parallel to prevent overheating due to excessive reaction, while the last three tubes are in series. The partial pressure of ammonia in the gases leaving each converter tube is about 250 atmospheres. Ammonia is removed by simple condensation after each contact with the catalyst. In all, 85% of gas is converted to ammonia. The residual gas after reduction to atmospheric pressure is used for other purposes.

BY COURTESY OF THE UNIVERSITY OF PADUA

FIG. 1.— DIAGRAMMATIC PLAN OF CASALE SYNTHETIC AMMONIA PLANT

In the three processes provision is made for heat interchange betw-een gas entering and leaving the converter, either inside the converter itself or in a separate heat interchanger, so that the heat of reaction maintains the temperature of the catalyst. Nitrogen and hydrogen are prepared as a mixture in the Haber-

Bosch process from producer gas (a mixture of nitrogen and carbon monoxide) and water gas (a mixture of hydrogen and carbon monoxide). Water gas and producer gas in suitable proportions are passed with steam over an iron oxide catalyst kept at a correct temperature, when nearly all the carbon monoxide reacts with steam to give a mixture of hydrogen and carbon dioxide; the latter gas is removed by solution in water under high pressure, while any unchanged carbon monoxide is absorbed by a solution of a cuprous salt (*e.g.,* ammoniacal cuprous formate). In the Casale process hydrogen is produced electrolytically, and in the Claude process the gas is obtained from coke-oven gas by a process in which other constituents are removed by liquefaction. In both processes the nitrogen-hydrogen mixture is produced by burning a calculated amount of air in the hydrogen.



BY COURTESY OF THE UNIVERSITY OF PADUA

FIG. 2.— SECTION OF CASALE CONVERTER

Alcohol Synthesis.—G. Patart has shown that methyl alcohol (methanol) is produced by the interaction of carbon monoxide and hydrogen, under conditions of high temperature and pressure, in the presence of zinc oxide. The activity of zinc oxide as a methanol catalyst is increased by the addition of certain acidic oxides (*e.g.,* oxides of chromium, manganese and uranium). A most efficient catalyst is produced by the reduction of a basic zinc chromate ($3ZnO \cdot CrO_3$). Two litres of methyl alcohol per hour can he produced for each litre of space occupied by catalyst when a mixture of hydrogen (two parts by volume) and carbon monoxide (one part) is passed under a pressure of 200 atmospheres over the catalyst kept at 400° C, at a rate corresponding to 20,000 litres per hour (measured at N.T.P.) of gas mixture.

Audibert has found that copper prepared by regulated reduction of cuprous or cupric oxide acts as a methanol-forming catalyst; both the activity and stability of this catalyst may be increased by the addition of small amounts of oxides of various metals (zinc, manganese, beryllium or cerium) which act as promoters. A catalyst containing 0·01 atoms of cerium for each atom of copper is stated to be highly reactive at so low a temperature as 300° C.

Experience in high-pressure practice gained through the development of ammonia syntheses enabled the Badische Anilin und Soda Fabrik to place the methanol synthesis on a manufacturing basis, and in 1925 to export 500,000 gallons of synthetic methanol to the United States.

The possible number of reactions that can be effected between a mixture of carbon monoxide and hydrogen is theoretically almost unlimited, and the course of reaction is largely dependent on the nature of catalyst employed. A catalyst made from zinc chromate leads to the production of substantially pure methanol from a mixture of carbon monoxide and hydrogen under conditions detailed above, but if the catalyst is made alkaline by the addition of, e g., potassium carbonate or chromate, the product contains beside methanol, n-propyl, isobutyl and higher alcohols, together with acids, free or combined as esters. The proportion of the various constituents depends on the rate of passage of the carbon monoxide-hydrogen mixture over the catalyst.

Addition of metallic cobalt to zinc chromate produces a catalyst which brings about the formation of methyl, ethyl, *n*-propyl, isobutyl, n-butyl and higher primary alcohols; small amounts of aldehydes can also be isolated, but the product contains no acids free or combined.

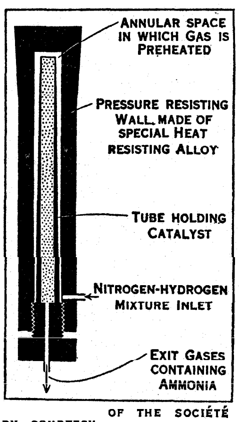
Production of Oil from Coal.—Bergius's process for conversion of coal into oil consists in heating powdered coal, preferably in a liquid medium, to a temperature of 450°–470° C, in the presence of hydrogen under a pressure of about 250 atmospheres The introduction of 5% of hydrated ferric oxide (bog-iron ore) assists the process by combining with sulphur contained in the coal; the oxide possibly functions also as a catalyst. A large amount of heat is produced by the hydrogenation which may result in rise of temperature and the consequent formation of coke.

The oil-coal mixture has a much better thermal conductivity than powdered coal alone, and it is possible with the assistance of a stirrer to keep the reacting mass within the necessary limits of temperature.

The liquefaction of coal is regarded by Bergius as proceeding in two stages: (1) hydrogen addition, and (2) a splitting up of large molecules into smaller ones, with subsequent further addition of hydrogen. Bergius's liquefaction process is applicable to all types of coal, including lignites, except the anthracites and coals which consist chiefly of fusain. A continuously acting plant is usually employed on the works scale. The coal-oil mixture is forced in at one end of a long, cylindrical iron converter down which it is propelled by a mechanically driven stirrer. Hydrogen is circulated through the converter which is partially immersed in a gas-heated lead bath. The products from 100 parts of bituminous coal are as follows: gas (methane and ethane), 20 parts; oil boiling up to 230° C, 20 parts; oil boiling at 230°–330° C, 10 parts; and oil boiling above 330° C, including pitch, 20 parts. The remaining products are ammonia, 0·5 parts; water, 8 parts; and ash, 10 parts. The oily products consist of members of the aliphatic, aromatic and hydroaromatic series. Compounds of a phenolic character, chiefly cresols, are also included. Motor spirit obtained from the products (about 15%) is very rich in aromatic and hydroaromatic hydrocarbons, and may be blended with petrol to give a mixture with good anti-knocking qualities.

The process of heating materials with hydrogen under pressure is termed berginisation and has been applied to asphalts, coke-oven tars, and heavy distillate oils for the production of light-boiling oil suitable for use as motor spirit.

High-pressure Plant.—Gases used in high-pressure processes are usually stored at atmospheric pressure in ordinary inverted bell-type, water-sealed gas holders. Gas from the holders is then compressed and passed into the high-pressure system as required. Multiple-stage compressors should be specially designed for the particular gas mixture, since gases vary in their deviation from Boyle's law. The design of the compressor should also guard against leakage of gas to atmosphere and the possibility of air being drawn into the plant.



BY COURTESY OF THE SOCIÉTÉ DE CHIMIE INDUSTRIELLE,

FIG. 3.— CLAUDE BOMB TUBE

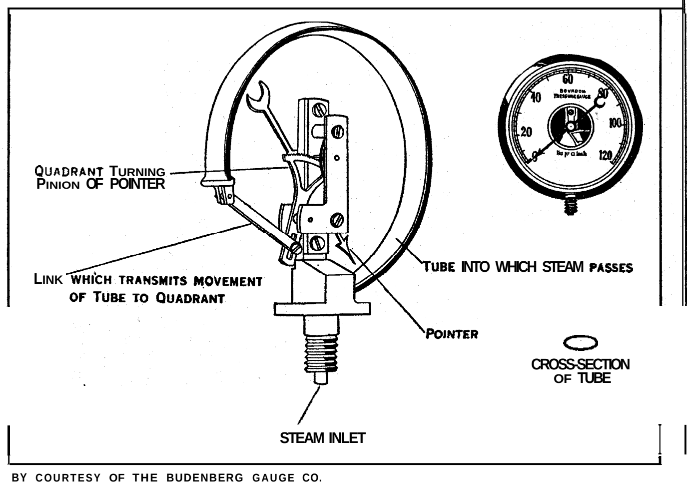
A large factor of safety must be employed in the construction of high-pressure vessels, owing to the possibility of blow holes and other structural faults. Vessels for use at ordinary temperatures are usually constructed of mild steel. When the vessel is to be subjected to both high pressure and high temperature, mild steel can no longer be used since its tensile strength begins to decrease very appreciably at about 300° C. If the reacting gases contain hydrogen, the metal may also suffer serious deterioration in strength owing to the removal of carbon by the action of hydrogen at the elevated temperature. In practice, a complex form of vessel is constructed in which the outer pressure-resisting shell, made of mild steel, is kept cool and away from the action of the hot gases (compare fig. 2); or else some special steel or alloy is used which retains a high tensile strength at the temperature to which it is subjected, and which suffers little deterioration through contact with gases employed in the process. (*See* fig. 3) Steels containing chromium and nickel have been found to be best suited to this purpose.

The construction of plant for chemical processes, involving the use of gases at high pressures and temperatures, has presented many difficulties, for example the making of pressure-tight enclosures, glands and valves, but the advantages which arise from the reduction in gas volumes and possible efficient heat recovery make such processes in many ways preferable to normal pressure systems.

BIBLIOGRAPHY.—F. Fischer, *Conversion of Coal into Oil* (trans. by R. Lessing) [1925] (includes chapters on hydrogenation of coal and synthetic processes under pressure); R. Taylor, *High Pressure Chemistry* [in the press]; B. Waeser, *Atmospheric Nitrogen Industry* [1926] (includes chapters on Haber-Bosch Synthesis of Ammonia, Production of Nitrogen and Hydrogen, also Bibliography); H. Wolbling, *Die Hydriesung* [Halle, 1926] (Technical Application of Catalytic Hydrogenation, including Fischer's Synthol and Bergius's Processes); Proceedings of the International Conference of Bituminous Coal, Nov. 1926, Carnegie Institute of Technology (includes papers by F. Bergius, F. Fischer and G. Patart). (R. TA.)

PRESSURE GAUGE, a term commonly applied to an instrument for measuring pressure, as distinct from a barometer, a manometer (*qq.v.*), or a gauge employed in vacuum practice. The following article deals with the type of gauge which registers pressure by the distortion of a metal tube or diaphragm, and which may be used to indicate the pressure of steam, gas, ammonia, water, brine, petrol, or oil. The lowest pressure requirements are those for blast pressures, or gas or air, working up to about 2 lb. per sq.in., and the highest the hydraulic gauges up to 12 tons per square inch. For very low pressures a diaphragm arrangement is employed. In the Schaffer gauges a corrugated diaphragm is acted upon by the pressure and its deflection communicates the movement through a link and toothed quadrant to the pinion, which turns the pointer around the gauge dial. Such gauges will withstand rough usage, as on road vehicles and portable engines.

The Bourdon type has a bronze tube of elliptical cross-section bent into circular form. One end is soldered to a central block through which the fluid enters (see fig.) and the other end is sealed, and coupled by a link to a pivoted quadrant with teeth meshing with those of a pinion on the pointer spindle. Backlash between the teeth is absorbed by a hair-spring exerting constant



BY COURTESY OF THE BUDENBERG GAUGE CO.

THE BOURDON GAUGE, SHOWING FLATTENED TUBE, WHICH UNCOILS WHEN PRESSURE IS ADMITTED AND AFFECTS THE POSITION OF THE POINTER AROUND THE DIAL

pressure on the pinion. Pressure within the tube tends to change its cross-section from elliptical to circular, and the tube consequently uncoils to a slight degree, so turning the pointer.

In a vacuum gauge the reduction of pressure has an opposite effect, and the mechanism must be arranged in reverse fashion to cause the pointer to move clockwise. In a *compound* gauge, reading for both pressure and vacuum, the latter figures are placed to the left of the pressure figures. For high pressures a steel tube is fitted instead of bronze, being more elastic and less affected by high temperatures. Special construction or some suitable safeguard is necessary in dealing with some gases, such as oxygen, or where corrosive action is set up.

Special types include the differential pressure gauge for registering the difference only in pressure at any two points. There are two inlet tubes and two hands, and if the pressures are equal there is no reading on the dial. The electric alarm gauge possesses electric contact devices to ring a bell at a definite minimum or maximum pressure. The electric control gauge closes a circuit at a definite pressure, and operates a relay in the circuit of an electric motor; *e.g.*, an electrically-driven air-compressor may be started and stopped automatically in accordance with the demands for air. The self-recording pressure-gauge traces a permanent record of varying pressures upon a chart. See also VACUUM and VACUUM-PUMP.

PRESTEIGN, urban district, Radnorshire, Wales, on the Lugg, which here forms the boundary between Wales and England. Pop. (1938) 1,102. Area. 4.2 sqmi. It has a G.W.R. station. The village was in the lordship of Moelynaidd until the 14th century, when Bishop David Martin of St. David's (1296–1328) conferred valuable market privileges upon his native place. In 1542 Presteign was named as the meeting-place of the county sessions for Radnorshire in conjunction with New Radnor. It has the fine parish church of St. Andrew, daring chiefly from the 15th century but with traces of Norman work. Presteign is the most easterly spot on the Welsh border; hence the expression "from St. David's to Presteign" to mark the breadth of Wales.

PRESTER JOHN, a fabulous mediaeval Christian monarch of Asia. The history of Prester John no doubt originally gathered round some nucleus of fact, though what that was is extremely difficult to determine. Before Prester John appears upon the scene we find the way prepared for his appearance by a kindred fable, which entwined itself with the legends about him. This is the story of the appearance at Rome (1122), in the pontificate of Calixtus II., of a certain Oriental ecclesiastic, whom one account styles "John, the patriarch of the Indians," and another "an archbishop of India." This ecclesiastic related wonderful stories of the shrine of St. Thomas in India, and of the miracles wrought there by the body of the apostle, including the distribution of the sacramental wafer by his hand.

Nearly a quarter of a century later Prester John appears upon the scene, in the character of a Christian conqueror and potentate who combined the characters of priest and king, and ruled over vast dominions in the Far East. This idea was universal in Europe from about the middle of the 12th century to the end of the 13th or beginning of the 14th. The Asiatic story then died away, but the name remained, and the royal presbyter was now assigned a locus in Ethiopia. Indeed, it is not improbable that from a very early date the title was assigned to the Abyssinian king, though for a time this identification was overshadowed by the prevalence of the Asiatic legend. At the bottom of the double allocation there was, no doubt, that confusion of Ethiopia with India which is as old as Virgil and perhaps older.

The first mention of Prester John occurs in the chronicle of Otto, bishop of Freisingen. This writer states that when at the papal court in 1145 he met with the bishop of Gabala (Jibal in Syria), who related how "not many years before one John, king and priest (rex et sacerdos), who dwelt in the extreme Orient beyond Persia and Armenia, and was, with his people, a Christian but a Nestorian, had made war against the brother kings of the Persians and Medes, who were called Samiards (or Sanjards), and captured Ecbatana their capital. After this victory Presbyter *John* —for so he was wont to be styled—advanced to fight for the Church at Jerusalem; but when he arrived at the Tigris and found no means of transport for his army, he turned northward, as he had heard that the river in that quarter was frozen over in wintertime. After halting on its banks for some years in expectation of a frost he was obliged to return home." About 1165, a letter was circulated purporting to be addressed by Prester John to the emperor Manuel. This letter, professing to come from "Presbyter Joannes, by the power and virtue of God and of the Lord Jesus Christ, Lord of Lords," claimed that he was the greatest monarch under heaven, as well as a devout Christian. The letter dealt at length with the wonders of his empire. It was his desire to visit the Holy Sepulchre with a great host, and to subdue the enemies of the Cross. Seventy-two kings, reigning over as many kingdoms, were his tributaries. His empire extended over the three Indies, including that Farther India, where lay the body of St. Thomas, to the sun-rising, and back again down the slope to the ruins of Babylon and the tower of Babel. In war thirteen great crosses made of gold and jewels were carried in wagons before him as his standards, and each was followed by 10,000 knights and 100,000 footmen. There were no poor in his dominions, no thief or robber, no flatterer or miser, no dissensions, no lies, and no vices. His palace was built after the plan of that which St. Thomas erected for the Indian king Gondopharus. Before it was a marvellous mirror erected on a many-storeyed pedestal; in this speculum he could discern everything that went on throughout his dominions, and detect conspiracies. He was waited on by 7 kings at a time, by 60 dukes and 365 counts; 12 archbishops sat on his right hand, and 20 bishops on his left, besides the patriarch of St. Thomas's the protopope of the Sarmagantians (Samarcand?), and the archprotopope of Susa, where the royal residence was. Should it be asked why, with all this power and splendour, he calls' himself merely "presbyter," this is because of his humility, and because it was not fitting for one whose chamberlain was a bishop and king, and whose chief cook was an abbot and king, to be called by such titles as these.

How great was the popularity and diffusion of this letter may he judged in some degree from the fact that Zarncke in his treatise on Prester John gives a list of close on 100 mss. of it. Of these there are 8 in the British Museum, 10 at Vienna, 13 in the great Paris library, 15 at Munich. There are also several renderings in old German verse.

The only other surviving document of the 12th century bearing on this subject is a letter of which ms. copies are preserved in the Cambridge and Paris libraries, and which is also included in mediaeval chronicles. It is a letter purporting to be written by Pope Alexander III. on Sept. 22, 1177, to *carissimo in Christo filio Johanni, illustro et magnifico indorum regi,* of whom he had heard from his physician Philip.

There is no express mention of the title "Prester John" in what seem the more genuine copies of this letter. But the address and a warning against a boastful spirit appear to indicate that the pope supposed himself to be addressing the author of the letter of 1165. In 1221 a rumour came out of the East that a great Christian conqueror was taking the hated Muslims in reverse and sweeping away their power. The name ascribed to the conqueror was David, and some called him the son or the grandson of Prester John of India The conqueror was in fact the famous Jenghiz Khan: but the delusion was dissipated slowly.

European travellers in Asia looked for a prince to whom the legend of Prester John could be attached. Carpini (1248) makes him the king of the Christians of India the Greater; Rubruquis (1253) gives the title of "King John" to Kushluk, king of the Naimans, and makes him a brother of Ung Khan (d. 1203), the ally of Jenghiz. In Marco Polo's narrative "Unc Khan," alias Prester John, is the lord of the Tatars up to the advent of Jenghiz Khan. This story is repeated by other writers. Both Marco Polo and Friar John of Montecorvino speak of the descendants of Prester John as holding territory in the plain of Kuku-Khotan (about 300 miles north-west of Peking). Friar Odoric gives a circumstantial account of this kingdom, and with this Prester John disappears from Asia to figure in African legend.

It is indeed probable that, however vague may have been the ideas of Pope Alexander III. respecting the geographical position of the potentate whom he addressed from Venice in 1177, the only real person to whom the letter can have been sent was the king of Abyssinia. The "honourable persons of the monarch's kingdom" whom the leech Philip had met with in the East must have been the representatives of some real power, and not of a phantom It must have been a real king who professed to desire reconciliation with the Catholic Church and the assignation of a church at Rome and of an altar at Jerusalem. Moreover, we know that the Ethiopic Church did long possess a chapel and altar in the Church of the Holy Sepulchre, and, though we have been unable to find travellers' testimony to this older than about 1497, it is quite possible that the appropriation may have originated much earlier. We know from Marco Polo that about a century after the date of Pope Alexander's epistle a mission was sent by the king of Abyssinia to Jerusalem to make offerings on his part at the Church of the Sepulchre; and it is extremely likely that the princes of the "Christian families" who had got possession of the throne of northern Abyssinia should have wished to strengthen themselves by a connection with European Christendom, and to establish relations with Jerusalem, then in Christian hands.

From the 14th century onwards Prester John had found his seat in Abyssinia. It is there that Fra Mauro's great map (1459) presents a fine city with the rubric, "Qui il Preste Janni fa residentia principal." When, nearer the end of the century (1481–1495), King John II. of Portugal was prosecuting inquiries regarding access to India his first object was to open communication with "Prester John of the Indies," who was understood to be a Christian potentate in Africa. And when Vasco da Gama went on his voyage from Mozambique northwards he began to hear of "Preste Joham" as reigning in the interior—or rather, probably, by the light of his preconceptions of the existence of that personage in East Africa he thus interpreted what was told him. More than twenty years later, when the first book on Abyssinia was composed—that of Alvarez—the title designating the king of Abyssinia is "Prester John," or simply "the Preste."

BIBLIOGRAPHY.—For the older aspects of the subject, *see* Ludolf's *Historia Aethiopica* and its *Commentary,* passim. The excellent remarks of M. d'Avezac, comprising a conspectus of almost the whole essence of the subject, are in the *Recueil de voyages et de mémoires* published by the Société de Géographie, iv. 547–564 (Paris, 1839). Two German works of importance which have been used in this article are the interesting and suggestive *Der Presbyter Johannes in Sage und Geschichte,* by Dr. Gustav Oppert (2nd ed., Berlin, 1870), and, most important of all in its learned, careful and critical collection and discussion of all the passages bearing on the subject, *Der Priester Johannes, by* Friedrich Zarncke of Leipzig (1876–79). *See* also Sir H. Yule's *Cathay and the Way Thither,* p. 173 *seq.,* and in *Marco Polo* (2nd ed.), i. 229–233, ii. 539–543.

PRESTIDIGITATION: *see* CONJURING.

PRESTON, municipal, county, and parliamentary borough and port, Lancashire, England, on the river Ribble, 209 mi. N.W. from London by the L.M.S.R. Pop. (1938) 113,200; area 9 sq.mi. The site consists of a ridge rising from the north bank of the river, nhile the surrounding country, especially to the west about the estuary, is flat. Among the numerous parish churches that of St. John, built in Decorated style in 1855, occupies a site which has carried a church from early times. Among several Roman Catholic churches, that of St. Walpurgis (1854) is a handsome building of Early Decorated character. Of public buildings the most noteworthy is the large town hall, with lofty tower and spire, in Early English style, built in 1867 from designs by Sir Gilbert Scott. The free public library and museum were established by the trustees of E. R. Harris in 1879, and a new building opened in 1893. This contains Dr. Shepherd's library and the Newsham collection of pictures. In addition, the same trustees endowed the Harris institute, a science and art school, in 1849, with £40,000. The grammar school, founded in 1550, mas housed in a building of Tudor style in 1841, but was purchased by the corporation in 1860. A bluecoat school was founded in 1jor. The Victoria Jubilee technical school was established in 1897 by the Harris trustees. There is also a deaf and dumb school. Preston is well supplied with public parks, there being Avenham park, Miller park, Moor park, the Marsh and the Deepdale grounds with an observatory. In early days Preston, owing to its geographical position, became an important trade centre with an agricultural market. Its importance progressively increased after the advent of the cotton industry, and in addition there are iron and brass foundries, engineering, cotton machinery, chemical and soap works, boiler works and shipbuilding and ship repairing works. Preston became an independent port in 1843, and after that time was progressive in increasing the depth of the seaward channel and building and improving the docks and quays. The main wet dock is 3,240 ft. long and 600 ft. wide. There is a total quayage of 8,500 ft. and the depth of the channel is 19 ft. at ordinary spring tide. A chamber of commerce was formed in 1916. A canal connects Preston with

Lancaster and Kendal. The parliamentary borough returns two members. The county borough was created in 1889.

History. — Preston, otherwise Prestune, was near the Roman station at Walton-le-Dale: and the great Roman road running from Warrington passed through it. It is mentioned in Domesday Book as one of Earl Tostig's possessions which had fallen to Roger of Poictou, and on his defection it was forfeited to the Crown. Henry II. (about 1179) granted the burgesses a charter — the first of 14 royal charters which have been granted to Preston. Elizabeth (1566) granted the town its great charter which ratified and extended all previous grants. Charles II. (1662 and 1685) granted charters, by which an additional weekly market on Wednesday was conceded and a three days' fair, beginning on March 16. The most important industry used to be woollen weaving. Other early industries were glove-making and linen weaving. The first cotton-spinning mill was built in 1777 in Moor Lane, and in 1791 John Horrocks built the Yellow factory. In 1835 there were 40 factories, chiefly spinning, yielding 70,000 lb. of cotton yarn weekly.

A gild existed perhaps in Saxon times, but the grant of a gild merchant dates from Henry II.'s charter, about 1179. The first gild of which there was any record was celebrated in 1328, at which it was decided to hold a gild every 20 years. Zip to 1542, however, they do not appear to have been regularly celebrated, but since that year they have been and still are held at intervals of 20 years. A special gild mayor is appointed on each occasion. The first mention of a procession at the gild is in 1500. One of the most important items of business was the enrolling of freemen, and the gild rolls are records of the population. The statement that Preston was burnt in 1322 by the Scots is probably false. The town suffered severely from the Black Death (1349–50), and again from pestilence in the year Nov. 1630 to Nov. 1631. During the Civil War Preston became the Lancashire Royalist headquarters. In February 1643 a Parliamentary force marched from Manchester and successfully assaulted it, but in March the earl of Derby recaptured the town. The Royalists did not garrison it, but after demolishing the greater part of the works left it unfortified. After the battle of Marston Moor Prince Rupert marched through Preston in September 1644 and carried the mayor and bailiffs prisoners to Skipton castle. On Aug. 17, 1648 the Royalist forces under the duke of Hamilton and Gen. Langdale were defeated at Preston by Cromwell. During the Rebellion of 1715 the rebel forces entered Preston Nov. 9, and after proclaiming the chevalier de St. George king, remained here for some days, during which the government forces advanced. The town was assaulted, and on Nov. 14, Gen. Forster surrendered his army to the king's forces. In 1745 Prince Charles Edward marched through on the way south and north.

The borough returned two members from 1295 to 1331, then ceased to exercise the privilege till 1529, but since that date (except in 1653) it has always sent two representatives to parliament. In the 18th century Preston had a high reputation as a centre of fashionable society, and earned the epithet still familiarly associated with it, "proud."

See H. Fishwick. *History of the Parish of Preston* (1900); W. F. Fitzgerald, "The Ribble Basin," *Journ., Manchester Geog. Soc.* (1927).

PRESTONPANS, police burgh, burgh of barony, parish and watering-place of East Lothian, Scotland, on the Firth of Forth, 9½ m. E. of Edinburgh by the L.N.E R. Pop. (1931), 2,426. A mile to the east of the village is the site of the battle of 1745, in which Prince Charles Edward and his highlanders gained a complete victory over the royal forces under Sir John Cope.

The salt trade, formerly flourishing, has declined. There are manufactures of fire-bricks, tiles and pottery, besides brewing and soap-making, and rich collieries at Tranent, 1 m. S.E, and elsewhere in the neighbourhood. Fisheries are less important than formerly. There are harbours at Morrison's haven to the west and at Cockenzie and Port Seton to the north-east, which form one burgh with a population of 2,526.

PRESTWICH, SIR JOSEPH (1812–1896), English geologist, was born at Clapham, Surrey, on March 12, 1812. He was educated in Paris, Reading and at University College, London. He was a wine merchant in London, and devoted his leisure more especially to the study of the Thames basin. In 1853 he was elected F.R.S. He published in 1851 *A Geological Inquiry respecting the Water-bearkg Strata of the Country around London,* which became a standard authority. With Dr. Hugh Falconer and Sir John Evans, Prestwich examined the implements discovered by Boucher de Ferthes in the gravels of the Somme valley; their investigations proved that man existed contemporaneously with the Pleistocene mammalia *(Phil. Trans.* 1861 and 1864). In 1874 Prestwich was appointed to the chair of geology at Oxford. During his professorship he wrote his great work, *Geology: Chemical, Physical and Stratigraphical* (vol. i., 1886; vol. ii., 1888). He died on June 23, 1896, at Shoreham.

See *Life* and *Letters of Sir Joseph Prestwich,* ed. by his wife (1899).

PRESTWICH, a municipal borough in the Middleton and Prestaich parliamentary division, Lancashire, England, 5 mi. N.W. of Manchester, on the L.M.S.R. Pop. (1938) 32,410. Area 3.8 sq.mi. It has cotton factories and is a suburb of Manchester, with which (and Salford) it is contiguous. It was incorporated 1939.

BRETE, CARLO DEL (1897–1928), Italian aviator, served in World War I as a submarine officer at the age of 17. After the war. he acted for a time as observer for naval seaplanes. In 1926 he obtained his pilot's certificate for the air service, and acted as second pilot to Commander De Pinedo on his Atlantic flight. His flight with Captain Ferrarin on June 2, 1928, lasting 58 hours 37 minutes, was at the time a record of endurance; a month later (July 3–4), again with Captain Ferrarin, he exceeded the longest non-stop flight which had ever been achieved, flying from Rome to Brazil (over 4,500 miles). Del Prete died on Aug. 16, 1928, as the result of an accident while inspecting an aeroplane.

PRETORIA, administrative capital of the Union of South Africa. Pop. (1921) 24,794 natives, 1,757 Asiatics, 2,140 coloured and 45,361 whites, the latter increasing by 1931 to 47,322. The city is built in a hollow, about the Aapies river, a tributary of the Limpopo. Pretoria is laid out in rectangular blocks. At the centre is Church square, on the south side of which are the Provincial Council buildings and other public offices, erected in 1892 in the Renaissance style. On the north side are the law courts and on the west the post office. The Union Government building built 1910–13 on Meintje's kop cost £1,800,000 and overlooks the city. It accommodates the governor-general and more than 1,000 officials. The lower slopes of the hill are laid out in beautiful terraced gardens. The city has several parks and sports grounds, including Burger park, and the zoological gardens. Signal hill rises 400 ft. above the plain, west of Burger park. The plateau at its foot is now occupied by the central railway station and workshops. There is an Anglican cathedral, several high schools, a normal training college, and the Transvaal university college, which includes an agricultural faculty and an experimental farm. Cement and iron are produced locally.

Pretoria was founded in 185j and was made the centre of a new district created at the same time. By treaty between the South African Republic (then comprising the districts of Potchefstroom. Rustenburg, Pretoria and Zoutpansberg) and the Republic of Lydenburg. concluded at Pretoria in 1860, the two republics were united and Pretoria was chosen as the capital of the whole State In September of that year the *Volksraad* held its first meeting in the new capital. Until 1864, however, when the civil war in the Transvaal ended, Potchefstroom remained the virtual capital of the country. From that year the seat of government has always been Pretoria. As revenue flowed in from the gold mines on the Rand, many buildings were erected in the capital, which was linked by railway with Cape Town in 1893 and with Lorenço Marques and Durban in 1895. In May, 1900, Kruger fled from the town, which surrendered in June to Lord Roberts. On May 31, 1902, the articles of peace, whereby the Boer leaders recognized British sovereignty, were signed at Pretoria, and five years later there assembled here the first parliament of the Transvaal, as a self-governing State of the British empire. On the establishment of the Union of South Africa in 1910, Pretoria became its administrative capital.

PRETORIUS, the family name of two of the early leaders of the "Trek" Boers--Andries Wilhelmus Jacobus Pretorius and

Marthinius Wessels Pretorius, father and son.

1. ANDRIES PRETORIUS (1799–1853), a Dutch farmer of Graaff-Reinet, Cape Colony, and a descendant from one of the earliest Dutch settlers in South Africa, left his home in the Great Trek, and by way of what is now the Orange Free State crossed the Drakensberg into Natal, where he arrived in Nov. 1838, at a time when the emigrants there were without a recognized leader. Pretorius was at once chosen commandant-general and speedily collected a force to avenge the massacre of Piet Retief and his party, who had been treacherously killed by the Zulu king Dingaan the previous February. Pretorius's force was attacked on Dec. 16 ("Dingaan's Day") by over 10,000 Zulus, who were beaten off with a loss of 3,000 men. In Jan. 1840 Pretorius with a commando of 400 burghers helped Mpande in his revolt against his brother Dingaan and was the leader of the Natal Boers in their opposition to the British. In 1842 he besieged the small British garrison at Durban, but retreated to Maritzburg on the arrival of reinforcements under Colonel (subsequently Sir) Josias Cloete and afterwards exerted his influence with the Boers in favour of coming to terms with the British.

He remained in Natal as a British subject, and in 1847 was chosen by the Dutch farmers there to lay before the governor of Cape Colony the grievances under which they laboured owing to the constant immigration of natives, to whom locations were assigned to the detriment of Boer claims. Pretorius went to Grahamstown, where Sir Henry Pottinger (the governor) then was; but Sir Henry refused to see him or receive any communication from him. Pretorius returned to Natal determined to abandon his farm and once more trek beyond the British dominions. With a considerable following he was preparing to cross the Drakensberg when Sir Harry Smith, newly appointed governor of the Cape, reached the emigrants' camp on the Tugela (Jan. 1848). Smith promised the farmers protection from the natives, and persuaded many of the party to remain, but Pretorius departed, and on the proclamation of British sovereignty up to the Vaal fixed his residence in the Magalisberg, north of that river. He was chosen by the burghers living on both banks of the Vaal as their commandant-general.

At the request of the Boers at Winburg Pretorius crossed the Vaal in July and led the anti-British party in their "war of freedom," occupying Bloemfontein on July 20. In August he was defeated at Boomplaats by Smith, and thereupon retreated north of the Vaal, where he became leader of one of the largest of the parties into which the Transvaal Boers were divided, and commandant-general of Potchefstroom and Rustenburg, his principal rival being Commandant-General A. H. Potgieter. In 1851 he was asked by the Boer malcontents in the Orange River Sovereignty and by the Basuto chief Moshesh to come to their aid, and he announced his intention of crossing the Vaal to "restore order" in the Sovereignty. His object, however, was rather to obtain from the British an acknowledgement of the independence of the Transvaal Boers. The British cabinet having decided on a policy of abandonment, the proposal of Pretorius was entertained. A reward of £2,000 which had been offered for his apprehension after the Boomplaats fight, was withdrawn.

Pretorius then met the British commissioners at a farm near the Sand river, and concluded the Sand river convention (Jan. 17, 1852) by which the independence of the Transvaal Boers was recognized by Great Britain. Pretorius recrossed the Vaal, and at Rustenburg on March 16 was reconciled to Potgieter, the followers of both leaders approving the convention, though the Potgieter party was not represented at the Sand river.

Pretorius died at his home at Magalisberg on July 23, 1853. In 1855 a new district and a new town were formed out of the Potchefstroom and Rustenburg districts and named Pretoria in honour of the late commandant-general.

2. MARTHINIUS PRETORIUS (1819–1901), the eldest son of Andries, was appointed in Aug. 1853 to succeed his father as commandant-general of Potchefstroom and Rustenburg, two of the districts into which the Transvaal was then divided. In 1854 he led his burghers against a chief named Makapan, who had murdered a party of 23 Boers, including ten women and children. The natives were blockaded in a great cave in the Zoutpansberg, and about 3,000 were starved to death or shot as they emerged.

Having thus chastised Makapan's clan, Pretorius created a strong central Government, and from 1856 onward set to work to form one Boer State to include the Orange River burghers. In Dec. 1856 representatives of the districts of Potchefstroom, Rustenburg and Pretoria met and drew up a constitution, and on Jan. 6, the "South African republic" was formally constituted, Pretorius having been elected president on the previous day. Though the Boers of the Lydenburg, Utrecht and Zoutpansberg districts refused to acknowledge the new republic, Pretorius, with the active co-operation of Paul Kruger (*q.v.*), endeavoured (1857) to unite the Orange Free State and the Transvaal, and a commando crossed the Vaal to support Pretorius. The attempt at coercion failed, but in Dec. 1859 Pretorius was elected president of the Free State. Pretorius had just effected a reconciliation of the Lydenburg Boers with those of the other districts of the Transvaal, and he assumed office at Bloemfontein in Feb. 1860. But the anarchy in the Transvaal effectually weaned the Free State burghers from any thought of immediate amalgamation with their northern neighbours. Pretorius, however, continued to intervene in the affairs of the Transvaal and at length (April 15, 1863) resigned his Free State presidency. Acting as mediator between the various Transvaal parties Pretorius in Jan. 1864 ended the civil strife, and in May following once more became president of the South African republic—now for the first time a united community.

To Pretorius more than any other man was due the welding of the Transvaal Boers into one nation. Pretorius contemplated indefinite expansion of the Transvaal State north, east and west. In April 1868, on the report of gold discoveries at Tati, he issued a proclamation annexing to the Transvaal on the west the whole of Bechuanaland and on the east territory up to and including part of Delagoa Bay. Portugal at once protested, and in 1869 its right to the bay was acknowledged by Pretorius, who in the same year was re-elected president. The Boer claim to the whole of Bechuanaland was not pressed by Pretorius in the face of British opposition, but in 1870, when the discovery of diamonds along the lower Vaal had led to the establishment of many diggers' camps, an attempt was made to enforce the claims of the Transvaal to that district.

Pretorius held repeated conferences with the Bechuana chiefs, but failed to persuade them to join the Transvaal to "save" their territory from the British. Finally, without consulting his colleagues, he agreed to refer the question of the boundary to the arbitration of R. W. Keate, then lieutenant-governor of Natal. The award, given on Oct. 17, 1871, was against the Boer claims. Pretorius loyally accepted the decision, but it aroused a storm of indignation in the Transvaal. The Volksraad refused to ratify the award and thereupon Pretorius resigned the presidency (Nov. 1871).

Pretorius then temporarily retired from politics, but after the first annexation of the State by Great Britain he acted (1878) as chairman of the committee of Boer leaders who were seeking the restoration of their independence. He was arrested in Jan. 1880 by order of Sir Garnet Wolseley on a charge of treason. (*See* the Blue Book [C. 2584] of 1880 for details of this charge.) He was admitted to bail, and shortly afterwards urged by Wolseley to accept a seat, which he declined, on the executive council. In December of the same year he was appointed, with Paul Kruger and P. Joubert, to carry on the government on the part of the insurgent Boers. He was one of the signatories to the Pretoria convention, and acted as a member of the triumvirate until the election of Kruger as president in May 1883. He then withdrew from public life; but lived to see the country re-annexed to Great Britain, dying at Potchefstroom on May 19, 1901. Within four months of his death he had visited Louis Botha and Schalk Burger, on behalf of Lord Kitchener, with the object of ending the war.

For the elder Pretorius *see* G. M. Theal, *Compendium of the History and Geography of South Africa* (3rd ed. 1878), and *History of South Africa,* vol. iv. [1834–54] (1893). For the younger Pretorius *see* vol. v. of the same series.

PREVENTIVE MEDICINE. The prevention of disease is the true ideal of medicine. Its application is twofold—the preventive medicine of the community which is generally termed Public Health or State Medicine, and the prevention of disease or its sequelae in the individual.

HISTORICAL DEVELOPMENT

Ancient Origins.—The practice of preventive medicine had its origin in the ancient world. Hippocrates classified the causes of disease into those concerned with seasons, climates and external conditions, and those more personal causes such as irregular food, exercise and habits of the individual. Through the Middle Ages the principles of preventive medicine were ignored, in spite of the scourges of leprosy and plague. Then with the Renaissance came the new learning on the nature both of health and disease, which revolutionised the whole content of medicine and gave it a fresh centre of gravity and a new outlook. Leonardo da Vinci—whose genius suggested some of the great discoveries of modern science—and Vesalius of Padua, were followed in the 17th century by Galileo, Harvey—who discovered the circulation of the blood—Helmont and the experimentalists. and Sydenham and the great practitioners who with their contemporaries observed the relation of the seasons, of telluric conditions, and the contagion in relation to the incidence of disease. This was quickly followed by new knowledge of anatomy, physiology and pathology. At the end of the first half of the 19th century a beginning had been made in the discovery of specific organisms in diseased tissues and by the end of the century the literature on Bacteriology and Parasitology (*see* BACTERIA AND DISEASE; PARASITIC DISEASES) had become enormous.

Practical Needs.—Concurrently with the growth of medical knowledge there was an empirical movement of practical prevention. Long before the days of Hippocrates men had sought to stem the tides of disease which threatened to overwhelm them. Even in Britain it was the ravages of pestilence in the Middle Ages—of leprosy from the 12th century, of the Black Death from the 14th, of sweating sickness in the 16th, and of cholera and smallpox subsequently—which compelled attention to the conditions which seemed responsible for these scourges. The great monastic orders and some of the historical cities—Rome, Venice and London—provided comfort, refuge and sustenance for the victims, and in 1388 was passed the first Sanitary Act in England, directed to the removal of nuisances. In 1443 came the first plague order recommending quarantine and cleansing; in 1518 were made the first rough attempts at notification of epidemic disease and of isolation of the patient; under Queen Elizabeth scavenging became more stringent; and as time passed men began to see that environment was one of the principal factors in the origin and spread of disease.

Experimental Method.—At first the new applications of medicine were suggested by medical practitioners. Three centuries ago Harvey indicated for us the true experimental method; he placed the blood in the forefront of physical life, and gave it a new chemical and physiological meaning, and by his demonstration of the circulation he provided a new conception of the method by which the blood carried its nourishment to all parts of the body. Fifty years later, Thomas Sydenham, another practitioner, living in a "generation of the strongest and most active intellects that England has produced," laid the basis of epidemiology by his observation of cases, his power of analysis and comparison, his deduction of laws of prevalence, and his suggestive hypothesis of "epidemic constitutions."

Richard Mead, a successful English practitioner in the first half of the 18th century, left behind him published works on poisons, on the plague and the methods of its prevention, on smallpox, measles and scurvy. Bradley and Rogers deduced from their general practice some of the principles of epidemiology, Fothergill described "putrid sore throat," and Haberman chickenpox. Huxham, of Totnes, became an authority on the treatment of fevers, recommended vegetable dietary in cases of scurvy and defined Devonshire colic, which his medical neighbour, Sir George Baker, traced to lead in the vats and cider presses. Willan made a systematic study of the health conditions of London. Withering, of Shropshire, contributed to our knowledge of the incidence of scarlet fever, analysed water, was a climatologist and used digitalis. Edward Jenner, a practitioner in Gloucestershire, introduced vaccination. James Lind issued the first treatise on scurvy and the health of seamen. Thackrah, who practised in Leeds, explored industrial health problems and described dust diseases and brassfounders' ague, and Michael Taylor of Penrith was the first to elucidate milk-borne epidemics. Indeed, the 18th and 19th centuries furnish a remarkable record of clinical discoveries which prepared the ground for the study of causation and the influence of external environment in relation to communal disease.

BRITISH PRACTICE

Legislative Action.—The applications of state medicine, in the 19th century, found their inspiration in England in two sources, and their expression in legislation. The twofold inspiration came from the recurrent outbreaks of cholera and consequent commissions of inquiry, and from popular demand for reform, which was realised after each of the four extensions of the franchise (1832–1918). The Legislature placed on the statute honk a wonderful series of enactments. The alarm caused by the ravages of cholera in 1831 led to the first steps in administrative sanitary reform; in 1849 there was a second visitation of cholera, and in 1854 a third. These cholera epidemics led to a new appreciation of the unsanitary condition of the country as a whole, to an understanding of the nature of the disease and its epidemicity, to the establishment of "cholera dispensary stations" and to the Infectious Diseases Prevention Act 1855.

Concurrently with and following upon these epidemics there were various commissions of investigation. In 1838–9 the Poor Law Commissioners drew attention to the prevalence of epidemic disease and its relation to poverty. The reports by Neil Arnott, Kay, Southwood Smith and Chadwick were the predecessors of another famous series of investigations in 1859–65 by Greenhow and his colleagues under the Privy Council into epidemic diarrhoea, pulmonary disease, infant mortality and ague; and also into the four "elementary requisites of popular healthiness," viz., adequate food supply, sufficient house accommodation, healthy physical surroundings and wholesome industrial circumstances. They led the way to the new application of medicine for the removal of nuisances, the prevention of contagion and infection and industrial hygiene and welfare.

In 1843 Sir Robert Peel, at the instigation of Edwin Chadwick, advised appointing a Royal Commission to inquire into the outbreaks of disease in large towns and the best means of improving the public health, the report of which led to the passing of the comprehensive sanitary measure in 1848, the establishment of the General Board of Health and the appointment of medical officers of health. In 1869 was appointed the Royal Sanitary Commission, on which sat Thomas Watson, James Paget, Henry Acland, Robert Christison and William Stokes, and before which Simon, Budd and Farr gave evidence. Speaking broadly, the 1843 commission found the existence of a serious national evil of insanitation and ill-health, and recommended a legislative remedy, whereas the 1869 commission found that the remedy had proved ineffective and recommended that "the present fragmentary and confused sanitary legislation should be consolidated." They proposed, in fact, for the first time, a Ministry of Health, and though the case miscarried, and the Local Government Board was created in 1871, a comprehensive Ministry of Health was at last established in 1919. The commission's summary of the national sanitary minimum of "What is necessary for civilized social life" provided the grand inventory of that period (1871) and was as follows:—

1. The supply of wholesome and sufficient water for drinking and washing.
2. The prevention of the pollution of water.
3. The provision of sewerage and utilisation of sewage.
4. The regulation of streets, highways and new buildings.
5. The healthiness of dwellings.
6. The removal of nuisances and refuse, and consumption of smoke.
7. The inspection of food.

8. The suppression of causes of diseases, and regulations in cases of epidemics.

9. The provision for the burial of the dead without injury to the living.

10. The regulation of markets, etc., public lighting of towns.

Registration of Death and Sickness.—The programme of 1875 represented the most enlightened thought of the time regarding the sphere and scope of preventive medicine. Even now it is almost a complete summary of the elements of a sanitary environment. The commission also showed how it could be worked out in practice by laying down the general principles to be followed and by drafting a new statute. They diagnosed with unfailing accuracy the causes of imperfect sanitary administration—(a) the variety and confusion of authorities concerned in the public health, (b) the want of sufficient motive power in the central authority, (c) the non-coincidence of areas of various kinds in local sanitary government, (d) the number and complexity of enactments, (e) the needless separation of subjects, (f) the leaving some general Acts to voluntary adoption and the permissive character of other Acts and (g) the incompleteness of the law. Finally, the commissioners lent all the power and prestige of their position and experience in unreserved support of the great principle of local self-government.

Public Health Act, **1875.**—The Public Health Act of 1875, which emerged from the labours of the Royal Sanitary Commission, may be regarded as marking a great advance in the development of sanitary administration. Before that time sanitation was interpreted in large measure as a negative policy—in a word, the removal of nuisances; after that time sanitation received a new connotation, positive, constructive, remedial. That is the reason why this Act forms the great line of division, the watershed in the progress of modern preventive medicine, on its environmental side. The report of Sir Robert Peel's Commission, in 1845, contains a significant suggestion in its recommendation that each local governing body should have a medical officer whose duty it should be "to ascertain the true causes of disease and death, more especially of epidemics increasing the rates of mortality, and the circumstances which originate and maintain such diseases, and injuriously affect the public health." No one can read the preamble of the report of the commission of 1869 on the history of the sanitary laws enacted up to that date without being impressed with their character. They dealt, almost monotonously with nuisances and their removal, sewerage and drains, sewage utilisation, the paving, lighting and cleansing of streets, common lodging-houses, the supervision of artisans' dwellings, smoke nuisances, local government and the burial of the dead. The only group of laws directly concerned with disease were the Vaccination Acts. Then came the Public Health Act of 1875, which in conception and working led for 20 years to enactments on the prevention of river pollution, the protection of water supplies, the provision of housing accommodation and isolation hospitals, and the notification and prevention of infectious disease. The elementary Education Act of 1870, and the Public Health Act of 1875, were forms of germinative legislation bearing fruit in a single generation.

The Practitioner's Aid.—Whilst the state was thus calling into being various public medical services, the practitioner in medicine and surgery was finding ways and means of preventing disease met with in his practice, both infectious and non-infectious. Abortion, miscarriage, still-birth are preventable conditions. Children's disorders such as ophthalmia, rickets, dental decay and malnutrition are preventable, and the same may be said of many diseases of the skin, the eye, ear, nose and throat. The examination of recruits and of insurance patients shows that much physical impairment is due to the effects of rheumatism, dyspepsia, constipation, bronchitis, anaemia, debility, neurasthenia, heart disease, dental decay, mental disease or disorders of metabolism. Some of these conditions are due to factors such as infection (fevers, rheumatism, tuberculosis, venereal disease, etc.), or degenerative processes, like arteriosclerosis and nephritis, or fatigue and unhygienic living; others are more obscure, but the great bulk of them are in large degree preventable. Midwifery alone provides many opportunities for preventive medicine.

Surgical Aid.—Surgical conditions seem at first sight to be less directly preventable, and curative only. Yet the task of the surgeon is to serve and assist nature by placing the human body and its organs at her service, by removing obstructions from her path, by supplementing and aiding her processes and by fortifying the body defences against infection or accident. All this is of the essence of preventive medicine. It is an alliance with nature against disruptive forces. Surgery finds its preventive expression in a great variety of ways. The fundamental principles of aseptic surgery are the elimination of sepsis and its practice is repair, the removal of hurtful tissues and the avoidance of disablement. Preventive surgery may be illustrated in a general way as follows:—

(a) Surgery in children's conditions—enlarged tonsils and adenoids, phimosis, hernia, ophthalmia.

(*b*) Surgery in deformities—rickets, tuberculosis, scoliosis, talipes, flat-foot, hammer-toe, fractures.

(*c*) General surgery—sepsis, tuberculosis, varicose veins, hernia, venereal disease, malignant disease, turnours, thoracic conditions, abdominal and genito-urinary surgery, gynaecology, dental caries.

(*d*) Industrial surgery—wounds, fractures, injuries, poisons, fumes, anthrax, tetanus, etc.

The first generation of the 20th century (1900–24) witnessed a continued development in sanitary environment, which indeed must always remain the foundation of preventive medicine, and in various new departures dependent upon the principles which had been established by the Public Health Act 1875, and by the growth of medical knowledge. The public health service expanded to include particular measures against tuberculosis and venereal disease, the provision of municipal midwives, and a remarkable extension of the supervision of maternity and child welfare. Indeed, the characteristic of this period was the progress made in personal hygiene as distinct from environmental hygiene. Its centre is the person rather than the premises. The School Medical Service was organized in 1907, systematic provision was made for the care of infancy in 1914, the National Health Insurance Act was passed in 1911 and medical research has been organized on a large scale.

Concurrently with these great movements increased attention was given to industrial welfare and the health of the factory worker. Time alone can show the effect on the public health of the wide extensions and applications of the public health principles of 1875. It cannot be doubted that an improved midwifery service, the care of the newborn infant, the systematic health supervision of every school child, improved hygiene in the workshop and factory and a system of health insurance by which medical aid is promptly available for 14,000,000 insured persons must exert in the course of time a profound effect upon the national health. That such an effect has already been produced is shown by the vital statistics. The following table gives the birth-rate, population, number of deaths, average annual death-rate and infant mortality from 1871 to 1920:—

Period	Average annual birth-rate per 1,000 living	Average estimated population	Average estimated number of deaths registered	Average annual death-rate per 1,000	Average annual infant mortality, *i.e.*, deaths of children under one year of age per 1,000 births
1871–1880	35·4	24,225,271	517,831	21·4	149
1881–1890	32·4	27,384,934	524,477	19·1	142
1891–1900	29·9	30,643,316	557,538	18·2	153
1901–1910	27·2	34,180,052	524,877	15·4	128
1911–1920	21·8	35,750,765*	518,805	14·3†	100

*Including civilian population only from 1915–18.
†Including civilian mortality only from 1915–18.

In 1927 the birth-rate had fallen to 16.7, the crude death-rate to 12.3 and the infant mortality rate to 69 per 1,000 born. The decline in the infant mortality rate from 153 per 1,000 born in 1891–1900 to less than 80 for 1920–4 and less than 70 for 1927 is one of the most significant and sensitive indications of the improvement of the public health. Perhaps an even more valuable indication is the expectation of life at birth. In 1871–80 the expectation of life at birth in London was for males 38 years, and for females 42. By 1920–2 these figures had risen to approximately 54 years for males and to 59 for females, a rise of 16 and 17 years respectively in two generations.

Since 1900 there have been various collateral developments in medicine which cannot fail to exert powerful influence on the prevention of disease. The use of X-ray (*q.v.*), of radium (*q.v.*), and of the ultra-violet rays has been conducive not only to greater accuracy of diagnosis, but also to steady improvement in the treatment of tuberculosis (*q.v.*) and cancer (*q.v.*). Heliotherapy (*q.v.*) and open-air treatment are likewise finding many applications. The perfection of the Wassermann-Bordet test and the discovery by Ehrlich of Salvarsan (the 606th preparation tried for syphilis) have advanced the diagnosis and treatment of this disease, now carried out in England and Wales in 186 (1927) specia! clinics receiving state subsidy (see VENEREAL DISEASES). The Widal reaction for typhoid and various tests for tuberculosis have been followed by the Schick and Dick immunizing tests for diphtheria and scarlet fever, and these have opened up new opportunities for the control of these diseases (see INFECTIOUS FEVERS.)

The dispensary and sanatorium treatment for tuberculosis has been greatly developed, and this has led to the arrest or retardation of the disease in many individuals. The disease has been steadily declining in Great Britain since about 1875. The new knowledge of filter-passing viruses has already created far-reaching possibilities, and that of the physiology of internal secretion has led to the introduction for therapeutic purposes of artificially prepared extracts, such as insulin (for diabetes), thyroxin (for myxoedema) and pituitrin (for acromegaly). (See ENDOCRINOLOGY.) There has also been an enormous development in the use of antitoxins, vaccines and serums (see IMMUNITY; SERUM THERAPY; VACCINE THERAPY)—the harvest of the epoch-making work of Louis Pasteur.

These advances are finding their way into various forms and degrees of State enactment, the most recent example of which is the Local Government Act of 1929, which inter alia made available for the whole community upwards of 100,000 hospital beds formerly allocated to the Poor Law.

Lastly, the creation of the League of Nations has facilitated considerable development in the international study of hygiene, and there has thus been opened a new sphere for the application of preventive medicine to international health problems and the control of the tropics for the white man. Plague, yellow fever, malaria and sleeping sickness have now, under favourable circumstances, come under man's dominion.

See J. G. Fitzgerald, P. Gillespie and H. M. Lancaster: *An Introduction to the Practice of Preventive Medicine* (1923). (*G.* N.)

THE UNITED STATES

Notable Advances.—The rapid growth of America was associated with primitive sanitary conditions, so that epidemics of typhoid fever, cholera, yellow fever, typhus fever and other preventable plagues marred the development of the country. In many instances the water supplies were contaminated and sewage and wastes were disposed of by ready methods that were unsanitary and unsatisfactory. The reforms along these lines in recent years have worked hygienic marvels.

In 1893 Theobald Smith demonstrated that Texas fever of cattle was transmitted by the bite of an infected tick, thus proving for the first time the great principle of insect-borne transmission of infection. Shortly afterwards the mosquito was shown to be the factor in the spread of malaria and then of yellow fever. Following this, other insects were found to be responsible for a long and growing list of infections. In 1900 Carter discovered the extrinsic period of incubation of yellow fever. In 1882 Carlos Finlay of Cuba implicated the responsible mosquito, but it remained for the United States Army Medical Commission, consisting of Reed, Carroll, Lazear and Agramonte, to prove the fact by a convincing demonstration in 1900. This discovery was soon put to practical use by White in New Orleans during 1905 when, for the first time, an epidemic of yellow fever was stamped out before the advent of frost. The work of Gorgas which made the building of the Panama Canal possible was a dramatic demonstration in preventive medicine.

The cause and modes of spread of tularaemia, another insect-borne disease, primarily of rabbits and secondarily of man, were discovered by McCoy and Francis, scientists of the Hygienic Laboratory of the U.S. Public Health Service. Ricketts lost his life from typhus fever in Mexico City while unravelling the mysteries of that disease, and McClintock was a martyr to Rocky Mountain spotted fever while studying that tick-borne infection which has been revealed by American investigators. A triumph was achieved by the Dicks of Chicago who demonstrated the cause of scarlet fever and developed an antitoxic serum for its cure, a toxin for its prevention and a skin test (the Dick test) by which it is possible to determine who are susceptible and who immune. Stiles pointed out the importance of hookworm disease and discovered an American species of this parasite. Trudeau founded at Saranac Lake, New York, the sanitorium for tuberculosis which now bears his name; Theobald Smith discovered the bovine tubercle bacillus; and Noguchi's brilliant achievements have placed some obscure problems on a secure scientific basis. In the field of nutrition, Atwater and Benedict, Osborne and Mendel, and Lusk and McCollum have enriched the important subject of dietetics, which is one of the most fundamental factors in health. Among other outstanding contributions should be mentioned the work of Goldberger on pellagra and Strong on trench fever. Oliver Wendell Holmes, as early as 1843, pointed out the contagiousness of puerperal fever. The blessings of anaesthesia (*q.v.*) were among America's first contributions to preventive medicine.

Administrative Measures.—The United States was a pioneer in recognizing the importance of clean, safe milk supplies. In Jan. 1908 the United States Public Health Service published a Bulletin of the Hygienic Laboratory entitled "Milk and Its Relation to the Public Health," which favourably influenced the milk supplies in the United States and elsewhere. Pasteurization was advocated and is now generally applied to all large milk supplies throughout the land. While the United States was somewhat tardy in supplying clean and safe water to its large cities, it developed the method of rapid (or mechanical) sand filtration for muddy waters and has been quick to seize the advantage of chlorination. The recent reduction of typhoid fever in the United States is one of the dramatic demonstrations of preventive medicine.

The United States was early in the field to develop special schools for public health education. A School of Public Health was established by Harvard University and The Massachusetts Institute of Technology in Boston in 1913 (Rosenau, Sedgwick and Whipple). Other universities have participated in this movement, especially the University of Pennsylvania (Abbott), Johns Hopkins University (Welch) and the University of Michigan (Vaughan). Names especially associated with public health administration are Biggs, Chapin, Shattuck, Wiley and Wyman.

Health administration in the United States is part of the police power of the several states. The Federal Government has no constitutional power for local administration of health codes. It has, however, full powers with reference to maritime quarantine and interstate quarantine; it acts in emergencies and it promotes public health through demonstrations, co-operation and investigation. Federal health activities are centred in the United States Public Health Service, which is a bureau of the Treasury Department. Each state has a health organization, and all the large cities and some of the smaller ones also have well organized health services. The county district is the weakest link in the sanitary chain, but in 1925, 280 of the 2,850 rural counties of the United States had full-time health officers. Many other agencies are active in preventive medicine throughout the country—for example, the International Health Board of the Rockefeller Foundation; the Rockefeller Institute for Medical Research; the

McCormick Institute for Infectious Diseases; the Society for the Study and Prevention of Tuberculosis; the National Health Council; the Metropolitan Life Insurance Company, as well as universities, health centres, etc. (M. J. Ro.)

PREVEZA or PREVESA, seaport, southern Epirus, in Greece; at the entrance to the Gulf of Arta, an inlet of the Ionian sea. Pop. (1928, last census before World War II) 8,659. The town is surrounded by dense olive groves. The harbour is small, and closed to large vessels by a bar of sand. Preveza exports dairy produce, valonia, hides and wool, olives and olive oil. About 3 mi. N. are the ruins of Nicopolis (*q.v.*).

It was seized by Ali Pasha in 1798 and recovered by Greece in 1912 during the first Balkan War. In April 1941 it was occupied by Italy.

PREVOST, ANTOINE FRANÇOIS (1697–1763), French author and novelist, was born at Hesdin, Artois, on April 1, 1697. He was educated at the Jesuit school of Hesdin, and in 1713 became a novice of the order in Paris, pursuing his studies at the same time at the college of La Flèche. At the end of 1716 he left the Jesuits to join the army, but he soon tired of life in barracks, and returned to Paris in 1719 with the idea, apparently, of resuming his novitiate. He is said to have travelled in Holland about this time; in any case, however, he returned to the army, this time with a commission. He joined in 1719–20 the learned community of the Benedictines of St. Maur, with whom he found refuge, he himself says, after the unlucky termination of a love affair. He took the vows at Jumièges in 1721 after a year's novitiate, and received in 1726 priest's orders at St. Germer de Flaix. He resided for seven years in various houses of the order, teaching, preaching and studying. In 1728 he was at the abbey of St. Germain-des-Prés, Paris, where he was engaged on the *Gallia christiana,* the learned work undertaken by the monks in continuation of the works of Denys de Sainte-Marthe, who had been a member of their order. His restless spirit made him seek from the Pope a transfer to the easier rule of Cluny; but without waiting for the brief, he left the abbey without leave (1728), and, learning that his superiors had obtained a *lettre de cachet* against him, fled to England.

In London he acquired considerable knowledge of English history and literature, traceable throughout his writings, and he has left an interesting account of English life in his famous memoirs. Before leaving the Benedictines Prévost had begun his most famous romance, *Me'moires et aventures d'un homme de qualité qui s'est retire' du monde,* the first four volumes of which were published in Paris in 1728, and two years later at Amsterdam. In 1729 he left England for Holland, where he began to publish (Utrecht, 1730) a romance, the material of which, at least, had been gathered in London—Le *Philosophe anglois, ou Histoire de Monsieur Cleveland, fils naturel de Cromwell, écrite par lui-mesme, et traduite de l'anglois* (Paris 1731–39, 8 vols., but most of the existing sets are partly Paris and partly Utrecht). Meanwhile during his residence at The Hague, he translated the *Historia* of De Thou, and, relying on the popularity of his first book, published at Amsterdam a *Suite* in three volumes, forming volumes v., vi. and vii. of the original *Me'moires et aventures d'un homme de qualité.* The seventh volume contained the famous *Manon Lescaut,* separately published in Paris in 1731 as *Les Aventures du chevalier des Grieux et de Manon Lescaut, par Monsieur D. . . .* The book was eagerly read, chiefly in pirated copies, as it was forbidden in France. In 1733 he left The Hague for London, and Miss M. Robertson gives an entry showing that he was in prison in London in December on a charge of fraud.

In the autumn of 1734 Prévost was reconciled with the Benedictines, and, returning to France, passed through a new, though brief, novitiate. In 1735 he was dispensed from residence in a monastery by becoming almoner to the prince de Conti, and in 1754 obtained the priory of St. Georges de Gesnes. He continued to produce novels and translations from the English, and, with the exception of a brief exile (1741–1742) spent in Brussels and Frankfort, he resided for the most part at Chantilly until his death on Dec. 23, 1763.

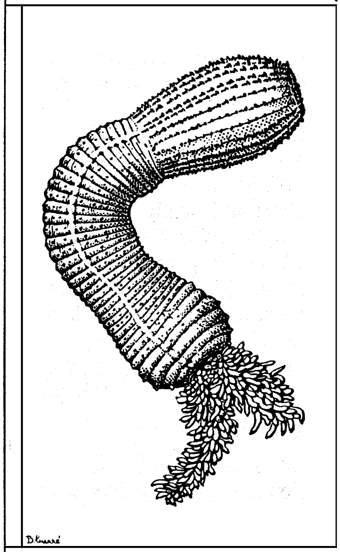
For the bibliography of Prévost's works, which presents many complications, and for documentary evidence of the facts of his life *see* H Harrisse, *L'Abbé Privost* (1896); also a thesis (1898) by V. Schroeder. A critical edition by M. Robertson of the 5th vol. of the *Mémoires et Aventures* dealing with Prévost's adventures in London, was published in 1927.

PRÉVOST, EUGENE MARCEL (1862–1941), French novelist, was born in Paris on May 1, 1862. He was educated at Jesuit schools in Bordeaux and Paris, entering the École Polytechnique in 1882. He published a story in the *Clairon* as early as 1881, but for some years after the completion of his studies he applied his technical knowledge to the manufacture of tobacco. He published in succession, *Le Scorpion* (1887), *Chonchette* (1888), *Mademoiselle Jauffre* (1889), *Cousine Laura* (1890), *La Confession d'un amant* (1891), *Lettres de femmes* (1892), *L'Automne d'une femme* (1893), and in 1894 he made a great sensation by an exaggerated study of the results of Parisian education and Parisian society on young girls, *Les Demi-vierges,* which was dramatized and produced with great success at the Gymnase on May 21, 1895. *Le Jardin secret* appeared in 1897; and in 1900 *Les Vierges fortes,* and a study of the question of women's education and independence in two novels, *Frédérique* and *Léa L'Heureux ménage* (1901), *Les Lettres à Françoise* (1902), *La Princesse d'Erminge* (1904), *L'Accordeur aveugle* (1905) and *Lettres à Frangoise Marie'e* (1908) were among his later novels. In 1904 *La Plus faible* was successfully produced at the Comédie Française In 1909 he was elected to the Academy.

PRIAM, in Greek legend, the last king of Troy (*q.v.*), son of Laomedon. According to Homer *(Iliad,* iii. 184) in his youth he fought on the side of the Phrygians against the Amazons. He had fifty sons and twelve daughters, and immense wealth. He was slain by Neoptolemus, son of Achilles, during the sack of Troy.

PRIAPEIA, a collection of poems (all together about 80 in number) in various metres on the subject of Priapus. It was compiled from literary works and inscriptions on images of the god by an unknown editor, who composed the introductory epigram.

BIBLIOGRAPHY—*See* F. Biicheler's *Petronius* (1904), L. Miiller's *Catullus* (1870), and *E.* Bahren, *Poetae latini minores,* i. (1879).



FROM THEEL, 'NORTHERN AND ARCTIC INVERTEBRATES

PRIAPULUS BICAUDATUS, A WORM-LIKE MARINE ANIMAL OF THE ARCTIC AND NORTH ATLANTIC SEAS

PRIAPULOIDEA, a small group of vermiform marine animals inhabiting the cold seas of both hemispheres; they were formerly placed near the Gephyrea, but their positionis uncertain, and it is doubtful if they are to be regarded as coelomate animals. Their early development is unrecorded, but O. D. Hammersten who studied the late larva of *Halicryptus* claims that it bears a strong resemblance to the Kinorhyncha (*q.v*), and accordingly suggests that the priapuloids are related to this group.

The Priapuloidea are cylindrical worm-like animals with a median anterior mouth devoid of tentacles. The body is covered with a thick cuticle which is shed in its entirety at least once during growth. The anterior end forms the invaginable introvert and is covered with longitudinal rows of small spines continued into the pharynx as powerful hooks: the body is ringed and dotted with small papillae: mouth and anus are terminal and the alimentary canal is straight; behind the anus there occur in *Priapulus* one or two hollow caudal appendages, probably respiratory in function. The nervous system, composed of a ring and a ventral cord, retains its primitive connection with the ectoderm: there are no specialized sense organs and no vascular system. There is a wide body cavity of doubtful homology. The sexes are separate and the organs of sex are one with the excretory organs. According to Schauinsland these organs are separately developed from the same pair of urogenital ducts that open to the exterior on either side of the anus. This author states that from this pair of blindly ending tubes there first arise branching tufts ending in flame-cells similar to those found in the Platyhelminths; these are the excretory organs, and, as sexual maturity approaches, from the walls of the ducts are formed pouches from which the sexual cells are developed. These pass out through the ducts.

There are two genera, *Priapulus* and *Halicryptus,* separated on the presence in *Priapulus* of the caudal appendages. They live in burrows in the mud, which they eat, in comparatively shallow waters up to 50 fathoms. The secretion of the circumanal glands serves to cement the walls of their burrows.

BIBLIOGRAPHY.—O. D. Hammersten, "Zur Entwicklungsgeschichte von *Halicryptus spinulosus* (von Siebold)," *Z. Wiss. Zool.* 112, (2) (1915), contains a discussion of the morphology and relationships of the Priapuloidea and a bibliography. (C. C. A. M.)

PRIAPUS (prē-ah′poōs, anglicized prī-ā′pus), a god of fertility, personification of the fruitfulness of nature, chief deity of Lampsacus on the Hellespont (Dardanelles). He was represented as a man, usually grotesquely ugly, with an enormous and erect sexual organ. Locally, he was thought to be the son of Dionysus and Aphrodite. His cult reached Greece somewhat late in the classical epoch, not becoming really important until Alexandrian times. Later still, it penetrated to Italy. Various legends, all of them late, bring him into connection with the gods of the Greek pantheon, particularly Aphrodite, often represented as his mother, Hermes, Dionysus, and other deities connected with fertility. In Bithynia he is a warlike god, associated with Ares. He absorbed, or was closely identified with, a number of minor rustic deities of similar type; *e.g.,* Phales, Conisalus, Tychon, etc.

He is perhaps best known as a god of gardens, where his image was commonly erected, both to give supernatural protection against thieves and for practical use as a scarecrow' (see, *e.g.,* Horace, *Sat.,* I., 8, 3, et seq.). But as the phallus is a common luck-bringing object, he was worshipped by persons in need of luck, such as hunters and fishermen, and also was frequently employed to keep off the evil eye (numerous examples are found in and outside of houses at Pompeii).

See Jessen in Roscher's *Lexikon, s.v.;* Herter, *De dis Atticis Priapi similibus* (Bonn, 1926).

PRIBILOF ISLANDS (often called the Fur Seal islands), a group of four islands, part of Alaska, lying in Bering sea in 56° 50′ N. and 170° W., about 180 m. north of Unalaska and 200 m. S.W. of Cape Newenham, the nearest point on the mainland. The principal islands are St. Paul (about 35 sq.m.; 13 m. long. from north-east to south-west; maximum width about six miles; named from St. Peter and St. Paul's day, on which it was discovered) and St. George (about 27 sq.m.; 10 m. long, maximum width, 4 m.; probably named after Pribilof's ship) about 30 m. south-east.

The native population in 1940 was 482. The white population act as supervisors. Only agents of the United States or Aleut natives are permitted as residents on the islands. The natives are employed in the sealing industry during the hunting season but in reality they are chiefly dependent on the U.S. Government for food, clothes, schools and medical attention. They maintain their own church on each island (the Russian-Greek Church).

The islands are hilly and of volcanic origin, without harbours, and have a mean annual temperature of about 35·7° F, and a rainfall of about 35 inches. There are only two seasons—rainy summers lasting from May to October, and dry winters from November to April. The flora is restricted to ferns, mosses and grasses, though there are a number of creeping willows and small shrubs.

Fur Industry.—The seals which visit the Pribilof islands from April until November are a distinct species *(Callorhinus ursinus)* with much better fur than that of any other. The sealing operations during the year 1937 resulted in a take of 55,000 skins, valued at approximately $250,000. The valuable herd of seals was rapidly being killed off in 1911, when the U.S. bureau of fisheries took over control. At that time the herd numbered about 125,000; by 1926 a census showed that it had increased to 761,281, and in 1937 it had increased further to almost 1,850,000.

Besides the fur seal there are blue and white foxes (more on St. George than on St. Paul). The natives trap foxes during the winter, when there are no sealing operations, and take about 1,000 pelts during the season. On St. George island and the two islets there are great bird rookeries, which are the breeding places of immense numbers of gulls, sea-parrots, auks and cormorants.

The islands were first sighted in 1767 by Joan Synd, and were visited in 1786 by Gerasim Pribilof, who discovered the fur seal rookeries for which they became famous. From Russia the islands passed with Alaska to the United States in 1867. From 1870 to 1890 the U.S. Government leased the islands to the Alaska Commercial Company. In 1890–1910 the North American Commercial Company held the monopoly, but in the meantime the industry shrank considerably owing to pelagic sealing. The islands were taken over by the U.S. bureau of fisheries in 1910 and since that time sealing operations have been administered directly by its representatives.

PRIBRAM, ALFRED FRANCIS (1859–), Austrian historian, was born in London Sept. 1, 1859. He studied in London and Vienna, and in 1894 became professor of modern history at the University of Vienna, being also elected a member of the Viennese Akademie der Wissenschaften. His main works are: *Oesterreich und Brandenburg* (2 vols., 1884–85); *Der Rheinbund* (1888); *Franz von Lisola und die Politik seiner Zeit* (1894); *Das bohmische Commerzcollegium* (1898); *Die niederoesterreichische Stande* (1898); *Oest. Staatsvertriige* (England) (2 vols., 1907–13); *Geschichte der Juden Wiens* (2 vols., 1918); *The Secret Treaties of Austria-Hungary 1879–1914* (English, German and French ed., 1919–23); *Austria-Hungary's foreign policy 1908–1918* (1923). Professor Pribram also finished and issued vols. 2 and 3 of Friedjung's ambitious work *Das Zeitalter des Imperialismus.* He was a contributor on a large scale to the 11th, 12th, 13th and 14th editions of the *Encyclopædia Britannica.* Pribram's output was comparatively small, owing to his cautious and conscientious methods of working. Truth was his principal preoccupation, and he sought it among documents. His *Secret Treaties* threw much light on modern history in 1929.

PŘIBRAM, a town of Bohemia, lies in the upper valley of the Litavka, near the edge of the Brdy Wald highlands. In its vicinity are some of the deepest silver and lead mines in the world, several centuries old, but now zinc, antimony and bismuth are the chief ores raised. There is a home glove industry. Beside the town rises the Heiliger Berg (1,889 ft.) with a church containing a miracle-working image of the Virgin, the principal place of pilgrimage in Bohemia. Pop. (1930) 10,468. Příbram was occupied by Germany in March 1939.

PRICE, RICHARD (1723–1791), English moral and political philosopher, son of a dissenting minister, was born on Feb. 23, 1723, at Tynton, Glamorganshire. He was chaplain and companion to a Mr. Streatfield at Stoke Newington, London, and by his death and that of an uncle in 1756 his circumstances were improved. In 1757 he married Sarah Blundell.

After publishing several sermons, philosophical papers, and the *Appeal to the Public on the Subject of the National Debt* (1771) he turned his attention to the question of the American colonies, and in 1776 he published a pamphlet entitled *Observations on Civil Liberty and the Justice and Policy of the War with America.* A second pamphlet on the war with America, the debts of Great Britain, and kindred topics followed in the spring of 1777. His name thus became identified with the cause of American independence. He was the intimate friend of Franklin; he corresponded with Turgot.

Price was an intimate friend of Priestley, in spite of the fact that they took the most opposite views on morals and metaphysics. In a published correspondence between them (1778) on the subjects of materialism and necessity, Price maintained, in opposition to Priestley, the free agency of man and the unity and immateriality of the human soul. The pamphlets on the

American War made Price famous. He preached to crowded congregations, and, when Lord Shelburne acceded to power, was offered the post of private secretary to the premier. In 1786 Mrs. Price died, and the remainder of his life appears to have been clouded by solitude and dejection. The progress of the French Revolution alone cheered him. On April 10, 1791, he died, worn out with suffering and disease. His philosophical importance is in the region of ethics. The *Review of the Principal Questions in Morals* (1757, 3rd ed. revised 1787) is professedly a refutation of Hutcheson, but is rather constructive than polemical. The theory he propounds is closely allied to that of Cudworth, but is interesting mainly in comparison with the subsequent theories of Kant.

Besides the above-mentioned, Price wrote an *Essay on the Population of England* (2nd ed., 1780); two Fast-day Sermons, published respectively in 1779 and 1781; and *Observations on the importance of the American Revolution and the means of rendering it a benefit to the World* (1784). A complete list of his works is given as an appendix to Dr. Priestley's *Funeral Sermon*. His views on the French Revolution are denounced by Burke in his *Reflections on the Revolution in France*. Notices of Price's ethical system occur in Mackintosh's *Progress of Ethical Philosophy*, Jouffroy's *Introduction to Ethics*, Whewell's *History of Moral Philosophy in England;* Bain's *Mental and Moral Sciences*. *See* also ETHICS, and T. Fowler's monograph on Shaftesbury and Hutcheson. For Price's life *see* memoir by his nephew, William Morgan.

PRICE, STERLING (1809–1867), American general, was born in Prince Edward county, Virginia, on Sept. 14, 1809. He was educated at Hampden Sidney college and afterwards studied law. In 1830 he removed to Missouri and from 1840 to 1844 served in the Missouri State legislature as speaker of the house of representatives. He was elected a U.S. representative in 1844 but resigned in 1846 to raise and lead the 2nd Missouri Cavalry Regiment in the Mexican War. In 1847 he was commissioned brigadier-general of volunteers and made military governor of Chihuahua. He was governor of Missouri, 1853–57, and State bank commissioner, 1857–61. In 1861 he was appointed major-general of the State militia. Upon the outbreak of the Civil War Price gathered 9,000 Confederate troops at Carthage, Mo., and defeated a small force of Union troops under Franz Sigel. Joined by other troops from Arkansas, Price fought the battle of Wilson's Creek, defeating the Union forces under Gen. Lyons. In the battle of Lexington, shortly afterward, Price captured over 3,000 Union troops, but he was forced to retreat before Gen. Frémont. In March 1862, he was commissioned major-general in the Confederate forces. He commanded under Van Dorn at the battle of Pea Ridge, Ark., on March 7, 1862, and in several engagements around Corinth, Miss. On July 4, 1863, he fought a sharp battle at Helena, Ark., and later prevented Steele's advance to the Red river. In Sept. 1864 he invaded Missouri and advanced to the environs of both St. Louis and Jefferson City, but was repulsed in his attacks at these places. After the war Price went to Mexico in the interest of a colonization project but he returned to Missouri and died at St. Louis on Sept. 29, 1867.

PRICE, THOMAS (1852–1909), Australian statesman, was born at Brymbo, North Wales, on Jan. 19, 1852. He was educated at a penny school in Liverpool, and became a stonecutter. He went to Australia for his health in 1883, where after a time he again found employment as a stonecutter, working on the parliament buildings in Adelaide. We was secretary for two years (1891–93) of the Masons' and Bricklayers' Society of South Australia, and then obtained a seat as Labour member in the House of Assembly. In 1900 he was made secretary of the Labour Party, and in 1901 became its parliamentary leader. He held office as prime minister of South Australia from 1905 until his death on May 31, 1909, at Hawthorn, near Adelaide.

PRICE. What prices are and what price, as a general conception, means would seem to be obvious enough. Yet economists, dealing with the relations of prices to different forms of economic activity and with their own interrelations find that they must take pains if they are to keep their conceptions of price clearly defined and consistent. Thus one may speak of the whole amount of money paid for a quantum of goods as their price, or—if the goods are of a homogeneous or standardized kind, sold by measure, weight, or tale—the amount of money given for each unit of the goods may be regarded as the price. Alternatively, price may be defined, not as a quantity of money but as a ratio between a quantity of money and a quantity of goods. This is generally the more useful conception, but the prices of unique goods, such as works of art, cannot be said to be ratios of quantities. The price ratio is usually stated as so many monetary units (shillings, pounds, dollars) per unit of commodity (ton, yard, bushel). In some markets, however, the ratio is expressed inversely, as so many ounces or yards per shilling, pound, or dollar. This would be a negligible difference if it were not that, as the makers of index numbers have found, where prices or percentage changes in prices are averaged or otherwise combined, precautions must be taken if the results are not to be affected by the particular form in which the price ratios are expressed.

A distinction may also be made between the conceptions of price as a ratio of quantities and as a ratio of values. If ten units of money are required to purchase one unit of a commodity, it may be inferred that a unit of the commodity is ten times as valuable as a unit of money and that the price ratio merely gives expression to that fact. That price is "value expressed in terms of money" is a standard definition. This should not be taken to mean that the values of goods are determined independently of or prior to the determination of their prices, or that the values of goods and of money are determined separately. The factors which determine the values both of goods and of money operate through the processes of exchange, and the values which are thus determined appear in the guise of money prices. It is probable, indeed, that the abstract notion of exchange value is nothing more than a generalization of the simpler idea of price. When we say that price is a ratio of values or that price is value expressed in terms of money, we logically imply, not that value is antecedent to price, but either that in respect of each particular transaction the limits within which the ratio of exchange can vary are established by the general state of the market, or that in analysing the factors which determine the price of any one commodity, the value or general purchasing power of money, may often, without too large an error, be assumed to be constant. The conception of the value of money, in turn, rests upon nothing more tangible than a broad view of all the various prices of different goods and services, but it is nevertheless a useful conception.

The Problems of Price.—The economic theory of price has two principal divisions. One division has to do with the interrelations of the prices of different goods and services, and with the way in which changes in production, consumption, and trade operate directly upon some prices and indirectly upon others. This division of price theory includes that important part of economics sometimes called the theory of value and distribution (or sometimes simply the theory of price-making) and also parts of other fields, such as the theory of international trade. It is concerned both with the tendencies which continually make for a coherent and consistent system of prices and with the subversive forces which make continuously for change. The other division of the theory of prices has to do with the causes of general movements of prices to a higher or lower level—movement which may continue gradually through a long period of years, but which may be broken by shorter movements, convulsive or cyclical in nature. The study of the long-continued general trends of price, and, in considerable measure, of their shorter movements as well, is commonly made a part of the general theory of money. The reason is not that general changes of prices are always attributable to the action of monetary factors alone, but that they are reflected in and in fact are changes of the value of money. They can be studied most conveniently and effectively by enquiring into the changing relations between the supply of money and credit and the volume of production and trade. In recent years especial attention has been given to what might be called the distortions of the whole interrelated structure of prices which accompany changes in their general level. The movements of certain classes of prices, for example, generally lag behind the movements of other classes of prices in a more or less systematic way.

Commodity prices are not the only prices with which economists are concerned. Securities such as bonds or debentures, stocks or shares and bills or notes, have their prices. Railway rates are prices. Foreign exchange rates express the price of current funds in one market in terms of current funds in another market. Wages, of course, may be regarded as the price of labour, rent as the price of the use of land or of other durable goods, and interest as the price of advances of money. Profits, however, are not prices, for they are not proportioned in any definite way to the amounts of goods or services supplied, but are contingent upon the success of particular undertakings. Nor are taxes prices, for the governmental services for which taxes pay are diffused, and not apportioned to different taxpayers in accordance with their respective contributions. Not even the fees which are paid to Government offices for licences or for particular services are in all respects like prices, for the amount of the fee is usually proportioned very loosely, if at all, either to the value of the service to the recipient or to its cost to the Government. But the charges which Governments make for supplying such things as water, gas, electricity and transport may be governed more or less completely, according to the circumstances of the particular case, by the principles in accordance with which prices are determined.

Equilibrium Price. — This is a price at which supply and demand are equal. A distinction has to be made between a temporary equilibrium, such as would express a balancing of the immediate factors which are operative in the market at any given time, and such an equilibrium as would be reached eventually if the particular factors now known to be at work could have their full effects. Equilibrium, then, is always relative to time. All economic equilibria are unstable, but it is convenient in analysis to take separate account of the factors which, if they were neither impeded nor deflected, might finally lead to a stable equilibrium. Market price is the price which will be found in a given market at a given time. It may be regarded as the limiting form of short-time or temporary equilibrium price. Normal price is a price just high enough to cover the expenses of production, including whatever profits are necessary to induce men to undertake the risks of productive enterprise. Because some firms produce at smaller expense than others, because the expense per unit of production often varies, directly or inversely, with the volume of output, and because of the difference, at any given time, between the average expense incurred per unit of product in a given establishment and the expense of producing an additional unit, the conception of normal price is attended with serious, though not altogether insuperable difficulties.

Competitive Price. — This is the price which results from the activities of many buyers and sellers, each of whom can affect the outcome only by buying or selling larger or smaller quantities according as the price is at one point or another. Monopoly price is a price fixed with a view to his or their own advantage by a single (exclusive) seller or buyer, or by a combination of sellers or buyers acting as a unit. Class price (or differential or discriminatory price) is possible only when a monopolist seller is able to deal separately with different classes of buyers or to manage in some other way to sell his goods in what are virtually separate markets. A speculative price is a present price which is influenced by estimates of what the price of the same commodity or security will be in the future. A contract price, or what is sometimes called in speculative markets a "future," is the present price for an exchange which is to be completed by delivery or by taking delivery in the future. Mint price is the price of gold in terms of money at a Government's mint or at a bank which acts as agent for the mint. Gold price is the rather misleading name sometimes given to the result obtained by dividing a price which is quoted in terms of some depreciated paper currency by the price, in terms of the same currency, either of gold or of funds payable in some other country where a gold monetary standard is at the time effective.

Demand Price. — This is the price at which some specified quantity of a given commodity will find purchasers. A schedule of demand prices or demand schedule, exhibits the general relation between the price of a commodity and the amount of it which will be purchased. Supply price, similarly, is the price at which a specified quantity of a given commodity will be offered in the market. The form of the supply schedule depends upon the conditions under which the particular commodity is produced and also upon the period of time which is taken into account. Thus a sudden general increase in demand (in the sense of a general upward movement of a schedule of demand prices) would have the effect of increasing the price at which a specified quantum of a given commodity would be offered for sale. But if the commodity is produced under conditions of increasing returns (*i.e.*, if the output can be increased without a proportionate increase of costs), an increase of demand, continued over a period of years, will have an opposite effect upon its supply price. Indeed, the gradual lowering of the supply prices of commodities produced under conditions of increasing returns need not wait upon a general increase of demand. It is necessary only that demand should be elastic, *i.e.*, that the demand price of successively larger quantities should not fall off too rapidly.' It follows that when an adequate period of time is taken into account, a schedule of supply prices may show that larger quantities will be supplied at lower instead of higher prices. A corresponding schedule of supply prices for a commodity produced under conditions of diminishing returns (*i.e.*, with increased output procurable only at a more than proportionate increase of costs) would, of course, like a schedule of short-period or "instantaneous" supply prices, show higher prices associated with larger quantums of supply. (See: also ECONOMICS, SUPPLY AND DEMAND, and VALUE.) **(A. YO.)**

For bibliography see PRICES, STATISTICS OF.

PRICE-CUTTING, the term used to indicate the practice of selling standard merchandise at a price below that advertised by the manufacturers. With many trade-marked articles the manufacturer attempts to maintain the price at which his products are sold to consumers. The idea is that both wholesalers and retailers should make a profit on his merchandise; otherwise they might refuse to handle it. When an article becomes so well known that it is widely accepted as a standard, it is a common practice, for retailers having similar gocds that they sell under the store label to reduce the price of the trade-marked article and use it in their advertising as a special attraction. Their clerks are instructed to try to sell the substitute bearing the store label instead of the trade-marked article requested. This practice is disadvantageous to the manufacturers inasmuch as the cut-price often makes the article unprofitable for other retailers and they also attempt to substitute other brands for the one advertised. When the distributor departs from the usual practice and sells for cash where most stores would extend credit, and when he refuses to deliver goods and requires the customers to carry their own purchases, he is expected to sell at a lower price because he gives less service. The reduced price of the "cash and carry" stores is not usually included in the term price-cutting. In most countries price-cutting is prevented by contract between the manufacturer and distributors. That form of contract has not been legal in the U.S. until the recent passage of "fair trade" laws by the separate States. Price maintenance is still illegal, by contract, excepting in States having these enactments. (H. E. A.)

PRICE MAINTENANCE. The subject of price maintenance, or, more specifically, resale price maintenance, is one that demands special consideration among the various types of price fixing, both from the legal and the economic aspects. Other forms of price fixing are treated elsewhere. For agreements and understandings as to prices among competing manufacturers, wholesalers or retail dealers, see ASSOCIATIONS, INDUSTRIAL, and also POOLS, IN INDUSTRY and CARTEL; for concentrations of industry in monopolistic, or quasi-monopolistic, forms, see TRUSTS; for price fixing by legal monopolies, such as railroads and other privately owned public utilities, see PUBLIC UTILITIES. All of these forms are found both in the United States and in the United Kingdom. The following discussion relates to resale price maintenance exclusively.

Resale price maintenance is the term applied to various devices by which individual manufacturers or distributors of particular trade-marked, branded, or otherwise identified articles fix minimum resale prices. The most widespread and important manifestation of resale price control is seen where the manufacturer of an article, by contract, fixes a price below which retailers shall not sell it to the public.

The practice has been fostered in the United States by manufacturers who sell trade-marked and well advertised commodities such as breakfast foods, toilet goods, proprietary medicines, books and musical instruments, and has been supported by trade associations of manufacturers and dealers in various lines of products. Supporting dealer organizations have the further objective of inducing the fixing of minimum prices high enough to insure a margin satisfactory to the dealer. In Great Britain there exists an association, known as the Proprietary Articles Trade Association, whose main object is to encourage and enforce this system. A similar association was founded in Canada in 1925 but was later disbanded when it was adjudged to be a combination in restraint of trade.

It is contended by the advocates of resale price maintenance that the maker of an article which bears a trade-mark that he has made valuable by extensive advertising should be entitled to stipulate the price at which it shall be sold by dealers to the public. It is claimed that the manufacturer cannot adequately protect his intangible property—the good will attaching to his trade-mark or brand—unless he restrains dealers who sell his products at a lower price than he suggests, sometimes less than cost, as a "leader" or a "draw" to customers. This use of "leaders," it is maintained, sometimes causes competing retailers to refuse to handle the goods because they can neither make a profit by meeting the low prices, nor sell at the manufacturers' higher resale prices, thus destroying good will of the dealer and reducing the number of dealer outlets.

In England, the legal status of resale price maintenance is based largely upon court application of common law rules respecting freedom of contract and the reasonableness of agreements in restraint of trade. The courts interpret the right of contract broadly and permit manufacturers to make resale price maintenance agreements among themselves and with their distributors provided undue restraint of trade is not shown. Resale price maintenance was considered by official committees in 1920 and again in 1931. The report of 1931 neither condemned, nor did it give unqualified approval to the practice.

Canadian policy follows quite closely that of England but is somewhat more restricted. In certain cases resale price maintenance has been declared to be against public policy, but the practice itself has not been passed upon. Resale price control by a combination of manufacturers, jobbers, and retailers of drugs was condemned in 1927, and a similar combination to control prices of tobacco products was likewise condemned as a combine within the meaning of the Canadian Combines Investigation Act.

In the United States prior to 1936, in cases coming before the U.S. Supreme Court, resale price maintenance was permitted in cases of goods distributed through bonafide agents rather than independent dealers, but otherwise goods sold under a trade name or mark were not exempted from the common law and statutory provisions against monopolies and restraints of trade. As early as 1907 the courts held that a system of contracts entered into by the manufacturer of a proprietary medicine with a large part of the wholesale and retail druggists stipulating the resale price of the product was unlawful and unenforceable on the grounds that it restrained trade (*Park and Sons* v. *Hartman,* 153 Fed. 24), and in 1911 the U.S. Supreme Court rendered a similar decision in the Dr. Miles case (*Dr. Miles Medical Co.* v. *Park and Sons Co.,* 220 U.S. 373). Patented and copyrighted articles have also been held to be within the scope of the Dr. Miles case, and agreements to maintain resale prices thereon declared unlawful.

In 1915, the Federal courts refused to issue an injunction restraining the manufacturer of a breakfast food from carrying out the policy of refusing to sell to those dealers unwilling to maintain resale prices. In 1922, the U.S. Supreme Court held that a corporation may have and announce a policy of refusing to sell to cut-rate dealers and withhold its goods but may not consistently go beyond this act and by contracts or combinations, express or implied, unduly hinder or obstruct the free and natural flow of commerce (*F.T.C.* v. *Beech-Nut Packing Co.,* 257 U.S. 441).

Throughout the period from the Dr. Miles decision in 1911 to the enactment of the National Industrial Recovery Act in June 1933 (48 Stat. 195), bills to legalize resale price maintenance in interstate commerce in the United States were continually presented to the Congress, but all failed of passage. In 1931, however, the State of California enacted a law legalizing resale price maintenance by contract between manufacturers or distributors and retail dealers within the State of California. With the setting up of the National Recovery Administration under the National Industrial Recovery Act, interest in the enactment of further State laws waned due to the fact that numerous codes contained price control provisions and a number provided for some form of resale price maintenance. Following the decision of the U.S. Supreme Court in the Schechter case (*Schechter Poultry Corp.* v. *U.S.,* 295 U.S. 495) which declared portions of the National Recovery Act unconstitutional, the movement to enact State resale price maintenance laws again gained momentum. By the end of 1935, ten States had enacted such laws, generally similar to the 1931 California act. Late in 1936, the U.S. Supreme Court declared the State laws of California and Illinois to be constitutional (Old *Dearborn Distributing Co.* v. *Seagram Distillers Corp.,* 299 U.S. 183, and *The Pep Boys, Manny, Moe & Jack of California, Inc.* v. *Pyroil Sales Co., Inc.,* 299 U.S. 198). These decisions provided such a stimulus that by 1939 44 of the States had legalized resale price maintenance, by laws commonly designated as Fair Trade Acts.

In 1937, the Tydings-Miller Act amended the Sherman Antitrust Act by exempting from the application of that act, "contracts or agreements prescribing minimum prices for resale of a commodity which bears, or the label or container of which bears the trade mark, brand, or name of the producer of such commodity, and which is in fair and open competition with commodities of the same general class produced or distributed by others when contracts or agreements of that description are lawful as applied to intrastate transactions, under any statute, law, or public policy now or hereafter in effect in any State, Territory, or the District of Columbia," and further declared that the making of such contracts "shall not be an unfair method of competition under the Federal Trade Commission Act." This exemption, however, is specifically stated in the act not to make lawful "horizontal" agreements or understanding on prices between competitors, whether they be manufacturers or distributors, and such "horizontal" agreements are still a violation of law when in restraint of trade or commerce among the States.

While resale price maintenance appears presently to find legal sanction in the United States and in the United Kingdom, consumer organizations and economists generally are opposed to the practice from the standpoint of its effects on the public, and many in the United States advocate returning to former policies on the ground that the evils inherent in a system of fixed retail prices outweigh the benefits of resale price maintenance to manufacturers of some lines of merchandise and a segment of the retail trade.

BIBLIOGRAPHY.—Report of Committee on Fixed Retail Prices, 662 (1920); Report of Registrar (1926) and of Commissioner (1927) under the Canadian Combines Investigation Act on the Canadian Proprietary Articles Trade Association; Reports of the U.S. Federal Trade Commission on Resale Price Maintenance (1929 and 1931); Report of the Commissioner under the Canadian Combines Investigation Act on an Alleged Combine in the Distribution of Tobacco Products (1938); E. T. Grether, *Resale Price Maintenance in Great Britain* (1935), *Price Control under Fair Trade Legislation* (1939).

(R. E. F.)

PRICES, STATISTICS OF. The following article deals with the movement of wholesale prices, (A) since 1782 in the United Kingdom; (B) since 1913 in the United States and other countries; (C) the wholesale prices of selected commodities; (D) the movement of retail prices of food in the United Kingdom.

These general movements are measured by index numbers (*see* INDEX NUMBERS), which are averages, computed in various ways, of the changes of prices of selected commodities. The relative importance given to the various classes of commodities in the principal index numbers for the United Kingdom are indicated in

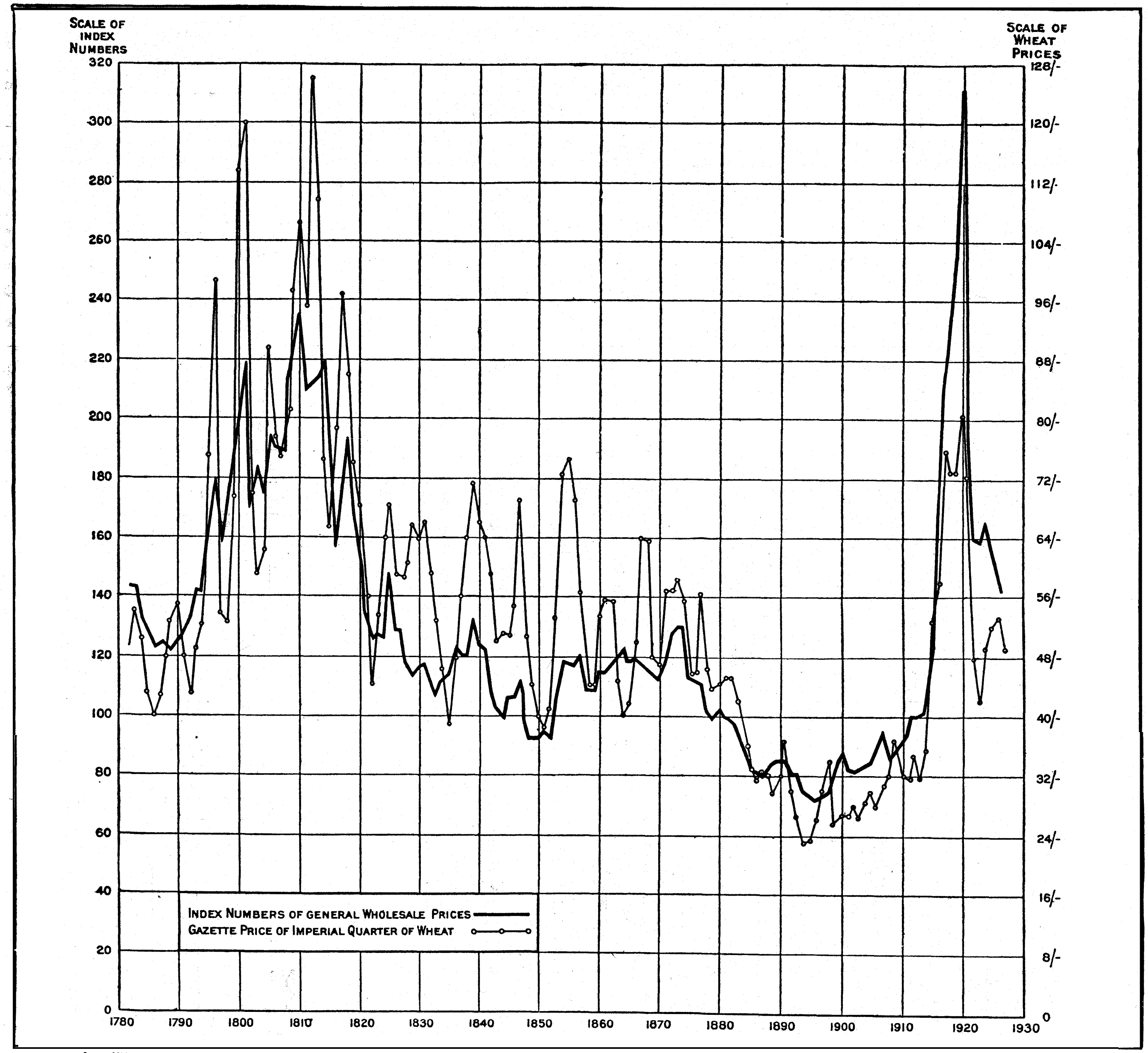


FIG. 1.—WHOLESALE PRICES IN THE UNITED KINGDOM, 1782–1927; CHANGES IN WHEAT PRICES COMPARED WITH CHANGES IN GENERAL PRICES

	Board of trade new series*	Statist or Sauerbeck		*Economist*	Jevons**
		base			
	base 1913	base 1867–77	base 1913†	base 1901–5	base 1782
Cereals . . .	113	178	144	159	175
Meat .	113	156	182	91	125
Other food, drink and tobacco .	127	88	56	114	200
	353	422	382	364	500
Coal and metals .	293	156	203	182	100
Textiles . . .	207	178	175	227	200
Miscellaneous .	147	244	240	227	200
	647	578	618	636	500
	1,000	1,000	1,000	1,000	1,000

*In the old series, discarded in 1920, the food group accounted for 652 and the materials for 348, when 1900 was the base year.

†These are the effective weights reached by Sauerbeck's numbers when comparison is made with 1913.

**These numbers are approximate. Jevons's tabulation mas not clear.

the table at the left.

During the very rapid and diverse price movements from 1914 to 1922 the results obtained by the three methods diverged (see table IV.): that of the Board of Trade is on the broadest and most scientific basis.

A. The United Kingdom.—Table I. and fig. 1 exhibit the general movement of wholesale prices, so far as it can be measured, for nearly 150 years. With the outbreak of the French wars in 1793 prices rose, and after some fluctuations, especially at the date of the Peace of Amiens in 1802, reached in 1810 a level nearly twice as high as in 1790. A considerable fall took place immediately after the battle of Waterloo, and, again with fluctuations, prices tended downwards to a minimum about 1850, when they were 25% lower than in 1790. In consequence of the Californian and Australian gold discoveries in 1847 and 1851 prices moved upwards on the whole till 1873. With renewed demand for gold in consequence of the demonetization of silver on the Continent, a considerable fall in prices followed and the minimum of the 150 years under review occurred in 1895–97. With the development of the South African gold mines prices then rose till the outbreak of the World War, and in 1913 reached

TABLE I. *General View of the Movement of Wholesale Prices in the United Kingdom, 1782 to 1927*
(Level of prices in 1913 taken as 100)

(*Jevons's Index-numbers till 1855. Sauerbeck's [later Statist] till 1920. Board of Trade till 1927. Jevons's and Sauerbeck's numbers equated at the dates 1856-59*)

Year in decade	*First Year of Decade*														
	1780	1790	1800	1810	1820	1830	1840	1850	1860	1870	1880	1890	1900	1910	1920
0	..	124	201	235	152	116	124	92	115	113	103	85	88	92	312
1	..	127	219	210	134	117	122	95	115	118	100	85	82	94	197
2	143	133	170	212	126	112	107	93	118	128	99	80	81	100	159
3	143	142	183	213	127	107	102	106	120	130	96	80	82	100	159
4	133	140	174	219	126	112	99	119	123	130	89	74	83	101	166
5	129	167	194	189	147	114	106	118	119	113	85	73	85	123	159
6	122	179	190	156	129	123	106	118	120	112	81	72	91	160	148
7	124	157	189	172	129	120	112	121	118	111	80	73	94	209	141
8	124	169	213	193	116	120	97	109	116	102	82	75	86	230	..
9	122	186	230	167	113	132	92	109	115	98	85	80	87	255	..

NOTE: In the period 1801 to 1820 Jevons's numbers for currency (paper standard) are used, not his lower figures corrected for depreciation (gold standard).

TABLE II. *Average Price of British Wheat per Imperial Quarter (480 lb.).* ***1783** to **1926**.* (Shillings and decimals of shillings.)

Year in decade	*First Year of Decade*														
	1780	1790	1800	1810	1820	1830	1840	1850	1860	1870	1880	1890	1900	1910	1920
0	36.7	54.7	113.8	106.4	67.8	64.2	66.3	40.2	53.3	46.8	44.3	31.9	26.9	31.8	80.7
1	46.0	48.6	119.5	95.2	56.1	66.3	64.3	38.5	55.3	56.7	45.3	37.0	26.7	31.7	71.4
2	49.2	43.0	69.8	126.5	44.6	58.7	57.2	40.8	55.4	57.0	45.1	30.2	28.1	34.8	47.9
3	54.2	49.2	58.8	109.7	53.3	52.9	50.1	53.2	44.7	58.7	41.6	26.3	26.7	31.8	42.1
4	50.3	52.2	62.2	74.3	63.9	46.2	51.2	72.4	40.2	55.7	35.7	22.8	28.3	35.0	49.3
5	43.1	75.2	89.7	65.6	68.5	39.3	50.8	74.7	41.8	45.2	32.8	23.1	29.7	52.9	52.1
6	40.0	98.6	79.1	78.5	58.7	48.5	54.7	69.2	49.9	46.2	31.0	26.2	28.2	58.2	53.2
7	42.4	53.7	75.3	96.9	58.5	55.8	69.7	56.3	64.4	56.7	32.5	30.2	30.6	75.7	..
8	48.3	51.8	81.3	86.2	60.4	64.6	50.5	44.2	63.7	46.4	31.8	34.0	32.0	72.9	..
9	52.7	69.0	97.3	74.5	66.2	70.7	44.2	43.7	48.2	43.8	29.7	25.7	36.9	72.9	..

TABLE III. *Retail Price of Bread in London per 4-lb. loaf, 1800 to 1925.* (Pence and decimals of pence)

Year in decade	*First Year of Decade*												
	1800	1810	1820	1830	1840	1850	1860	1870	1880	1890	1900	1910	1920
0	15.3	14.7	10.2	10.5	10.0	6.8	8.8	8.0	7.0	6.0	5.2	5.9	11.6
1	1j.5	14.0	9.3	10.4	9.0	6.8	9.0	9.0	7.0	6.2	5.0	5.5	12.4
2	9.5	17.0	8.3	9.6	9.5	6.8	8.5	9.8	7.4	6.2	5.3	5.8	9.2
3	8.7	15.7	9.0	8.7	7.5	8.3	7.5	8.0	7.0	5.8	5.6	5.8	8.5
4	9.7	11.4	10.4	8.0	8.5	10.5	7.0	7.3	6.8	5.5	5.5	5.8	8.7
5	13.1	10.3	10.8	7.0	7.5	10.8	7.5	6.8	6.2	5.1	5.5	8.0	9.9
6	11.7	11.7	9.2	8.0	8.5	10.8	8.8	7.2	6.3	5.1	5.5	9.0	..
7	10.8	14.3	8.9	8.5	11.5	9.0	10.3	8.1	5.6	5.5	5.4	10.6	..
8	11.6	11.8	10.2	10.0	7.5	7.5	9.3	7.5	5.7	6.0	5.8	8.9	..
9	13.7	10.3	11.0	10.0	7.0	7.8	7.8	7.1	6.0	5.1	6.1	9.1	..

TABLE IV. *Monthly Index Numbers* ("Statist")
(Average of Jan.-July 1914=100)

End of	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	192j	1926	1927
Jan.	..	117	150	193	225	233	298	239	160	158	166	176	157	149
Feb.	..	122	154	199	227	227	317	220	160	160	169	174	155	150
March	..	126	158	205	228	224	316	215	161	161	166	170	153	149
April	100	128	163	209	230	224	323	206	163	162	166	167	152	149
May	..	130	164	212	231	235	316	196	164	160	166	165	153	150
June	..	129	159	218	233	242	311	189	164	155	166	159	152	149
July	..	129	158	214	233	250	309	191	162	151	168	163	153	148
Aug.	106	130	163	213	237	258	308	187	157	151	168	163	154	149
Sept.	108	131	163	214	239	260	302	181	155	155	I	161	155	147
Oct.	109	133	173	219	239	272	291	168	158	155	177	158	159	146
Nov.	108	137	183	222	237	280	272	166	158	160	176	161	159	147
Dec.	111	143	187	225	237	28j	252	162	1j6	161	179	158	150	147

Yearly Average

	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927
Statist . .	131	164	212	233	249	301	193	160	157	176	165	154	148
Economist	1 8	167	212	234	244	298	190	167	170	183	175	160	155
Board of Trade:													
(Oldseries) .	127	16j	215	237	263	326							
(New series)				..		316	203	164	164	171	165	152	146

approximately the same level as in 1844 and 1881.

This general view is of course based on the average of the movements of prices of many commodities and eliminates the effects of the variations in supply and demand on the prices of particular goods. The only complete record at all easily obtainable for one nearly unchanged commodity is that of the prices of British wheat, which are shown in Table II. and fig. 1. The

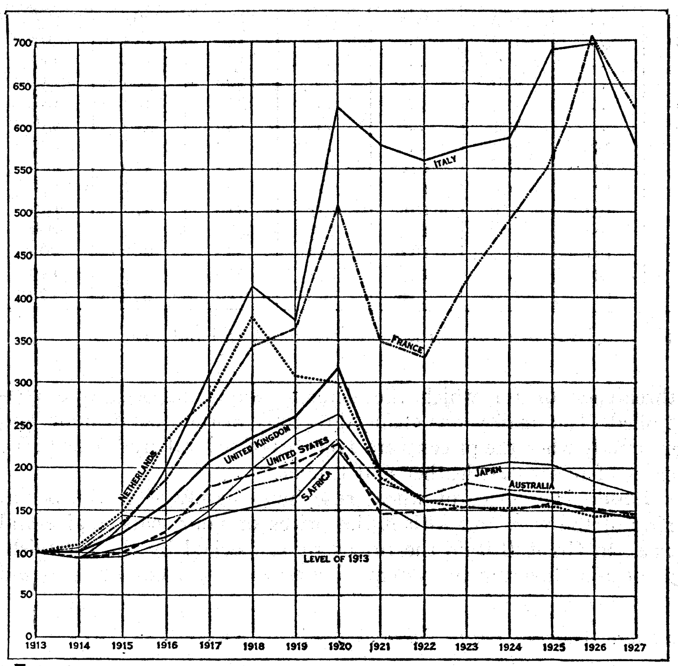


FIG. 2.—RISE AND FALL OF WHOLESALE PRICES IN EIGHT COUNTRIES FROM THE YEARS 1913–1927 INCLUSIVE

fluctuations in the price of wheat were extreme over the whole period 1782 to 1878; after the latter of these dates the increased availability of the American and other distant sources of supply partially steadied the price, which no longer was dependent on the English harvest as in the Napoleonic wars. On a broad view it is seen that the price of wheat has moved with the prices of things in general—both the general index-number and the price of wheat had in 1927 returned nearly to their levels of 1783—but the rise of wheat prices was much the greater of the two in the Napoleonic wars and much the less in the World War, while its fall was delayed in the decades following 1820. A detailed study of the diagram would show the sharp rise in prices during the Crimean War, 1854–55 (especially on wheat prices), the American Civil War, 1861–63, the Franco-Prussian War, 1870–71, and the South African War, especially in 1899–1900, as well as in the two great movements in 1790–1815 and 1913–21. Also the dates of the well-known commercial crises are marked by sudden drops of price, *e.g.* in 1825, 1836, 1839, 1847, 1857, 1873, 1880, 1891 and 1907.

It is interesting also to study the only record of retail prices that is available throughout the century, namely the price of bread in London (Table III.). It will be found on examination that there is a fairly constant relationship between the prices shown in tables II. and III. expressed by the formula:—price of the 4-lb. loaf in pence= 2·06+(number of pence per quarter of wheat÷98).

Immediately after the declaration of war in 1914 prices began to rise, and with certain interruptions continued to mount up till the spring of 1920, when the index numbers reached their maximum (Statist 323, end of April; Economist 326, end of March; Board of Trade 357, average of July). Till Oct. 1917 the increases showed a remarkable regularity, averaging 2% monthly, equivalent cumulatively to 27% per annum; on this scale the index in the successive Octobers would reach 106 in 1914, 135 in 1915, 171 in 1916, 217 in 1917 and 258 in 1918, numbers which (except the last) are in close agreement with those shown in Table IV. There was, however, a definite seasonal movement superimposed on this regularity; in the first three or four months of each year prices moved up with special rapidity, while in the summer the increase was slackened and in some cases was replaced by a fall. The check in the increase in the summer of 1917, following a specially rapid rist, is attributable to the control of prices which by that date was general. From Aug. 1917 prices continued to rise in spite of control till Sept. 1918, but the rise in these 13 months aggregated to only 13% (239 against 213).

After the armistice prices fell slowly for five months, during the season in which in previous years the increase had been specially rapid, but expectations of a permanent fall were not realized; in the year beginning April 1919, the index rose from 224 to 323, or 44%. The reaction began in the early summer of 1920, and the fall was very rapid in the following winter and continued till the end of 1921, when prices were 60% above the pre-war level, and only half those at the maximum of April 1920 by the Statist account. During the subsequent four years the movement was relatively slight, but there was a definite fall and rise in the middle of 1923, and a further rise in the latter part of 1924. The gold basis was restored in May 1925, and both in anticipation of this and after it there was a fall amounting to 10% in the whole year, till prices were 58% above 1913; equilibrium with the United States price index was reached in the latter part of 1925. In 1926 and 1927 the tendency was downwards, and in the winter 1927–28 prices were less than 50% higher than at the outbreak of war.

B. Other Countries.—The world movement of prices is best indicated by the United States index number, since in that country alone the gold basis has been maintained throughout the period 1913 to 1925. In the United States prices rose rapidly, from the year 1916 to a maximum in 1920—in April the index was 273—and then fell rapidly till the spring of 1921; after slight variations, there was a rise from June 1924 to Feb. 1925, and during the subsequent six months the number remained close to 160. The index then fell till April 1927 (144) and rose to 149 in the winter of 1927–28. In all the countries included in Table V. there was a rise from 1915 to 1920, greater or smaller according to the amount of paper money issued. In Germany and Austria the increase was so great that the numbers reached were almost incredible. After 1920 there was a fall in all the index numbers in the table; by the end of 1925 Canada, Australia, South Africa, Sweden, the Netherlands, Switzerland and Germany had returned to the gold basis, and in Canada and Europe there was a close approximation to the American index. There was a general slight fall in 1926–27. In Belgium, France and Italy depreciation recommenced in 1922, and in France and Italy prices had in 1925 passed the 1920 average. In 1936 Belgium reconstituted her currency, and in 1927 Italy and in 1928 France stabilized the exchange of lire and francs respectively. At the end of 1925 Japan was taking steps to stabilize her currency.

C. Selected Commodities.—When commodities are taken separately, the measurements can be made more exactly, subject to the two following qualifications: (1) during the war period the ordinary sources of supply were so disturbed that pre-war kinds and qualities were no longer in the market (in the Economist index number 25 out of the 44 quotations included were subject to some modification of quality); and (2) a statement of prices is generally taken as meaning the price at which a purchaser can obtain the goods he desires, and at which a merchant is willing to sell, but in the time of control and rationing these conditions did not obtain, and the price was fixed by other conditions than those which influence a free market.

Table VI. is based on the prices tabulated annually, in the *Journal* of the Royal Statistical Society, by the editor of the Statist. The index numbers have been recast, the average price in 1913 being taken as 100 for each commodity; the totals have been obtained by grouping together the separate entries on the same plan as in the original, but the change in the base year affects the results, which thus differ from those given in Table IV. in the same way as if the weights had been changed.

It is at once evident that the various prices have not followed the same course; the extremes in 1920 were house coal, whose price rose only 49% in seven years, and Java sugar, where the price is 587%. This wide divergence of itself shows that the general

TABLE V. *Index Numbers* of *Wholesale Prices.* (Average 1913 = 100.) †

Year	United Kingdom Board of Trade		United States Dept. of Labour	Canada Official	Australia, Official	South Africa, Official	Sweden		Netherlands, Official	Switzerland, Lorenz	Belgium, Official	France, Official	Italy, Bachi	Japan, bank of Japan
	Old series	New series					Svensk Handelstidning	Official						
1913	100	100	100	100	100	100	100	100	100	..	..	100	100	100
1914	100½	..	98	102	106	97	116	..	109	100	100	102	95	96
1915	123	..	101	110	147	107	145	..	146	..	..	140	133	97
1916	160	..	127	132	138	123	185	..	226	..	..	188	200	117
1917	209	..	177	179	153	141	244	..	276	..	..	262	306	149
1918	230	..	194	199	178	153	339	..	373	..	..	339	409	196
1919	255	..	206	209	189	165	330	..	304	..	..	356	366	236
1920	319	307	226	244	228	223	347	359	292	..	..	509	624	259
1921	..	197	147	172	175	160	..	222	182	191	366	345	578	200
1922	..	159	149	152	162	128	..	173	160	168	367	327	562	196
1923	..	159	154	153	179	127	..	163	151	181	497	419	575	199
1924	..	166	150	155	173	129	..	162	156	175	573	489	585	206
1925	..	159	158	160	169	128	..	161	155	162	558	555	689	202
1926	..	148	151	156	168	123	..	149	145	147	744	703	697	179
1927	..	141	147	151	167	124	..	146	148	146	615*	618	574	174

"Converting the new currency into the old at the ratio 1 to 5. †Average 1914 = 100 for Switzerland and Belgium.

index number cannot have great precision. The prices as recorded are the resultants of at least five forces, viz., the general inflation of prices, the conditions of supply and demand for the separate commodities, the control of supply, the control of prices, the change of quality. In 1915–16 the principal increases may be traced to the diminution or difficulty of supply (cereals, sugar, flax), to acuteness of demand (wool) or to both (timber). In 1917–18 the prices of nearly all commodities whose supply was threatened or for which the demand was increased were controlled. The quality was changed directly in the case of flour, and indirectly when the prices were averages of several grades, as in the cases of meat, flax, leather and timber.

Food.—The price of wheat rose immediately after the beginning of the war, and with it the prices of flour, oats, maize and rice. In Great Britain the prices were checked by the establishment of a Government system of purchase at the end of 1916 and

TABLE VI. *"Statist"* Index *Numbers. Average for Each Year. Average for 1913 Taken as 100 in Each Case*

	1919	1920	1921	1922	1923	1924	1925	1926	1927
Vegetable food:									
Wheat									
English Gazette	229	253	229	148	132	155	163	167	155
American	205	253	202	143	130	148	171	161	160
Flour, town made white	153	216	211	150	130	144	164	161	149
Barley, Gazette	278	330	200	147	124	172	154	132	154
Oats, Gazette	274	301	181	152	140	142	142	132	133
Maize, U.S. mixed	334	384	163	132	152	168¶	163¶	126¶	130¶
Potatoes, English	254	311	254	167	128	238	197	163	174
Rice, Rangoon	313	501	226	172	172	206	195	198	194
Average	255	319	208	151	138	172	169	155	156
Animal food:									
Beef: Carcass, London									
Prime	200	231	215	164	147	152	148	137	130
Middling	220	255	224	167	152	155	150	137	127
Mutton: Carcass, London									
Prime	184	233	211	202	173	180	172	144	139
Middling	203	258	224	217	192	185	176	179	142
Pork: Carcass, London	233	306	221	184	162	127	154		155
Bacon, Waterford	248	311	232	189	148	138	167	169	133
Butter, Friesland	212	253	210	170	156	177	174	145	150
Average	214	264	220	185	161	159	163	151	139
Tropical food:									
Sugar									
West Indian*	402	610	205	158	268	246**	171**	175**	173**
Beet, German*	..	..	..	148	246	213	125	123	
Java, floating cargo	400	687	202	141	224	198‡	113‡	116‡	125‡
Coffee			149						
East India*	180	183		149	145	188	190	191	177
Rio*	215	210	119	140	104	161	186	168	135
Tea									
Congo, Common*	270	..	87	172	220	182	157	156	135
Indian, good medium?	182	114	85	162	207	215	181	205	174
Average Import*	171	165	137	164	194	209	202	208	205
Average*	300	432	162	152	203	197	157	157	151
ALL FOOD: Average	250	322	203	164	161	172	164	154	149

*The entries in these cases of similar commodities are averaged before inclusion in the index numbers, †These commodities are not included in the index numbers. **White Javas, C.I.F. from 1924. ‡Raw centrifugals from 1924. ¶La Plata from 1924.

TABLE VI. (Continued).

Statist Index Numbers. Average for Each Year. Average for 1913 Taken as 100 in Each Case

	1919	1920	1921	1922	1923	1924	1925	1926	1927
Minerals:									
Iron									
Scottish pig*	215	326	257	151	165	148	127	133	123
Cleveland pig*	235	357	236	157	187	151	125	150	125
Common bars	249	366	247	145	153	161	153	148	145
Copper									
Standard	135	143	102	93	97	93	91	85	82
English tough cake†	135	153	98	90	95	92	89	86	83
Tin, Straits	128	150	85	81	102	125	133	148	151
Lead, English pig	154	209	127	141	148	187	196	168	134
Coal									
Best Yorkshire house‡	211	149	150	160	151	128	138	141‖	107
Newcastle steam†	293	330	187	159	181	143	106	105‖	96
Average export	331	572	250	173	180	168	144	134	127
Average*	218	276	172	135	144	144	140	138	124
Textiles:									
Cotton									
Middling American	280	330	134	173	218	232	180	134	136
Bhownuggar G. F.	251	240	102	141	176	194	194	136	145
Flax									
Petrograd*¶	..	..	331	279	245	353	271	191	282
Russian av. import*	423	837	287	206	205	253	293	177	179
Hemp									
Manila fair roping*	185	207	127	105	105	139	145	135	137
Petrograd clean*	388	383	..		150	213	234	196	175
Jute, good medium	189	169	104	116	98	120	187	166	129
Wool									
Merino, Port Philip*	372	444	177	217	243	297	228	203	211
Merino, Adelaide*	338	337	122	180	214	268	183	172	184
Lincoln half hogs	183	178	69	79	97	153	139	121	124
Silk Tsetlee§	236	351	241	261	220	213	164	145	140
Average*	271	319	170	167	174	209	193	155	157
Miscellaneous:									
Hides									
River Plate, dry*	182	167	78	74	76	81	92	83	99
River Plate, salted*	206	192	93	93	86	91	93	84	110
Average import*	198	233	111	93	95	100	115	108	114
Leather									
Dressing hides*	187	223	129	125	120	117	118	109	118
Average import*	211	370	240	187	163	176	171	185	192
Tallow, town	255	218	105	101	106	123	123	111	99
Oil									
Palm	197	198	105	98	103	114	115	101	97
Olive	..		..	..	134	161	149	161	207
Linseed*	375	356	129	158	173	172	175	129	128
Seeds, linseed;	306	345	159	166	171	178	177	139	191
Petroleum, refined	204	298	260	186	153	154	154	153	153
Soda, crystals	249	317	295	259	217	214	211	211	211
Nitrate of soda	216	215	165	125	117	118	116	115	109
Indigo, Bengal	332	527	416	358	273	220	209	205	200
Timber									
Hewn: average*	344	300	172	116	120	125	120	122	114
Sawn: import*	369	416	249	187	208	193	195	170	171
Average*	268	307	195	167	151	152	150	144	147
Average, materials	256	302	181/180	159	156	168	161	146	144
Average, food and materials	253	311		161	158	169	162	149	146
Statist number	242	295	183	154	152	164	161	150	144

*The entries in these cases of similar commodities are averaged before conclusion in the index numbers. †These commodities are not included in the index numbers. ‡Wallsend Hetton in 1913. ¶Livonian Z. K. from 1921. §Common New Style from 1921. ‖Average price January-April, 1926.

by the control of the prices of home-grown cereals, in 1917; with this system, flour of mixed materials was substituted for wheat-flour and the product sold at a price kept constant and relatively low by the help of a subsidy, beginning in the autumn of 1917. In the case of wheat and flour the subsidy and control continued till the beginning of 1921, but the prices rose; the prices of other cereals increased very rapidly from the autumn of 1919. An attempt was made to control the consumption of oats in 1917–18, otherwise cereals were not rationed. The wholesale price of potatoes was fixed from time to time, the Government undertaking to make good growers' losses, but the price was changed so frequently that the control had little effect. After the general fall of prices in 1920–21, the fluctuations were principally due to rather abnormal harvest vicissitudes.

During the war the price of meat increased somewhat less than that of commodities in general. Prices were fixed in Great Britain in Aug. 1917 and consumption was rationed early in 1918; after the armistice, control was gradually released, but prices of beef and mutton changed very little during the two years after the first fixing of them. After the great drop in prices in 1921–22, wholesale prices of beef and pork remained relatively low, and those of mutton high during the period 1922–25. Sugar was controlled till

TABLE VII. *Average of Retail Food Price Changes in the United Kingdom* (*Ministry of Labour Gazette*).
Level in July 1914 Taken as 100

Beginning of	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928
January	118	145	187	206	230	236	278	185	175	175	178	171	167	162
February	122	147	189	208	230	235	263	179	173	177	176	168	164	159
March	124	148	192	207	220	233	249	177	171	176	176	165	162	155
April	124	149	194	206	213	235	238	173	168	167	170	159	155	155
May	126	155	198	207	207	246	232	172	162	163	167	158	154	154
June	132	159	202	208	204	255	218	170	160	160	166	158	154	156
July	133	161	204	210	209	258	220	180	162	162	167	161	159	157
August	134	160	202	218	217	262	226	175	165	164	168	161	156	156
September	135	165	206	216	216	267	225	172	168	166	170	162	157	156
October	140	168	197	229	222	270	210	172	172	172	172	163	161	..
November	141	178	206	233	231	291	200	176	173	179	172	169	163	..
December	144	184	205	229	234	282	195	178	176	180	174	169	163	..
Year	131	160	198	215	219	256	230	176	169	170	171	164	160	..
Wholesale food (*Statist*) year	142	173	225	231	245	308	210	173	163	174	169	158	152	..

the beginning of 1921, at which date the world's supply had been adjusted to the new conditions, but the supply of beet sugar did not recover, and prices were relatively high till 1925.

Materials.—The prices of coal, iron and steel were subject to great fluctuations. Iron and steel were controlled during the war, and from Nov. 1917 till early in 1919 a subsidy was given to producers. On its removal prices rose very considerably in consequence of the great demand for construction and repairs. Subsequently there was the general collapse in prices, marked by the coal strike of 1921, partly due to the gradual return to normal conditions of the Continental coal mines and steel works. Some stimulus was given to prices by the French occupation of the Ruhr district in 1923, but by the end of 1924, it was evident that the world's capacity for coal and steel production was in excess of requirements, and prices fell to an unremunerative level. The prices of copper and tin and, in some years, of lead fell relatively to general prices.

The prices of cotton and wool reached great heights in the boom of 1920, followed by a complete collapse in 1921. During the period 1922–25 a world shortage of supply (as compared with normal requirements) kept prices on a high level, while continued fluctuations of price hampered manufacture. The extraordinary rise in the price of flax was due to the cutting off of the Polish-Russian supply, which had not recovered by the end of 1925. Space does not permit any analysis of the price movements of

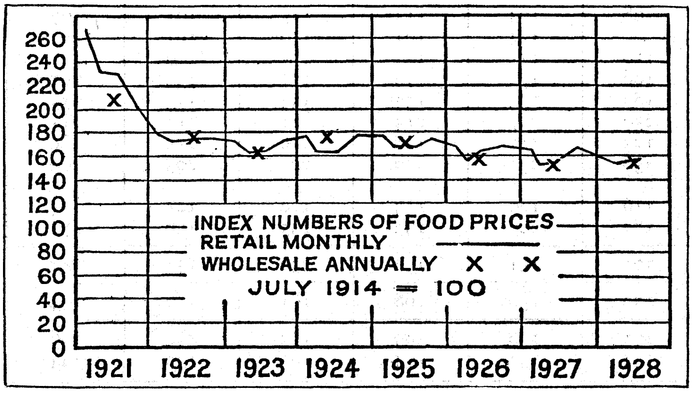


FIG. 3 — SEASONAL MOVEMENT OF PRICES OF FOOD. AND COMPARISON OF WHOLESALE AND RETAIL PRICES

miscellaneous materials, or of that of rubber, not included in the Statist list.

D. Retail Prices of Food in the United Kingdom.—Table VII. shows the movement of the Ministry of Labour's index of retail food prices. This measures the relative cost of purchasing each month exactly the same quantities and as nearly as possible the same kind of food as in a standard budget of working-class expenditure; this budget is based on an investigation made in 1904 and was modified slightly in 1914. During the period of control, 1917–19, the index is to some extent fictitious, since the quantities of the goods included could not be purchased, and generally no allowance is made for modifications of purchases when prices are changing unequally; but there is good reason to believe that these considerations are of little importance after 1920. There is a seasonal fall in the spring and rise in the autumn, owing to the inclusion of dairy produce, and in particular to the supposition that the same number of eggs are bought in January and April; but not improbably this reflects a real change in the cost of nourishment. Though the number is based on an average of prices all over the country, it is nearly applicable to all districts, since in recent years there has been increasing uniformity in prices.

The *Statist* wholesale food index is repeated (on the basis of July 1914) for comparison, though the range of commodities and their relative importance are not the same in the two numbers. The rise up to 1920 is considerably smaller in the retail index, while the concurrence since 1921 is very striking, as shown in fig. 3. Retail prices in 1921 did not fall, however, so rapidly as wholesale, and it is to be expected that their movements will be later and of a smaller amplitude than those of wholesale prices.

(A. L. B.)

United States.—The course of wholesale prices in the United States between 1890 and 1913, as measured by weighted index numbers (*see* INDEX NUMBERS) of the U.S. Bureau of Labor Statistics, is shown in Table I. below, and changes in wholesale and other prices between 1913 and 1938 are shown in Table II.

Table I. shows the drop of wholesale prices to a low point in 1896–97, following the long decline which began in 1865, and the subsequent rise, with occasional interruptions, to the beginning of the World War. Between 1896 and 1913 wholesale prices in the United States rose at an average annual rate of 2·3%. Table II. continues the story, with additional material concerning prices in other markets. In all price fields we find sharp war-time advances, drastic declines in 1920–21, moderate changes during the era of post-war prosperity from 1922 to 1929, and violent recessions during the business decline of 1929–33. Price fluctuations in the two major post-war trade cycles were greatest among wholesale prices and farm prices. In 1932–33 indexes for these groups were below the levels prevailing in 1913. Net changes during the period 1913–38 brought about wide price disparities. Living costs and the composite index of wage rates, security

TABLE I. Movements of Wholesale Prices in the United States
1890–1913
1913 = 100

1890	81	1902	84
1891	80	1903	86
1892	75	1904	86
1893	77	1905	86
1894	69	1906	89
1895	70	1907	94
1896	67	1908	90
1897	67	1909	97
1898	70	1910	101
1899	75	1911	93
1900	81	1912	99
1901	79	1913	100

TABLE II. *Movements of Various Price Indexes in the United States, 1913–38; 1913 = 100*

Year	Wholesale prices*	Farm prices†	Retail food prices$	Cost of living§	General price level¶
1913 .	100	100	100	100	100
1914 .	98	100	102	101	100
1915 .	100	97	101	102	103
1916 .	122	117	114	110	117
1917 .	168	173	146	130	139
1918 .	188	200	168	152	157
1919 .	199	211	190	176	'73
1920	221	209	211	202	193
1921 .	140	124	161	180	163
1922	138	131	151	169	158
1923	144	141	155	172	165
1924 .	140	142	154	173	166
1925	148	154	166	177	170
1926	143	144	172	179	171
1927	137	138	166	175	171
1928	138	148	164	173	176
1929 .	136	145	166	173	179
1930 .	124	125	158	169	168
1931 .	105	86	130	154	150
1932 .	93	64	108	139	132
1933 .	94	69	105	132	129
1934 .	107	89	117	137	137
1935	115	107	128	141	145
1936	116	113	130	142	154
1937 .	124	120	135	147	161
1938 .	113	94	125	145	154

*Weighted index of U.S. Bureau of Labor Statistics, based on 784 series of price quotations (550 price series prior to 1926).

†Weighted index of U.S. Bureau of Agricultural Economics, based on farm prices (*i.e.*, prices received by producers) of 47 agricultural products.

‡Weighted index of U.S. Bureau of Labor Statistics, based on the prices, at retail, of 84 articles of food in 51 cities. (The index numbers for the years 1913–18 are based on the prices of 22 articles of food, those for the years 1919–34 on the prices of 42 articles of food)

§Weighted index of U.S. Bureau of Labor Statistics, based on the cost of food, clothing, rent, fuel and lighting, house-furnishings and certain miscellaneous items.

¶Index constructed by the Federal Reserve Bank of New York. It is a weighted composite of index numbers of industrial commodity prices, equipment and machinery prices, hardware prices, automobile prices, farm prices, retail food prices, rents, other cost of living items, transportation costs, realty values, security prices and wages.

prices and commodity prices were some 50% higher than in 1913; retail food prices 25% higher; wholesale prices 13% higher; and farm prices 6% lower. These shifts reflect major changes in the internal organization of the national economy.

Details of the movements of wholesale prices in recent years are most accurately measured by the revised index of the Bureau of Labor Statistics. constructed on the 1926 base (Table III).

TABLE III. *Movements of the Level of Wholesale Prices in the United States, 1924–39, by Months*
1926 = roo

	1924	1925	1926	1927	1928	1929	1930	1931
Jan. .	roo	103	103	96	96	96	92	78
Feb.	100	104	102	96	96	95	91	77
March .	98	104	101	95	95	96	90	76
April .	97	102	100	94	97	95	90	75
May .	96	102	100	94	97	95	89	73
June .	95	103	100	94	97	95	87	72
July .	96	104	99	94	97	96	84	72
Aug.	97	104	99	95	98	96	84	72
Sept	97	103	100	96	99	96	84	71
Oct.	98	104	99	97	97	95	83	70
Nov. .	99	104	98	96	96	93	81	70
Dec.	101	103	98	96	96	93	80	69
	1932	**1933**	**1934**	**1935**	**1936**	**1937**	**1938**	**1939**
Jan. .	67	61	72	79	81	86	81	77
Feb. .	66	60	74	79	81	86	80	77
March .	66	60	74	79	80	88	80	77
April .	65	60	73	80	80	88	79	76
May	64	63	74	80	79	87	78	76
June .	64	65	75	80	79	87	78	76
July .	64	69	75	79	80	88	79	75
Aug. .	65	69	76	80	82	87	78	75
Sept. .	65	71	75	81	82	87	78	79
Oct. .	64	71	76	80	81	85	78	79
Nov. .	64	71	76	81	82	83	77	79
Dec. .	63	71	77	81	84	82	77	79

These measurements reflect the exceptional stability of the price level prior to 1929, the sustained decline of the four years following, and the fluctuations that occurred during the expansion of 1933–37 and the subsequent business movements.

TABLE IV. *Movements of Wholesale Prices of Important Commodity Groups in the United States, 1914–38; 1926 = 100*

Year	All commodities	Farm products	Foods	Hides and leather products	Textile products	Fuel and lighting	Metals and metal products	Building materials	Chemicals and drugs	House furnishing goods	Miscellaneous	Raw materials*	Semi-manufactured articles†	Finished products‡	Non-agricultural products§
1914 . .	68	71	65	71	55	57	80	53	81	57	90	68	70	68	66
1915 . .	69	71	65	75	54	52	86	53	112	56	87	67	81	69	68
1916 . .	85	84	76	93	70	74	116	68	161	61	101	83	118	82	88
1917 . .	117	129	104	124	99	105	151	88	165	74	122	123	150	109	114
1918 . .	131	148	119	126	137	109	136	99	182	93	134	136	154	125	125
1919 .	139	158	129	174	135	104	131	116	157	106	139	146	158	131	129
1920 . .	154	151	137	171	165	164	149	150	165	142	167	152	198	150	161
1921 . .	98	88	91	109	94	97	117	97	115	113	109	88	96	103	105
1922 .	97	94	88	105	100	107	103	97	100	103	93	96	99	96	102
1923 . .	101	99	93	104	111	97	109	109	101	109	100	98	119	99	104
1924 . .	98	100	91	101	107	92	106	102	99	105	94	98	109	96	100
1925 . .	103	110	100	105	108	96	103	102	102	103	109	107	105	101	103
1926 . .	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
1927 . .	95	99	97	108	96	88	96	95	97	97	91	96	94	95	94
1928 . .	97	106	101	121	95	84	97	94	96	95	85	99	94	96	93
1929 . .	95	105	100	109	90	83	100	95	94	94	83	97	94	94	92
1930 . .	86	88	90	100	80	78	92	90	89	93	78	84	82	88	85
1931 . .	73	65	75	86	66	67	84	79	79	85	70	66	69	77	75
1932 . .	65	48	61	73	55	70	80	71	73	75	64	55	59	70	70
1933 . .	66	51	60	81	65	66	80	77	73	76	62	56	65	70	71
1934 . .	75	65	70	87	73	73	87	86	76	81	70	69	73	78	78
1935 .	80	79	84	90	71	73	86	85	80	81	68	77	74	82	78
1936	81	81	82	95	71	76	87	87	80	82	70	80	76	82	80
1937 .	86	86	85	105	76	78	96	95	84	90	78	85	85	87	85
1938	79	68	74	93	67	76	96	90	78	87	73	72	75	82	82

*109 commodities; †93 commodities; $582 commodities; §618 commodities. (These numbers relate to the period 1926–38.)

Group movements of prices in wholesale markets are in Table IV. Farm and textile products suffered most severely in the business recession of 1929–32, while metals and house-furnishings showed the smallest declines. In general, as is shown in the classification based on degree of fabrication, the prices of raw materials fell most sharply, while those of finished goods showed the smallest declines. The subsequent record is one of general improvement, though farm products and raw materials generally remained at relatively low price levels and metal products, building materials and finished goods, particularly products of the heavy industries, remained high in price. This sharp discrepancy, which means at once low purchasing power on the part of agricultural producers and high costs in the markets for building materials and new investment generally, constitutes one of the persistent obstacles to enduring economic recovery.

The most comprehensive collection of price quotations on individual commodities is that compiled by the United States Bureau of Labor Statistics, and available in monthly releases of that agency. Quotations on important individual commodities are published in numerous trade papers and commercial journals.

(F. C. Mi.)

BIBLIOGRAPHY.—*Value, Price and Profit*, ed., E. M. Aveling (1898); F. W. P. Lawrence, *Why Prices rise and fall* (1920); P. Koch, *Les Variations du pouvoir d'achat de l'unite monetaire nationale . . . du 11 Nov. 1918 au Ier Jan. 1922* (Bordeaux, 1924); M. Bowniatian, *La Loi de variation de la valeur et les movements generaux des prix* (1927); J. A. Todd, *The Science of Prices* (2nd ed. 1927); A. J. W. Keppel, *The Theory of the Cost-Price System* (1928); G. Cassel, *Post-War Monetary Stabilization* (1929); J. S. Lawrence, *Stabilization of Prices* (1929); Annual *Bulletins* on Wholesale Prices, U.S. Bureau of Labor Statistics; Arthur W. Marget, *The Theory of Prices* (1938); F. C. Mills, *The Behavior of Prices* (1927), *Prices in Recession and Recovery* (1936); W. C. Mitchell, "The Making and Using of Index Numbers," Part I, *Bulletin 284*, U.S. Bureau of Labor Statistics (1921); F. L. Thompson, *Agricultural Prices* (1936); George F. Warren and Frank A. Pearson, *Prices* (1933).

PRICHARD, JAMES COWLES (1786–1848), English physician and ethnologist, was born on Feb. 11, 1786, at Ross, Herefordshire. He adopted medicine as a profession mainly because of the facilities it offered for anthropological investigations. He took his M.D. at Edinburgh, afterwards reading for a year at Trinity College, Cambridge, whence, joining the Church of England, he migrated to St. John's College, Oxford, afterwards entering as a gentleman commoner at Trinity College, Oxford, but taking no degree in either university. In 1810 he settled at Bristol as a physician, and in 1813 published his *Researches into the Physical History of Man*. The central principle of the book is the primitive unity of the human species, acted upon by causes which have since divided it into permanent varieties or races.

In 1843 was published his *Natural History of Man.* Prichard may fairly be called the founder of the English branch of the sciences of anthropology and ethnology. In 1811 he was appointed physician to St. Peter's hospital, Bristol, and in 1814 to the Bristol infirmary. In 1822 he published a *Treatise on Diseases of the Nervous System*, and in 1835 a *Treatise on Insanity and other Disorders affecting the Mind*, in which he advanced the theory of the existence of a distinct mental disease, "moral insanity." In 1842, following up this suggestion, he published *On the different forms of Insanity in relation to Jurisprudence designed for the use of Persons concerned in Legal Questions regarding Unsoundness of Mind*. In 1845 he was made a commissioner in lunacy, and removed to London. He died there on Dec. 23, 1848. At the time of his death he was president of the Ethnological Society and a fellow of the Royal Society.

See Memoir by Dr. Thomas Hodgkin (1798–1866) in the *Journal of the Ethnological Society* (Feb. 1849); Memoir read before the Bath and Bristol branch of the Provincial Medical and Surgical Association (March 1849) by Dr. J. A. Symonds *Journ. Eth. Soc.*, (1850); *Prichard and Symonds in Special Relation to Mental Science*, by Dr. Hack Tuke (1891).

PRICKLY ASH (*Zanthoxylum americanum*), a North American shrub or small tree of the rue family (Rutaceae), called also toothache tree, found in woods and thickets from Quebec to Minnesota and southward to Virginia and Missouri. While usually a shrub, it sometimes attains a height of 2j ft. and a trunk diameter of 6 inches. It bears alternate, pinnate leaves, composed of from 5 to 11 ovate, dark green, somewhat pointed leaflets, with the twigs and leaf-stalks usually prickly. The small greenish flowers, which appear before the leaves in early spring, are borne in short axillary clusters; the fruit is a black ellipsoid capsule about $\frac{1}{6}$ in. long, containing one or two seeds.

The similar but larger Herculesclub (*Z. clavaherculis*), known also as sea ash and pepperwood, occurs along streams from southern Virginia to Florida west to Kansas and Texas.

PRICKLY LETTUCE (*Lactuca scariola*), an annual or biennial herb of the family Compositae, closely allied to the garden lettuce (*q.v.*), native to Europe and widely distributed in temperate regions as a naturalized weed. It is a whitish green, usually smooth plant, with a stiff, erect stem, 2 to 7 ft. high, bearing oblong, more or less toothed or cut leaves, with spiny midribs and edges, usually clasping the stem by a more or less eared or heart-shaped base. The very numerous heads of yellow flowers are borne in a large open panicle.

The plant is noteworthy in that the leaves exhibit a marked tendency to become vertical. Moreover, when growing in open places, equally exposed to the sun during either half of the day, the vertical leaves often assume a north and south direction. Because of this characteristic the designation compass-plant is sometimes applied to this species of lettuce, as it also is to various other plants of similar habit.

PRICKLY PEAR, the name given to cacti of the genus *Opuntia,* from the appearance of their fruit. There are about 250 species, all originally American, but several have been introduced elsewhere and, in some places (*e.g.,* Australia), have overrun the countryside. Most species have flattened, jointed stems, and the flowers are white or red. The prickly pear proper is *O. vulgaris; O. Ficus-indica* is Indian fig. The fruit of both of these forms is edible. *O. subulata* is remarkable in that the leaves are large and functional. From *O. tuna,* the tuna hedges are grown in the West Indies, where it is also used as a food plant for the cochineal insect (*Coccus cacti*). (*See* CACTUS)

PRIDE, THOMAS (d. 1658), Parliamentarian general in the English Civil War, is stated to have been brought up by the parish of St. Bride's, London. Subsequently he was a drayman and a brewer. At the beginning of the Civil War he served as a captain under the earl of Essex, and was gradually promoted to the rank of colonel. He distinguished himself at the battle of Preston, and with his regiment took part in the military occupation of London in December 1648, which was the first step towards bringing the king to trial. Pride is chiefly remembered for the expulsion (Dec. 6, 1648) of the Presbyterian and Royalist elements in the House of Commons. This, resolved by the army council and ordered by the lord general, Fairfax, was carried out by Colonel Pride's regiment. Taking his stand at the entrance of the House of Commons with a written list in his hand, he caused the arrest or exclusion of the obnoxious members, who were pointed out to him. After about a hundred members had been thus dealt with ("Pride's Purge"), the mutilated House of Commons proceeded to bring the king to trial. Pride was one of the judges of the king and signed his death-warrant, appending to his signature a seal showing a coat of arms. He commanded an infantry brigade under Cromwell at Dunbar and Worcester. He took no conspicuous part in Commonwealth politics, except in opposing the proposal to confer the kingly dignity on Cromwell. He was knighted by the Protector in 1656, and was also chosen a member of the new House of Lords. He died at Nonsuch House, Surrey, on Oct. 23, 1658. After the Restoration his body was ordered to be dug up and suspended on the gallows at Tyburn along with those of Cromwell, Ireton and Bradshaw, though it is said that the execution of this sentence was evaded.

See Noble, *Lives of the Regicides;* Bate, *Lives of the Prime Actors and Principal Contrivers of the Murder of Charles I.;* Carlyle, *Cromwell's Letters and Speeches.*

PRIDEAUX, HUMPHREY (1648–1724), English divine and Oriental scholar, born at Place, Cornwall, on May 3, 1648, was educated at Westminster School and Christ Church, Oxford. His account of the famous Arundel marbles just given to the university, *Marmora Oxoniensia* (1676), won for him the favour of Heneage Finch, who secured his rapid preferment. Prideaux held several livings, was Hebrew lecturer at Christ Church (1679–86), and dean of Norwich (1702–24). He died on Nov. 1, 1724.

Prideaux's most important work was The Old and New Testament connected in the History of the Jews (1716), which not only displayed but stimulated research.

A volume of his letters to John Ellis, some time under-secretary of state, was edited by E. M. Thompson for the Camden Society in 1875; they contain a vivid picture of Oxford life after the Restoration. For a complete list of his printed and ms. work see Bibliotheca *Cornubiensis* (ii., 527–533 and iii. 1319).

PRIDE OF CALIFORNIA (Latkyrus *splendens*), a name given to a North American plant of the pea family (Leguminosae), native to the mountains of southern California, called also campo pea. It is closely allied to the sweet pea of the gardens, and bears showy clusters of brilliant red flowers.

PRIENE (mod. *Samsun* kale), an ancient city of Ionia on the foot-hills of Mycale, about 6 m. N. of the Maeander. It was formerly on the sea coast, but now lies some miles inland. It is said to have been founded by Ionians under Aegyptus, a son of Neleus. Sacked by Ardys of Lydia, it revived and attained great prosperity under its "sage," Bias, in the middle of the 6th century. Cyrus captured it in 545; but it was able to send twelve ships to join the Ionian revolt (500–494). Disputes with Samos, and the troubles after Alexander's death, brought Priene low, and Rome had to save it from the kings of Pergamum and Cappadocia in 155. Orophernes, the rebellious brother of the Cappadocian king, who had deposited a treasure there and recovered it by Roman intervention, restored the temple of Athena as a thank-offering. Under Roman and Byzantine dominion Priene had a prosperous history. It passed into Muslim hands late in the 13th century. The ruins, which lie on successive terraces, were excavated mainly in the late 19th century. The city, as rebuilt in the 4th and 3rd centuries, was laid out on a rectangular scheme. It faced south, its acropolis rising nearly 700 ft. behind it. The whole area was enclosed by a wall 7 ft. thick with towers at intervals and three principal gates. On the lower slopes of the acropolis was a shrine of Demeter. The town had six main streets, about 20 ft. wide, running east and west and fifteen streets about 10 ft. wide crossing at right angles, all being evenly spaced; and it was thus divided into about So *insulae*. Private houses were apportioned four to an *insula*. The systems of water-supply and drainage can easily be discerned. The houses present many analogies with the earliest Pompeian. In the western half of the city, on a high terrace north of the main street and approached by a fine stairway, was the temple of Athena Polias, a hexastyle peripteral Ionic structure built by Pythias, the architect of the Mausoleum. Under the basis of the statue of Athena were found in 1870 silver tetradrachms of Orophernes, and some jewellery, probably deposited at the time of the Cappadocian restoration. Fronting the main street is a series of halls, and on the other side is the fine market place. The municipal buildings, Roman gymnasium, and well preserved theatre lie to the north, but, like all the other public structures, in the centre of the plan. Temples of Isis and Asclepius have been excavated. At the lowest point on the south, within the walls, was the large stadium, connected with a gymnasium of Hellenistic times.

See Society of Dilettanti, Ionian Antiquities (1821), vol. ii.; Th. Wiegand and H. Schrader, *Priene* (1904); on inscriptions (360) see Hiller von Gartringen, Znschriften von *Priene* (Berlin, 1907), with collection of ancient references to the city.

PRIEST, the contracted form of "presbyter" (*πρεσβύτερος*, "elder"; see PRESBYTER), a name of office in the early Christian Church, already mentioned in the New Testament. But in the English bible the presbyters of the New Testament are called "elders," not "priests"; the latter name is reserved for ministers of pre-Christian religions. The reason of this will appear more clearly in the sequel; it is enough to observe at present that, before our English word was formed, the original idea of a presbyter had been overlaid with others derived from pre-Christian priesthoods, so that it is from these and not from the etymological force of the word that we must start in considering historically what a priest is. The theologians of the Greek and Latin churches expressly found the conception of a Christian priesthood on the hierarchy of the Jewish temple, while the names by which the sacerdotal character is expressed—*ἱερεύς*, sacerdos—originally designated the ministers of sacred things in Greek and Roman heathenism, and then came to be used as translations into Greek and Latin of the Hebrew *kōhēn*. *Kōhēn*, *ἱερεύς*, sacerdos, are, in fact, fair translations of one another; they all denote a minister whose stated business was to perform, on behalf of the community, certain public ritual acts, particularly sacrifices, directed Godwards. Such ministers or priests existed in all the great religions of ancient civilization.

Early Priesthoods.—Among the Babylonians and Assyrians magic and soothsaying were intertwined with priestly functions, as was the case in early Hebrew pre-exilian days with the *Kōhēn*. The bark (from bark to see, inspect) was a soothsaying priest who was consulted whenever any important undertaking was proposed, and addressed his inquiries to Samaš the sun god (or Adad) as *bêl* biri or lord of the oracle (accompanied by the sacrifice of lambs). (See OMEN and DIVINATION.)

As contrasted with the bark or soothsaying priest we have the *ašipu,* who was the priest-magician who dealt in conjurations (*šiptu*), whereby diseases were removed, spells broken, or in expiations whereby sins were expiated. Now, as the conjurations were addressed to the deity, *ašipu,* according to the definition given above, comes more reasonably under the category of priest. In Babylonia priesthoods were endowed with great wealth and power, and even the king stood in awe of them. (See Johns, Babylonian and Assyrian Laws, Contracts *and* Letters, p. 212 sqq.) These powerfully-organized priesthoods, as well as the elaborate nature of their ritual and apparatus of worship, must have deeply and permanently impressed the exiled Jewish community. Thus arose the more developed system of Ezekiel's scheme (xl.–xlviii.) and of the Priestly code and the high dignity which became attached to the person of the High Priest (reflected in the narrative of Uzziah's leprosy in 2 Chron. xxvi. 16–20).

Among the ancient Egyptians the local god was the protector and lord of the district. Consequently it was the interest and duty of the inhabitants to maintain the cultus of the patron-deity of their city who dwelt in their midst. Moreover, in the earlier times we find the prince of the nome acting as the High Priest of the local god, but in course of time the state. represented by the king, began to an ever-increasing degree to take oversight over the more important local cults. Thus we find that the Egyptian monarch was empowered to exercise priestly functions before all the gods. We constantly see him in the wall-paintings, portrayed as a priest in the conventional attitudes before the images of the gods. In the chief sanctuaries the chief priests possessed special privileges, and it is probable that those in the immediate entourage of the king were elected to these positions. The highest nobility in the nome sought the honour of priesthood in the service of the local deity. One special class called kher *heb* was charged with reciting the divine formulae. which were popularly held to possess magical virtue. In the middle empire (VIIth to XIIth Dynasties) the lay element maintains its position in religious cultus despite its complexity. But under the new empire (Dynasties XVIIIth and following) the professional priest had attained to ominous power. Priests increased in number and were divided into ranks; temples possessed larger estates and became more wealthy.

Ancient Greece.—Homer speaks of special priests who preside over ritual acts in the temples to which they are attached; but his kings also do sacrifice on behalf of their people. The king, in fact, both in Greece and in Rome, was the acting head of the state religion, and when the regal power came to an end his sacred functions were not transferred to the ordinary priests, but either they were distributed among high officers of state, as archons and prytanes, or the title of "king" was still preserved as that of a religious functionary, as in the case of the rex *sacrorum* at Rome and the *archon basileus* at Athens. In the domestic circle the union of priesthood and natural headship was never disturbed; the Roman paterfamilias sacrificed for the whole family. On the other hand, gentes and *phratriae,* which had no natural head, had special priests chosen from their members; for every circle of ancient society, from the family up to the state, was a religious as well as a civil unity, and had its own gods and sacred rites. We cannot speak of priestly power and hardly even of a distinct priestly class.

In Greece the priest, so far as he is an independent functionary and not one of the magistrates, is simply the elected or hereditary minister of a temple charged with "those things which are ordained to be done towards the gods" (see Aristotle, Pol. vi. 8), and remunerated from the revenues of the temple, or by the gifts of worshippers and sacrificial dues. The position was often lucrative and always honourable, and the priests were under the special protection of the gods they served. But their purely ritual functions gave them no means of establishing a considerable influence on the minds of men, and the technical knowledge which they possessed as to the way in which the gods could be acceptably approached was neither so intricate nor so mysterious as to give the class a special importance. There was, indeed, one sacred function of great importance in the ancient world in which the Greek priests had a share. As man approached the gods in sacrifice and prayers, so too the gods declared themselves to men by divers signs and tokens, which it was possible to read by the art of Divination (*q.v.*). In many nations divination and priesthood have always gone hand in hand; at Rome, for example, the augurs and the XV. viri *sacrorum,* who interpreted the Sibylline books, were priestly colleges. In Greece, on the other hand, divination was not generally a priestly function, but it did belong to the priests of the Oracles. (See ORACLE.) The great oracles, however, were of Panhellenic celebrity and did not serve each a particular state, and so in this direction also the risk of an independent priestly power within the state was avoided.

In Rome, again, where the functions of the priesthood were politically much more weighty, where the technicalities of religion were more complicated, where priests interpreted the will of the gods, and where the pontiffs had a most important jurisdiction in sacred things, the state was much too strong to suffer these powers to escape from its own immediate control: the old monarchy of the king in sacred things descended to the inheritors of his temporal power; the highest civil and religious functions met in the same persons (cf. Cic. De dom. i. 1); and every priest was subject to the state exactly as the magistrates were, referring all weighty matters to state decision and then executing what the one supreme power decreed. And it is instructive to observe that when the plebeians extorted their full share of political power they also demanded and obtained admission to every priestly college of political importance, to those, namely, of the pontiffs, the augurs, and the XV. viri *sacrorum.* The Romans, it need hardly be said, had no hereditary priests.

Aryan Religions.—In historical times the priesthood in India is rigidly confined to members of the Brahman caste. But at an earlier date the warrior caste often became priests. The power of the priesthood began with the delegation by the king of his sacrificial duties to an appointed official. This power grew with the growing importance of the sacrifice and the complication of its ceremonial. In the post-Vedic period "right" or "wrong" simply meant the exact performance or the neglect, whether intentional or unintentional-of all the details of a prescribed ritual, the centre of which was the sacrifice. At this period the priestly caste gained its unbounded power over the minds of men. For further details as to the development of the priestly caste and wisdom in India the reader must refer to BRAHMANISM.

Among the Zoroastrian Iranians, as among the Indian Aryans, the aid of a priest to recite the sacrificial liturgy was necessary at every offering (Herod. i. 132), and the Iranian priests (âthravans, later **Magi)** claimed, like the Brahmans, to be the highest order of society; but they did not acquire the powers of the Indian priesthood; in particular, the priesthood, as it was not based on family tradition, did not form a strict hereditary caste. Nevertheless, it formed a compact hierarchy not inferior in influence to the clergy of the Christian middle ages, had great power in the state, and were often irksome even to the great king. But the monarchs had one strong hold on the clergy by retaining the patronage of great ecclesiastical places.

The Persian religion throughout all its multitude of purifications, observances and expiations was a constant warfare against impurity, death and the devil. Amid all the ceremonialism of its priesthood there were also high ideals set forth in Zoroastrian religion of what a priest should be. Thus we read in Vendidâd xviii., "Many there be, noble Zarathustra, who bear the mouth bandage, who have yet not girded their loins with the law. If such a one says 'I am an Athravan' he lies, call him not Athravan, noble Zarathustra, said Ahura Mazda; but thou shouldst call him priest, noble Zarathustra, who sits awake the whole night through and yearns for holy wisdom that enables man to stand on death's bridge fearless and with happy heart, the wisdom whereby he attains the holy and glorious world of paradise."

Semitic Races.—Among the nomadic Semites there was no developed priesthood. Religion partook of the general simplicity of desert life; apart from the private worship of household gods and the oblations and salutations offered at the graves of departed kinsmen, the ritual observances of the ancient Arabs were visits to the tribal sanctuary to salute the god with a gift of first-fruits or the like (see NAZARITE and PASSOVER), and an occasional pilgrimage to discharge a vow at the annual feast and fair of one of the more distant holy places. (See MECCA.) These acts required no priestly aid; each man slew his own victim and divided the sacrifice in his own circle; the share of the god was the blood which was smeared upon or poured out beside the stone set up as an altar or perhaps as a symbol of the deity. We find therefore no trace of a sacrificial priesthood, but each temple had one or more doorkeepers, whose office was usually hereditary and who had the charge of the Temple and its treasures.

The sacrifices and offerings were acknowledgments of divine bounty and means used to ensure its continuance; the Arab was the "slave" of his god and paid him tribute, as slaves used to do to their masters, or subjects to their lords; and the free Bedouin, trained in the solitude of the desert to habits of absolute self-reliance, knew no master except his god. The decision of the god might be uttered in omens which the skilled could read, or conveyed in the inspired rhymes of soothsayers, but frequently it was sought in the oracle of the sanctuary, where the sacred lot was administkred for a fee by the *sādin.* The sanctuary thus became a seat of judgment, and here, too, compacts were sealed by oaths and sacrificial ceremonies. These institutions, though known to us only from sources belonging to an age when the old faith was falling to pieces, are certainly very ancient. The fundamental type of the Arabic sanctuary can be traced through all the Semitic lands, and so appears to be older than the Semitic dispersion.

With the beginning of a settled state the sanctuaries rose in importance and all the functions of revelation gathered round them. A sacrificial priesthood arose as the worship became more complex (especially as sacrifice in antiquity is a common preliminary to the consultation of an oracle), but the public ritual remained closely associated with oracle or divination, and the priest was, above all things, a revealer. That this was what actually happened may be inferred from the fact that the Canaanite and Phoenician name for a priest (*kōhēn*) is identical with the Arabic *kāhin,* a "soothsayer." Soothsaying was no modern importation in Arabia; its characteristic form—a monotonous croon of short rhyming clauses—is the same as was practised by the Hebrew "wizards who peeped and muttered" in the days of Isaiah. The *kāhin,* therefore, is not a degraded priest but such a soothsayer as is found in most primitive societies, and the Canaanite priests grew out of these early revealers. In point of fact some form of revelation or oracle appears to have existed in every great shrine of Canaan and Syria, and at Hierapolis it was the charge of the chief priest, just as in the Levitical legislation.

The Hebrews, who made the language of Canaan their own, took also the Canaanite name for a priest. But the earliest forms of Hebrew priesthood are not Canaanite in character; the priest, as he appears in the older records of the time of the Judges, Eli at Shiloh, Jonathan in the private temple of Micah and at Dan, is more like the *sādin* than the *kāhin*. The whole structure of Hebrew society at the time of the conquest was almost precisely that of a federation of Arab tribes, and the religious ordinances are scarcely distinguishable from those of Arabia, save only that the great deliverance of the Exodus and the period when Moses, sitting in judgment at the sanctuary of Kadesh, had for a whole generation impressed the sovereignty of Jehovah on all the tribes, had created an idea of unity between the scattered settlements in Canaan such as the Arabs before Mohammed never had. But neither in civil nor in religious life was this ideal unity expressed in fixed institutions, the old individualism of the Semitic nomad still held its ground. Thus the firstlings, first-fruits and vows are still the free gift of the individual which no human authority exacts, and which every householder presents and consumes with his circle in a sacrificial feast without priestly aid.

As in Arabia, the ordinary sanctuary is still a sacred stone set up under the open heaven, and here the blood of the victim is poured out as an offering to God. (See especially 1 Sam. xiv. 34, and cf. 2 Sam. xxiii. 16, 17.) The priest has no place in this ritual: he is not the minister of an altar; but the guardian of a temple, such as was already found here, and there in the land for the custody of sacred images or other consecrated things (the ark at Shiloh, 1 Sam. iii. 3; images in Micah's temple, Judges xvii. 5; Goliath's sword lying behind the "ephod" or plated image at Nob, 1 Sam, xxi. g; no doubt also money, as in the Canaanite temple at Shechem, Judges ix. 4). Such treasures required a guardian; but, above all, wherever there was a temple there was an oracle, a kind of sacred lot, just as in Arabia (1 Sam. xiv. 41, lxx.), which could only be drawn where there was an "ephod" and a priest (1 Sam. xiv. 18, Sept., and xxiii. 6 seq.). The Hebrews had already possessed a tent-temple and oracle of this kind in the wilderness (Exod. xxxiii. 7 seq.), and ever since that time the judgment of God through the priest at the sanctuary had a greater weight than the word of a seer, and was the ultimate solution of every controversy and claim (1 Sam, ii. 25; Exod. xxi. 6, xxii. 8, g, where for "judge," "judges," of A.V. read "God" with R.V.).

The temple at Shiloh, where the ark was preserved, was the lineal descendant of the Mosaic sanctuary and its priests claimed kin with Moses himself. In the divided state of the nation, indeed, this sanctuary was hardly visited from beyond Mt. Ephraim; and every man or tribe that cared to provide the necessary apparatus (ephod, teraphim, etc.) and hire a priest might have a temple and oracle of his own at which to consult Jehovah (Judges xvii., xviii.); but there was hardly another sanctuary of equal dignity. The priest of Shiloh is a much greater person than Micah's priest Jonathan; at the great feasts he sits enthroned by the doorway, preserving decorum among the worshippers; he has certain legal dues, and, if he is disposed to exact more, no one ventures to resist (1 Sam. ii. 12 *seq.*, where the text needs a slight correction). The priestly position of the family survived the fall of Shiloh and the capture of the ark, and it was members of this house who consulted Jehovah for the early kings until Solomon deposed Abiathar.

Ultimately, indeed, as sanctuaries were multiplied and the priests all over the land came to form one well-marked class, "Levite" and legitimate priest became equivalent expressions, as is explained in the article LEVITES. But between the priesthood of Eli at Shiloh or of Jonathan at Dan and the priesthood of the Levites as described in Deut. xxxiii. 8 seq. there lies a period of the inner history of which we know almost nothing. It is plain that the various priestly colleges regarded themselves as one order, that they had common traditions of law and ritual which were traced back to Moses, and common interests which had not been vindicated without a struggle. The kingship had not deprived them of their functions as fountains of divine judgment (cf. Deut. xvii. 8 seq.); on the contrary, the decisions of the sanctuary had grown up into a body of sacred law, which the priests administered according to a traditional precedent. According to Semitic ideas the declaration of law is quite a distinct function from the enforcing of it, and the royal executive came into no collision with the purely declaratory functions of the priests. The invective of Hos. iv. equally with the eulogium of Deut. xxxiii. proves that the position which the later priests abused had been won by ancestors who earned the respect of the nation as worthy representatives of a divine Torah.

The ritual functions of the priesthood still appear in Deut. xxxiii. as secondary to that of declaring the sentence of God, but they were no longer insignificant. With the prosperity of the nation, and especially through the absorption of the Canaanites and of their holy places, ritual had become much more elaborate, and in royal sanctuaries at least there were regular public offerings maintained by the king and presented by the priests. (Cf. 2 Kings xvi. 15.) Private sacrifices, too, could hardly be offered without some priestly aid now that ritual was more complex; the provision of Deut. xviii. as to the priestly dues is certainly ancient, and shows that besides the tribute of first-fruits and the like the priests had a fee in kind for each sacrifice, as we find to have been the case among the Phoenicians according to the sacrificial tablet of Marseilles. Their judicial functions also brought profit to the priests, fines being exacted for certain offences and paid to them (2 Kings xii. 16: Hos. iv. 8: Amos ii. 8). The greater priestly offices were therefore in every respect very important places, and the priests of the royal sanctuaries were among the grandees of the realm (2 Sam. viii. 18; 2 Kings x. 11, xii. 2); but there is not the slightest trace of an hereditary hierarchy officiating by divine right, such as existed after the exile. The sons of Zadok, the priests of the royal chapel, were the king's servants as absolutely as any other great officers of state; they owed their place to the fiat of King Solomon, and the royal will was supreme in all matters of cultus (2 Kings xii., xvi. 10 seq.); indeed the monarchs of Judah, like those of other nations, did sacrifice in person when they chose down to the time of the captivity (1 Kings ix. 25; 2 Kings xvi. 12 seq.; Jer. xxx. 21).

The detailed steps which prepared the way for the post-exile hierarchy, the destruction of the northern sanctuaries and priesthoods by the Assyrians, the polemic of the spiritual prophets against the corruptions of popular worship, which issued in the reformation of Josiah, the suppression of the provincial shrines of Judah and the transference of their ministers to Jerusalem, the successful resistance of the sons of Zadok to the proposal to share the sanctuary on equal terms with these new-comers, and the theoretical justification of the degradation of the latter to the position of mere servants in the Temple supplied by Ezekiel soon after the captivity, need not here be dealt with. Already in the time of Josiah altar service and not the judicial or "teaching" function had become the essential thing in priesthood (Deut. x. 8, xviii. 7); the latter, indeed, was not forgotten (Jer. ii. 8, xviii. 18), but by the time of Ezekiel it also has mainly to do with ritual, with the distinction between holy and profane, clean and unclean, with the statutory observances at festivals and the like (Ezek. xliv. 23 seq.). What the priestly Torah was at the time of the exile can be seen from the collection of laws in Lev. xvii.–xxvi., which includes many moral precepts, but regards them equally with ritual precepts from the point of view of the maintenance of national holiness. The holiness of Israel centres in the sanctuary, and round the sanctuary stand the priests, who alone can approach the most holy things without profanation, and who are the guardians of Israel's sanctity, partly by protecting the one meeting-place of God and man from profane contact, and partly as the mediators of the continual atoning rites by which breaches of holiness are expiated. In the old kingdom the priests had shared the place of the prophets as the religious leaders of the nation; under the second Temple they represented the unprogressive traditional side of religion, and the leaders of thought were the psalmists and the scribes, who spoke much more directly to the piety of the nation.

But, on the other hand, the material influence of the priests was greater than it had ever been before; the Temple was the only visible centre of national life in the ages of servitude to foreign power, and the priests were the only great national functionaries, who drew to themselves all the sacred dues as a matter of right and even appropriated the tithes paid of old to the king. When the High Priest stood at the altar in all his princely state, when he poured out the libation amidst the blare of trumpets, and the singers lifted up their voices and all the people fell prostrate in prayer till he descended and raised his hands in blessing, the slaves of the Greek or the Persian forgot for a moment their bondage and knew that the day of their redemption was near (Ecclus. l.). The High Priest at such a moment seemed to embody all the glory of the nation, as the kings had done of old, and when the time came to strike a successful blow for freedom it was a priestly house that led the nation to the victory which united in one person the functions of High Priest and prince. From the foundation of the Hasmonean state to the time of Herod the history of the high-priesthood merges in the political history of the nation; from Herod onward the priestly aristocracy of the Sadducees lost its chief hold over the nation and expired in vain controversy with the Pharisees.

The influence of the Hebrew priesthood on the thought and organization of Christendom was the influence not of a living institution, for it hardly began till after the fall of the Temple, but of the theory embodied in the Priestly Code of the Pentateuch. Two points in this theory were laid hold of—the doctrine of priestly mediation and the system of priestly hierarchy. The first forms the text of the principal argument in the Epistle to the Hebrews, in which the author demonstrates the inadequacy of the mediation and atoning rites of the Old Testament, and builds upon this demonstration the doctrine of the effectual high-priesthood of Christ, who, in His sacrifice of Himself, truly "led His people to God," not leaving them outside as He entered the heavenly sanctuary, but taking them with Him into spiritual nearness to the throne of grace.

The idea that presbyters and bishops are the successors of the Old Testament priesthood first appears in full force in the writings of Cyprian. The further development of the notion of Christian priesthood was connected with the view that the Eucharist (*q.v.*) is a propitiatory sacrifice which only a consecrated priest can perform. It is sufficient to remark here that the presentation of the sacrifice of the mass came to be viewed as the essential priestly office, so that the Christian presbyter really was a *sacerdos* in the ancient sense. Protestants, in rejecting the sacrifice of the mass, deny also that there is a Christian priesthood "like the Levitical," and have either dropped the name of "priest" in reference to any specific office, or use it in a quite emasculated sense.

BIBLIOGRAPHY.—For non-Christian religions, *see* articles under heading "Priest" in Hastings, *Encyclopaedia of Religion and Ethics*, vol. x., by various writers, where many references are given under each division of the subject; and with special reference to Christianity, *see ibid.* vol. viii., article "Ministry" by A. J. Maclean, and the art. CHRISTIANITY. For an official statement from the Roman Catholic point of view, *see* article "Priest" and related topics in the *Catholic Encyclopedia.* The literature of the subject, both theological and historical, is very extensive; only a limited number of typical references can be given here: J. G. Frazer, *The Golden Bough,* third edition (esp. part i. "The Magic Art and the Evolution of Kings"); M. Jastrow, *Die Religion Babyloniens* u. *Assyriens* (1905–12); H. Hackmann, *Buddhism as* a *Religion* (Eng. tr. 1910); R. F. Johnson, *Buddhist China* (1913); J. H. Breasted, *A History of Egypt* (1906); J. E. Harrison, *Themis* (1912); W. Robertson Smith, *Religion of the Semites* (first publ. 1889); J. Wellhausen, *Proleg. zur Geschichte Israel's* (6th ed. 1905); E. W. Hopkins, *The Religions of India* (1896); J. H. Moulton, *Early Zoroastrianism* (1913); W. W. Fowler, *The Religious Experience of the Roman People* (1911). The work of W. Robertson Smith and J. G. Frazer is epoch-making and fundamental for all further study.

PRIESTLEY, JOSEPH (1733–1804), English chemist and Nonconformist minister, was born on March 13, 1733, at Fieldhead, a hamlet in the West Riding of Yorkshire. His father, Jonas Priestley, a woollen-cloth dresser of moderate means, was a Nonconformist. At the age of 12 the son was sent to a neighbouring grammar school, but later Kirkby, a minister at Heckmondwike, took entire charge of his education. From the age of 16 to nearly 20 he worked at Chaldee and Syriac, began to read Arabic, and mastered 'S Gravesande's *Natural Philosophy,* together with various textbooks of logic and metaphysics. He also learned French, German and Italian. In 1752 he went to Daventry to attend the Nonconformist academy there.

In 1755 he was appointed to a small congregation at Needham Market, in Suffolk. In 1758 he obtained a more congenial congregation at Nantwich, where he opened a school at which the elementary lessons were varied with experiments in natural philosophy. Three years later he removed to Warrington as classical tutor in a new academy, and there he attended lectures on chemistry by Dr. M. Turner of Liverpool and pursued the studies in electricity which gained him the fellowship of the Royal Society in 1766 and supplied him with material for his *History of Electricity.* In 1767 he was appointed to the charge of Mill Hill Chapel at Leeds, where he wrote many political tracts attacking the Government policy towards the American colonies. He also began his researches into "different kinds of airs," getting a plentiful supply of "fixed air" from a brewery next door to his house.

In 1772, the year in which he was chosen a foreign associate of the French academy of sciences, Priestley accepted the position of librarian and literary companion to Lord Shelburne (afterwards 1st Marquess of Lansdowne) at Calne, with a salary of £250 a year and a house. He travelled with his patron on the Continent and in Oct. 1774 he met Lavoisier and his friends in Paris and gave them an account of the experiment by which on the previous Aug. 1 he had prepared "dephlogisticated air" (oxygen). In 1780 he left Lord Shelburne, who allowed him an annuity of £150 for life, and settling at Birmingham was appointed junior minister of the New Meeting Society. There he found friends in Matthew Boulton, James Keir, James Watt and Erasmus Darwin. On July 14, 1791 the Constitutional Society of Birmingham arranged a dinner to celebrate the anniversary of the fall of the Bastille. Priestley, according to his own account, "had little to do with it." But his predilections in favour of the revolutionists were notorious, and the mob seized the occasion to burn his chapel and sack his house at Fairhill. He and his family escaped, but his possessions were destroyed and the labour of years annihilated. He retreated to London, where he felt safe, though he continued to be an object of "troublesome attention," and even the fellows of the Royal Society shunned him. He received an invitation to become morning preacher at Gravel Pit Chapel, Hackney, and there he remained until 1794, when he determined to emigrate to America. Settling at Northumberland, Pennsylvania, he lived there for nearly ten years, until his death on Feb. 6, 1804.

Priestley made very important contributions to pneumatic chemistry—the study of gases—and was the inventor of the "pneumatic trough" which allowed gases to be collectkd and examined. By heating spirits of salt he obtained "marine acid air" (hydrochloric acid gas), and he was able to collect it because he happened to use mercury, instead of water, in his pneumatic trough. Then he treated oil of vitriol in the same way, but got nothing until by accident he dropped some mercury into the liquid, when "vitriolic acid air" (sulphur dioxide) was evolved. Again he heated fluorspar with oil of vitriol, as K. W. Scheele had done, and because he was employing a glass vessel he got "fluor acid air" (silicon fluoride). Heating spirits of hartshorn, he was able to collect "alkaline air" (ammonia), again because he was using mercury in his pneumatic trough; then, trying what would happen if he passed electric sparks through the gas, he decomposed it into nitrogen and hydrogen, and "having a notion" that mixed with hydrochloric acid gas it would produce a "neutral air," perhaps much the same as common air, he synthetized sal ammoniac. Dephlogisticated air (oxygen) he prepared in Aug. 1774 by heating red oxide of mercury with a burning-glass, and he found that in it a candle burnt with a remarkably vigorous flame and mice lived longer than in an equal volume of ordinary air. He concluded that it was not common air, but the substance "in much greater perfection," that rendered common air respirable and a supporter of combustion. Of the analogy between combustion and respiration—both true phlogistic processes in his view—he had convinced himself three years before, and his paper, "On Different Kinds of Air" (*Phil. Trans.*, 1772) described experiments which showed that growing plants are able to "restore" air which has been vitiated, whether by being breathed or by having candles burnt in it. He noted that when hydrogen and oxygen were exploded together a mist or dew coated the inside of the vessel, but it was Cavendish who showed that the dew consisted of water.

Priestley had an unusual gift, as well as a passion, for experimenting, although he had received no scientific education; probably for this reason he supported the doctrine of phlogiston to the very last in spite of the fact that his own researches had probably given Lavoisier (*q.v.*) the clue to the oxygen theory of combustion. But although his theoretical knowledge was weak his observations and experiments had a profound influence on the development of chemistry.

Priestley was a most voluminous writer, and his works (excluding his scientific writings) as collected and edited by his friend J. T. Rutt in 1817–32 fill 25 octavo volumes. His chief theological and philosophical works were *Institutes of Natural and Revealed Religion* (3 vols., 1772–74); *History of the Corruption of Christianity* (2 vols., 1782); *General History of the Christian Church to the Fall of the Western Empire,* vols. i. and ii. (1790), vols. iii. and iv. (1802–03); and *Disquisitions relating to Matter and Spirit* (1777).

His chief books on chemistry were six volumes of *Experiments and Observations on different Kinds of Air,* published between 1774 and 1786; *Experiments on the Generation of Air from Water* (1793); *Experiments and Observations relating to the Analysis of Atmospheric Air,* and *Considerations on the Doctrine of Phlogiston established and that of the Composition of Water refuted* (1800). He also published (1767) a treatise on the *History and Present State of Electricity,* which embodies some original work, and (1772) a *History of Discoveries relating to Vision, Light and Colours,* which is a mere compilation.

See also T. E. Thorpe, *Joseph Priestley* (1906), O. Lodge, "Joseph Priestley" in *Nine Famous Birmingham Men* (ed. J. H. Muirhead, 1909).

PRIEUR, PIERRE (c. 1626–*c.* 1676), French enamel painter. He married Marie (1610–1677), sister of Jean Petitot, as her second husband. In 1669 he was in England, painting a miniature of Charles II. and another of Lady Castlemaine, both after Cooper, for the king of Denmark. In 1670 he was in Poland, painting for the Danish monarch a portrait of King Michael, and in the following year was in Denmark executing a remarkable series of portraits of the children of Frederick III. All these, with some beautiful enamel badges for the Order of the Elephant, are in the Danish royal collection. By Christian V. he is said to have been sent to Spain and Russia, where several examples of his work, dated 1676, are to be seen in the Hermitage, Leningrad. He died in Denmark, in 1676. He was a Huguenot, and was said to possess secret colours in enamel, especially a blue, which were not known to his Petitot relations. His work in England is of great rarity; Lord Dartrey possesses the finest example, and there are two remarkable works in the Pierpont Morgan collection and one at Windsor Castle. (G. C. W.)

PRIEUR DE LA MARNE [PIERRE LOUIS PRIEUR] (1756–1827), French politician, was born at Sommesous (Marne) on Aug. 1, 1756. He practised as a lawyer at Chblons-sur-Marne until 1789, when he was elected to the states-general. He became secretary to the Assembly, and the violence of his attacks on the ancien *régime* won him the nickname of "Crieur de la Marne." In 1791 he became vice-president of the criminal tribunal of Paris and in May 1796 president of the Convention, hiding from May 1795 until the amnesty proclaimed in the autumn of that year. In 1816 he was banished as a regicide. He died in Brussels on May 31, 1827.

See Pierre Bliard, *Le Conventionnel Prieur de la Marne en mission dans l'ouest 1793–1794 d'après* des documents ine'dits (1906).

PRIEUR-DUVERNOIS, CLAUDE ANTOINE, COMTE (1763–1832), French politician, was born at Auxonne on Dec. 2, 1763, and was known as Prieur de la Côte d'Or. He was a member of the legislative assembly and of the Convention. In 1793 he was employed in breaking up the Federalist movement in Normandy, but he was arrested by the Federalist authorities of Caen, and only released in July 1793 after the defeat of their forces at Vernon. On Aug. 14, 1793, he became a member of the committee of public safety, allying himself with Carnot in the organization of national defence. Under the Directory he sat in the Council of the Five Hundred, retiring after the coup *d'e'tat* of 18 Brumaire (Nov. 9, 1799). In 1808 he was created a count of the empire, and in 1811 retired from the army with the grade of chef *de* brigade. He was one of the founders of the École Polytechnique, and shared in the establishment of the Institute of France; the adoption of the metric system and the foundation of the bureau of longitude were also due to his efforts. Prieur died at Dijon on Aug. 11, 1832.

See J. Gros, *Le Comité de salut public* (1893); and E. Charavay, *Correspondance de Carnot,* vol. i., which includes some documents drawn up by Prieur.

PRILEP, a town in southern Serbia, Yugoslavia. Pop. (1931) 21,405. The town owes its chief importance to a large annual fair. The town is famous in Serbian history as the birthplace and capital of Marko Kralyevich, one of the favourite national heroes, who held his kingdom, after the fall of Serbia in 1389, as a vassal of the Turks. Legend says that before his death he buried his sword deep in the rocks of Prilep and left his magic horse Sharatz to nibble the moss near by, with the promise of reappearing in his country's hour of need. In the Balkan Wars (1912–13) the Serbs successfully stormed the heights, reputed to be impregnable. In 1941 the town was occupied by Bulgaria.

PRIM, JUAN, MARQUIS DE LOS CASTILLEJOS, COUNT DE REUS (1814–1870), Spanish soldier and statesman, was born at Reus, Catalonia, on Dec. 12, 1814. He served in the volunteers of Isabella II. in 1834, becoming lieutenant-colonel during the Carlist War In 1839, as a progressist opposed to the dictatorship of Espartero, he was exiled. Elected deputy for Tarragona in 1843, he defeated Espartero at Bruch and entered Madrid in triumph with Serrano. The regent Maria Christina made him major-general and count of Reus. Narvaez, the prime minister, who did not understand what constitutional freedom meant, sentenced Prim to six years' imprisonment in the Philippine islands; the sentence was not executed, and until the amnesty of 1847 Prim remained an exile in England and France. On his return he was made captain-general of Porto Rico and military representative with the sultan during the Crimean War. Elected to the Cortes in 1854, he supported O'Donnell, who promoted him lieutenant-general in 1856. He was made marquis de los Castillejos and a grandee of Spain for his valuable services in Morocco (1860). A member of the opposition against Narvaez, at his death (1868) Prim and Serrano raised the standard of revolt at Cadiz. with Admiral Topete commanding the fleet. In July 1869 Serrano was elected regent, and Prim became president of the council and was made a marshal. He was shot by unknown assassins on leaving the chamber of the Cortes on Dec. 28, 1870.

See F. Jiménez y Guited, *Historia militar y politica del general D. Juan Prim . . .* (2 vols., 1860); L. Blairet, *Le Général Prim et la situation actuelle de l'Espagne* (1867); Guillaumot, *Juan Prim et l'Espagne* (1870); H. Leonardon, *Prim* (1901, bibl.); F. González Llanos, *Biografiá política y militar del . . . general . . . Prim . . .* (1860).

PRIMARIES, a term applied to preliminary elections in which delegates to conventions or candidates for office are nominated directly by the voters, instead of being chosen by political conventions as was formerly the universal custom in the United States. The primary election is by ballot, is accompanied by the same election machinery, regulations and safeguards, and is fully as "official" as the final election. The first use of the direct primary in the United States so far as known, was in Crawford county, Pa., in 1868, from whence it spread to other counties of that State and of States in the Middle West, South and West. It was not until the opening of the 20th century, when a wide-spread distrust of political conventions had grown up, that the method was adopted by an entire State. In 1903, Wisconsin, under the leadership of Governor Robert M. La Follette, passed a mandatory primary law. Oregon passed a similar law the following year. By 1915 the direct primary for some purposes had been adopted by nearly every State in the Union, although its scope and administrative details varied widely from State to State. In 1928 it was mandatory in all but five States. Utah permitted primaries if desired by a political party but did not require them. Connecticut, Delaware, New Mexico and Rhode Island had no primary law.

In several States the primary law applies to all political parties, but in most States minor parties which do not poll a fixed minimum vote, or a certain percentage of votes cast at the previous election, are allowed to nominate their candidate by convention if they prefer. Likewise, primaries may be held to nominate candidates for all or for only certain offices. In most of the Western States the law applies to almost all elective officers from the governor down to and including local officials. In New York, however, a State convention is held for the nomination of State officials and the application of the direct primary is for local officers only. In six States in 1928 presidential electors were nominated through primaries.

Methods by which aspirants for nomination have their names placed upon the primary ballot vary widely. The most commonly used is that by petition, wherein a fixed number of signatures, or signatures totalling a certain percentage of the voters must be secured by the candidate. A second method is to allow any one to have his name entered upon the payment of a certain fee, which varies in amount according to the importance of the office. A third method is to allow party committees to designate "official" aspirants for nomination—with the reservation that others may place their names on the ballot by petition. In Colorado conventions are held previous to the primary and all names placed in nomination before the convention and receiving 10% or more of that body's vote are placed on the ballot. A similar system exists in South Dakota with the provision there that other names may be added by petition.

Primaries may be either open or closed. In the first case the voter has a choice of the ballot of any party regardless of his regular party affiliations. The open primary was used in only three States, Colorado, Montana and Wisconsin in 1928. The voter was given the ballots of all parties as he entered the booth, and upon his exit he placed the one he had marked in one box and the others in a discard box. The advantage of this procedure is that the voter is able to keep his party affiliation a secret. The most commonly used closed primary procedure is that of enrolment in a political party at the time of registration previous to election. In a few States the voter does not declare his party until he steps up to receive his ballot. In neither of these procedures, however, as in the open primary, is there any guarantee that the voter will vote for the nominees of the same party in the final election as in the primary. In this respect the primary so far as party government is concerned is defective, in that it allows the voter to interfere with the selection of candidates in a party to which he does not belong. Where the final race is likely to be close he may vote for a candidate of the opposing party whom his own candidate can more easily defeat, or, if his own party has little chance, he may vote for his favourite among the candidates of the other party, in which case the minority party sinks to an ineffective position. In Wisconsin, for example, the Democratic candidates often receive too few votes in the primary to give them a place on the final ballot, in which case they are forced to run as independents or discontinue the race. Some States require a voter, if challenged, to swear that he has supported for a certain time the party in which he enrols. Others require a promise to vote for the same party's nominees in the final election, while a few States require a promise of support for a longer period, in Illinois, for example, for two years.

There is also a wide variation among States in the vote necessary at a primary to constitute a choice. Where more than two candidates are usually on the ballot it is evident that the leading one may not always have a majority. Most of the primary laws of the United States provide merely that the candidate with the highest number of votes is nominated. This method, however, may allow a minority candidate to win in case several majority candidates divide the majority vote between them. It also may keep good majority men out of the race for fear of creating a split that would give an undesired candidate the nomination. To obviate this defect a number of States, especially in the South, where a victory in the primary usually means a victory in the election, require an absolute majority to win, and, if no candidate has this, a "run-off primary" between the two highest candidates is held a few weeks after the regular primary. Two States in 1928, Alabama and Florida, used a system of preferential voting, the voter designating second choices as well as first. If a candidate had a majority of first choices, the election was thereby decided, but if no majority appeared, all but the two highest candidates were dropped and the second choices were then added, the candidate having the highest number of both winning. Indiana, Louisiana and Minnesota at one time had preferential voting but abandoned it. In Indiana if no candidate received a majority in the primary, the nominee was chosen by a regularly constituted State convention. In Iowa the same procedure takes place if no candidate receives 35% of the votes in the primary. Just as under the convention system a defeated candidate may start an independent movement, so in most States a candidate defeated in the primaries may seek election as an independent. In Wisconsin, where the real contest is between factions of the Republican Party, this is often done. Maryland, Oregon and California do not permit it while several other States permit it only under certain restrictions.

Non-partisan primaries are held for some offices in which the candidates are nominated without regard to party lines. Twice the number are nominated as there are offices to be filled at the election. Non-partisan primaries originated in municipal elections where national and State party lines have less significance. In 1928 North Dakota and Wisconsin had non-partisan primaries for all cities, Minnesota and Utah for cities of the first and second class, and certain other States for cities under home rule charters, or under the commission or city-manager forms of government. County officers in three States are elected by non-partisan primaries, and Minnesota, since 1913, has chosen its members of the legislature this way. In 12 States in 1928 judges were chosen by non-partisan primaries, a practice in line with the growing movement to take the judiciary out of politics. Non-partisan primaries do not, however, do away entirely with party politics for parties generally openly endorse their favoured candidates. On the other hand, where the local vote is non-partisan national parties have difficulty in maintaining effective local organization.

BIBLIOGRAPHY.—15. M. Rocca, *Primary Laws* (1927); C. E. Merriam, *Primary Elections* (1909) and *The American Party System* (1922); *L.* Overacker, *The Presidential Primary* (1927); *E.* N. Sait, *American Parties and Elections* (1927); S. Lewis. *Party Principles and Practical Polztics* (1928); *E.* C. Meyer, *Nominating System: Direct Primaries versus Convention* (1902); *E.* T. Brackett, "The Direct Primary versus the Convention," *Proceedings* of the Academy of Political Science, vol. iii. (1913); J. Macy, "The Influence of Primary Elections upon Party Organizations," *Proceedings* of the American Political Science Association, vol. iv. (1907); and, *Annuls of the American Academy,* vol. cvi. (1923) containing 13 articles on various phases of the primary and its operations in certain States by well-known writers.

PRIMATE, a title applied during the 4th and 5th centuries A.D. to both secular and ecclesiastical officials. The Theodosian Code mentions primates of towns, districts and fortified places *(Primates urbium, vicorum, castellorum)*. The Pragmatic Sanction of Justinian also mentions primates governing a district, *primates regionis;* and in this sense the title survived, under Turkish rule, in Greece until the 19th century. An official called "primate of the palace" is mentioned in the laws of the Visigoths. Primas also seems to have been used loosely during the middle ages for "head" or "chief." Du Cange cites *primas castri.* The title, however, has been more generally used to denote a bishop with special privileges and powers. It was first employed almost synonymously with *metropolitan* to denote the chief bishop of a province having his see in the capital and certain rights of superintendence over the whole province. At the Council of Nicaea (A.D. 325) the metropolitan constitution was assumed as universal, and after this the terms "metropolitan," and "primate," to denote the chief bishop of a province, came into general use. The title of primate was used more generally in Africa, while elsewhere metropolitan was more generally employed.

At a later date "primate" became the official title of certain metropolitans who obtained from the pope a position of episcopal authority over several other metropolitans and who were, at the same time, appointed vicars of the Holy See. This was done in the case of the bishops of Arles and Thessalonica as early as the 5th century. The archbishop of Reims received the title of *primas inter primates.* By the False Decretals an attempt was made to establish such a primacy as a permanent institution, but the attempt was not successful and the dignity of primate became more or less honorary. The overlapping of the title is illustrated by the case of England, where the archbishop of York still bears the title of primate of England and the archbishop of Canterbury that of primate of all England.

BIBLIOGRAPHY.—See Du Cange, Glossarium; Hinschiue, *Kirchenrecht* (Berlin, 1869); Moeller, History of the Christian *Church,* translated from the German by Andrew Rutherford (1902); Bingham, Origines *ecclesiasticae* (1840).

PRIMATES, an order of mammals, including man, the apes, monkeys, tarsiers and lemurs. The name, meaning "chiefs," was given by Linnaeus in 1758. Linnaeus also included the bats, assigned to a separate order by modern zoologists.

Structure and Habits.—Primates are primarily arboreal animals with hands and feet adapted for climbing. The fingers and toes are provided with nails (rarely compressed as claws). The great toe of the hind-foot is usually more or less divergent and the foot functions as a grasping organ, branches of trees being seized between the great toe and the four outer toes. The hands serve both for climbing and for manipulating food. The limbs are relatively long and slender, with free movements of rotation and supination. The lower primates (lemurs) are practically quadrupeds that run and leap in the trees but in the more advanced monkeys and apes there is an increasing tendency to climb with the arms extended above the head and the weight of the body suspended beneath the branches (brachiation). On the other hand, in the baboons the limbs plainly show secondary adaptation for running on the ground, both in their somewhat dog-like proportions and in the reduction of the great toe.

In the stem type of arboreal monkeys, vision is dominant over smell, whereas in typical ground-dwelling mammals the reverse is the case. Hence the occipital poles of the brain, which are connected with vision, are much enlarged. The adjustments for balancing in such actively climbing animals are extremely various and rapid; this requires a correspondingly complex development of the cerebellum and of the cerebral areas of the brain concerned with the movements of the limbs and body. As intelligence increases the prefrontal lobes of the brain develop. Thus the brain of monkeys is proportionately larger and more complexly convoluted than in ordinary ground-living animals. As a whole the brain of the Old World monkeys presents the ground-plan of the human brain without the special developments and complications connected with man's superior mentality.

The bony braincase closely follows the shape of the brain, except in front, where the large eye sockets jut forward, thus enabling the achievement of binocular, stereoscopic vision. Owing to the forward growth of the temporal lobes of the brain the greater wings of the sphenoid are moved forward to form the back-wall of the orbits, which are thus separated by a bony partition from the temporal fossae.

Hearing is acute and the temporal lobes are large. A thin bony shell, the auditory bulla, on the under-side of the braincase behind the socket for the lower jaw, covers the lower side of the cavity of the middle ear and is connected by a bony tube with the root of the external ear; the latter resembles that of man but usually has a point on its upper rim and lacks a lobule below.

In the more primitive primates, *e.g.* lemurs, the jaws are long and slender and the muzzle pointed. In typical monkeys, however, the jaw is shortened and deepened and the muzzle broad, the nose and lips assuming more or less the human aspect. The opposite halves of the lower jaw are fused in front even in young animals. The dentition is adapted for a mixed diet, with fruits or vegetation prevailing. The teeth in an adult Old World monkey number 32, as in man. The incisors are cutting teeth, the lower ones slightly inclined forward. There are two pairs in both upper and lower jaw. The canines are sharp and adapted for biting; the upper premolars are bicuspid, *i.e.,* with single, outer and inner cusps; and the low-crowned molars are surmounted by low cusps.

The female reproductive organs are fundamentally as in man (except in details) and there is likewise only a single pair of breasts in the female. The placenta is disc-shaped and intimately attached to the wall of the uterus.

Thus a typical monkey differs from an ordinary mammal such as a dog in its thorough adaptation to arboreal life, in the greater activity of the visual as compared with the olfactory powers, in its more advanced type of brain, and in its much greater likeness to man in the entire ground-plan of its anatomy.

Such a monkey is structurally connected on the one hand with lower primates (including New World monkeys, tarsiers and lemurs) and on the other hand with the higher primates, the anthropoid apes and man. Even the still existing species of primates form a fairly gradual transition from the tree-shrews at the base to highly specialized forms like the spider-monkey, the orang-utan and man, which stand far out on widely divergent branches.

LOWER PRIMATES

The Tree-Shrews.—The tree-shrews (Tupaiidae) are generally classed as Insectivora (*q.v.*) but they are related to Primates in many anatomical details. The pen-tailed tree-shrew (*Ptilocercus*) of Borneo is a mouse-like arboreal animal. Its hands and feet are five-toed and provided with claws, the thumb and great toe somewhat divergent. The food includes insects and fruit; the upper molar teeth are tritubercular, the lower molars tuberculo-sectorial (see MAMMALIA). The skull is lemur-like, especially in the ring-shaped orbit and inflated auditory bulla, which completely encloses the ring-like tympanic bone and ear-drum. The brain is primitive in having relatively unreduced olfactory parts and very feebly-developed neopallium or higher part of the brain. *Tupaia* and related genera of India and the Malayan region are in many ways more advanced toward the lemur type.

Imperfect fossil jaws and teeth, apparently of tree-shrews not greatly different from modern forms, have been found in Lo er Eocene deposits in Wyoming.

The **Tarsioids.**—Of equal antiquity are the oldest known forerunners of the true primates, represented by fossil jaws and teeth from the Lower Eocene of Wyoming and New Mexico and apparently belonging respectively to the tarsioid and lemuroid division of the order. Even at this early date a breaking up of the groups into different genera was in progress. In some of the tarsioid genera the incisors were already enlarging and the molars acquiring round, blunt cusps instead of the sharp-edged V-shaped cusps of their Cretaceous insectivorous ancestors. Probably from some of the less specialized of these Lower Eocene tarsioids sprang the line leading to *Pseudoloris* of the European Eocene. This genus in turn had already progressed far toward the modern *Tarsius.* The most famous Lower Eocene tarsioid was the little skull *Anaptomorphus* (*Tetonius*) *homunculus,* at one time, though erroneously, supposed to be in the direct line of human descent. That strange-looking animal, the spectral tarsier, survives today in the forests of the larger Malay islands. About as large as a good-sized rat, it has long jerboa-like hind legs, with which it can make extraordinary leaps, presumably to capture insects. Both the hands and feet have long spreading digits tipped with flattened discs for grasping the branches of the trees in which it lives. The lower part of the heel-bone and navicular are lengthened into long narrow rods to increase the leaping power. The huge eyes are brought forward so that their inner borders almost meet across the nose, which is small and resembles the platyrrhine type. The ears are very large. The brain, although large, is of remarkably low type for a primate. Accordingly the skull, which largely reflects the character of the brain and sense organs, reveals enormous circular orbits, a swollen braincase, expanded auditory bullae and a reduced, greatly constricted nasal-chamber. The jaws are slender and the teeth small, the upper molars being transversely widened with low, rounded cusps. *Tarsius* appears to be the rather specialized survivor of a very old primate stock structurally intermediate between the tree-shrews and lemurs below and the monkeys, apes and man above. Most of the known Eocene tarsioids are too specialized in their teeth to be the ancestors of the monkeys (with possible exceptions noted below). The foot structure of at least two of these forms already showed more or less of the characteristic elongation of the heel-bone and navicular.

The **Lemuroids.**—Along with the tarsioids in the Lower and Middle Eocene of North America occur the fossil teeth and jaws of another group of Primates, constituting the family Notharctidae, the members of which ranged in size from a chipmunk to a cat. During the Eocene, the first and second upper molar teeth gradually evolved from a three-cusped to a four-cusped stage. Apparently the entire family then became extinct, but some of them may possibly have given rise to the ancestral South Amencan monkeys. In *Notharctus* osborni from the Middle Eocene of Wyoming the hands and feet were of the grasping, climbing type, much like those of existing lemurs. The skull was far less specialized than that of contemporary tarsioids, both skull and dentition retaining the primitive features of lemurs on the one hand and monkeys on the other. Thus the dental formula of *Notharctus* $(I\frac{2}{2}\ C\frac{1}{1}\ P\frac{4}{4}\ M\frac{3}{3})\times 2=40$ is the primitive one for all primates. The braincase is primitive with no great expansion of the brain and with an unreduced nasal-chamber. The orbits were protected behind by a rim of bone, not by a fully developed partition. The auditory region and base of the cranium, backbone, forearm, pelvis and hind-feet were like those of lemurs.

Structurally related to the Notharctidae was the European Eocene family Adapidae. The skull was more robust than that of Notharctus, with higher crests, more massive cheek-arches and more expanded lower jaws. On the other hand, the lower molars were relatively smaller, with sharper oblique cross-crests. In many skeletal features the Adapidae approached the modern Madagascan lemurs, to which they were either directly ancestral or closely related.

Madagascar has been the lemuroid headquarters for a long period. To-day it is the home of many species and genera of three families, while a number of recently extinct forms of widely different genera have also been found there. The central family is the Lemuridae, including the true lemurs, which range in size from the tiny mouse-lemur (*Microcebus*) to the extinct short-limbed *Megaladapis,* as large as a half-grown brown bear.

The typical lemur has a fully arboreal skeleton, with grasping hands and feet, although certain species live in rocky places. The animal is essentially an arboreal quadruped, which runs and leaps on top of the branches. The head is fox-like, but the eyes are very large and protrude from their sockets. The ears are usually large and movable. The food consists of msects, fruits and leaves. The lower incisors and much reduced canines are sharply inclined forward, compressed and pointed. With these the animals comb their fur and seize their food. The upper molars have a rounded inner cusp connected by a sharp small cross-crest with the front one of the two rounded outer cusps. The opposite halves of the lower jaw are not fused in front as in the higher primates. The skull varies in length from the extremely long skull of *Megaladapis* to the short sloth-like skull of *Myoxicebus.* The placenta is diffuse, with a large allantois, and is indeciduous; *i.e.,* is torn away from the uterine wall at birth.

The indrisine lemurs or sifakas, also peculiar to Madagascar, have more monkey-like faces. The central types have very long hind limbs and long hands and feet and are good climbers and leapers. The indris has a tall like that of a rabbit; the different species of *Propithecus* have brilliant areas of colour against a dark background. All are very conspicuous in a museum-case but as they are nocturnal animals their bizarre colouring may have a disruptive or concealing effect at night.

The skeleton could be derived directly from that of the Eocene lemuroids by emphasizing certain details almost to the point of caricature. These indrisine lemurs have a spiral colon, recalling that of other leaf-eating animals; the molar teeth also are adapted to cutting vegetation, the blades of each W-shaped lower molar fitting between corresponding V's of the upper molars. The area for the insertion of the masseter or outer jaw-muscle on the outer side of the lower jaw is greatly expanded and the bony cheek-arches are strengthened to support the powerful grinding muscles. The lower front teeth are reduced to a single pair. The detailed construction of the skull is obviously a modification of the primitive Eocene lemuroid type.

The extinct *Archaeolemur* (or *Nesopithecus*) resembled some of the South American monkeys in its upper and lower premolars and molars and in certain features of the skull, but in many other features (such as the middle ear region) it is connected with the indrisine lemurs. It seems probable that *Archaeolemur* illustrates one of the structural phases through which the ancestors of the New World monkeys may have passed in their descent from lemuroid ancestors. There is also a gradual transition in the form of the "braincast" and of the furrows on its surface between these lemuroids and the New World monkeys.

The last family of Madagascar lemuroids is that of the aye-aye (Daubentonia or Chiromys), one of the most extraordinary of all animals. Arboreal in habit, it has very large ears with which it listens for the sound of insect grubs boring beneath the bark. When it locates a grub it gnaws through the bark and into the wood with its rodent-like front teeth, which are large and compressed with sharp tips. Into the narrow slot thus opened it thrusts its very long, attenuated third finger, hooking the grub on the end of its curved nail. In accordance with its grub- and fruit-eating habits its molar teeth are much reduced. The general anatomy of the aye-aye agrees with that of other Madagascar lemuroids (especially the indris group). Fossil jaws with gnawing front teeth, much like those of the aye-aye, have been found in the French Eocene. These are more or less intermediate between the Eocene tree-shrews (Plesiadapidae) and the modern aye-aye. Probably the indrisine lemurs are a related off-shoot of the primitive tree-shrew-lemur stock.

The lemurs of southeastern Asia and of Africa differ in certain respects from the Madagascar lemurs, but agree with them in the curious comb-like arrangement of the lower front teeth. The lorises (Lorisidae) extend from tropical India southeastward through most of Malaya and are also represented in west Africa. The slender loris (*Loris gracilis*) is a large-eyed, small-nosed, nocturnal form with long and excessively slender bent limbs and no tail. It clings to the branches and feeds upon leaves and fruit, small birds, insects and mice. The awantibo (*Arctocebus*) and the potto (*Perodicticus*) of Africa have heavier skulls and blunter-cusped molats. The hands are extremely specialized for grasping and have very large thumbs and vestigial second fingers.

The galagos of Africa (Galaginidae), commonly known as "bush babies," are active arboreal leapers, catching insects on the wing. They have long, pointed muzzles and very large eyes and ears. They approach the tarsioids in these characters and in the elongation of the tarsal bones for leaping. But they differ in the lemur-like character of the lower front teeth, and the resemblances between the two families seem partly due to parallelism. Pronycticebus from the French Lower Oligocene is represented by a fossil skull structurally intermediate between the Eocene adapids and the modern lorisids.

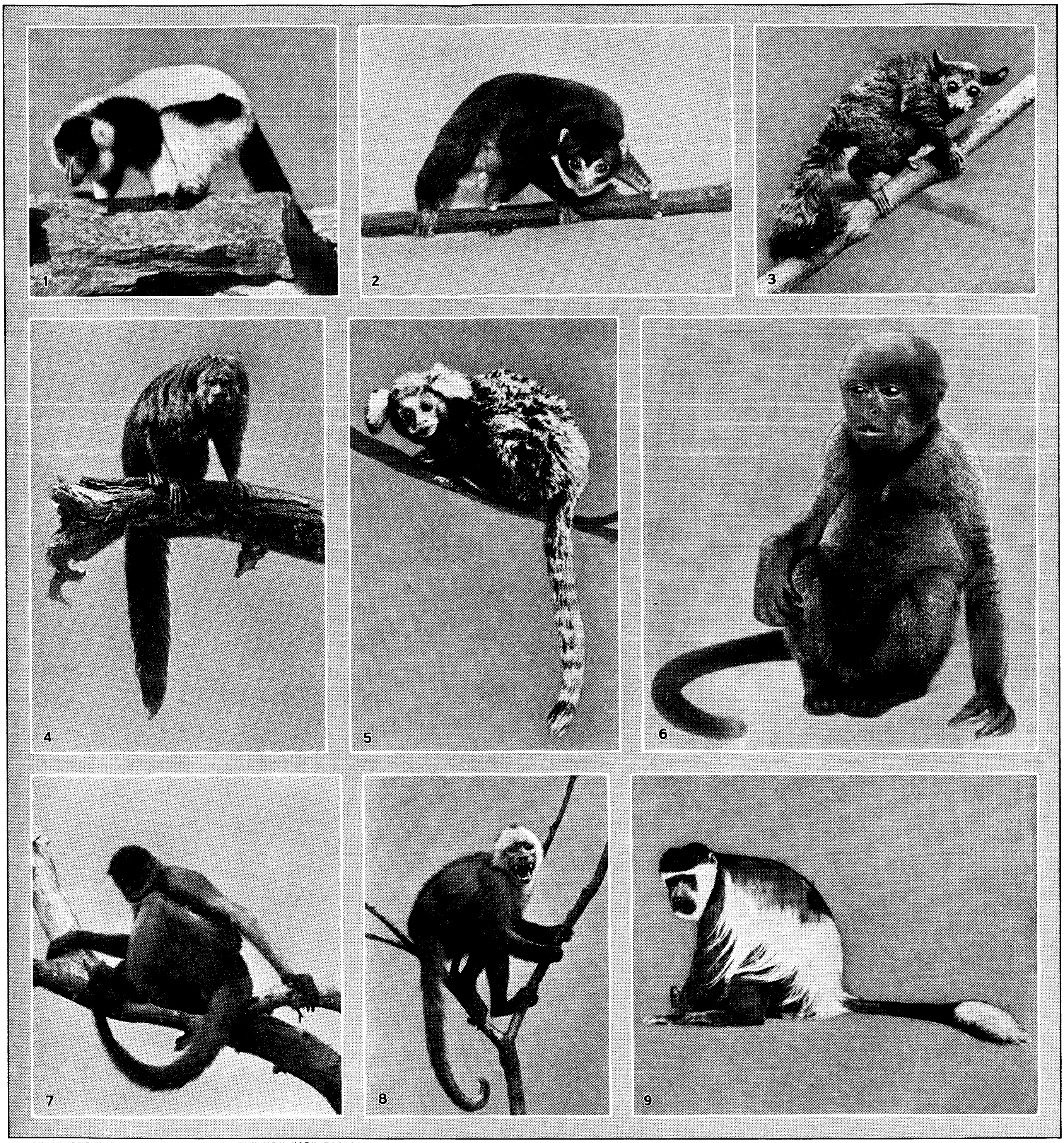
NEW WORLD MONKEYS

The American monkeys are differentiated from those of the Old World by the widely separated nostrils facing laterally, whence the name "platyrrhine" (flat-nosed). The head is rounded with relatively small jaws and the ears lack the pointed tip common in Old World monkeys. The buttocks do not bear callosities and the thumb is never truly opposable to the other digits. The opposable great toe of the hind-foot bears a flattened nail, but the nails of the other digits of both hand and foot are frequently compressed laterally and in the marmosets become claws.

The American monkeys are all arboreal. The recent genera inhabit the tropical forests of South America, a few species extending northward into Central America, spider-monkeys and certain marmosets even to Mexico. Except from Ecuador northward, the Andes limit the western range of monkeys, though some howlers, spider-monkeys and sapajous reach an elevation in Guatemala of 6,000 to 7,000 feet. A fossil cebid Homunculus, found in lower Miocene formations in Patagonia, indicate the great antiquity and former wide range of the family.

Cebidae.—The recent Cebidae, which comprise all the platyrrhine monkeys except the marmosets, are divided into some ten quite distinct genera. Of these the most central or primitive type is probably Callzcebus, of which numerous species, known as titis or teetees inhabit the forests of Brazil and neighbouring countries. They feed on fruits, insects and small birds and are extremely vociferous. They are very small, with long, bushy, non-prehensile tails. Rather closely related to these are the dourocoulis (Aotus or *Nyctipithecus*), the only truly nocturnal monkeys. The huge,

PRIMATES



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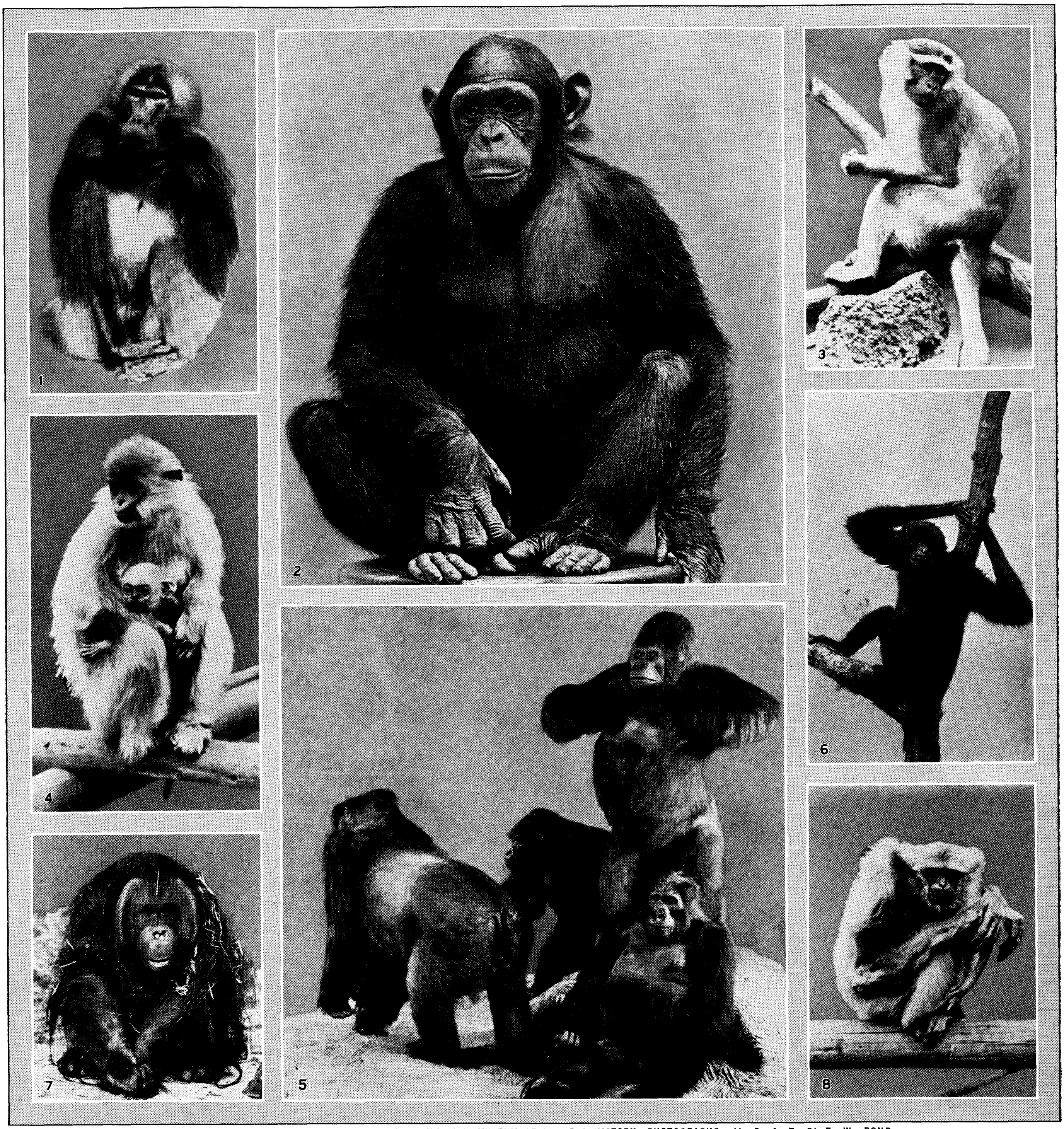
LEMURS AND MONKEYS OF THE OLD AND NEW WORLDS

1. The ruffed lemur (Lemur *varius*) of the Malagasy region. It is coloured either black and white or reddish brown, and feeds on birds, reptiles, eggs, insects and fruit
2. The lemuroid potto (*Perodicticus potto*) or West African slow-lemur, an almost tailless primate somewhat larger than a squirrel
3. Bush baby (*Galago* alleni) of Africa, a small arboreal lemur with long pointed muzzle and very large eyes and ears
4. Woolly Saki (Pithecia *monachus*), a tropical American monkey characterized by a bushy tail and whiskers of long, loose fur
5. The common or white-eared marmoset (*Hapale* (*Callithrix*) *jacchus*), a diminutive American monkey that feeds on insects and fruit
6. An immature woolly monkey (*Lagothrix lagotricha*) of tropical America, distinguished by the naked, singularly human face and the powerful prehensile tail used for picking up objects as well as for climbing
7. Spider monkey (*Ateleus geoffroyi*) of tropical America, so designated because of its extremely slender limbs. The tail is very long and prehensile and the hand is thumbless. It is easily tamed
8. White faced capuchin monkey (*Cebus capucinus*), a vivacious American species that derives its name from the cowl-like form assumed by the hair on the crown of the head. It is common in captivity
9. Guereza (*Colobus abyssinicus*), an arboreal African monkey hunted for its fur which forms a black and white mantle on the sides and back

PRIMATES



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OLD WORLD MONKEYS AND APES

1. Celada Baboon (***Theropithecus gelada***), a large terrestrial monkey of southern Abyssinia. On the old males the hair develops into a mantle-like mane which covers the forequarters, leaving the chest bare
2. Chimpanzee (Pan ***calvus***), the smaller of the two great man-like apes inhabiting equatorial Africa. It seldom exceeds 4½ feet in height and is almost completely arboreal, sleeping in nests in trees
3. Guenon (Cercopithecus tantalus), a small arboreal monkey of the African forests. It subsists chiefly on fruits and leaves
4. Capped Langur female and young of the Malay Peninsula. In common with other members of the langur family, it has slender limbs and a very long tail, and feeds on leaves
5. Group of mountain gorillas (Gorilla ***beringei***), Belgian Congo, showing two males and two females, the standing male being in characteristic posture of thumping his chest. The male at the left is in the position generally assumed by the gorilla when moving about on the ground
6. Siamang (***Hylobates*** (***Symphalangus***) ***syndactylus***) Malay Peninsula and Sumatra; largest of the gibbon group with an average height of 3 feet. It is distinguished from other gibbons by a laryngeal air-sac
7. Orang-utan (***Simia satyrus***), "man of the forest," the least man-like of the three great anthropoid apes. It inhabits Borneo and Sumatra
8. The silvery gibbon (***Hylobates leuciscus***), one of the small arboreal apes of the Indo-Malay peninsula and East Indies

closely-approximated eyes and short face, surrounded by a ruff of pale fur, give these little animals a peculiarly owl-like expression. *Aotus* lives on fruits and insects which it hunts at night, remaining hidden during the day. Some species are reputed to have remarkable vocal powers, but in captivity they are often very silent. The nose is more prominent than in any other American monkey, the nostrils resembling those of catarrhine forms. This is probably correlated with the close approximation of the enlarged eyes. Its behaviour in captivity and the anatomy of the olfactory parts of the brain, indicate that smell is well-developed, perhaps more so than in the higher members of the family. This is probably of more service to nocturnal than to diurnal forms, but is nevertheless probably a primitive character. Both titis and dourocoulis use the hands in holding food but do not exhibit the manifold manipulations of these organs seen in the sapajous.

Two genera of small monkeys, placed in the sub-family *Pithecinae,* are *Pithecia,* the saki and *Brachyurus* or *Cacajao,* the uakari, both with several species. They are characterized by extremely procumbent incisors. The sakis have long, loose fur, that of the head often directed forward on the crown and forming a thick beard about the jaws. The tail is bushy and son-prehensile. The uakaris are the only short-tailed American monkeys. The face is naked and in one species is a brilliant vermilion; the body is covered with pale sandy or straw-coloured long hair.

The squirrel-monkeys (*Saimiri* or *Chrysothrix*), are extremely diminutive. The face is short and round and the back of the head projects markedly, its balance on the neck giving a particularly human appearance. The cerebrum, relatively very large, is slightly convoluted, but overhangs the cerebellum to a greater extent than in any other primate, even man. These monkeys are chiefly insectivorous, and associate in small groups. Some half-dozen species are known, ranging from the Amazonian forests to Costa Rica. They are richly coloured little animals often seen in captivity.

Cebus is aptly called by H. O. Forbes "the typical genus of the American monkeys." The common names sapajou and capuchin are applied to these familiar monkeys. They are vivacious and relatively hardy, individuals having been known to survive in captivity for 25 years in the north temperate zone. The thumb is well-developed, though not opposable and the hands are used in a great variety of manipulations. The tail is slightly prehensile and usually carried curved toward the underside. With the superior functional adaptation of the hands is correlated a large, highly-developed brain and an intelligence comparable to that of the Old World monkeys. Over 20 species have been described, some extending as far north as Nicaragua. In Colombia *Cebus apella* is found at nearly 7,000 feet.

A group of closely related monkeys comprises the woolly monkeys *Lagothrix*, the spider-monkeys *Ateleus* (or *Ateles)* and, intermediate between these, the woolly spider-monkey *Brachyteles.* These are fruit-eating monkeys, all considerably larger than *Cebus. Lagothrix* has particularly soft, woolly fur, greyish or brownish in colour, and a naked black peculiarly human face. The spider-monkeys have long hair and remarkably slender elongate limbs. But while woolly monkeys have the thumb well-developed, it is entirely absent externally in the spider-monkeys, though bony and muscular vestiges are present under the skin. The other fingers are elongated and form a highly serviceable hand for rapid progression in the treetops. Spider-monkeys in captivity frequently walk erect on their hind-legs for a few feet. *Brachyteles* forms a link between these two genera in certain respects. Its fur is woolly like that of *Lagothrix;* the thumb is intermediate, greatly reduced but usually still visible externally. In its attenuated limbs it approximates *Ateleus.* These three genera all have long and powerful prehensile tails, of which the extremity is naked on the under side and provided with friction-ridges like a finger. This organ is used not merely in climbing but also for picking up objects. These monkeys are easily tamed, affectionate and intelligent. The brain, especially in *Ateleus,* is exceptionally large and complex.

The last Cebid genus to be mentioned is *Alouatta (Mycetes),* the howler monkey, with several species. The group is notorious for its extraordinary vocal powers, their roars being audible for several miles. The howlers are gregarious, living on leaves and fruit and are the largest and heaviest American monkeys, though the limbs are shorter than those of the spider-monkey. The powerful prehensile tail is very similar to that of the monkeys last described but this may be an example of parallelism in view of numerous differences in other respects. The most noteworthy anatomical feature is the vocal apparatus. The hyoid bone is expanded into a great bony cup, the thyroid cartilage greatly dilated and the angle of the jaw enlarged to protect these structures. The intelligence of the howlers is low and the brain extremely small and poorly developed. Their relation to other genera is unsettled.

Callitrichidae.—The second family of the American monkeys is that of the marmosets, Callitrichidae or Hapalidae, including the diminutive, squirrel-like marmosets proper, *Callitrichus* or *Hapale,* and the closely related tamarins, *Midas.* Some zoologists have considered these the most primitive American monkeys, but they probably represent dwarfed descendants of primitive Cebidae. In addition to small size, they are characterized by reduction of the jaws with a correlated loss of the third molar, leaving but 32 teeth. The digits, except the hallux, Sear sharp curved claws in place of nails, forming, in such small creatures, highly efficient organs for arboreal locomotion. The hands are used for grasping food, but lack the varied functions of these members in larger monkeys, a fact which may be correlated with the inferior intelligence of marmosets. In the hind foot the great toe is relatively smaller and less opposable than in the Cebidae. The cerebrum, though very large, is almost devoid of convolutions. Marmosets are usually found in small groups and subsist on insects and fruit. They have occasionally bred in captivity, producing up to three young at a birth, instead of one as in monkeys in general. *Callimico,* a peculiar type previously assigned to the genus *Midas,* has most of the external features, including claws, like the Callitrichidae, but the skull, though essentially that of a marmoset, has certain likenesses to the Cebidae, the most important being the retention of the third molars. O. Thomas proposes a new subfamily, Callimiconinae, which he is inclined to place in the Cebidae, but its affinities seem to be with the marmosets.

Origin of the New World Monkeys.—The monkeys of South and Central America form an entirely different series from the monkeys of the Old World and in spite of their general similarity to the latter, they probably have been derived from a different ancestral stock.

In the first place the face in New World monkeys differs widely from that in Old World monkeys, especially in the fact that in the New World or platyrrhine series the nostrils are usually widely separated at the base and are directed laterally. Other external differences from the Old World monkeys have been noted above. The New World monkeys may also be at once distinguished by the fact that there are three bicuspid or premolar teeth on each side, both in the upper and in the lower jaws, whereas in Old World monkeys there are two. In the region of the middle ear, on the lower side of the skull, New World monkeys have a large ring-like tympanic bone, whereas in Old World monkeys the same element forms a bony gutter, completely covering the drum-membrane on the lower side of the skull. Moreover, the cheek-bone of New World monkeys has a broad contact with the parietal bone, which is never the case in Old World monkeys. The placenta in New World monkeys is disc-like, without the secondary placenta seen in Old World monkeys.

All known New World monkeys both living and fossil stand on a rather high plane of evolution and there are no "living fossils" to connect the group definitely with any older fossil family. It is also difficult to be sure which is the most primitive living genus, but after repeated analyses of the characters of the skull and teeth it seems probable that the most primitive are certain small monkeys of the family Cebidae, especially the owl monkey *(Aotus)* and *Callicebus.* As noted above, the olfactory region of *Aotus* is less reduced than in most Cebidae and marmosets. These little monkeys have large orbits, short deep lower jaws, short muzzles and unreduced molar teeth. They agree with certain North American Eocene tarsioids in their dental formula $(I\frac{2}{2}\,C\frac{1}{1}\,P\frac{3}{3}\,MI)\times 2=36$

and in the general form of the skull, but they differ from all known tarsioids in that the tarsal bones are not elongated. On the other hand, it is not impossible that the skeleton of the South American monkeys may have been derived from the type illustrated in the North American Eocene Notharctus, but in the present state of knowledge this inference is unsafe in view of the prevailing resemblances of the dentition and skull of *Aotus* to the tarsioids rather than to the notharctids. Finally there is the possibility that the New World monkeys may be derived from early extinct lemuroids resembling *Archaeolemur*.

Typical platyrrhine monkeys (Homunculus) in the Lower Miocene of Patagonia have been found in association with a peculiar mammalian fauna which for millions of years had its headquarters in South America; but some of the ancestral stocks of this fauna have been found in far earlier (Eocene) deposits of North America. In view of other available evidence, an ultimate North American origin for the New World primates seems quite possible. The monkeys now inhabiting Central America are closely related to those of Guiana and Brazil.

The New World monkeys as a whole exhibit a profound adaptation to arboreal life and probably originated in some heavily forested region such as they now occupy.

OLD WORLD MONKEYS

The Old World or Catarrhine division comprises three families: monkeys, apes and man. The first of these, the Cercopithecidae or tailed monkeys, distinguished from the American monkeys by the features mentioned above, are subdivided into two subfamilies, first, Cercopithecinae, including the macaques, baboons, mangabeys and guenons, and second, Semnopithecinae, comprising the langurs and the guerezas. In general the Old World monkeys are gregarious, living in small bands or large troops numbering hundreds.

The Cercopithecinae all have cheek-pouches for temporary storage of food. Of this group the macaques, probably the best-known of all monkeys, are widely distributed through India and the East Indies, extending northward to northern China and Japan, while one species, the Barbary ape, inhabits Morocco, Algeria and the Rock of Gibraltar. The macaques are among the most generally adaptable of monkeys and are hardy and long-lived in captivity. Though agile climbers, they are by no means exclusively arboreal and some are entirely terrestrial. They are usually omnivorous and the crab-eating macaque of India lives chiefly on Crustacea. They have fore and hind limbs of about equal length. The thumbs, though short, are opposable and the animals have considerable manual dexterity. There is a median air-sac connected with the larynx. The ischial callosities are well-developed. The tail may be long, short or practically absent, as in the Barbary ape, *Inuus ecaudatus*. Prominent examples are Macacus *rhesus*, the common rhesus monkey, M. *cynomolgus*, the crab-eating macaque, M. *sinicus*, the bonnet monkey, M. *silenus*, the lion-tailed macaque, all of India, and M. *speciosus*, the red-faced monkey of Japan.

The baboons constitute a group of large monkeys of terrestrial habit, closely related to the macques, but differing in the great elongation of the muzzle, which gives the head a dog-like form. The skeleton also reflects the terrestrial habits in the form and proportions of the limbs. The various species, mostly of the genus Papio, inhabit practically the whole African continent south of the Sahara, and one extends into Arabia. They live in large troops under the leadership of an old male and are omnivorous, feeding on roots, insects, fruits, etc., and often raiding plantations. One of the largest is the powerful chacma baboon of South Africa, Papio porcarius. The grey-mantled hamadryas, P. *hamadryas*, of Abyssinia and Arabia, is the sacred baboon of ancient Egypt. The most remarkable of all is the mandrill, P. sphinx of west Africa. This is one of the weirdest and most gorgeously-coloured of mammals. The nose is scarlet, the cheeks bear corrugated swellings of brilliant blue and the posterior part of the body exhibits various tints of violet and scarlet, while the fur shows great variety of colour on different parts of the body. An aberrant form placed in a separate genus is the gelada baboon of Abyssinia, *Theropithecus* gelada. In this animal the nasal region is concave, the nostrils somewhat short of the tip of the snout and the jaws shorter than in *Papio*. The baboons are a modified branch of the macaque group and in structural essentials the two types are quite similar. In captivity a hybrid offspring has been produced from a male rhesus macaque and a female mandrill.

The name mangabey is applied to a small group of arboreal fruit-eating monkeys of west Africa, which compose the genus Cercocebus. They are characterized by flesh-coloured or white upper eyelids and they lack laryngeal air sacs. Mangabeys are rather slender animals, with long limbs and tail and are intermediate between the macaques and the guenons of the genus *Lasiopyga* (or *Cercopithecus*). This genus, with several subgenera, comprises a vast number of species, more than any other genus of monkeys, scattered over almost the entire African continent, but each occupying a somewhat restricted area. The last lower molar tooth lacks the fifth cusp present in the other Old World monkeys thus far described. The fur is commonly "ticked," *i.e.*, the hairs ringed with light and dark colours, and many species exhibit brilliant tints. Whiskers and beards are common. The guenons are mostly rather small arboreal monkeys, inhabiting forests and subsisting on fruits and leaves. Their cheek-pouches are exceptionally capacious. Of the vast number of species a few of the more familiar forms, to give only the common names, are the green monkey, mona, diana, grivet, vervet, deBrazza monkey and moustached monkey. These, and many others, are common inhabitants of zoological gardens.

Semnopithecinae.—The second sub-family (Semnopithecinae) includes the genus *Semnopithecus*, which comprises the sacred monkeys of India, which with their relatives of Asia and the East Indies are commonly termed langurs. In the same sub-family are placed the guerezas of Africa. The most remarkable feature of these monkeys is the structure of the stomach which, in correlation with their leaf-eating habits, is greatly enlarged and divided into sacculated compartments. Cheek-pouches are absent in the langurs but are said to be present in some guerezas. *Semnopithecus* has the hind-legs rather longer than the arms and a very long tail. The jaws are relatively short, the thumb shorter than in Cercopithecinae. The hanuman monkey (*S. entellus*) of central and northern India is one of the best-known species. In the large snub-nosed monkeys (*Rhinopithecus*) of northwestern China and Tibet, the nose is concave with a protruding upturned point. The proboscis monkey or kehau of Borneo (*Nasalis* larvatus) has the most remarkable physiognomy of all monkeys. The nose is enormously elongated, in old males even hanging down over the mouth. Both the snub-nosed and proboscis monkeys have the sacculated stomach and are closely related to the true langurs.

The guerezas are found only in Africa, inhabiting the forests in small troops. They also feed largely on leaves. The most striking difference anatomically is the reduction of the thumb to a vestige, which, however, often bears a minute nail. This reduction parallels in a remarkable manner the condition in the American spider-monkeys. The guerezas are generally known generically as *Colobus*. In certain species of these monkeys, which are much hunted for their skins, the hair forms a long mantle on the sides and back. The white-tailed colobus (C. caudatus), black' in general with white mantle and tail, is a particularly beautiful species. The langurs and guerezas are difficult to keep in captivity and are not often seen in zoological collections.

Origin and Evolution. — The Old World or catarrhine monkeys are widely distributed, mostly in tropical Asia and Africa, a few outlying forms reaching as far north as Tibet, China and Japan, while the baboons extend southward to South Africa. A single species, the Barbary ape of North Africa inhabits the Rock of Gibraltar in Europe. In the Pliocene, however, fossil monkeys of various species have been recorded in England, Germany, France, Italy, Greece, north Africa and India. In the Miocene of Tuscany there was a large form (Oreopithecus), in which certain features of the molar teeth suggest remote relationship with the anthropoid apes. In the Lower Oligocene of Egypt was found a small lower jaw fragment, *Apidium*, the lower molars of which may be transitional from the tuberculo-sectorial or primitive mammalian type to the bilophodont form (with two cross-crests) of the Old World monkeys. The group seems to have originated somewhere either in Africa or in the European-Asiatic landmass and negative palaeontological evidence indicates their complete absence from America and the Australian region.

No known fossil forms definitely connect the Old World stock with the New World series, tarsioids, lemuroids or tree-shrews. The New World series, for reasons given above, seems entirely independent; while the known fossil tarsioids appear too peculiarly specialized to be direct ancestors of the Old World stock; yet such tarsioids as Necrolemur and *Microchoerus* are the only forms so far known that have even the appearance of evolving toward the catarrhine stage. This is broadly characterized as follows.

Nostrils, closely approximated and opening downward. tending to form a V; molars with two cross-crests; dental formula $I\frac{2}{2}\ C\frac{1}{1}\ P\frac{2}{2}\ M\frac{3}{3}$. Tympanic bone forming a gutter leading to the outer ear; stomach simple or (in *Semnopithecus*) highly complex; habits primarily arboreal, the animals climbing as pronograde quadrupeds, mostly on top of the branches. Hands and feet prehensile. Thumb opposable, more or less flattened nails on all digits Tail long, short or wanting, never prehensile. Cheek-pouches in most genera. Large callous areas on buttocks, with corresponding flattening on lower ends of pelvis. Placenta double, consisting of a primary and secondary discoidal area with smooth chorion between them.

Although we have not as yet been able to trace the direct fossil ancestors of the Old World group into formations older than at most Lower Oligocene, even the known living and extinct tree-shrews, lemuroids and tarsioids preserve the broad stages by which arboreal insectivorous mammals with a relatively low type of brain were transformed into monkeys with a relatively high type of brain, with binocular, stereoscopic vision and an advanced method of intra-uterine nourishment of the young.

ANTHROPOID APES

Among the Old World primates one group is distinguished from the rest by its far closer resemblance to man, a likeness recognized in the name anthropoid (man-like) apes. These include the gibbons, the orang, chimpanzee and gorilla (*qq.v.*). The anthropoids have usually been collectively grouped in a single family Simiidae, but this name is now frequently restricted to the orang, chimpanzee and gorilla, a second family, Hylobatidae ("tree-walkers"), comprising the much smaller gibbons.

Hylobatidae.—The range of this family is now restricted to southeastern Asia, especially the Malay peninsula, Borneo, Sumatra and some other East Indian islands, though in the Miocene gibbons extended into Europe and in the Pliocene as far north as central China. They are slender, long-limbed, monkey-like apes, the most striking feature being the enormously elongate arms, which reach the ground when the animal stands erect. Like other anthropoids, they are tailless. They differ widely from the tailed monkeys in their mode of progression, as they do not run on all fours, either in the trees or on the ground, but hang and swing from branches by their long arms and hook-like fingers, making almost incredibly long leaps in the manner of a trapeze gymnast. This mode of arboreal locomotion has been called "brachiation" by Sir Arthur Keith. While travelling thus by the hands, gibbons use the feet for prehension and carrying food. They sit upright and when on the ground run swiftly in an erect position, holding the arms out as balancers. Gibbons differ from most Old World monkeys in the absence of cheek-pouches and in the pattern of the molars, which is essentially that of the great apes and man. They also in common with these forms have a vermiform appendix and flattened sternum. They nevertheless retain some Old World monkey characters; for example, the small ischial callosities are present, and the central bone in the wrist is retained as a separate element. Air-sacs, formed as extensions of the laryngeal ventricles, well-developed in the Simiidae, are present only in the siamang.

About a dozen species of Hylobates have been described, a few well-defined, but most of them, based chiefly on hair colour (which is a variable character even in the same species), are of doubtful validity. Among the more distinctive may be mentioned H. hoolock which extends northwesterly as far as Bhutan, H. *lar* in Burma and Siam, and H. leuciscus in Java. The colours in general are black, fawn or grey, sometimes with white around the face or on the hands. The fur is soft and woolly. A considerably larger black gibbon, the siamang, found in Sumatra, is now separated as *Symphalangus,* the name referring to the fusion of the second and third digits of the foot. This animal has a better developed chin than any other anthropoid, but its most conspicuous character is the possession of a large laryngeal air-sac capable of inflation. The siamang when standing erect may exceed three feet in height. Forms closely related to the Sumatra siamang, S. *syn*-dactylus, occur in adjacent regions. The vocal ability of gibbons is most remarkable, their high-pitched cries being audible for a mile or more.

Simiidae.—The three genera of great apes constituting the family Simiidae, the orang-utan of Borneo and Sumatra and the chimpanzee and gorilla of the African forests, are by far the closest of all animals to man. Their divergences from man, striking though some of them are, are nearly all differences in degree rather than in kind, and these apes are nearer anatomically and physiologically to man than to any of the tailed monkeys. Their differences from man are largely correlated with habit. Man has become terrestrial, while the apes have retained their primary arboreal habit, and have even developed further arboreal adaptations in varying degrees. In the orang these have become greatly exaggerated, while in the gorilla, which has become partly terrestrial, they are less marked. The chimpanzee is intermediate. The arms have become long and the relatively short legs retain the opposable great toe. This disproportion of limbs results in a peculiar secondary type of quadrupedal progression on the ground, the hands resting on the knuckles and the fore-part of the body somewhat elevated. The spinal column has a suggestion of the curves seen in man, but the balance of the head on the neck, the weight of the long arms, form of pelvis and weak gluteal and calf muscles, collectively preclude an habitual erect bipedal gait, though the animals often stand erect. Divergence from the Old World monkeys and likeness to man is seen in the absence of ischial callosities and cheek-pouches and in the presence of the vermiform appendix. The development of laryngeal air-sacs, apparently a point of difference, is in reality a likeness, since man retains homologous vestiges of these in the laryngeal ventricles. In the chimpanzee and gorilla (but not in the orang) the central bone of the wrist becomes fused with the scaphoid during embryonic life, as in man. The menstrual cycle has the same phases as man and in the chimpanzee the interval is the same. In this animal the period of gestation is nine months and the placenta is essentially of the human type. The secondary placenta, present in Old World monkeys, is absent. Even the brain, though roughly only about one-third the size of that of man, is essentially a miniature of the human brain, no part or organ of one being absent in the other, but the differences being differences of proportion of certain parts. The susceptibility of anthropoids to many human diseases to which other animals are relatively immune, indicates the close chemical similarity, and the well-known precipitin tests by G. F. Nuttall show the blood of these apes to be essentially identical with that of man, while differing from that of Old World monkeys.

Of the three great apes, the least man-like is the orang-utan (Malay, "man of the forest") which inhabits swampy coastal forests of parts of Borneo and Sumatra. This animal is completely arboreal, rarely descending to the ground, and exhibits exaggerated brachiating adaptations. It is a large ape, over 4 ft. high, with heavy body and short feeble legs but very long arms extending to the ankles when the animal stands erect. The digits of both hands and feet are elongated and hook-like, except the relatively short thumb and great toe. Though the orang is rather deliberate in his motions and does not leap through the trees, as does the gibbon, the elongation of the arms permits an extended reach from branch to branch and enables it to progress with considerable rapidity. Among structural characters the following may be noted: there are but 12 pairs of ribs as in man; the cranium is rounded and lacks the prominent supraorbital crest of the

African anthropoids; the carpus retains the central bone as in monkeys and gibbons; the laryngeal air-sacs are enormously developed, extending far down under the arms and on the chest in adult animals; the hair is coarse and sparse but very long and bright red in colour; a feature frequently, but not always, present in old males is a pair of prominent ridges of connective tissue on the cheeks. The orang feeds on fruits, especially the durian. There is probably only one species, with several local varieties. It is usually known as *Simia satyrus* (or *Pongo pygmaeus*). A fossil jaw ascribed to *Simia,* in the Upper Pliocene of India, and a molar tooth *(Paleosimia)* from the Miocene indicate the ancient differentiation of the orang line.

The chimpanzee, variously known as *Anthropopithecus* and *Pan,* and the gorilla *(Gorilla)* both inhabit the great forests of central Africa, the chimpanzee having far the wider range. The latter is smaller, more agile and more completely arboreal in habit. The gorilla, probably owing to its great weight (males exceed 400 lb.), is largely terrestrial, though it climbs readily and in the west coast species the females and young are said to sleep in nests built in trees. Though the arms are somewhat longer than those of the chimpanzee, the hands have shorter fingers and are less adapted for brachiation; the feet show distinct secondary adaptation to walking on the ground. The foot of the mountain gorilla (G. *beringei)* of the eastern Congo presents the closest approach to the human foot found among primates. In both chimpanzee and gorilla the ribs number 13 pairs, one more than in man, but the total number of presacral vertebrae is the same, and a 13th rib in man is not uncommon. In both apes the hair is mainly black. In the chimpanzee the skin is usually light-coloured in early life, tending to become dusky later; in the gorilla the face is intensely black. In both animals a heavy brow-ridge overhangs the eyes and in the gorilla the cranial form in adult males becomes greatly altered by the development of huge crests for muscle-attachment. The gorilla has well-marked alae of the nose, separated from the cheeks by distinct grooves. *See* CHIMPANZEE, GORILLA.

Origin **and** Evolution.--Of the fossil gibbons the best known is *Pliopithecus antiquus* from the Miocene of middle Europe. This differs from the recent gibbons in the lesser specialization of the canines and front lower premolar. A fossil humerus and femur of *Pliohylobates eppelsheimensis* from Eppelsheim, Germany, are close to those of the recent gibbons.

The earliest known forerunner of the gibbons and possibly also of the great apes and man is the fossil lower jaw named *Propliopithecus haeckeli,* from the Lower Oligocene of Fayûm, Egypt. This little jaw, while no bigger than that of a small monkey, already shows the relatively great depth characteristic of all anthropoids and of early man; its molar teeth also have the five main cusps arranged substantially as in the higher forms. Many nominal species of fossil anthropoid apes of the genera *Dryopithecus, Sivapithecus* and others are known.

MAN

The origin and evolution of man is fully discussed in other articles (ANTHROPOLOGY; BRAIN; MAN, EVOLUTION OF, etc.).

BIBLIOGRAPHY.—General: W. H. Flower and R. Lydekker, *Mammals, Living and Extinct* (1891); *H.* O. Forbes, *A Handbook to the Primates* **(1894)**; various authors, *Harmsworth Natural History,* vol. i. (1910); D. G. Elliot, *A Review of the Primates* (1912); *W.* L. H. Duckworth, *Morphology and Anthropology* (1915).

Tree Shrews: W. E. L. Clark, *Proc. Zool. Soc. Lond.* (1924–25–26–27). Tarsioids. **W.** D. Matthew and W. Granger, *Bull. Am. Mus. Nat. Hist.* (1915); various authors, "Discussion on the Zoological Position of *Tarsius,*" *Proc. Zool. Soc. Lond.* **(1925)**; H. **H.** Woollard, *Proc. Zool. Soc. Lond.* (1925).

Lemuroids: A. Milne Edwards and A. Grandidier, "Histoire Naturelle des Mammifères" in A. Grandidier, *Histoire Physique . . . de Madagascar* (1875); H. **F.** Standing, *Trans. Zool. Soc. Lond.* (1908); *H.* G. Stehlin, *Abhand. Schweiz. Palaeont. Gesell* **(1912)**; **R. I.** Pocock, *Proc. Zool. Soc. Lond.* (1918); W. K. Gregory, *Mem. Am. Mus. Nat. Hist.* (1920); J. P. Hill, A. Subba Rau. and F. Ince, *Proc. Zool. Soc. Lond.* (1928).

New World Monkeys: *See* general works above; also R. I. Pocock, *Proc. Zool. Soc. Lond.* **(1920)**; W. K. Gregory, *Origin and Evolution of the Human Dentition* **(1922)**.

Old World Monkeys: R. I. Pocock, *Proc. Zool. Soc. Lond.* **(1926)**.

Anthropoid Apes and Man: *See* general works above; also Sir A. Keith, *Engines of the Human Body* **(1920)**; *Brit. Med. Journ.* (1923); W. K. Gregory, *Origin and Evolution of the Human Dentition* **(1922)**; also K Landsteiner and Miller, *J. Experim. Medicine* (1925); *Proc. Am. Philos. Soc.* **(1927)**; *Quart. Rev. Biol.* (1927); C. F. Sonntag, *Morphology and Evolution of Apes and Man* (1924); *G.* Elliot Smith, *Essays on the Evolution of Man* (1924); W. Koehler, *The Mentality of Apes; R.* M. Yerkes, *Almost Human.*

(W. K. G.; J. H. McG.)

PRIME MINISTER. Though a Wolsey or a Cecil might, in practice, achieve for a time a predominant position among the counsellors of the English Crown, the persistence of the doctrine that ministers were all equally royal servants, severally responsible to the sovereign for their respective departments, was for centuries fatal to the recognition of any such predominance in theory Thus Burnet describes Clarendon as "chief, or the only, minister," but the latter knew only too well that the style "first minister" was "a title so newly translated out of French into English that it was not enough understood to be liked, and every man would detest it for the burden it was attended with." Even in the 18th century it is more usual to find partnerships of two or three individuals, such as Marlborough and Godolphin, Harley and St. John, Stanhope and Sunderland, Townshend and Walpole, Newcastle, Henry Pelham and Hardwicke, sharing the principal burden of government. But the place vacated by the sovereign when, from 1717 onwards, he ceased to attend cabinet meetings, had necessarily to be filled by a single individual, and this presiding officer developed naturally, almost inevitably, into a prime minister. Walpole, though he "unequivocally denied" the title, is usually reckoned the first of the line, and certainly during his last spell of office (1720–42) he developed many of the attributes of premiership. He was master of his cabinet; he insisted on a general subscription by his colleagues to the Whig principles; he dismissed his opponents; he dispensed the royal patronage; and, with reservations, he may be described as commanding a majority in the House of Commons. How novel, how dangerously unpopular, such a position still was may be gathered from the proceedings of both houses in 1741. "According to our Constitution," said Sandys, "we can have no sole and prime minister . . every . . . officer has his own proper department; and no officer ought to meddle in the affairs belonging to the department of another." And the minority in the House of Lords was, if possible, even more downright. "We are persuaded," they protested, "that a sole, or even a first minister, is an officer unknown to the law of Britain, inconsistent with the Constitution of the country and destructive of liberty in any Government whatsoever."

On the fall of Walpole the further development of the office was checked, firstly, by the group system and consequent group Coalition Governments of the latter half of George II.'s reign, and later, by the interference of George III., who aspired to be himself "the only element of coherence in a ministry." Thus Grenville (1763–65) thought that "Prime Minister is an odious title," and North (1770–82) would not countenance it even from his own family. It was the younger Pitt who, on the fall of personal government, consolidated the work of his predecessors and by his long tenure of power (1783–1801) accustomed the nation to the office, if not to the name. The extent of his achievement can be measured by the terms of his famous interview with Lord Melville in 1803. They are axiomatic. He "stated not less pointedly and decidedly his sentiments with regard to the absolute necessity there is in the conduct of the affairs of this country, that there should be an avowed and real minister, possessing the chief weight in the council, and the principal place in the confidence of the king. In that respect there can be no rivalry or division of power. That power must rest in the person generally called the first minister, and that minister ought, he thinks, to be the person at the head of the finances. . . ." Nevertheless, old prejudices die hard. In 1806 it could still be said in parliament that "the Constitution abhors the idea of a prime minister," and in 1829 that "nothing could be more mischievous or unconstitutional than to recognize by act of parliament the existence of such an office." Such recognition was not granted until 1905, and even now the prime minister is known to the law merely as someone who has precedence next after the archbishop of York.

The prime minister is appointed by the sovereign. "I offered," said Sir Robert Peel (1834–35, 1841–46) on his resignation of office, "no opinion as to the choice of a successor. That is almost the only act which is the personal act of the sovereign; it is for the sovereign to determine in whom her confidence shall be placed." And, as late as 1894, Queen Victoria could call Lord Rosebery (1894–95) without consulting the retiring prime minister, Gladstone (1868–74, 1880–85, 1886, 1892–94), or the wishes of the parliamentary majority. Nevertheless, the Crown's freedom of choice is narrowly circumscribed. The "economic" reforms of Rockingham's administration (1782), by reducing the royal patronage, made it less easy for the sovereign to put ready-made majorities at the disposal of whatever minister he might fancy, and the Reform bills of the 19th century made the ministry dependent on parliament and the electorate rather than on the royal favour. The prime minister is normally the acknowledged head of the party commanding a majority in the House of Commons, and it is only, therefore, on occasions when no party commands an absolute majority of the House, or when the majority party has no acknowledged head, that there is room for the exercise of the royal discretion.

It will be obvious from what has been said above that the prime minister has no salary as such. He merely draws the emoluments of whatever office he may happen to hold. At the close of the 17th century the lord treasurer was already regarded as the most important Government official, and since the Treasury came to be put into commission, the leading minister has normally held the office of first commissioner, or first lord (until the middle of the 18th century he was usually chancellor of the Exchequer as well). But Chatham (1766–67) was lord privy seal; Salisbury (1885–86, 1886–92, 1895–1902), successively secretary of State and lord privy seal; and Ramsay Macdonald (1924) simultaneously first lord of the Treasury and secretary of State. In addition, the prime minister is usually leader of the house of which he is a member. D. Lloyd George (1916–22), however, finding his duties too onerous, transferred this burden to other shoulders. In the 18th century, when cabinets were almost exclusively composed of peers, the leading minister, curiously enough, was recruited most of the time from the Commons; in the 19th century, when commoners came to form the bulk of the cabinet, the prime minister was, more often than not, a peer. As a result, however, of the passage of the Parliament Act of 1911, truncating the powers of the Lords, and of the rise of a Labour Party with few adherents in the upper house, the Commons have, for the time being, at any rate, achieved a practical monopoly of the office. Thus, for instance, Lord Curzon's claims to the premiership were passed over, in 1923, in favour of those of Stanley Baldwin.

"As the cabinet stands between the sovereign and parliament," wrote Gladstone, "so the prime minister stands between the sovereign and the cabinet." He it is who, with the king's consent, appoints his fellow ministers to their respective posts. Originally, of course, the sovereign exercised an unfettered choice. Even so old and faithful a servant as Cecil never knew whom the queen would appoint to her council. Even in Anne's reign it required the united and persistent pressure of a ministry to get a Harley out or a Sunderland in. Even Pitt, at the close of the 18th century, had to put up with Thurlow, "the king's chancellor," and, at the dawn of the 19th century, to do without Fox, the king's *bête noire*. So even to-day, when the prime minister's choice is theoretically as free as was originally the Crown's, the pressure of party, the claims of talent and the prescriptive rights of previous office-holders render that freedom largely nugatory. With the right of appointment is bound up the right of dismissal, but the responsibility of the cabinet to the prime minister and the remaining functions of the latter belong properly to the history of the cabinet (*q.v.*). For lists of the prime ministers and other principal Government officials see MINISTRY.

BIBLIOGRAPHY.—Such books as ***The Prime Ministers of Britain*** (4th ed., 1924) by the Hon. Clive Bigbam, give certain dates and facts, but the history and functions of the office can only be authoritatively studied in the memoirs and biographies of the statesmen themselves and in the party, ministerial and cabinet history of the last two centuries. (F. L. B.)

PRIMITIVE METHODISTS, a community of nonconformists, formed in consequence of the belief that Methodism as founded by the Wesleys tended, after the first generation, to depart from the enthusiasm that had marked its inception and to settle down to the task of self-organization. There were some ardent spirits who continued to work along the old lines and whose watchword was revivalism; and out of their efforts came the Bible Christian, the Independent Methodist and the Primitive Methodist denominations. One of the zealous evangelists to whom Primitive Methodism owes its existence was Hugh Bourne (1772–1852), a millwright of Stoke-upon-Trent. He joined a Methodist society at Burslem, but, business taking him at the close of 1800 to the colliery district of Harrisehead and Kidsgrove, he was so impressed by the prevailing ignorance and debasement that he began a religious revival of the district. His open-air preaching was accompanied by prayer and singing, a departure from Wesley's practice and the forerunner of the well-known "camp meeting." One of the after-fruits of this revival was the conversion (Jan. 1805) of the joint founder of Primitive Methodism, William Clowes (1780–1851), of Burslem, who threw his house open for love-feasts and prayer-meetings, and did a great deal of itinerant evangelization among the cottages of the countryside. The first "camp meeting" was held on Mow Cop, since regarded as the Mecca of Primitive Methodism. It lasted from 6 A.M. to 8 P.M., and Bourne and his friends determined to continue the experiment as a counterblast to the parish wakes of the time, which were little better than local saturnalia; but serious difficulties were presented by the antagonism of the Wesleyan Methodist circuit authorities. But Bourne and his friends persisted against both Conference and the local superintendent, who issued bills declaring that no camp-meeting would be held at Norton in August 1807. The meeting was held and ten months later Bourne was expelled by the Burslem Quarterly Meeting. Camp-meetings went steadily on, and in 1810, the methods of the meetings organized by Bourne and Clowes were found to be incompatible with those of Wesleyan Methodism. A chapel was built at Tunstall, which became the nucleus of a circuit. Clowes and James Crawfoot, an ex-Wesleyan local preacher, were set apart as preachers to "live by the gospel," and in February 1812 the name "Primitive Methodist" was formally adopted.

The period 1811–43 was a time of rapid expansion for the new sect. Enthusiasts pressed forward through the "Adam Bede" country to Derby (which became the 2nd circuit in 1816), Nottingham, where a great camp-meeting on Whit Sunday 1816 was attended by 12,000 people, Leicestershire, where Loughborough became the 3rd circuit, with extensions into Rutland, Lincolnshire and Norfolk, and ultimately to Hull, which became the 4th circuit, and where a meeting which deserves to be called the First Conference was held in June 1819. The Hull circuit during the next five years, through its Yorkshire, Western, North-Western and Northern Missions, carried on a vigorous campaign with great success, especially among the then semi-savage colliers of Durham and Northumberland. Simultaneously Tunstall circuit, having thrown off its lethargy, was carrying on an aggressive evangelism. Work in the Black Country was extended to Liverpool and Manchester on the one side and South Shropshire on the other; and thence to Herefordshire, Glamorganshire and Wiltshire. Thenceforward, while the Oxford Movement was awakening one section of the people of England the Primitive Methodists were making themselves felt among other classes of the population. The early Primitive Methodists had to meet mob violence that often amounted to sheer ruffianism, especially in Wessex and the home-counties. On the other hand there was legal persecution all over the country, and the preachers suffered many things from the hands of rural clergy and county magistrates. There are a score of cases of serious imprisonment, and a countless number of arrests and temporary detention. Local preachers received notice to quit their holdings, labourers were discharged, those who opened their cottages for meetings were evicted, and to show any hospitality to a travelling preacher was to risk the loss of home and employment.

The years 1842–53 mark a transition period in the history of

Primitive Methodism. From being a loosely jointed home missionary organization, the movement developed on the lines of a real connectionalism. One of the first steps was to move the Book Room and the meeting place of the executive committee to London. Soon after came the gradual process by which the circuits handed over their mission-work to a central Connexional Committee. The removal to London was proof that the leaders were alive to the necessity of grappling with the rapid growth of towns and cities, and that the Connexion, at first mainly a rural movement, had also urban work to accomplish. The period 1853–85 finds Primitive Methodism as a connection of ten federated districts, a unity which may be described as mechanical rather than organic. Conference—the supreme assembly—was a very jealously guarded preserve, being attainable only to preachers who had travelled 18 and superintended 12 years, and to laymen who had been members 12 and officials 10 years. This exclusiveness naturally strengthened the popularity and power of the districts, where energy and talent found a scope elsewhere denied. Thus Hull district inaugurated a bold policy of chapel-buildings; Norwich that of a foreign mission; Sunderland and Manchester the ideal of a better-educated ministry; Nottingham district founded a middle-class school; Leeds promoted a union of Sunday-schools, and the placing of chapel property on a better financial footing. The period as a whole had some anxious moments; emigration to the gold-fields and the strife which afflicted Wesleyan Methodism brought loss and confusion between 1853 and 1860. Yet when Conference met at Tunstall in the latter year to celebrate its jubilee it could report 675 ministers and 11,384 local preachers, 132,114 members, 2,267 chapels, 167,533 scholars and 30,988 teachers.

Work in Australia and New Zealand prospered, and the former country finally contributed over 11,000 members to the formation of the United Methodist Church of Australia, New Zealand with its 2,600 members preferring to remain connected with the home country. In the United States there had been a quiet but steady growth since the first agents went out in 1829. There are now three Conferences—the Eastern, Pennsylvania and Western, with about 70 ministers, 100 churches and 7,000 members. The Canadian churches had a good record, consummated in 1884 when they contributed 8,000 members and 100 ministers to the United Methodist Church of the Dominion. In January 1870 the first piece of real foreign missionary work was begun at Fernando Po, followed in December of the same year by a mission on the Orange River in South Africa. This station is the centre of a polyglot circuit or district and carries on an efficient institution for training teachers, evangelists and artisans. In 1899 another South African mission was started, and a few years later work was begun in Southern Nigeria.

Since 1885 Primitive Methodism has been developing from a "Connexion" into a "Church," the designation employed since 1902. At home a Union for Social Service was formed in 1906, the natural outcome of Thomas Jackson's efforts for the hungry and distressed in Clapton and Whitechapel, and of similar work at St. George's Hall, Southwark. Other significant episodes have been the Unification of the Funds, the Equalization of Districts and the reconstruction of Conference on a broader basis, the Ministers' Sustentation Fund and the Church Extension Fund, and the enlargement and reorganization of the college at Manchester. This undertaking owes much to the liberality of Sir William P. Hartley, whose name the college, which is affiliated to the Victoria University of Manchester, now bears. The Christian Endeavour movement in Great Britain derives, perhaps, its greatest force from its Primitive Methodist members; and the appointment of central missions, connectional 'evangelists and mission-vans, which tour the more sparsely populated rural districts, witness to a continuance of the original spirit of the denomination, while the more cultured side is fostered by the Hartley lecture. In 1932 the Primitive Methodists combined with the Wesleyan Methodists and the United Methodist Church to form the Methodist Church.

For recent statistics *see* art. METISODISM. On the history see H. B. Kendall, *The Origin* and *History of the Primitive Methodist Church* (2 vols., 1906); and *What* hath *God wrought? A Centenary Memorial of the P.M. Church* (1908). (A. J. G.; X.)

PRIMO DE RIVERA, MIGUEL (1870–1930), Spanish soldier and statesman, known as the Marquis de Estella, was born at Jerez de la Frontera Jan. 8, 1870, and studied at the Madrid military academy. After four years in Toledo he was ordered to Morocco in 1893 as lieutenant of the Infantry Regiment of Extremadura, and in Oct. of the same year was promoted to the grade of captain for extraordinary personal bravery. In 1895 he was adjutant to Gen. Martinez Campos in Cuba, and rose to be major commanding the infantry battalion of Zamora.

He served in the Philippines in 1897, and negotiated the Treaty of Biagnabato (Biacabato) on Dec. 12, 1897. He then held commands at Barcelona, on the general staff and at Algeciras. In 191j he was appointed governor of Cadiz, and spent a month at the French front during the World War. His speech to the Hispano-American Academy advocating the exchange of Gibraltar for Ceuta or other North African territory, and corrosively criticising the Government's policy in Morocco, resulted in his being relieved from the governorship of Cadiz. His exceptional military talents, his brilliant exploits, his unaffected simplicity and straightforwardness, his sympathy with the feelings and interests of the army and the nation, had won for him the confidence of the King, the general staff and the public, so that despite his outspokenness in the academy, he was soon afterwards promoted to be general and chief of the First Infantry Division in Madrid.

In 1921 Estella was elected senator for Cadiz, and in a powerful speech urged the necessity of relieving the nation of the Moroccan burden. Whereupon Primo once again lost his post. But the effects of his courage and patriotism prevailed once more over considerations of petty discipline, and he was entreated to undertake the most difficult and dangerous post in Spain—that of captain-general of Catalonia—with a view to ending the reign of terror there, of which the central Government was content to remain a listless onlooker. The new captain-general soon reaped a measure of success fully proportionate to his chivalrous character, his personal influence and his limited legal powers.

Easy and generous to the point of familiarity in his private life, Estella was punctilious and exacting in matters affecting the nation, the army and the monarch, and his integrity was proverbial. He soon recognized the chaos in Catalonia as one of the indirect consequences of the breakdown of the parliamentary regime. This was also responsible for the mismanagement of the Morocco campaign, as well as for the ferment in the army brought about by the niggardliness, the favouritism and criminal recklessness of the central Government. Although the evil had long been diagnosed nobody had had the courage to uproot it, until the dauntless Marquis de Estella issued the manifesto dated Sept. 12, 1923, suspending the constitution and proclaiming in its place a directorate consisting of military and naval officers. He announced that this arrangement was but a bridge leading to a future system of government better suited to Spain's needs than that which he abolished. This military coup d'état was carried out without bloodshed.

The methods of the directorate were prompt and radical. (See SPAIN: *History*.) Primo called into being under the name la *Unión Patriótica*, a fellowship of "citizens of goodwill" to work for the realization of ethical ideals in public life, and hinder a return to the venal system just swept away. This innovation was welcomed with marked enthusiasm, and within a few months the members numbered over 1,250,000. Mindful of the undertaking he had given at the outset, Primo dissolved the directorate on Dec. 3, 192j, and substituted a government composed of civil as well as military ministers—mostly young men—as a preparatory step towards a new regime. The dictator became premier, and his policy was pursued for a considerable period. He resigned on Jan. 28, 1930, and died in Paris on March 16, 1930.

PRIMOGENITURE, a term used to signify the preference in inheritance which is given by law, custom or usage, to the eldest son and his issue. or in exceptional cases to the line of the eldest daughter. The history of primogeniture is given in the article LAW OF SUCCESSION. See also INHERTTANCE; INTESTACY.

BIBLIOGRAPHY.—H. Maine, Ancient Law (1861), Early History of Institutions (1875); K. E. Digby, History of the Law of Real Property (1875); C. S. Kenny, *Law of Primogeniture* in England (1878); F Pollock and F. W. Maitland, History of English Law (1895); E. Cecil, Primogeniture (1895).

PRIMROSE. The genus *Primula* contains about goo species distributed throughout the cooler parts of Europe and Asia, and found also on the mountains of Abyssinia and Java; a few are American. They are herbaceous perennials, with a permanent stock from which are emitted tufts of leaves and flower-stems which die down in winter; the new growths formed in autumn remain in a bud-like condition ready to develop in spring. They form the typical genus of Primulaceae (*q.v.*), the floral conformation of which is very interesting on several accounts independently of the beauty of the flowers.

The variation in the length of the stamens and of the style in the flowers of *Primula* has attracted much greater attention since Charles Darwin investigated them. Some of the flowers have short stamens and a long style, while others have long stamens, or stamens inserted so high up that the anthers protrude beyond the corolla tube, and a short style. Gardeners and florists had for centuries been familiar with these varrations, calling the flowers from which the anthers protruded "thrum-eyed" and those in which the stigma appeared in the mouth of the tube "pin-eyed."

Darwin showed by experiment that the most perfect degree of fertility, as shown by the greatest number of seeds and the healthiest seedlings, was attained when the pollen from a short-stamened flower was transferred to the stigma of a short-styled flower, or when the pollen from the long stamens was applied to the long style. As in any given flower the stamens are short (or low down in the floner-tube) and the style long, or conversely, it follows that to ensure a high degree of fertility cross fertilization must occur, and this is effected by the transfer of the pollen from one flower to another by insects. Incomplete fertility arises when the stigma is impregnated by the pollen from the same flower. The size of the pollen-grains and the texture of the stigma are different in the two forms of flower.

Among species found in Britain may be mentioned the common primrose (P. vulgaris); the cowslip (P. *veris*); and the oxlip (P. elatior), a rare plant found only in the eastern counties. In addition to these, two other species occur in Britain, namely, the Eurasian P. farinosa, bird's eye primrose, found in Wales, the north of England and southern Scotland, and P. scotica, which occurs in Orkney and Caithness. These two species are found also in high arctic latitudes, and P. *farinosa,* or a very closely allied form, exists in Fuegia. About 15 species occur in North America, chiefly in the western and northwestern parts of the continent.

The auricula (*q.v.*) of the gardens is derived from P. *auricula,* a yellow-flowered species, a native of the Swiss mountains. The Himalayas are rich in species of primrose, often very difficult of determination or limitation, certain forms being peculiar to particular valleys. Of these P. denticulata, *stuarti, sikkimmensis, nivalis, floribunda,* may be mentioned as frequently cultivated, as well as the lovely rose-coloured species P. rosea. The royal cowslip (P. *imperialis*) resembles P. *japonica* but has leaves measuring 18 in. long by 5 in. wide. It grows at an elevation of 9,000 ft. in Java and has deep yellow or orange flowers.

The primrose is to be had in cultivation in a considerable variety of shades of colour, ranging from the palest yellow to deep crimson and blue. Since the varieties do not reproduce quite true from seed, it is necessary to increase special kinds by division. The primrose is at its best in heavy soils in slight shade, and with plenty of moisture during the summer. One of the most popular of winter and early spring decorative plants is the Chinese primrose, *Primula* sinensis, of which some superb strains have been obtained. *P. japonica,* a bold-growing and very beautiful Japanese plant, is hardy in sheltered positions in England but must be grown in the cool greenhouse over most of the U.S. P. cortusoides of Siberia and P. sieboldi of Japan, of which there are many lovely forms, is suitable for outdoor culture and under glass. There are several small-growing hardy species which should be accommodated on the best positions on rockeries, where they are secure from excessive dampness during winter; excess of moisture at that season is the worst enemy of the choice Alpine varieties. They are propagated by seed and by division of the crowns after flowering. P. forresti is an orange-yellow flowered species from China, as is also P. bulleyana. They are hardy in favoured spots in the rock garden.

Evening primrose belongs to the genus Oenothera (*q.v.*) (family Onagraceae).

The Cape primrose comprises hybrid forms of Streptocarpus, a South African genus belonging to the family Gesneriaceae. The Arabian primrose is Arnebia *cornuta* of the family Boraginaceae, a garden annual.

PRIMULACEAE, a family of gamopetalous dicotyledons belonging to the order Primulales and containing 22 genera with about 600 species. It is cosmopolitan in distribution, but the majority of the species are confined to the temperate and colder parts of the northern hemisphere and many are arctic or alpine. Nine genera are represented in the British flora.

The plants are herbs, sometimes annual as in pimpernel (*Anagallis arvensis*), but generally perennial as in *Primula,* where the plant persists by means of a sympodial rhizome, or in Cyclamen by means of a tuber formed from the swollen hypocotyl. The leaves form a radical rosette as in *Primula* (primrose, cowslip, etc.), or there is a \\ell-developed aerial stein which is erect, as in species of *Lysimachia,* or creeping, as in Lysimachia *nummularia* (creeping jenny or moneywort). Hottonia (water violet) is a floating water plant with submerged'leaves cut into fine linear segments. The leaves are generally simple, often with a toothed margin; their arrangement is alternate, opposite or whorled. The flowers are solitary in the leaf-axils as in pimpernel, moneywort, etc., or umbelled as in primrose, where the umbel is sessile, and cowslip, where it is stalked, or in racemes or spikes as in species of Lysimachia. Each flower is subtended by a bract, but there are no bracteoles, and corresponding with the absence of the latter the two first developed sepals stand right and left. The flowers are hermaphrodite and regular with parts in fives (pentamerous) throughout, though exceptions from the pentamerous arrangement occur. The sepals are leafy and persistent; the corolla is generally divided into a longer or shorter tube and a limb which is spreading, as in primrose, or reflexed, as in Cyclamen; in *Soldanella* it is bell-shaped; in Lysimachia the tube is often very short, the petals appearing almost free; in Glaux the petals are absent. The five stamens spring from the corolla-tube and are opposite to its lobes; this anomalous position is generally explained by assuming that an outer whorl of stamens opposite the sepals has disappeared, though sometimes represented by scales as in Samolus and Soldanella. The superior ovary—half-inferior in *Samolus*—bears a simple style ending in a capitate entire stigma, and contains a free-central placenta bearing generally a large number of ovules, which are exceptional in the group Sympetalae in having two integuments. The fruit is a capsule dehiscing by five, sometimes ten, teeth or valves, or sometimes transversely (a pyxidium) as in Anagallis.

Cross pollination is often favoured by dimorphism of the flower, as shown in species of Primula. The two forms have long and short styles respectively, the stamens occupying corresponding positions half-way down or at the mouth of the corolla-tube; the long-styled flowers have smaller pollen-grains, which correspond with smaller stigmatic papillae on the short styles (see PRIMROSE).

The family is divided into five tribes by characters based on the presence or absence of tubers, the regularity of the flower, the aestivation of the corolla, etc. The ovules are generally semianatropous so that the seed is peltate with the hilum in the centre on one side (or ventral), but sometimes, as in Hottonia and Samolus, anatropous with the hilum basal—together with the method of dehiscence of the capsule and the relative position of the ovary.

The chief British genera are Primula; and the Lysimachia, loosestrife, including L. *Nummularia,* moneywort; Anagallis, pimpernel; and Hottonia, water violet. The most familiar American genera are Primula (primrose), Samolus (water pimpernels and brookweeds), Lysimachia (loosestrife), and Dodecatheon (shooting stars or American cowslips).

See F. Pax and R. Knuth, "Primulaceae," *Pflanzenreich* 22 (iv, 237): 1–386, fig. 1–75 (1905).

PRINA, GIUSEPPE (1768–1814), Italian statesman. He was an adherent of Napoleon Bonaparte, and when Eugene Beauharnais became viceroy of Italy, was appointed minister of finance. His skill in devising fresh taxes to meet the enormous demands of Napoleon's government made him the best-hated man in Lombardy. After the emperor's forced abdication in 1814 Prina's party moved in the senate that delegates should go to Vienna to request that Eugène Beauharnais be raised to the throne of a free Italian kingdom. This provoked the formidable riot in which Prina was dragged about the town for four hours, until almost torn to pieces, he received his death-blow.

PRINCE, MORTON (1854–1929), U.S. psychologist, was born in Boston, Mass., Dec. 21, 1854, and was educated at Harvard university (B.A., 1875; M.D., 1879). His particular interest lay in the study of abnormal psychology, a field in which he taught for many years. He was founder (1906) and editor (1906–29) of the *Journal of Abnormal Psychology.* His books include *The Nature of Mind and Human Automatism* (1885); *Dissociation of a Personality* (1906); *The Unconscious* (1913); *The Psychology of the Kaiser* (1915); and *Clinical and Experimental Studies in Personality* (1929). He died Aug. 31, 1929.

PRINCE, a title implying either political power or social rank. The Latin word *princeps* originally signified merely "the first." As an honorary title it was applied in the Roman republic to the *princeps senatus, i.e.,* the senator who stood first on the censor's list, and the *princeps juventutis, i.e.,* the first on the roll of the equestrian order. The assumption of the style of *princeps senatus* by Augustus (*q.v.*) first associated the word with the idea of sovereignty and dominion, but throughout the period of the empire it is still used as a title of certain civil or military officials; while in the middle ages it is applied vaguely in charters to the magnates of the State or the high officials of the palace, *principes* being treated as the equivalent of *proceres, optimates* or *seniores.* In the Visigothic and Lombard codes *princeps* is the equivalent of *rex* or *imperator.*

From Italy the use of the title spread—first, with the crusaders, to the Holy Land, where Bohemund, son of Tancred, took the style of prince of Antioch; next, with the Latin conquerors, into the East Roman empire, where in 1205 William de Champlette, a cadet of the House of Champagne, founded the principality of Achaea and the Morea. This example was followed by lesser magnates, who styled themselves loosely, or were so styled by the chroniclers, "princes." From the East the fashion was carried back to France; but there the erection of certain fiefs into "principalities," which became common in the 15th and 16th centuries, certainly implied no independent sovereignty, and the title of "prince" ranked below that of "duke," being sometimes borne by cadet branches of ducal houses. On the other hand, the title of "prince" was borne from the time of Charles VII. or Louis XI. by the sons of the royal house, so-called "princes of the blood," who took precedence in due order after the king. To these were added, from the time of Louis XIV., the *princes légitimés,* recognized bastards of the sovereign.

In Germany, Austria and other countries formerly embraced in the Holy Roman empire the title of "prince" had a somewhat different history. During the first period of the empire, the "princes" were the whole body of the *optimates* who took rank next to the emperor. In the 11th century, with the growth of feudalism, all feudatories holding in fief of the Crown ranked as "princes." Towards the end of the 12th century, however, the order of princes *(Furstenstand)* was narrowed to the more important spiritual and temporal feudatories who had a right to a seat in the diet of the empire in the "college of princes" (*Fürstenbank*). Finally, in the 13th century, seven of the most powerful of these separated themselves into a college which obtained the sole right of electing the emperor. These were called "prince electors" (*Kurfürsten*), and formed the highest rank of the German princes *(see* ELECTORS). The formal designation of "prince" (*Fürst*) was, however, extremely rare in Germany in the middle ages; but in the 17th and 18th centuries the number of principalities was increased.

Thus, in Germany, with the decay of the empire the title "prince" received a sovereign connotation, though it ranked, as in France, below that of "duke." There were, however, in the countries formerly embraced in the Holy Roman empire other classes of "princes." Some of these inherited titles, sovereign under the old empire, but "mediatized" during the years of its collapse at the beginning of the 19th century; others received the title of "prince" at the end of the empire as "compensation" for ceded territories. There were also in Austria and Germany "princes," created by the various German sovereigns, and some dating from the period of the old empire, who took a lower rank, as not being "princes of the Holy Roman empire" nor entitled to any royal privileges. Some of these titles were bestowed to give rank to the morganatic wives and children of royal princes; others as a reward for distinguished service, *e.g.,* Hardenberg, Bliicher, Bismarck. In this latter case the rule of primogeniture was usual, the younger sons taking the title of "count" *(Graf).* All these princes were styled *Fürst,* having the predicate "Serene Highness" (*Durchlaucht*). The word *Prinz,* actually synonymous with *Fürst,* was reserved as the title of the non-reigning members of sovereign houses and, with certain exceptions (*e.g.,* Bavaria), for the cadets of mediatized ducal and princely families. The heir to a throne was "crown prince" (*Kronprinz*), "hereditary grand duke" (*Erbgrossherzog)* or "hereditary prince" (*Erbprinz*). The heir to the crown of Prussia, when not the son of the monarch, had the title of "prince of Prussia" (*Prinz von Preussen).*

In Italy the title "prince" (*principe*) is also of very unequal value. The heads of great families sometimes bear the title of "prince," sometimes that of "duke." The title of "prince of Naples" is attached to the eldest son of the king of Italy.

"Prince" is also the translation of the Russian title *knyaz.* In general, though the title "prince" implies descent from one or other of the ruling dynasties of Russia, it is in itself of little account owing to its being borne by every member of the family.

The title of "prince" is also borne by the descendants of those Greek Phanariot families *(see* PHANARIOTES), who formerly supplied hospodars to the Turkish principalities on the Danube. The only instance in Europe of "prince" as a completely sovereign title is that of the prince of Monaco, the formal style having been adopted by the Grimaldi lords in 1641.

Great Britain.—In Great Britain "prince" and "princess" as titles are confined to members of the royal family, though nonroyal dukes are so described in their formal style *(see* DUKE). Nor is this use of great antiquity; the custom of giving the courtesy title of "prince" to all male descendants of the sovereign to the third and fourth generation being foreign to English traditions. It was not till the reign of Henry VII. that the king's sons began to be styled "princes"; and as late as the time of Charles II., the daughters of the duke of York, both of whom became queens regnant, were called simply the Lady Mary and the Lady Anne. The title of "princess royal," bestowed on the eldest daughter of the sovereign was borrowed by King George II. from Prussia. Until recent years the title "prince" was never conferred on anybody except the heir-apparent to the Crown, and his principality is a peerage. Since the reign of Edward III. the eldest sons of the kings and queens of England have always been dukes of Cornwall by birth, and, with a few exceptions, princes of Wales by creation, Before that Edward I. had conferred the principality on his eldest son, afterwards Edward II., who was summoned to and sat in parliament as prince of Wales. But Edward the Black Prince was the original grantee of the principality as well as of the dukedom, under the special limitations which have continued in force to the present day. The entail of the former was "to him and his heirs the kings of England" and of the latter "to him and his heirs the first-begotten sons of the kings of England." Hence when a prince of Wales and duke of Cornwall succeeds to the throne the principality in all cases merges at once in the Crown, and can have no separate existence again except under a fresh creation, while the dukedom, if he has a son, descends immediately to him, or remains in abeyance until he has a son born. If, however, a prince of Wales and duke of Cornwall should die in the lifetime of the sovereign, leaving a son and heir, both dignities are extinguished, because his son, although he is his heir, is neither a king of England nor the first-begotten son of a king of England. But, if instead of a son he should leave a brother his heir, then —as was decided in the reign of James I on the death of Henry, prince of Wales, whose heir was his brother Charles, duke of York—the dukedom of Cornwall would pass to him as the first-begotten son of the king of England then alive, the principality of Wales alone becoming merged in the crown.

But even now the children of the sovereign other than his eldest son, though by courtesy "princes" and "princesses," need a royal warrant to raise them de *jure* above the common herd; and even then they remain "commoners" till raised to the peerage. In 1905 King Edward VII established what appears to be a new precedent, by conferring the titles of "princess" and "highness" upon the daughters of the princess Louise, duchess of Fife, created "princess royal."

PRINCE EDWARD ISLAND, the smallest province of the dominion of Canada, lies between 45° 58′ and 47° 7′ N. and 62° and 64° 27′ W. The island lies in a great semi-circular bay of the Gulf of St. Lawrence, which extends from Point Miscou in New Brunswick to Cape North in Cape Breton. From the mainland it is separated by Northumberland strait, which varies from 9 to 30 mi. in width. Structurally, however, it is a continuation of northern plain of Kew Brunswick and on the island the red rocks again appear (Permian with Triassic outliers). The island is extremely irregular in shape; deep inlets and tidal streams almost divide it into three approximately equal parts; from the head of Hillsborough river on the south to Savage Harbour on the north is only one and a half miles, while at high tide the distance between the heads of the streams which fall into Bedeque and Richmond bays is even less. North of Summerside the land nowhere rises more than 175 ft. above sea level; but between Summerside and Charlottetown, especially near north Wiltshire, is a ridge of hills, running from north to south and rising to a height of nearly 500 ft. From Charlottetown eastwards the land is low and level. Beds of peat, dunes of drifted sand, alluvial clays and mussel mud occur in and near the creeks and bays. The north shore, facing the gulf, is a long series of beaches of fine sand, and is a favourite resort in summer. On the south low cliffs of crumbling red sandstone face the strait. The oceanic influences make the climate of the province milder than that of the neighbouring mainland. The mean January temperature is 16° and the mean for July a little over 65°. The winter and summer rainfall is about the same—between 3 and 5 in. in January and July respectively. Fogs are much less common than in either New Brunswick or Nova Scotia.

Area and Population.—The greatest length of the island is 145 mi., its greatest breadth 34 mi., its total area 2,184 sq.mi. The population stood at 94,021 in 1871, just before the union with Canada in 1873, and slowly increased to 109,078 (1891); then it declined till it reached 88,038 (1931), and rose again to 95,047 in 1941. On the other hand urban movement brought a slow but continuous increase of town people; Charlottetown 7,872 (1871); 14,821 (1941). As with all the maritime provinces, there was long a steady migration to the Canadian west and to the United States. The population is mainly of British descent, census returns showing 84% British, in part the descendants of American Loyalists; 14.5% French, original settlers and refugees from Nova Scotia. A few Indians of the Micmac tribe remain.

Government.—The government of the province rests upon the (Imperial) British North America act of 1867, and its amendments, together with all pre-union laws and institutions not altered or abolished by these acts, including the British common law and the constitutional conventions of British government. Prince Edward Island was united with the dominion of Canada (July 1, 1873) by an Imperial Order in Council (June 26, 1873) under the B.N.A. Act of 1867. This act provided for representation in the parliament of Canada, by senators and a number of members of the commons in proportion to its population as compared with that of Quebec (65 members). A later B N.A. act (1915) set a minimum in the commons at the existing number of senators, notwithstanding any decline in population.

The provincial government at Charlottetown consists of a lieutenant-governor, appointed and paid by the dominion, a ministry on the constitutional model, and a legislative assembly of 30 members, elected for five years unless sooner dissolved. Each of the 15 electoral districts in the province has two representatives, a councillor and an assemblyman.

Finance.—The revenue of the province in 1871 was $385,000; in 1940, $2,030,000. Large items are gasoline, corporation and succession taxes. The province, unlike all the others, is under prohibition and draws no revenue from liquor control.

Education.—Education in Prince Edward Island is compulsory and free and is almost entirely conducted by the state. Of a total school and college population of 19,689, 18,308 were enrolled in free public elementary, 756 in privately controlled (including denominational) schools, and 610 in courses of college standing in 1943. There are two colleges, Prince of Wales college, and St. Dunstan's, a Roman Catholic institution, both in Charlottetown.

Agriculture.—All the staple crops are grown, especially oats, potatoes and turnips. Wheat is raised only for local consumption. The total area of field crops was 494,100 ac. in 1941. Of this 218,353 acres represented hay, and 125,264 acres oats. The acreage under potatoes (39,856) produced 2,840,000 tons in 1941. In 1941 there were 44,000 milk cows; 46,000 sheep; 54,000 swine. Total production of butter (1941) was 3,569,400 lb., total production of cheese (1941) 684,300 lb. Fruit is raised less extensively than in Nova Scotia.

Fisheries.—Lobsters are an important catch (49 lobster canneries in 1940; more than in any other province), together with smelts, herring, cod and mackerel. The total value of the fisheries in 1940 was $714,870. Experiments begun in 1929 by the dominion department of fisheries led to the successful establishment of commercial oyster farming.

Other Industries.—The island has natural forests of birch, beech, maple, pine, spruce, cedar and other woods. Forested land (1940) covered 725 sq.mi. There were 1,088 employees in industry in 1939, of whom about 300 were engaged in fish processing, chiefly carried on at Charlottetown. Fox farming in Canada began with experiments made in Prince Edward Island in 1894. In 1938–39, 70,420 pelts (worth $20 to $70 per pelt) were produced (about 22% of total Canadian production).

Communications.—A railroad runs from end to end of the island (Tignish to Elmira) with branches to Georgetown, Murray Harbour, Charlottetown and Cape Traverse. The railway, originally built by the province, became a part of the Canadian National railway system in 1919. A wide gauge branch from Charlottetown to Borden connects by car ferry with the mainland at Tormentine, N.B. Ice impedes winter navigation in Northumberland strait and at Charlottetown from mid-December to early April. But after 1917–18 powerful ice-breaking ferry boats plied the ferry passage all winter. Total railway mileage in 1941 was 286 mi. Statistics of civil aviation in the province (1940) showed 1,207 passengers; freight 6,251 lb.; mail 73,217 lb.

History.—Jacques Cartier sighted Prince Edward Island in June 1534. Later it was called Ile St. Jean until renamed after the Duke of Kent in 1799. Under the French little attention was paid to the island prior to the peace of Utrecht, when they began to make efforts to colonize it; and the creation of a feudal proprietorship gave to the French settlers a precarious existence. In 1758 the island, with its capital at Port La Joie (Charlottetown), was occupied by a British force under Lord Rollo, and a partial expulsion of the French inhabitants took place, comparable with that of the Acadians from the mainland of Nova Scotia. Ceded finally to England in 1763, it became a separate government ten years later. At this period an unfortunate system of large land grants to a group of proprietors blocked settlement and created claims that had ultimately to be bought out. Meantime, in 1803–04, Thomas Douglas, Earl of Selkirk (*q.v.*), brought out with great success an emigrant settlement of dispossessed Highland tenantry. In the period from the close of war in 1815 until the middle '60s, the island had an uneventful but happy history, its economy based on agriculture, fishing and shipbuilding with open and profitable trade with Great Britain, the West Indies and the United States. The passing of free trade, the abolition of the navigation laws (1849) and the abrogation of American reciprocity greatly altered the outlook, and seemed to demand a change. The people of the province favoured maritime union as proposed at Charlottetown in 1864, but refused confederation in 1867. They were persuaded to enter in 1873 largely by the offer of the dominion to assume the island railway. Economic hardship after confederation led to a decline of immigration, a slackening in the growth of population, and later (1901 to 1931) an actual decline. Politics in Prince Edward Island in the 20th century turned on these relations. In spite of discontent, however, the government remained in the hands of the orthodox Liberal and Conservative parties.

BIBLIOGRAPHY.—See *Canadian Census; Canada Year Book* (annual); *Handbook of Prince Edward Island,* Department of the Interior, Ottawa; D. Campbell, *History* of *Prince Edward Island.* (S. LEA.)

PRINCE RUPERT, port, British Columbia, Canada, situated over 480 mi. N.W. of Vancouver. Pop. (1941) 6,714. The city is built on an island, connected by a steel bridge with the mainland and is a western terminus of the Canadian National railways (previously that of the Grand Trunk Pacific). There is a fine natural harbour, sheltered by Digby island and a promontory of the Tsimpsean peninsula with a government dry dock and a shipbuilding yard. Steamers run regularly to Vancouver, Anyox, Stewart, Seattle, etc. Fish, largely halibut and cod, form the chief article of trade, and there are refrigerating plants and fish-fertilizer works, and lumber and shingle mills. Mining and lumbering are carried on in the neighbourhood. It took its name from the nephew of Charles I of England, who was first governor of the Hudson's Bay company.

PRINCES' ISLANDS, a cluster of nine islands in the Sea of Marmora, forming a caza of the prefecture of Constantinople. They figure in Byzantine history chiefly as places of banishment. A convent in Prinkipo (now a mass of ruins at the spot called Kamares) was a place of exile for the empresses Irene, Euphrosyne, Zoe and Anna Dalassena. Antigone was the prison of the patriarch Methodius, and its chapel is said to have been built by the empress Theodora. In Khalki the monastery of the Theotokos (originally of St. John), which since 1831 has been a Greek commercial school, was probably founded by John VI or VII. Palaeologus was rebuilt about 1680, and again in the 18th century by Alexander Ypsilanti, hospodar of Moldavia. Close beside it is the tomb of Edward Barton, second English ambassador to the Porte. Hagia Trias (a school of theology since 1844) was rebuilt by the patriarch Metrophanes. On Prote were the monasteries to which Bardanes (Philippicus), Michael I. Rhangabes, Romanus I (Lecapenus) and Romanus IV (Diogenes) were banished.

See G. Schlumberger, *Les Îles des Princes* (Paris, 1884); A. Grisebach, *Rumelien und Brussa* (Gottingen, *1839).*

PRINCETON, a city of Illinois, U.S.A., 105 mi. W.S.W. of Chicago; the county seat of Bureau county. It is on federal highways 32 and 6, and is served by the Burlington route, as well as by many truck and bus lines. Pop. 4,762 in 1930; in 1940 it was 5,224.

It is the trading centre of a very productive corn farming region and hybrid seed corn processing plants and other smaller manufacturing industries.

PRINCETON, a city of southwestern Indiana, U.S.A., on federal highway 41, 27 mi. N. of Evansville; county seat of Gibson county. It is served by the Chicago and Eastern Illinois and the Southern railways. Pop. (1930) 7,505; in 1940 it was 7,786. It is the trade centre for an agricultural region, and there are coal mines and gas and oil wells. The city was founded in 1814 and chartered in 1884.

PRINCETON, a borough of Mercer county, New Jersey, U.S.A., on the Lincoln highway about equally distant (50 mi.) from New York and Philadelphia; served by the Pennsylvania railroad. Pop. 1930 federal census 6,992; 1940 census 7,719 (13% Negroes and 5% foreign-born white). During the school year this is increased by some 3,000 students and teachers, and at commencement or on the occasion of a big ball game there are frequently 50,000 visitors. Princeton is on high land (210 ft. above sea level) surrounded on three sides by Stony brook. Lake Carnegie (3.5 mi. long and 800 ft. wide), the gift of Andrew Carnegie, was constructed in 1905–06. The borough is a beautiful academic and residential community, with no factories. It is the seat of Princeton university (*q.v.*), Princeton Theological seminary (Presbyterian), St. Joseph's college (Roman Catholic, 1914), Westminster Choir college (founded 1926 in Dayton, Ohio; moved to Princeton 1932), Institute for Advanced Study (1930) and several preparatory schools for boys and for girls. The Lawrenceville school for boys (1810) is 5 mi. west. Princeton Theological seminary, established by the general assembly of the Presbyterian Church in 1812, has had many theologians among its professors and presidents and has trained more than 7,000 men for the ministry. At times there have been as many as 30 denominations represented in the student body. It is well endowed and has a fine campus near the university. On the eastern shore of Carnegie lake, in the township of West Windsor, are the laboratories of the department of animal pathology of the Rockefeller institute. There are many beautiful modern estates, and a number of colonial buildings still stand. The Quaker meeting-house adjoining the battlefield and replacing one built in 1726 dates from 1760. "Morven," the homestead of the Stocktons, built between 1701 and 1709, has entertained many presidents and other prominent persons. "Rockingham," at Rocky Hill, a village 3 mi. north, was occupied by Washington for three months in the autumn of 1783, and it was there that he wrote his farewell orders to the army. It is now maintained as a historical museum.

Settlement there began in 1696 and the name was adopted in 1724. Princeton was incorporated as a town in 1813 and as a borough in 1873. Among the early settlers was Richard Stockton, grandfather of the signer of the Declaration of Independence who bore the same name, and John Olden, great-grandfather of New Jersey's Civil War governor. The College of New Jersey (now Princeton university) moved there from Newark in 1756. On Aug. 27, 1776, the first legislature of New Jersey met in Princeton. On Jan. 3, 1777, near Stony brook about a mile west of Princeton, Washington won an important victory over part of Cornwallis' troops, both sides losing many brilliant officers. A battle monument by MacMonnies, which has as the central figure an equestrian statue of Washington, was dedicated in 1922. In old Nassau hall, the largest building in the Colonies when it was erected in 1754–56, the Continental Congress sat from June 30 to Nov. 4, 1783, receiving there on Oct. 31 the news that peace had been signed.

PRINCETON, a city in the mountains of southern West Virginia, U.S.A., the county seat of Mercer county; on the Virginian railway and federal highways 19 and 21, 10 mi. N.E. of Bluefield. Pop. 6,224 in 1920 (93% native white); 7,426 in 1940 by the federal census. Coal mining and lumbering are the principal industries, and there are several textile and garment factories. The city was founded in 1826 and incorporated in 1862.

PRINCETON UNIVERSITY, a privately-endowed nonsectarian institution of higher learning for men, at Princeton, N.J., until 1896 called officially the College of New Jersey. Its buildings, about 80 in number, are grouped in the central portion of a campus of 800 acres which is one of the most beautiful in the country.

Nassau hall, the oldest and historically the most interesting building on the campus, was at the time of its completion in 1756 the largest academic building in the American colonies. It was designed by Robert Smith, architect of Independence hall in Philadelphia and named in honour of William of Nassau, William III of England. There in 1783 General Washington received the formal thanks of the American congress for his conduct of the Revolutionary War.

Characteristic of life at Princeton, in addition to the university's rural location and consequently its active outdoor interests, are the residential dormitory system (in 1936 there were 25 campus dormitories housing the majority of the students), the system of elective upper-class eating clubs and the form of student self-government illustrated particularly by the student council, by the "honor system" and by undergraduate participation in the administration of university discipline.

The university offers (1936) undergraduate courses in the liberal arts and sciences leading to the degree of A.B., many graduate courses in the same fields leading to the degrees of A.M., M.F.A. and Ph.D., and technical courses in engineering leading to the degree of B.S. in engineering and ordinarily after one year of graduate study to the degrees of C.E., E.E., M.E. and Ch.E. A field artillery unit, maintained and staffed by the War Department, offers a course extending through four years and two summers, at the satisfactory completion of which, provided he also gains his university degree, the candidate receives from the President of the United States a commission in the Officers Reserve Corps.

In all admissions, regard is given to character, personality and promise as well as to scholarly attainment. Enrolment is limited in the undergraduate department to approximately 2,300 and in the graduate school to 250. Under the Princeton plan an upperclassman concentrates upon a definite subject within one of the 15 departments of the university, and prepares himself for what are known as "comprehensive examinations" at the end of each year, the final examination covering the work of the two previous years. In order to receive his degree he must attain a standing of better than average grade.

A feature of instruction is the preceptorial method, introduced in 1905, by which large classes are broken into small groups or informal conferences with "preceptors" on prescribed reading, especially in the departments of philosophy, history, politics, art, English and the languages. Princeton has no professional schools for utilitarian ends, except the school of engineering and possibly the school of architecture, although both of these are so strongly humanistic in their curricula and methods that they are in marked contrast in this respect with the usual American engineering and architectural schools. The school of architecture is developed directly out of the department of art and archaeology, and on successful conclusion of the course the degree of Master of Fine Arts is conferred.

In assuming the university title in 1896, it was definitely concluded that Princeton's future did not lie in developing professional schools but in upholding pure learning and in devoting herself "to the liberal aspects of those studies which underlie and broaden professional and technical education." The university therefore is not a congeries of professional schools overshadowing an undergraduate department, but consists of a large, homogeneous and well organized body of undergraduate students, with a small and carefully selected graduate school, devoted to the liberal arts and sciences.

There are a large number of scholarships and fellowships, both graduate and undergraduate, and a particularly well developed system whereby undergraduates of limited means are enabled to earn part or all of their expenses. During the year 1935–36 over 700 undergraduates were thus assisted.

The university is governed by a board of trustees, not less than 23 nor more than 40 in number, of which the Governor of the State of New Jersey (and in his absence the chairman of the board) is presiding officer. Eight of the trustees are elected, two each year, by the alumni of the university; the others are elected by the board.

History. — The university owes its origin to a movement set on foot by the Synod of Philadelphia in 1739 to establish in the Middle Colonies a college to rank with Harvard and Yale in New England and William and Mary in Virginia. Owing to dissension in the Church, no progress was made until 1746, when the plan was again broached by the Synod of New York, formed by the secession of the presbytery of New York and the presbytery of New Brunswick, radical (New School) presbyteries of the Synod of Philadelphia. Most of the leaders of the presbytery of New Brunswick had been educated at Log college, a school with restricted curriculum about 20 m. from Philadelphia, founded in 1726 but recently closed. The opportunity was taken by the Synod of New York to found a larger institution of higher learning, broader in scope and training, and to transfer to the new project the Log college interests. On Oct. 22, 1746, John Hamilton, acting governor of New Jersey, granted a charter for erecting a college in New Jersey, which was opened in May, 1747, at Elizabeth, N.J. A second charter was granted by Gov. Jonathan Belcher who on his arrival in the province in 1747 had at once taken the college under his patronage. The college was removed to Newark where the first graduation exercises were held in 1748; but the situation was unsuitable, and in 1752 the trustees voted to remove the college to Princeton. While additional funds were being collected in Great Britain, work was begun in Princeton in 1754 on the first college building, Nassau hall.

John Witherspoon, president during the Revolutionary period, influenced the college strongly by his personality and political prominence, and graduates of his training became leaders in public affairs. The history of the college during the first half of the 19th century was uneventful. Because of its large Southern clientèle, it suffered in the Civil War a blow from which it recovered only under the energetic administration of President James McCosh (1868–88). The undergraduate enrolment was nearly trebled, gifts amounting to more than $2,000,000 were contributed, only half of which sum was for endowment, 14 new buildings were erected, and important changes in the curriculum were put into effect. Fellowships were established in 1869, the elective system was introduced in 1870, the John C. Green school of science was erected in 1873, the graduate department was systematized in 1877 and the faculty grew from 17 to 40 and the number of volumes in the library from 25.000 to 65,000.

Under President Francis L. Patton (1888–1902) a school of electrical engineering was established, the "honor system" was instituted and the plan of electing alumni trustees adopted, 17 buildings were erected, the student body was doubled and the faculty increased to 100, while the endowment reached two and a half million dollars. In 1902 Professor Woodrow Wilson, of the Class of 1879, was elected president. In his administration the undergraduate curriculum was again revised, the departmental system was organized, an extensive building programme was completed. To obtain the necessary funds a committee of 50 alumni was formed, later changed into a Graduate Council. Through their agency in the eight years of President Wilson's administration the University received over four and one-half million dollars, the faculty was greatly strengthened and the library increased to 271,000 volumes. A plan for grouping the University into small self-contained units was prematurely proposed by the president in 1907 and was withdrawn by the trustees. The Princeton plan of a residential building for graduate students had been successfully tested on a small scale and a bequest in 1908, although inadequate for the full project which included professorships and fellowships, gave the plan its first semblance of permanent realization. Additional funds being conditionally offered in 1909, controversy developed as to the site for the building and finally as to the plan itself, the president no longer favouring it. A further bequest of about two millions for the project brought matters to a head and the president recommended acceptance of the legacy. In September 1910, having received the democratic nomination for Governor of New Jersey, he resigned the presidency.

Prof. John Grier Hibben, of the class of 1882, professor of philosophy in the university, was the fourteenth president of Princeton, Jan. 1912 to June 1932. His administration was marked by extended administrative reorganization, by very large additions to the endowment and by extensive expansion along material and scholastic lines. Faculty autonomy was made complete: a joint committee of trustees and faculty considers all matters of educational policy and administration; the faculty has voice in forming its committees and initiates appointments, promotions and increases of salary; the rights of the individual in cases of dismissal are safeguarded; faculty retiring allowances and insurance have been arranged. In the World War over 5,000 Princeton men saw service, 150 of them losing their lives; university laboratories were occupied by government bureaux of research.

The Honourable Edward Dickinson Duffield of the class of 1892 and a Trustee of the University served as acting president until the election of Harold Willis Dodds, Professor of Politics, as fifteenth president in June, 1933.

In 1913 the erection of the residential graduate college rendered permanent what had been an experimental feature of the Princeton graduate school. The school of architecture was opened in 1920. The school of engineering was in 1921 reorganized. Continuing the Princeton tradition for scientific research, the sum of $3,000,000 was secured in 1927, one-third being a grant from the General Education Board. The school of public affairs, designed to give its students a broad background for an understanding of and active participation in local, state, national and international affairs, was founded in 1930. Among the 29 buildings erected since 1912 are the psychological, engineering and chemical laboratories. a hall of mathematics, headquarters for the school of architecture, a new infirmary, a new chapel, the university dining halls, a university theatre, and ten dormitories. Plans have been developed for a new library building.

In 1936 the endowment was $27,068,388.58, operating income $2,820,241.64 (of which $1,164,586 was income from investments and $1,180,442 from student fees) and disbursements $2,757,-911.89. The library contained 740,000 volumes exclusive of pamphlets, etc.; the teaching staff numbered 334 and the student enrolment was 2,586, of which 2,302 were under-graduates, and 284 graduate students.

PRINCIPAL AND AGENT. In law an agent is a person authorized to do some act or acts on behalf of another, who is called his principal. The law regulating the relations of principal and agent is almost alike throughout the whole British empire, and differs only slightly from the law of the rest of Europe.

In a general view of the law of agency it is necessary to have regard to the rights and duties of the principal, the agent, and third persons with whom the agent deals. The agent should not do what he has no authority for; yet as between the principal and those with whom the agent deals, the test of the principal's responsibility for what is done by the agent on his behalf, but in excess of his actual authority, is his ostensible authority.

Agents are of different kinds, according to the extent of their implied powers. The main restraint in the powers of an agent is in the old maxim, delegatus *non* potest delegare, designed to check the complexity that might be created by enquiries into repeatedly-deputed responsibility. As a general rule an agent cannot delegate his authority or put another in his place; but this rule is sometimes modified, for it may arise from the nature of his employment or the necessity of the case that he has to employ other persons for the accomplishment of certain objects.

In the general case agency is constituted by the acceptance of the mandate or authority to act for the principal, and the evidence of this may be either verbal or in writing. But an agent who has to execute a deed in the absence of the principal must be appointed by deed for that purpose. As a corporation aggregate can in general act only by deed its agent must be so appointed, except in the case of trading corporations and joint stock companies, to which this rule has no application. Agency is often constituted, at the same time that its extent is defined, by mere appointment to some known and recognized function—as where one is appointed agent for a banking establishment, factor for a merchant, broker, or traveller. In these cases usage defines the powers granted to the agent; and the employer will not readily be subjected to obligations going beyond the usual functions of the office; nor will third persons dealing with the agent be bound by private instructions inconsistent with its usual character. While, however, third persons, ignorant of such secret limitations, are not bound to respect them, the agent himself is liable for the consequences of transgressing them. Agency may also be either created or enlarged by implication. What the agent has done with his principal's consent the person with whom he has dealt is justified in believing him to be authorized to continue doing.

In questions of this kind the distinction between a general and a special agent is important. A general agent is one employed to transact all his principal's business of a particular kind; as a factor to buy and sell; a broker to negotiate contracts of a particular kind; a solicitor to transact his legal business; a shipmaster to do all things relating to the employment of a ship. Such an agent's power to do everything usual in the line of business in which he is employed is not limited by any private restriction or order unknown to the party with whom he is dealing. On the other hand, it is incumbent on the party dealing with a particular agent, *i.e.,* one specially employed in a single transaction, to ascertain the extent of his authority. As to a mercantile agent, see FACTOR.

The obligations of the principal to the agent are: to pay the agent's remuneration, or, as it is often called, commission, the amount of which may be fixed by contract or usage; to repay all advances made by the agent in the regular course of his employment; to honour the obligations lawfully undertaken for him; and to indemnify the agent against all liabilities incurred by him in the proper execution of his mandate. The agent is bound to exercise proper skill and use the proper means for carrying out the functions which he undertakes. He must devote to the interests of his principal such care and attention as a man of ordinary prudence does on his own. He must observe the strictest good faith; and must not enter into transactions in which his interests are in conflict with the interests of his principal. Thus, when he is employed to buy, he must not be the seller; when he is employed to sell, he must not be the buyer. A mercantile agent who guarantees the performance by persons with whom he deals of the obligations contracted by them is said to hold a del credere commission.

In the United States courts have often been somewhat more liberal in interpreting an agent's powers than in England, a fact probably attributable to the absence on the part of third parties dealing with agents, of the degree of caution characteristic of an older business community. On the other hand, statutes in some American states forbid certain types of agents, notably real estate brokers, from recovering their commissions at law unless their contract of employment was written and signed. It should be noted further that modern American merchandizing practice works out into many situations deemed by business men "agencies," which may however be dealt with by the law as "sales"; a situation which makes reliance on any general statements of law quite unsafe. Finally, especially in the United States, much of the law as to a master's responsibility for the acts of his servant (see MASTER AND SERVANT) has been carried over to make a principal responsible for wrongs committed by his agent in the course of his employment.

See also AUCTIONS AND AUCTIONEERS; BROKER; FACTOR; GUARANTEE, etc.; also Smith's Mercantile Law (12th ed., 1924); Bowstead, On Agency (7th ed., 1924). Tiffany, Agency (2nd ed. by Powell); Mechem, Principles of Agency; Klaus, 28 Columbia L. Rev. 312, 441.

PRINCIPE ISLAND, a Portuguese island in the Gulf of Guinea, of volcanic origin, 90 m. N.E. of St. Thomas with an area of 42 sq.m. The highest point is Pico-Papagaio, nearly 3,000 feet Pop. 4,938 (169 Europeans). The tsetse fly (which is not found in St. Thomas) infests the wooded part of the island, and through it sleeping sickness has been spread. The chief settlement is S. Antonio. Cocoa is cultivated.

PRINCIPLE, in philosophy, means something ultimate (Latin *principium,* a beginning). The early Greek philosophers applied the term (or rather its Greek original ἀρχή) to whatever they regarded as the primal stuff of which things are made, the source of all things. The term was used in this sense even in the 17th century or later. The followers of Paracelsus and others described salt, sulphur and mercury as "principles," in the sense of ultimate elements; and Robert Boyle used "principles" and "elements" indifferently as synonymous terms. The term "principle" was naturally applied not only to the original stuff of reality but also to its fundamental laws. And now only the fundamental laws or assumptions of science and philosophy are usually called principles, the terms elements, energy, etc. being used instead of "principle" in the other application it once had. Popularly the term is often employed for any kind of general truth or guiding norm. Hence the pleonasm "first principles" to distinguish them from derivative truths or secondary norms, etc.

PRINGLE, SIR JOHN (1707–1782), British physician, was born on April 10, 1707, at Stitchel, Roxburghshire, and educated at St. Andrews, at Edinburgh, and at Leyden. He settled in

Edinburgh as a physician, but after 1734 also acted as professor of moral philosophy in the university. In 1742 he became physician to the earl of Stair, then commanding the British army in Flanders, and in 1744 was appointed physician-general to the forces in the Low Countries. In 1749, having settled in London, he was made physician in ordinary to the duke of Cumberland, and subsequently received other court appointments as physician, being made a baronet in 1766. In Nov. 1772 he was elected president of the Royal Society, but resigned his presidency in 1778. He died on Jan. 18, 1782. Pringle was the founder of modern military medicine. He remedied camp sanitation and the ventilation of hospitals, and laid down the principles for preventing dysentery and hospital fever, at the same time showing that the different forms of dysentery were varieties of one disease and that gaol fever was the same as hospital fever.

His chief works are: *Observations on the Nature and Cure of Hospital and Jayl Fevers* (1750); "Experiments on Septic and Antiseptic Substances" in the *Philosophical Transactions* of the Royal Society (1750), and especially the *Observations on the Diseases of the Army* (1752). His *Six Discourses* (1783), contains a biography by A. Kippis.

PRINGSHEIM, NATHANAEL (1823–1894), German botanist, was born at Wziesko in Silesia, on Nov. 30, 1823. He studied at the universities of Breslau, Leipzig, and Berlin, graduated in 1848 as doctor of philosophy with the thesis *De forma et incremento stratorum crassiorum in plantarum cellula,* and rapidly became a leader in the great botanical renaissance of the 19th century. His contributions to scientific algology were of striking interest. Pringsheim was among the very first to demonstrate the occurrence of a sexual process in this class of plants, and he drew from his observations weighty conclusions as to the nature of sexuality. Together with the French investigators G. Thuret and E. Bornet, Pringsheim ranks as the founder of our scientific knowledge of the algae. The conjugation of zoospores, regarded by Pringsheim, as the primitive form of sexual reproduction, was a discovery of fundamental importance. A work on the course of morphological differentiation in the Sphacelariaceae (1873), a family of marine algae, is of great interest, inasmuch as it treats of evolutionary questions; the author's point of view is that of Naegeli rather than Darwin. Closely connected with Pringsheim's algological work was his investigation of the Saprolegniaceae, a family of algoid fungi, some of which cause disease in fish. His career as a morphologist culminated in 1876 with the publication of a memoir on the alternation of generations in thallophytes and mosses.

From 1874 to the close of his life Pringsheim's activity was chiefly directed to plant physiology. He founded the *Jahrbuch für wissenschaftliche Botanik,* and the German Botanical Society. His work was for the most part carried on in his private laboratory in Berlin; he only held a teaching post of importance for four years, 1864–68, when he was professor at Jena. He died in Berlin on Oct. 6, 1894.

His works include memoirs on *Vaucheria* (1855); the Oedogoniaceae (1855–58); the Coleochaeteae (1860) *Hydrodictyon* (1861); and *Pandorina* (1869) The last mentioned bore the title *Beobachtungen uber die Paarung de Zoosporen.*

A fuller account of Pringsheim's career will be found in *Nature,* (1895) vol. li., and in the *Berichte der deutschen botanischen Gesellschaft* (1895), vol. xiii.

PRINSEP, VALENTINE CAMERON (1838–1904), English artist, was born on Feb. 14, 1838. His father, Henry Thoby Prinsep, who was for sixteen years a member of the Council of India, had settled at Little Holland House, which became a centre of artistic society. Val Prinsep first studied under G. F. Watts, and later in Paris in the *atelier* Gleyre. "Taffy," in his friend Du Maurier's novel *Trilby,* is said to have been sketched from him. He was an intimate friend of Millais and of Burne-Jones, with whom he travelled in Italy and he had a share with Rossetti and others in the decoration of the hall of the Oxford Union. He first exhibited at the Royal Academy in 1862 but the first picture to attract notice was a portrait (1866) of General Gordon in Chinese costume. He was elected A.R.A. in 1879 and R.A. in 1894. In 1877 he went to India where he painted a huge picture of the Delhi durbar, exhibited in 1880 and afterwards hung at Buckingham Palace. Prinsep wrote two plays, *Cousin Dick* and *Monsieur le Duc,* produced at the Court and the St. James's theatres respectively; two novels; and *Imperial India: an Artist's Journal* (1879). He was one of the founders of the Artists' Corps.

PRINTING. Letterpress printing is the art of producing impressions by means of pressing an inked relief surface on to paper or other material. The term "printing" can be applied to any process by which a print is obtained, but it usually refers to typography, or, as it is now generally termed, "letterpress printing," which includes not only printing from type, but the obtaining of impressions from wood cuts, line and half-tone blocks in monochrome and colour. It has been claimed that the craft of letterpress printing is the medium which turned the darkness of the middle ages into light; which secured to posterity the intellectual achievements of the past; and which furnished to civilization a means of recording all future progress.

The Chinese were the first printers. The oldest known printed book, printed from blocks, was discovered in the Chinese province of Kansu in 1900. It bears the statement, "Printed on May 11, 868. by Wang Chieh. for free general distribution. in order in deep reverence to perpetuate the memory of his parents." Printing from movable type was first done by Pi Shêng in China in the years 1041 to 1049. Both events are well authenticated. Because of the large number of characters in what in Chinese corresponds to an alphabet, the new method was not generally adopted.

History. — There is no certainty as to the actual date of the European invention of printing from movable type, which was independent of the discovery of the principle by the Chinese, but it is assumed that it took place about 1440. At an early date books were printed from engraved wood blocks, thus the term "block books" indicates that all the words on the page of a book have been cut by hand on to a solid block of wood. It is by no means certain, however, if these preceded the invention of movable types, for it is known that block books were produced after the invention of printing. In fact, no extant block book bears a date earlier than 1470. That prints were obtained from wood blocks previous to 1440 there is ample evidence, but these were of a pictorial character. In the John Rylands library, Manchester, England, there is a wood block print depicting St. Christopher, dated 1423. It is known that block prints were produced in Japan as early as A.D. 770.

Just as there is no actual certainty as to the date of the European invention of printing from movable types, so it is also doubted who the inventor really was and where the invention took place. Claims are made for Germany, Holland, France and Italy. One authority, however, sums up the position by stating: —

> Holland has books but no documents;
> France has documents but no books;
> Italy has neither books nor documents;
> Germany has both books and documents.

It is generally agreed that certain letters of indulgence are the first documents bearing a printed date, and these were printed from type cast in a mould and issued in 1454 and 1455 from a press at Mainz, and ascribed to Johann Gutenberg.

From the press at Mainz a Vulgate bible was published in 14j6. This was attributed to Gutenberg, the strongest claimant to the honour of the invention of printing. This book became known as the Mazarin bible, because a copy was found in the famous library of Cardinal Mazarin, or, as it is sometimes called, the 42-line bible, owing to the fact that the large majority of its pages are 42 lines to the column, of which there are two on a page. In 1457 the Mainz psalter was produced; it was the first book to bear the name of the printer and the place and date of its production. It was also the first attempt at colour printing. The printers were Johann Fust and Peter Schoeffer, the latter one of Gutenberg's workmen.

From Mainz the art of printing spread throughout the continent. In 1464 Sweynheym and Pannartz, two Germans, carried it into Italy, beginning at Subiaco near Rome. In 1469 Johann and Wendelin, of Speier, began in Venice. They were followed there by Nicolas Jenson, a Frenchman, who printed from 1470 to 1480. Jenson added lower case to the capital letters he found on the Roman monuments, and the type design thus created has since remained standard. Another famous printer in Venice was Aldus Manutius, who printed from 1495 to 1515. He was the originator of Italic lower case letters, to which were later added Italic capitals. Aldus, as he was generally known, contributed to the spread of learning by printing the classics in small inexpensive volumes. In 1470 printing was introduced into France by three men of German nationality, Krantz, Gering and Friburger, who in that year set up a printing establishment within the precincts of the Sorbonne in Paris.

Berthold Ruppel is usually credited with the introduction of printing into Switzerland, the date being possibly 1468. The most famous and learned printer in Swiss history was Joannes Froben (*q.v.*). With him was associated, as press corrector, the great Dutch scholar. Desiderius Erasmus. In the Low Countries (Holland and Belgium) printing was done at Utrecht as early as 1471, but the name of the printer is unknown. N. Ketelaer and G. de Leempt were the first Dutch printers to place their names in a printed book of their own production, the date being 1473.

Spain's first known printer was Lambert Palmart who began at Valencia in 1474. The best known name in the history of Spanish printing is that of Kromberger, Jacob and John (father and son), the elder having begun at Seville soon after the opening of the 16th century, the exact date being unknown.

William Caxton was England's first printer. He was a native of Kent. After serving an apprenticeship to a London mercer, he resided for a period of about 30 years in the Low Countries, where he eventually became governor of a company of English merchants known as the English Nation. He learned the art at Cologne and, with Colard Mansion, started business at Bruges, removing in 1476 to Westminster where he set up a press at "The Red Pale" in the Almonry. His first production in England was a papal indulgence, issued on Dec. 13, 1476. He continued there during an active period of 15 years, producing about 100 volumes. He died in 1491 and his press passed to his assistant, Wynkyn de Worde.

The introduction of printing into England was characterized by a number of innovations. In all other countries the pioneers were wandering German printers who began to print in Latin. England's first printer was an Englishman who used only his own language. Caxton wrote or translated much of the material he converted into books, and he printed with type faces of a design that was neither Gothic nor Roman.

The quality of printing began to deteriorate in the 16th century, owing somewhat to the fact that the ruling powers in church and State became alarmed because the new art seemed to be creating too much freedom of thought. Measures of repression were adopted and printing ceased to be an art and became merely a vehicle for the conveyance of information. Some great printing and publishing families, such as the Estiennes in France and Plantin and the Elzevirs in the Low Countries, carried on the traditions, but the general level of quality was low. A change came in England early in the 18th century. In 1720 William Caslon began to produce a Roman type face that was little more than a refinement of that designed by Nicolas Jenson, but it was accepted as a practically new design and has ever since borne Caslon's name. It exercised a profound influence upon 18th century typography. A generation later John Baskerville, after seven years of experimenting with type, ink and paper-making, began to print in Birmingham. Because of the high quality of his productions he, too, exercised a decided influence upon the printing of the time. Just before Baskerville's death in 1775, another printer of similar eminence was coming into notice in Italy. He was Giambattista Bodoni, who began at Parma in 1768 and continued until his death in 1813.

Printing began in the Western Hemisphere in Mexico City, probably in 1539, when a printer named Giovanni Paoli reached there with an equipment sent, at the request of the reigning archbishop, by John Kromberger, of Seville, Spain. In what is now the United States, the first press began at Cambridge, Mass., in 1638. The Rev. Jesse Glover had left England with it, but had died on the way over. It was set up by Stephen Day and his son Matthew, a lad of 18 years, who had some knowledge of printing. Their first work was called the "Freeman's Oath." The first book from the press, known as the Bay Psalm Book, was produced in 1640.

The deterioriation in the quality of printing, which began to manifest itself in the 16th century, continued with exceptions noted through the 17th, 18th and 19th centuries. A revival came in the last decade of the 19th century, led by William Morris at the Kelmscott Press in England. Morris' books were issued in limited editions and are prized by book-collectors. They cannot be said to be highly successful, however, as books; it was pictorial effect rather than legibility for which Morris strove. He had many imitators, but few successful followers.

The standard of book-making in the 20th century remained high. In England, apart from the few excellent private presses, good work was produced by the presses of the universities and many other commercial printing-houses. Bruce Rogers (1870–) in New York, and Daniel Berkeley Updike (1860–1941) at the Merrymount Press, in Boston, produced volumes that from all the points that go to make up good book-making were scarcely surpassed. Frederic W. Goudy (1865–) produced type designs that will give his name a permanent place in printing history.

The Printing Press.—The development of the printing press provides a remarkable history of achievement. Hand presses were for more than 100 years constructed of wood and operated on the screw principle. Willem Janszon Blaeu (1571–1638), of Holland, made the first improvements, but no radical change came until the end of the 18th century. Adam Ramage, of Philadelphia, and Charles, Earl of Stanhope, of London, working at about the same time, made further improvements, Stanhope's press, appearing in 1800, being the first to be constructed entirely of iron. George Clymer, beginning in Philadelphia and continuing in London from 1817 to 1834, was the first to abandon the screw entirely, his substitute being a series of compound levers. The hand-lever press, known as the Washington hand press, operated on the toggle-jointed bar principle, appeared about the same time and eventually superseded all others. John J. Wells, Peter Smith and Samuel Rust, of New York, all had a hand in its development.

In 1790, William Nicholson, an Englishman, took out a patent for a cylinder press, but this did not get beyond the drawing of plans. It was left for Frederick Koenig—a Saxon—to construct the first power-driven machine in 1811. This, however, proved but little more than the adaptation of power to the hand press, and it is assumed that only one of these machines was made and used for book printing. Soon after this, Koenig and a fellow-countryman, Andrew Bauer, constructed a flat-bed machine with a continually revolving cylinder. Two of these machines, called cylinder presses, were erected in The Times, London, and the issue dated Nov. 29, 1814, states that it "was printed by steam power." The machine produced 1,100 impressions per hour, thus quadrupling the output of a hand press. Later, a machine was constructed to print upon both sides of the sheet before delivery, and these machines were in operation until 1827.

Koenig returned to Germany in 1817, and Applegarth and Cowper, engineers of The Times, built a machine in 1827 for printing on one side of the sheet, and capable of giving 4,000 impressions an hour. This was in use until 1848, when Applegarth invented a new type of machine with cylinders in a vertical position and on which the type was secured by means of wedge-shaped column rules. Around the type cylinder were grouped eight impression cylinders, the sheets being delivered in a vertical position and taken off by hand. The output of this machine was 8,000 impressions per hour. There was only one of these machines made and it was ultimately replaced by the Hoe type revolving machine, which made way for the Walter rotary perfecting press in 1868.

In 1846, Robert Hoe, founder of the world-renowned American printing machinery manufacturing firm, built a new style of press. This was known as the Hoe type revolving machine. The type cylinder was placed in a horizontal position and the type secured in cast-iron beds by special locking up apparatus. Each bed repre-

PARABOLAS SALOMONIS

Incipit prologus sancti Jeronimi pb̄ri in parabolas salomonis.

Iungat epistola quos iungit sacerdotium: immo carta non dividat quos xp̄i nectit amor. Cōmentarios in osee. amos. zachariā malachiā. quoq; poscitis. Scripsissē: si licuisset pre valitudine. Mittitis solacia sumptuum. notarios nr̄os et librarios sustentatis: ut vobis potissimū nr̄m desudet ingeniū. Et ecce ex latere frequēs turba diūsa poscentiū: quasi aut equū sit me vobis esurientibꝫ aliis laborare: aut in racione dati et accepti cuiq; preter vos obnoxi⁹ sim. Itaq; lōga egrotatione fractus ne penitus hoc anno reticerē et apud vos mutus essem. tridui opus nomini vr̄o consecraui. interpretationē videlicet triū salomonis voluminū: masloth qd̄ hebrei parabolas. vulgata editio pūbia vocat: coeleth. quē greci ecclesiasten. latine cōcionatorē possum⁹ dicere: sirasirim. qd̄ i lingua nr̄am vertit canticū cāticor. Fertur et panarethos. ihu filii sirach liber: et ali⁹ pseudographus. qui sapiencia salomonis inscribit. Quorū priorē hebraicum reperi. nō ecclasticū ut apud latinos: sed parabolas p̄notatū. Cui iūcti erāt ecclesiastes et canticū canticor: ut similitudinē salomonis. nō solū numero librorū: sed eciā materiar genere coequaret. Secūdus apud hebreos nusq; est: quia et ipse stilus grecam eloquētiā redolet: et nōnulli scriptorū veterū hūc esse iudei filonis affirmāt. Sicud ergo iudith et thobie et machabeorū libros. legit quidē eos ecclia. sed inter canōicas scripturas nō recipit: sic et hec duo volumina legat ad edificationē plebis: nō ad auctoritatem ecclesiasticor dogmatū cōfirmandam.

Si cui sane septuaginta interpretum magis editio placet: habet eā a nobis olim emēdatā. Neq; enī noua sic cudim⁹: ut vetera destruam⁹. Et tamē cū diligentissime legerit. sciat magis nr̄a scripta intelligi: que nō in tercium vas transfusa coacuerit: sed statim de prelo purissime cōmendata teste: suū saporē seruauerit. Incipiunt parabole salomonis.

Parabole salomonis filii david regis isrl̄: ad sciendā sapientiam et disciplinā: ad intelligendā verba prudentie et suscipiendā eruditationē doctrine: iusticiā et iudiciū et equitatē: ut detur paruulis astutia: et adolescenti sciencia et intellectus. Audiēs sapiēs sapientior erit: et intelligēs gubernacula possidebit. Animaduertet parabolam et interpretationem: verba sapientū et enigmata eorū. Timor dn̄i principiū sapientie. Sapientiam atq; doctrinam stulti despiciunt. Audi fili mi disciplinā pr̄is tui et ne dimittas legem mr̄is tue: ut addatur gracia capiti tuo: et torques collo tuo. Fili mi si te lactauerint peccatores: ne acquiescas eis. Si dixerint veni nobiscū. insidiemur sāguini. abscōdam⁹ tēdiculas cōtra insontem frustra. deglutiamus eū sicud infernus viuentē et integrum. quasi descēdentē in lacū: omnē preciosā substanciā reperiem⁹. implebim⁹ domus nr̄as spoliis. sortem mitte nobiscum. marsupiū sit unum omniū nr̄m: fili mi ne ambules cū eis. Prohibe pedem tuū a semitis eor. Pedes enī illor ad malū currūt: et festināt ut effundant sāguinem. Frustra autem iacit rete ante oculos pēnator. Ipsi q; contra sanguinē suū insidiantur: et

AFTER A FACSIMILE BY SCHWENKE OF THE PELPLIN COPY OF THE GUTENBERG BIBLE, BY COURTESY OF THE NEW YORK PUBLIC LIBRARY

ILLUMINATED PAGE FROM THE GUTENBERG BIBLE

The Gutenberg Bible, traditionally accepted as the first book printed from movable type, was issued at **Mainz,** Germany, about 1454. The illustration shows **page** one of the Proverbs of Solomon. The pages are illuminated to give the effect of a hand-copied manuscript, as desired by the printers, who did not wish their invention discovered. The book was probably printed in 10 sections on 6 Dresses workina simultaneously. **Of** nearly 300 copies, only 45 are known to be in existence to-day

sented one page of a newspaper. Grouped around the type cylinder were four, six or ten impression cylinders, each of which had feeders laying on sheets of paper. As the main cylinder rotated, the type was inked by a roller, the sheets as they were fed in being taken by grippers to receive the inked impression of the type. In this instance, the sheets were delivered by means of "mechanical flyers." This machine was capable of turning out 2,000 sheets per feeder per hour, *i.e.,* with a four-cylinder machine 8,000 impressions were obtained. The first machine was erected in London in 1856; it had six cylinders and was installed to print *Lloyd's Weekly Newspaper.*

An impetus was given to the production of newspapers by the invention of the papermaking machine by the brothers Fourdrinier, in 1803, while the knowledge of how to cast curved stereo plates also helped forward the development of newspaper production. In 1865, the first printing press to print from a continuous reel of paper was made by an American named William Bullock The machine consisted of four cylinders—two impression cylinders and two plate cylinders—but as the paper passed from the reel it had to be cut before printing. This led to many difficulties and the machine was soon discarded owing to its unreliability.

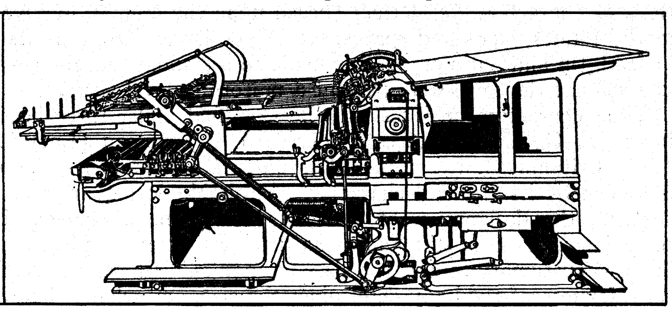
The proprietors of *The Times* were continually endeavouring to construct a rotary perfecting machine and in 1868 the famous Walter rotary perfecting press was built to print *The Times. A* reel of paper was used, both sides being printed from curved stereo plates and the sheets delivered flat. These were used until 1895, and were undoubtedly the models from which present-day newspaper rotaries have developed. One drawback to the speedy production of newspapers in the early days of the rotary machine was that they were delivered flat and had to be folded by hand. In 1870, the first folder attachment was invented by two English engineers, G. Duncan and W. A. Wilson, and since then the development of the rotary press has been rapid: the reason undoubtedly being the overcoming of the folding difficulty which in turn has enabled proprietors to produce newspapers in large numbers and at the nominal price at which they are now sold. Present-day newspaper presses are capable of printing simultaneously from as many as 1j reels and to produce over 300,000 copies per hour. Credit must be given to Sir Rowland Hill for the inception of the idea of printing on both sides of the paper from a reel, the suggestion having emanated from him in 1835.

In 1822, Daniel Treadwell of Boston applied power to a machine built on the "bed and platen" principle. The original machine of this type was improved upon by Adams, of Boston, and for many years this class of machine was used for printing fine books and woodcuts.

The next notable development of a printing machine was one worked by treadle and adaptable for the printing of small jobbing work such as cards, handbills, etc. The first machine of this character was made by S. P. Ruggles, of Boston, Mass., in 1830, and was known as the Ruggles card press. Just over a quarter of a century later (1856) George P. Gordon, an American, built a press which proved to be the forerunner of what are now known as light platen machines. This was constructed with the type bed in a vertical position, was named "the Franklin," and rapidly became in general use throughout the world.

Improvements on platen machines became necessary by the introduction of half-tone and colour printing. In 1869 Merritt Gally, of Rochester, N.Y., invented a new type of platen machine known as the Universal press which proved the pattern for heavy platen machines for colour printing. About 1850 a London printer named Main introduced a new type of flat-bed printing machine. Instead of a continuous rotary motion, as in the Koenig machine, the cylinder "rocked," making about three quarters of a revolution and then reversing, at the same time rising to allow the return of the bed. This machine was generally known as a "tumbler" and was the forerunner of what is now known in Great Britain as the Wharfedale stop-cylinder machine which was invented about 1860 by William Dawson and David Payne of Otley.

The modern type of flat-bed printing machine is known as the two-revolution press. It is so called because the cylinder, the rotary movement of which is continuous, makes two revolutions far every sheet printed. The second revolution occurs as the cylinder rises to permit the return of the bed carrying the forme. (This movement was a feature of the Napier machine built about 1830.) The most widely used form of this type of machine, and the one which has made it so popular, was invented in 1883 by Robert Miehle, a practical pressman, and the first



BY COURTESY OF LINOTYPE AND MACHINERY CO.
TWO-REVOLUTION PRINTING MACHINE

machine was installed in America in 1888. "The Miehle," as it is generally termed, has revolutionized the manufacture of printing machinery. It is to be found in most printing offices, producing not only commercial but the finest coloured work; machines of this type are made for every class of work, and are known as single-colour, two-colour and perfecting machines, respectively.

Mechanical Typesetting.— The first type composing machine was patented in England in 1822 by Dr. William Church of Boston. This machine set ordinary founder's type from channels previously filled by hand. Upon the depression of the respective keys, the type was released into a raceway, it being delivered in one continuous line and subsequently justified by hand. This was followed by numerous attempts, all more or less successful, to set and justify founder's type mechanically. All these efforts, however, still left the problem of distribution unmastered, the most successful attempt to achieve this being that of Joseph Thorne who, in 1880, brought out a combined typesetting and distributing machine.

In 1878 Ottmar Mergenthaler (1854–99), a German immigrant to America in 1872, constructed a "type impression" machine and in 1885 took out patents for a slug casting machine, the forerunner of the Linotype. In the following year, 1886, this machine was actually used in the United States, but was not introduced into Great Britain until 1890. The typograph, another slug casting machine, was the invention of John Raphael Rogers, who was a consulting engineer with the Mergenthaler Linotype Company. The first machine was built in Cleveland, but, as the U. S. courts found that Rogers infringed certain patents owned by the Mergenthaler Company, the use of the machine was prevented in the United States. Ultimately, the Mergenthaler Company purchased the U.S. rights of the typograph company. In 1890 this machine was being built in Canada and, on the expiration of the linotype agreement, its manufacture was commenced in Detroit, Mich. In 1893 the manufacture of the typograph was undertaken in Germany, the first typograph built in that country being put on the market in 1896. Germany is now the headquarters for the manufacture of this type of machine where it has achieved a remarkable success.

It was about the same time as Mergenthaler placed his invention for a slug casting machine on a successful basis that Tolbert Lanston, a clerk in the Pensions Office at Washington, developed and perfected a method of casting type by means of a perforated sheet on the Jacquard principle. He applied for his patent in 1885, this being granted two years later, the year in which the first machine was produced.

The Practice **of Printing.**—As in all processes of printing, there are two main operations in letterpress printing: (1) The setting up of the type, reading, making up the type and blocks into pages, imposition and locking up. This embraces the work of a compositor and is done in the composing room. (2) Printing, which includes the fixing of the forme on the machine, making ready (a process whereby irregularities of pressure are removed), getting position on the sheet, inking and the printing of the sheets. This work is done by the machine minder or the pressman, the latter being the American term.

Type.—The typefounder supplies type to the printer in founts which are of varying weights but made up in recognised proportions of characters, *i.e.,* letters (based upon the number of "A's" in the fount), signs and spaces, etc. Type is cast from an alloy of lead, tin and antimony and is made to a standard height (·918 in.) so that the faces may present a uniformly level surface.

Type characters or faces may be classified under three headings: (1) Gothic (Encyclopaedia Britannica), (2) Roman (Encyclopædia Britannica), (3) Italic (*Encyclopædia Britannica*). Type is known by its size and character. Within the last quarter of a century, the designation of sizes has undergone a change. In some instances it is still known as nonpareil, brevier, pica, etc., but it is customary to give the sizes in "points." In this the vertical thickness of the body determines the size, and what is known as the "point system" is now accepted as a standard measurement. There are 72 points to the inch. A point, therefore, is approximately ·0138 inch. The sizes are graduated by points up to 12-point; those above 18-point are multiples of 6-point. There are types from 3- to 5-point but these are not in general use, being too small for ordinary purposes. The $5\frac{1}{2}$-point is used considerably in American newspaper "want" advertisements.

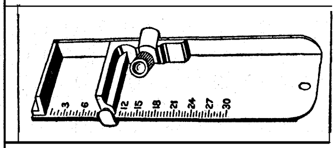
The following are a few of the approximate sizes of type in general use for printing books:—

Points	Old terms	Number of words to a square inch
6	Nonpareil	47
7	Minion	38
8	Brevier	32
9	Bourgeois	28
10	Long Primer . . .	21
11	Small Pica . . .	17
12	Pica	14
14	English	11
18	Great Primer . . .	7

The above table is set in 8 point: the body of this book is set in 9 point. In addition to these sizes there is a wide variety of display types, *i.e.,* types used for advertisement purposes which can be cast up to 144-point:—12 times the size of 12-point, or, to use an old term, 12-line pica. However, it is deemed inadvisable to cast in metal much above 72-point or 6-line pica. There is no accepted standard for naming type faces. Similar characters of design bear the distinctive names which the different type founding firms give it.

Composing.—The first work of a compositor when the type is received from the founder is to "lay" it in cases. A case may be described as a wooden tray about $32\frac{1}{2}$ in. long, $14\frac{1}{2}$ in. broad and about $1\frac{1}{3}$ in. deep. The case is divided by cross partitions into "boxes," each of which holds a different character. Generally, there are two kinds of cases, namely, the upper case (capitals) and the lower case (small letters). It is usual for the upper case to have 98 boxes, the capitals on one side and small capitals on the other, and the lower case 53. The divisions in the upper case are all of the same size while those in the lower case are of varying sizes according to the number of a particular letter contained in the fount. For instance, the box for the lower case "e" is about five times the size of that for the capital "E" in the upper case. The letters in the lower case are not placed in alphabetical order but in accordance with the frequency with which a particular letter is used in the English language, those most frequently used being nearest the hand of the compositor.

When the compositor is given "copy" to set up, he places it in front of him on the upper case, and memorizing as many words as he can he proceeds to pick up from the various boxes in the case the particular letters required. These letters he places in a "composing stick" which in reality is a narrow metal tray (usually about 10 in. long and 2 in. wide) with flanges on the back and the right hand side, and on the left an adjustable slide which can be fixed to the particular "measure" or length of line required for the work in hand. On each type there is a "nick" (or "nicks"), *i.e.,* a slight groove on the front of the "body" of the type, which is a guide to the correct placing of the type in the composing stick. At the completion of each word "a space" (a short piece of metal) is inserted, it being by this means that the words are separated. When the line is completed it is "justified" or made tight to the "measure" of the composing stick with spaces of varying widths, to make the lines of uniform length.



BY COURTESY OF STEPHENSON, BLAKE & CO.
COMPOSING "STICK"

The compositor proceeds to set up the matter line by line until the stick is full. He then carefully removes the type from the stick and places it upon a shallow tray with raised edges on three sides called a "galley." When a galley is full, proofs are taken and read in conjunction with the manuscript, the reader carefully marking in by recognized symbols the corrections necessary. This is returned to the compositor who makes the necessary alterations by lifting, where necessary, the line out of the galley and replacing it in the stick, the reason for this being to ensure that justification of the lines is uniform throughout during the process of correction. When the work is completed finished proofs are pulled, usually in galley form, and sent to the author for correction.

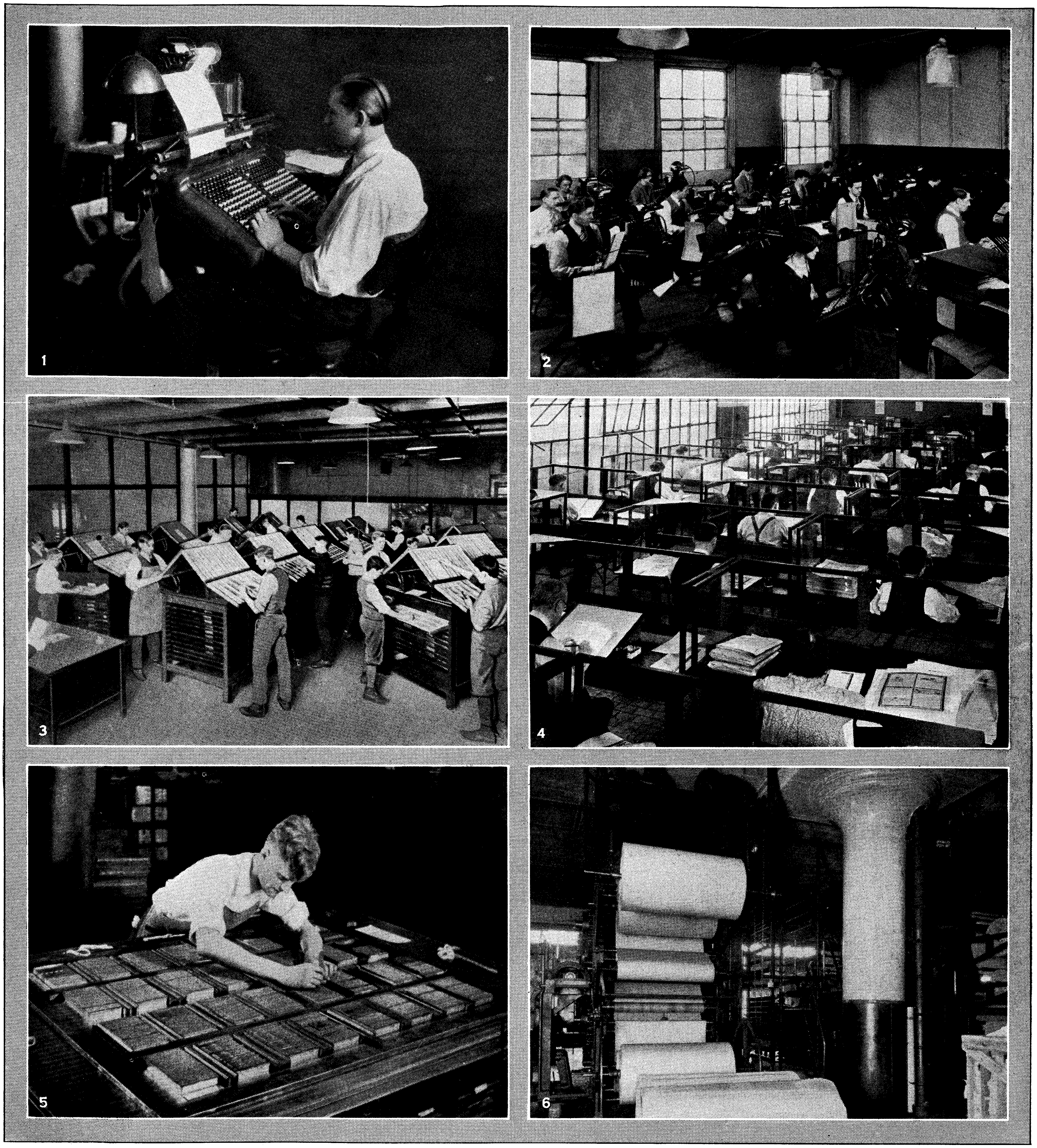
The next operation in the production of a book is to make the type up into pages, the depth and width of which are determined by the size of paper on which it is to be printed. It is usual to send the author another set of proofs for a final "revise." When the work is finally passed for press, the pages are placed in such a position that when the sheet is printed and folded they fall in correct sequence. This is called "imposition," and includes placing the pages within an iron frame called a "chase," which, when there are a number of pages to be printed together, has crossbars—one across the length of the chase, the other across the width. The determined space between the pages is filled up with what is called "furniture," which is made of either wood or metal, and about $\frac{1}{4}$ in. lower than type, so that it does not get inked during the process of printing. The whole is then locked up within the chase by means of a system of wedges, called "quoins," thus making the type and furniture portable. When this is accomplished it is known as a forme and is ready to be printed.

Composing Machines.—The setting of the type for newspapers, magazines and books is now almost entirely a question of mechanical composition and the machines used for this purpose can be divided into two classes:

(1) That which casts a "slug" (or line of type), such as the Linotype, Intertype, Typograph and Ludlow.

(2) That which produces justified lines of single types, and known as the Monotype.

Slug-Casting Machines.—Such machines as the Linotype and Intertype consist of a keyboard, magazines (containing matrices), casting apparatus and a distributing system. The compositor on these machines is called an "operator," and when he presses a key representing a particular character on the keyboard, it operates certain levers which allow a matrix, with the letter cut into its edge, to be released from the magazine. The matrix, dropping on to a revolving belt, is carried automatically to an assembly box. By touching another key, a double wedge spaceband is placed between the words. When the line is full a lever is depressed and causes the matrices and spacebands to be carried to a position in front of the mould, behind which is situated a pot of molten metal. While in this position, the line is justified by the pushing up of the spacebands from below, the line thus spreading out to the full measure. A plunger in the metal pot then descends and forces the molten metal into the mould and against the face of the matrices. The resultant metal bar or "slug" with the letters in relief is then automatically trimmed for height and thickness prior to its being ejected on to a receiving galley. The matrices from which the slug has been cast have meanwhile



BY COURTESY OF R. R. DONNELLEY AND SONS COMPANY

SCENES IN VARIOUS DEPARTMENTS OF A PRINTING PLANT

1. Operator at the keyboard of a monotype composing machine. The keyboard action perforates a reel of paper, which, when fed into another machine, the "caster," causes to be delivered on to a tray a separate piece of type for each letter in the matter "set" on the keyboard

2. A battery of monotype keyboards, here assembled in a sound-proof room to prevent distraction of the operators from the "copy" by noise

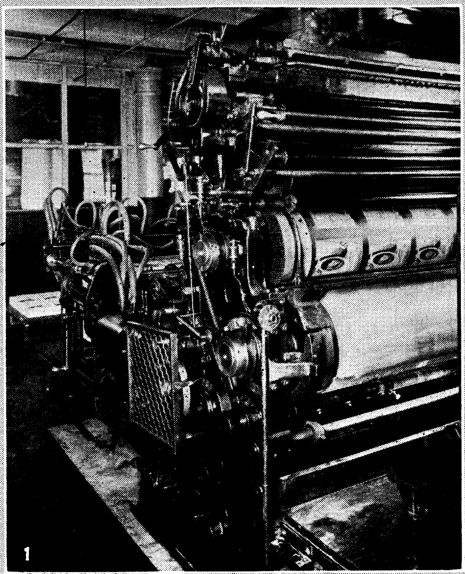
3. Setting type by hand. The larger, or "display," sizes of type are still set by hand. The composing room here shown is in the school of a large American plant

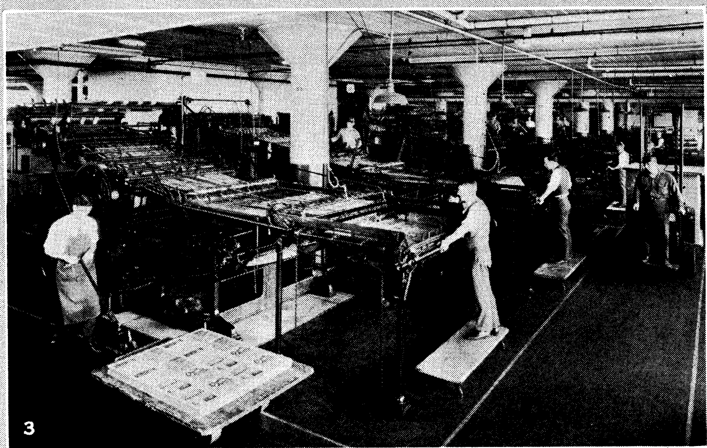
4. The proof-room, showing proof-readers seated at each of the glass enclosed desks. The readers compare printed proofs with author's manuscript. For some kinds of work copy-holders read author's manuscript aloud to readers

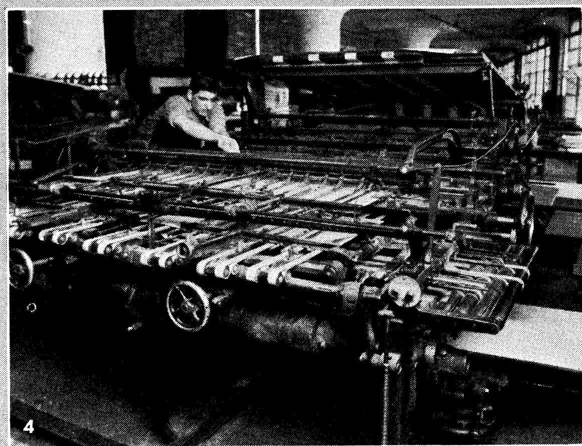
5. A "stone-hand" working on a 32-page forme. This is termed imposing. When ready, this forme will be locked up with metal wedges, called quoins, in the iron frame, or chase, which surrounds it and taken to the press for printing

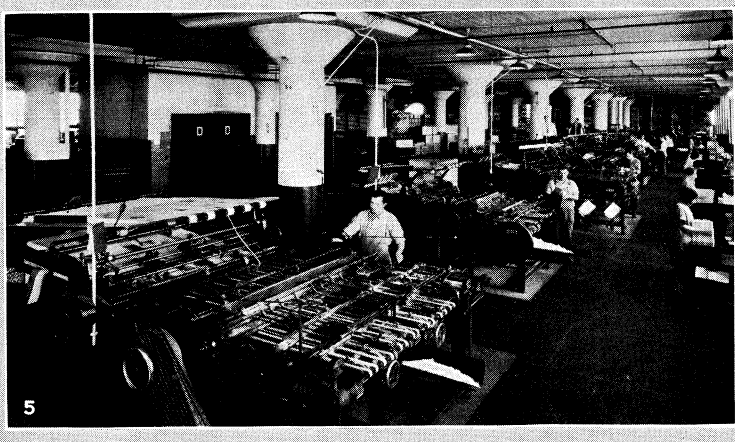
6. Handling rolls of paper in the pressroom. These rolls, or "reels" as they are called, weigh from 1,200 to 2,200 lb. according to the width and kind of paper. Mechanical handling, as here shown, is practically necessary.

PRINTING









BY COURTESY OF R. R. DONNELLEY AND SONS COMPANY

VIEWS OF PRESSES, FOLDERS AND TIPPING MACHINES

1. Side and back view of an offset press. Below the rollers at top is the printing plate fixed round a cylinder. The plate prints upon the rubber blanket on the cylinder below, which in turn prints upon the paper

2. Modern rotary or "web," press for commercial work. These presses print direct from curved plates, secured on a cylinder, onto the paper. The paper is automatically fed from the roll. After being printed the paper, as it reaches the "delivery end," is folded and cut. When presses print on both sides of the paper, they are called "perfecting presses"

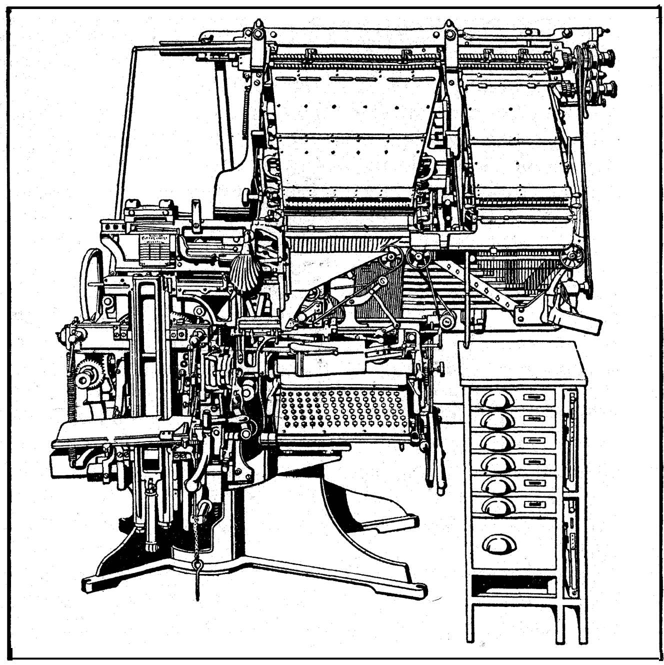
3. Flat-bed press equipped with an automatic feeder (left), which feeds the sheets of paper, and with extension delivery (right), which is automatically lowered to the floor as the printed sheets pile up after being printed. The piles of printed sheets when completed are transported by trucks (right) to the folding machines. Presses of this type are used extensively in colour-printing

4. Adjusting a folding machine. These folders are automatically fed and will fold printed sheets with any number of pages into "book form"

5. Battery of folding machines. The automatic feeder is on the left; the folded sheets (in this case book signatures of 32 pages each) may be seen in the "lay-boy" in the bottom right hand corner of the illustration

6. Girls working glueing machines used for "tipping" inserts onto book sections

been lifted by an arm to the top of the machine, and are caused to travel along a serrated distributor bar until the matrix finds its way into its correct channel in the magazine. Each matrix has on its top edge a double series of seven teeth, the arrangement of same varying with each matrix. The individual matrix travelling along the corresponding rail on the distributor bar eventually arrives at a break in the rail on which it has been hanging and



BY COURTESY OF LINOTYPE AND MACHINERY CO

MODERN LINOTYPE

has no alternative but to drop into its respective magazine channel.

All the operations are automatic and continuous, it being possible for three lines of matrices to be in circulation at the same time, one in course of assembly, another in the process of casting and a third in the stage of distribution.

The Typograph is a further and somewhat different expression of slug-casting machine. In this machine the matrices hang on a series of wires which converge fan-shape towards the point of assembly. As the operator touches the respective keys on the keyboard, the matrices slide by gravity down the wires to the point of assembly. The line is justified by means of circular space discs which expand as they are caused to revolve just prior to the casting. The slug cast by this machine does not require trimming to give either the height or the body width. The operation of distribution is performed automatically, the top frame of the machine tilting backwards and so reversing the angle of the wires when the matrices automatically slide back to their original postion.

The Ludlow Typograph is a class of slug-casting machine designed for the production of display lines. It does not, however, set up matrices, its function being to produce cast slugs from lines of matrices set up by hand in a special composing stick. As each line is set by the compositor the stick containing it is clamped into the machine which produces a solid line of type with the characters in slug form. This particular form of slug-casting machine is employed in the main for producing head-lines for use in newspaper and periodical work, advertisements and various similar purposes.

Monotype.—The Monotype is a system of mechanical composition that produces justified lines of single types. It comprises two distinct machines—a keyboard and a caster, The keyboard has the appearance of an elaborate typewriter. As the operator depresses each key, holes are punched into a strip of paper which automatically travels with each tap of the keys from one spool-holder to another, each letter being represented by its particular combination of perforations. At the end of each line a pointer indicates what special keys should be touched in order to ensure the justification of such line when eventually cast in metal.

When the spool is completed it is placed in position on the casting machine which contains a metal pot, a mould and a matrix holder called the "die case." The latter usually contains 225 matrices arranged in 15 rows of 15 in the compass of a 3-in. square. The perforated strip of paper controls the action of the mechanism which brings the respective matrices into position over the mould in the order-desired. When the matrix has been momentarily clamped into position, a jet of metal is forced into the mould and the type cast. The characters as cast are pushed along until, when the line is completed, they are automatically transferred on to a galley. The last line of the spool is the first to be cast, but when each galley is completed the lines will run in correct sequence as in the copy. There is an adaptation of the Monotype machine by which rules, ornaments, and a wide range of display type faces may be cast, and afterwards put into cases to be used by the hand compositor.

Machining.—When the forme is sent to press from the composing room the printer's work commences. The printer is called a machine-minder in Great Britain, and a pressman in America, and it mainly depends upon him as to whether the work bears the hall mark of "quality" (or otherwise), the printing of the sheets demanding the greatest of care in every stage.

The first operation is to prepare the impression surface (the platen or cylinder) by covering it with a number of sheets of a suitable paper. This is followed by locking the forme securely in the bed of the machine in a position necessary to the requirements of the particular work in hand. The quoins securing the work in the chase are loosened, and the type "planed down" with a planer, *i.e.,* a smooth flat piece of wood is placed on the type and carefully struck with a mallet to ensure that the "feet" of the type rest solidly on the bed; the quoins are then again tightened and an impression "pulled" on a sheet of paper. Invariably this first pull shows irregularities in the weight of pressure, some parts being so weak that they are unreadable and others so heavy as nearly to cut through the sheet of paper. It is in the rectification of these inequalities that the skill and experience of the machine-minder are exhibited, for unless this work is done with understanding, the printed sheets will appear "patchy" and difficult to read. When the printed sheet has been made "readable" the pages are "registered," *i.e.,* placed to print in the proper position on the sheet, and in printing book work, made to "back up" correctly. A well printed book, if the pages are of uniform size, should have the lines on both sides of the leaf printing exactly on the back of each other.

When a forme of type is registered, a sheet is sent to the reader for revision (in case of any letters having been broken off or a word "pied"). While this is taking place, the operation called "make-ready" is commenced, and it is not unusual for a large forme to take two or even three days to make ready. The desired results are obtained by cutting out on a sheet of thin paper the heavy parts with a sharp knife and "patching up" with paste on the sheet, varying thicknesses of paper on those parts that are weak. When the sheet is completed it is "stuck up" on the impression surface in a position corresponding exactly with that part of the forme which requires the particular treatment. Another impression is then pulled, and the work of cutting out and patching up is continued until the impressions seen on the back of the sheet present an even and regular appearance. The supply of ink has then to be adjusted so that the requisite amount will be transferred to the type in a uniform manner throughout the "run."

When printing half-tone work, "interlaying" is often done to ease the pressure on the high lights and to give greater resistance to the solids contained in the plate while printing. "Overlaying" is invariably used when printing illustrations either in monochrome or colour. It is a means of supplying the graduated pressure necessary to ensure that a clean sharp impression of the inked blocks will be made upon the sheet of paper.

There are various methods of making overlays, the usual being to pull three impressions from the block on thin, hard paper On the first sheet, which is the foundation sheet, all the high lights are cut out; on the next sheet all the solids are carefully cut out and pasted accurately in a corresponding position on to the first sheet. The third sheet has the high lights and intermediate tones cut out, leaving the three-quarter tones and solids; this is then pasted on to the foundation sheet on which the solids have already been fixed. When the overlay is completed and held up to the light "a picture" of the illustration in its various tones will be seen. The overlay is then pasted on to the impression surface in a position to correspond exactly with the block on the bed of the machine; thus the varying tones in the plate will receive graduated degrees of pressure, and by this means a true representation of the tones in the block is obtained when inked and impressed on to a sheet of paper.

There are mechanical means of making overlays. The most popular form is known as the "chalk" overlay. An inked impression of the illustration is taken on both sides of a piece of paper, which is treated with a chalk preparation. The ink, according to its density, acts as a resist when the prepared paper is immersed in a solution of chloride of lime, the result being that a graduated surface in hardened chalk is obtained in exact relation to the tones contained in the plate, the solids being highest and the other tones correspondingly lower. When the etching is completed the paper is allowed to dry and then pasted an to the impression surface. Another method (a photo-mechanical one) is that of a thin piece of zinc etched in relief, with the tones in correct relation to each other.

When printing newspapers there is no time for making ready and when blocks are printed they are prepared mechanically by putting the printing surface on different planes. This is generally called "bumping" and is done by making a metal "interlay" which is forced into the back of the plate, with the result that the tones in the plate are slightly raised in accordance with the pressure required to give a correct impression, the solids being highest and the high lights lowest. This method of obtaining regulated pressure is likewise frequently resorted to in magazine printing and in a particular method of colour printing.

Duplicate Plates.—To secure economical and expeditious production of large editions it is necessary to print at the same time a number of duplicate plates identical with the original page of type or blocks. This is done by two processes, known as stereotyping and electrotyping.

Stereotyping.—Stereotyping is a process whereby duplicate plates of pages of type and relief printing blocks are obtained. This is done by taking a mould of the forme in plaster of paris or papier mâché, placing it in a "casting box" and pouring molten metal into the box and over the face of the mould.

Like others of the crafts included in the printing industry, there is some obscurity about the date of the invention of this process, but it can be safely dated as about the beginning of the 18th century (1700–25). It is attributed to William Ged, an Edinburgh goldsmith. It is believed that he made a mould by pouring gypsum (plaster of paris) over a page of type, and allowing it to set. In 1730 it is known that he went to Cambridge and made plates for a bible for the university, but it is said that these plates were spoiled by the printers and the process abandoned. Ged returned to Edinburgh in 1733, where he died in 1749. About 1779, Tilloch and Foulis seemed to have "re-invented" the process of stereotyping, since they took out patents in April 1784 for a method of making plates for printing. Earl Stanhope is likewise credited with having reintroduced Ged's process early in the 19th century. In America, stereotyping was introduced by David Bruce (1813) who served his apprenticeship in Edinburgh. The first book stereotyped in the United States was the Westminster Catechism, printed by John Watts in 1813.

The Plaster Process.—This method of making stereotype moulds is not now in general use, but certain firms in England employ it for duplicating half-tone plates, the usual method being to spread on a sheet of stout paper a coating of about $\frac{1}{8}$ in. of fine plaster of paris which, when about to set, is placed in contact with a forme (the imposed type matter or blocks), and subjected to pressure. When the plaster is set, the mould is dried by heat.

The Paper Process.—A plate by the papier mâché method is obtained by making a "flong" composed of blotting and tissue papers pasted together. The particular method of making a flong is largely an individual opinion of the stereotyper, but generally it is made up of a sheet of strong, coarse blotting called a backing sheet. On this a fine sheet of blotting is pasted, followed by three sheets of tissue one on top of the other. It being necessary to keep the flongs damp, they are placed between damp blankets. The type from which stereotypes are to be made is placed within bevelled type-high bearers and locked up in a strong chase, the bearers serving the purpose of protecting the edges of the type and facilitating the moulding.

Moulding.—The face of the forme is then carefully brushed over with oil, the open spaces between the lines being packed with card or pieces of thin metal to prevent the cracking of the flong when moulding. A piece of the damp flong about an inch larger all round than the surrounding bearers is placed face-downwards (tissue side) on to the forme and, by means of a stiff brush with a long handle, is beaten by hand evenly into the type until a uniform depth is obtained. The "blanks" (depressions) on the back of the flong are then filled in with felt or card and covered with a strong sheet (usually brown paper). Both the forme and the flong are then placed into a drying press, being kept under pressure until the flong is baked dry. The flong is then carefully removed from the iorme and becomes known as a matrix, or, as the stereotyper calls it, a "mat." This is then trimmed, and a long piece of brown paper, called a "tail," is pasted on to one end. The latter acts as a guide to lead the molten metal on to the face of the matrix when the plate is being cast.

Casting.—The matrix is then placed in a casting box which consists of two flat surfaces, the top part being hinged so that it may be thrown back in a perpendicular position. When the matrix is placed in the box it is held in position by two steel gauges which not only determine the thickness of the plate but prevent the molten metal running out at the bottom and sides of the casting box. When the matrices and gauges are correctly positioned the top is lowered and clamped to the lower surface. It is then tightly secured by means of a screw, the whole of the box being tilted into a perpendicular position. The mouth of the box is bevelled to allow the molten metal to be easily poured in. This is done by means of a ladle. A few moments are allowed for the metal to set. When the box is opened the gauges are removed and the matrix relieved from the newly cast plate, the casting operations being repeated from the same mould according to the number of stereo plates required. The plate has then to go through a series of finishing operations to put it in a proper condition for printing. The plates are mounted on a block of wood to bring the printing surface to type height.

Newspaper and Periodical Printing.—It is in newspaper and magazine production that stereotyping has made the greatest progress. Speed is essential in these particular branches of printing, and instead of a wet flong a special manufacture of dry flong is used, the matrix being moulded either by cylindrical pressure, usually known as a "mangle," or by means of a special press on the platen principle. The matrix is then dried and when thoroughly free from moisture is placed in a casting box which is half cylindrical in form and conforms to the diameter of the cylinder of the printing machine on which the plate is to be printed. Metal is then pumped direct from the metal pot into the casting box. When the plate is cool it is removed from the box in a semi-circular shape.

Automatic Casting.—The ever-increasing demand for speed and accuracy in the production of newspapers has brought into general use an ingenious machine called "the Autoplate." This is an American invention, capable of producing two plates in a minute in place of the one plate in three minutes, which was the usual time taken to cast a plate when the work was done by hand. On the Autoplate the matrix is fixed into clips and carried to the casting box, which, when closed, is flooded with molten metal pumped from a large metal pot. After a short "dwell," the casting box is opened and the plate removed from the matrix, the former being cooled by a system of water circulation. The plate is then mechanically bored, routed and finished, ready for the printing press, every operation being automatically controlled.

A later development in the automatic casting of stereotype plates is the invention of a Swiss engineer and is known as "the Winkler." In this instance, a "perfect plate" is produced without resorting to the usual finishing operations. The metal pot is directly connected with the casting box and the weight of the metal in the pot provides the necessary pressure to cast a large sized plate without leaving surplus metal to be trimmed off. This machine produces two finished plates per minute.

Electrotyping. — Electrotyping is an electrolytic method of producing a duplicate printing plate. In this process a mould from the original is taken in wax or prepared lead, on which a coating of copper is electrolytically deposited.

When Volta invented the galvanic battery in 1799, the foundation of the process was laid. About 1839, two Englishmen (Thomas Spencer, of Liverpool, and C. J. Jordan, of London) and Prof. Jacobi, of St. Petersburg, were experimenting with the making of plates by the science of electrometallurgy. About the same time, J. A. Adams, a wood-engraver in New York, is credited with having made an electrotype, which was used for printing in 1841; this process he also used for duplicating illustrations for Harper's family bible, which was issued between 1842 and 1844. To obtain a mould he used a soft metal. About 1840 Smee's battery was introduced, making the deposition of copper a commercial proposition. About this date graphite was first used to make the surface of a mould made in beeswax conductive. A French cabinetmaker, M. Victor Morel, took a prominent part in improving the process for printing purposes. He was ultimately engaged to install a foundry in the establishment of Cassell (London). Electrotyping owes a debt to this publishing and printing house for the experiments they made at great cost, with a view to perfecting the electrotyping process. Beeswax as a moulding medium was first used by them.

Moulding.—The first operation in electrotyping is to run melted beeswax on to a perfectly level metal plate called a "case." This must be such that it will withstand the great pressure exerted on the moulding press. When the wax has had time to "set" the surplus is trimmed from the edges with a knife, the case then being put into a machine which shaves the surface of the wax down to a standard height, making it of uniform thickness. The wax is usually flared over with a gas flame to give it a smooth surface, the case having to be kept at a regular temperature until the moulder is ready to take a mould on the wax from the original. This is a most important operation. Before moulding, the case and the forme are brushed over with fine graphite, care being taken to have all the loose particles of black-lead removed before being placed in contact with each other. They are then put in a press and subjected to the necessary pressure. The presses are of great strength and are usually operated by hydraulic methods. When the mould is made the case is taken to a workman called a "builder" who trims the wax which has spread over the edges of the case with a knife, at the same time reducing to an even height the wax standing in high relief through being forced into the lower parts of the forme which do not have to print. The mould then goes to the "black shop" where it is carefully and thoroughly dusted and polished with graphite. This is done either by hand or machine, the purpose being to make the surface conductive, as otherwise the copper shell would not grow upon the mould. A thin piece of copper is now inserted into the wax at the top end of the case. In the copper there are two holes through which hooks are placed to enable the case to be hung on the negative rod in the depositing bath.

Previous to placing the mould in the bath "stopping out" takes place. This is done by running a hot iron over the surface of the wax to within about an inch of the actual moulding on three sides of the mould, thus removing the graphite, and rendering the surface non-conductive. If this is not done a waste of copper will be entailed, but care has to be taken that the copper connection inserted into the wax comes within the area of conductivity, since otherwise it would not be possible to obtain a shell. The mould is thoroughly washed over with a strong force of water to remove all foreign matter from the surface. The modern tendency is to obtain moulds by the lead process. A piece of specially prepared lead is pressed into the original forme by a press of great power, It is claimed that a greater degree of accuracy and a finer reproduction is obtained by this method because changes of temperature do not affect lead in the same way as wax.

Deposition.—The mould is now ready for the depositing bath, although it sometimes is previously prepared by covering it with a solution of copper sulphate into which fine iron filings are sprinkled and the whole stirred with a soft camel's-hair brush, thus precipitating a fine film of copper on the mould. Extreme care has to be taken to see that all connections are clean.

The depositing equipment consists of a bath or tank which is lead lined. This is filled to within about 6 in. of the top with water into which is placed copper sulphate and a percentage of sulphuric acid. When completed the solution should have a density of about 20° Beaumé. When working, the solution is agitated to keep the concentration uniform while a regular temperature has to be maintained. The electrical current necessary for depositing is obtained from a dynamo situated in close proximity to the bath. The current is carried from the dynamo through a resistance board to the bath by two copper rods which run along the length of the tank, one being connected to the positive pole and the other to the negative pole of the dynamo. Flaced on the long copper rods are shorter copper rods running across the bath. On the short rod connected with the positive pole and suspended by means of hooks into the solution is a copper plate called an anode. The prepared mould is suspended in a similar manner on the other short rod connected with the negative pole with its face towards the anode.

The copper sulphate when dissolved in the water and sulphuric acid breaks up into two portions: — (I) a copper portion which is electrically positive, (2) a sulphate portion which is electrically negative. The positive copper portion is attracted to the negative pole, *i.e.*, the wax mould and is there deposited while the negative sulphate portion travels to the anode (which is positive) and there combines with the copper to yield more copper sulphate so that the concentration of the bath is kept more or less constant. In this way the Shell is grown until a sufficient thickness is obtained.

Nickel is deposited in a similar manner, but the bath is composed of a solution of nickel sulphate and ammonium chloride. Electrotypes are sometimes faced with a deposition of nickel to increase their durability and also to prevent certain chemical actions taking place which may occur when printing with coloured inks from a copper surface. The deposition of chromium is at the moment receiving much attention, it being one of the hardest metals and of great durability.

Backing.—When the deposition is complete the mould is taken from the bath and the shell removed by pouring hot water over it until the wax melts, the wax removed being melted and used again. Tbe next operation is the backing up of the copper shell which when it is released from the wax is trimmed round the edges and prepared for receiving about ¼ in. of molten metal. As the metal (which is composed of lead, tin and antimony) will not adhere to copper, the back of the shell has to be "fluxed." This is done by brushing it over with a soldering fluid and covering it with "tin foil," heat being applied until the two fuse together. The shell is then placed face downwards on to a pan or tray with flanges, and molten metal poured over the back and allowed to solidify.

When the backing is completed it is removed from the pan and the face cleaned free from wax. It is then trimmed and passed through a series of finishing operations such as roughing and planing the back, routing the "blanks," bevelling the plate and mounting it on wood or metal, great care having to be exercised in every detail to ensure that the printing face is not damaged.

It is by the process of electrotyping that the duplication of the highest grade of printing plates is undertaken and that the reproduction of the finest half-tones and colour plates in accurate register and with fidelity to the original is made possible.

A Swiss inventor has made "shells" by spraying metal on to a mould, using a special tool, called a "pistol," through which metal in the form of wire is automatically fed. This is fused by gas and spread in a state of sub-divisions by means of compressed air on to a matrix. Should this invention prove successful, the whole method of the duplication of printing plates may become revolutionized.

PRINTING MACHINES

The different styles of printing machines are too numerous to detail. In America they are called "presses" and in Great Britain (with the exception of proving presses) they are called "machines." They may, however, be classified as platens, automatics, cylinders and rotaries. Many firms adopt standard makes of machines to suit their requirements. The larger number of machines in general use print on one side of the sheet at a'time, but in offices where magazines and books are produced "perfecting" machines are employed. These machines have two type beds and two impression cylinders, thus when one side of the sheet is printed, it is mechanically reversed and the other side receives an impression from another set of plates or type. In colour printing there are machines for printing a number of colours before delivery of the sheets. The usual method in multi-colour printing, is to print two colours before the sheet is delivered. There are two impression cylinders and two beds each with its respective forme of type or blocks. When the sheet receives its first impression it is transferred to another cylinder and the second colour is superimposed on the first. Thus, in reproducing pictures in four colours the sheets go through the machine twice before the work is completed.

Colour printing has been attempted by placing machines "tandem wise," *i.e.,* end on to each other, the sheets being carried from one machine to another by means of a travelling conveyor and automatically placing the sheets into the lays on the respective machines. Four colours have been printed by this method. The most effective multi-colour printing method, however, is that done on rotary presses, where a sheet is taken by means of grippers round a large impression cylinder and receives an impression from four sets of plates, each inked with a different colour.

The Hand Press.—The hand press is of the platen type, *i.e.,* an impression is taken from the whole forme at the same moment by means of a flat surface. The hand press is mainly used for proof-pulling. Photo-engravers usually pull the proofs of their plates on such a press, and it is invariably used by amateurs and those running private presses for printing small editions.

On the hand press the type bed runs on two rails and is propelled under the platen by means of a rounce consisting of a handle and a pulley to which belts are attached; the ends of the belts are secured to the ends of the bed, and by turning the handle the bed is moved to and fro as the belts wind and unwind round the pulley; while to obtain the necessary pressure the platen is depressed by means of a lever, which when pulled forward acts upon a toggle joint (inclined pieces of metal) bringing it into a perpendicular position. This forces the platen down and presses the sheet on to the inked forme. On the bar being released the platen is lifted to its normal position by springs. Attached to the end of the type bed a hinged frame is fixed and covered with parchment or fine linen; this is called the "tympan," and it is on this that the making ready is fixed and the sheet of paper secured by means of "lays" (pins being usually used). The paper is kept from being soiled by a "frisket" (another hinged frame fixed on to the top of the tympan and covered with paper with parts cut out corresponding to the area of the type which has to be printed). The portions of paper remaining on the frisket keep the sheet from being marked by the furniture or chase which is liable to become inked when rolling a forme by hand. Two hundred and fifty impressions an hour are considered a good production on this type of press.

Platens. — The platen machines now used are generally known as "light" and "heavy" types. The terms explain the class of work for which they are intended.

Light platens are fast-running machines suitable for general job work, and are invariably actuated by what is known as the "clam shell" movement, which brings the platen on which the packing and "making-ready" are fastened, and on which the sheet to be printed is placed to guides, into a position where the sheet can be pressed against the forme, which is held in a perpendicular position. The forme is automatically inked by two or three rollers passing over the surface, the ink being fed by a roller from a "duct" on to a rotating "disc," which assists in the distribution of the ink before the inking rollers take up a supply from the disc. The platen and the bed are brought together by means of rods working on eccentrics. By moving a lever acting upon the eccentric the platen is thrown back, thus preventing the forme from printing by keeping the platen from reaching the forme. This style of machine can be worked by treadle, although motive power is now usually employed. The feeder stands in front of the machine, lifts a sheet of paper with his right hand, places it on to lays on the platen which rises and prints the sheet. On the return motion of the platen the feeder removes the printed sheet with his left hand and places it on a table, at the same time placing another sheet on to the platen ready for printing. The average size of a sheet printed on these machines is 10 in. by 15 in. and the speed is approximately 1,500 impressions per hour.

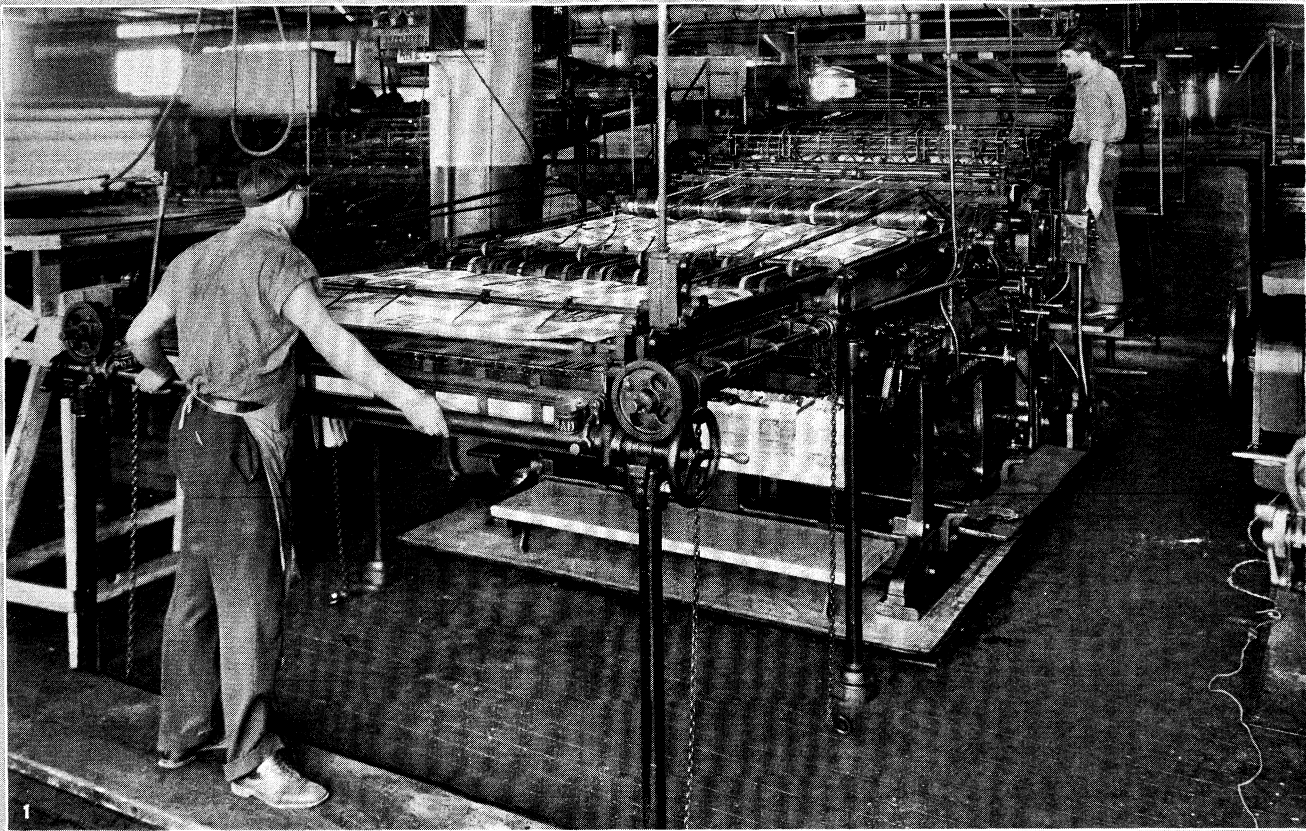
Heavy platens are of exceptional strength built to meet the exacting demands of high grade printing. The frame is cast in one solid piece and the platen is placed on finished rails. The movement of the platen is known as the "rocking-sliding" action due to the platen having on its underside semi-circular rails which work on the rails on the frame and is controlled by a cam known as a "swan's neck." The platen is connected with the back of the frame by two arms, the ends on the platen side working in eccentrics. As the machine works the platen is brought into action with a rocking motion until it reaches a perpendicular position and is then pulled into contact with the forme by a "slide up" or parallel movement.

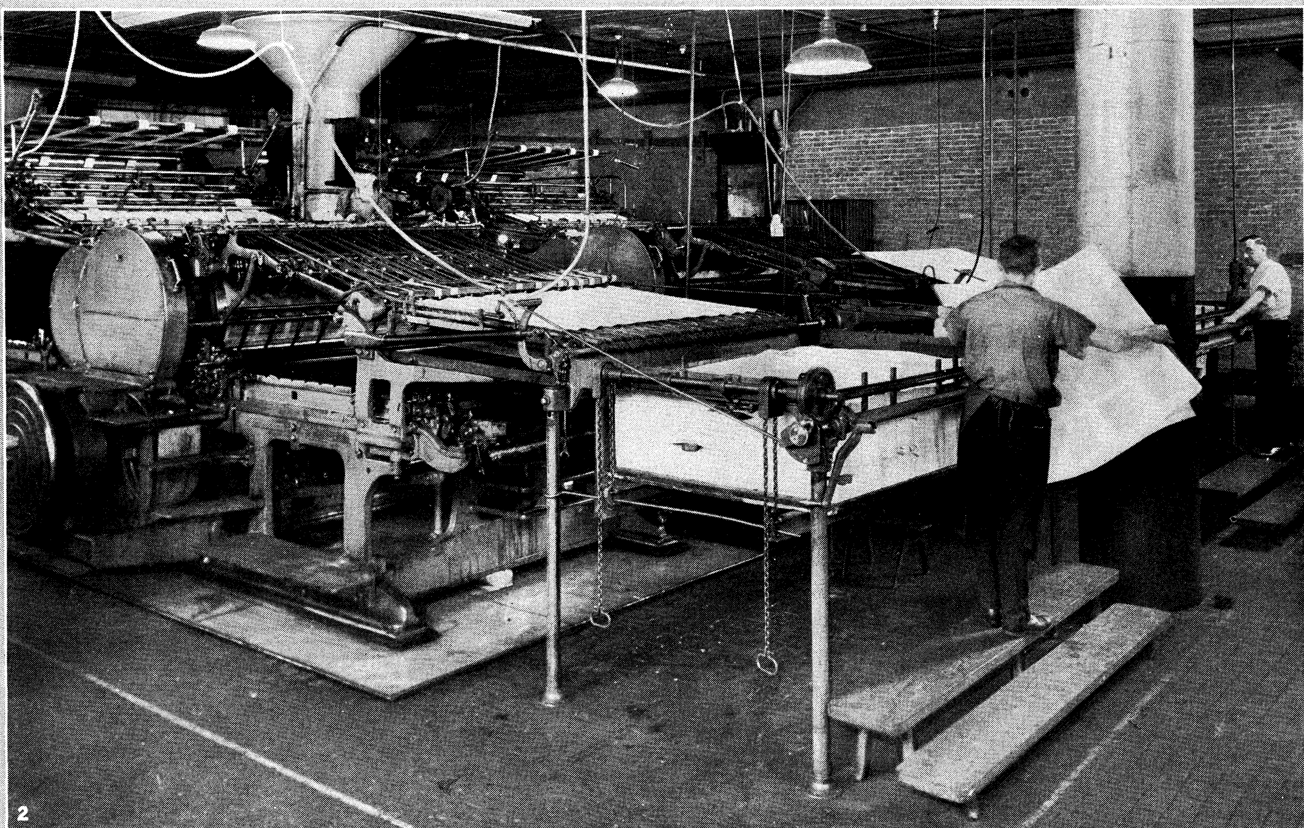
A cylindrical inking system is *a* feature of this class of machine. The ink from the duct is fed on to a series of rollers, and oscillating metal drum. This ensures a better distribution and also enables a graduated supply of ink to be conveyed to the forme by four inking rollers. It is on this style of machine that the best half-tone and colour work is printed. The machines are built for large sheets (the usual size being about 22 by 14), and are fed and operated in the same way as light platens. The average production from a heavy platen is approximately about 1,000 impressions per hour.

Cylinders. — The term "cylinder" is given to those machines where the impression is obtained by means of a cylinder pressing a sheet of paper on to the face of a forme which is secured on a flat horizontal bed. The cylinder runs in bearings held by brackets and rotates as the bed moves to and fro beneath it. There are three different styles, (a) the drum cylinder, (b) the stop cylinder, (c) the two-revolution cylinder.

The drum cylinder, the successor to Koenig's machine (1811), is now but little used. The cylinder, continually revolving, makes one revolution for each impression. One half of the cylinder is lower to allow for the return of the type bed which has a short travel. When the cylinder completes its travel the gripper automatically opens and the printed sheet is transferred to a delivery apparatus known as the "flyers." The sheets as they are delivered are placed one on top of the other on a board at the rear of the machine. The inking equipment is what is usually known as the "pyramidical system," the ink duct being placed in front of the cylinder and the ink transferred to the forme by a system of rollers. The sheets are fed in from the top or crown of the cylinder. These machines are made in various sizes, and a production of between 2,000 and 3,000 is a fair average.

The stop cylinder is essentially an English machine, and commonly known as a "Wharfedale." In this class there is a small cylinder, about three quarters of the circumference being used for impression. On both ends of the cylinder pinions are geared into corresponding racks on each side of the type bed One of the gears on the cylinder "runs loose" and the other is fixed with the teeth on the under portion cut away. This allows for the return of the bed after the sheet has been printed. The carriage is supported by "bowls" running on rails and receives its reciprocating motion by





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FLAT-BED CYLINDER PRESSES IN OPERATION

1. A large flat-bed cylinder printing press showing automatic feeder at one end and extension delivery at the other. The cylinder grips a sheet of paper upon every alternate revolution. On the first revolution the paper is carried around the cylinder. Simultaneously the bed of the press, in which the type matter is secured, moves to and fro and the paper is printed. By the second revolution of the cylinder the printed sheet is released from the cylinder and travels down the tapes towards the delivery table. 2. View from the driving-side of the same type of press as in fig. 1. The printed sheets are seen coming down the tapes towards the delivery table. The tapes carrying the printed sheets do not move continuously but only when the bed is moving from the delivery towards the feeding end. Consequently the sheet's progress is retarded, permitting it a longer interval to dry before reaching the delivery table where it will lie upon the sheet printed immediately before it. As the pile of printed sheets on the delivery table increases, the delivery table is lowered automatically. Then the piles of printed sheets are removed by means of trucks. To hasten drying many presses are equipped with drying apparatus which may be either gas or electric, over which each sheet passes in its journey towards the delivery table

means of racks fixed on the underside of the carriage geared into large wheels running on bearers and in gears. These are connected by a rod to another set of gear wheels which obtain their motion from small pinions keyed on to the driving shaft.

The cylinder is rotated by means of racks fixed on the side of the bed. As the carriage is propelled to and fro the gears on the cylinder turn the cylinder and in this way the sheet is printed and is usually fed by hand to lays at the base of the cylinder. When printed it is automatically removed to the delivery board by means of "flyers."

The inking system includes an ink trough, or "duct," situated at the back of the machine. From the duct a supply of ink is fed by means of rollers and placed on to a "slab" fixed to the end of the carriage. As the carriage moves to and fro, the ink on the slab is distributed by a group of rollers. The inking rollers (held in brackets behind the cylinder) get their supply of ink from the slab as it passes under them and by this means inking the printing surface. This type of machine is made in a large number of sizes and can run at anything from 1,000 to 2,000 impressions an hour.

The Vertical Job Press.—This press is an adaptation of the stop-cylinder principle to a small printing machine with automatic feeding device. The movement of the bed is on a vertical plane with the cylinder rotating over the forme but in an opposite direction to the bed.

This machine has been likened to a cylinder machine placed on its end but with the cylinder on which the sheet is placed travelling over the inked forme. The cylinder stops to enable the grippers to take a sheet from the feedboard. The sheets are automatically fed into lays and, after printing, are delivered at the back of the machine. It is a high speed machine capable of printing a sheet 19 in. by $13\frac{1}{2}$ in. and producing about 3,000 copies per hour.

There are on the market two or three well known machines that are adaptations of the stop-cylinder principle to a small press with automatic feeding device.

The two-revolution machine is now generally accepted as the standard type of cylinder printing machine for general work. It derives its name from the fact that the cylinder makes two revolutions for each sheet printed. During one revolution the sheet is printed, after which the cylinder rises clear of the forme to allow the return of the carriage to deliver the sheet on to the flyers. In this type of machine the cylinder is not actuated by the bed. Both cylinder and bed are driven independently but in unison with each other.

The inking mechanism is on the slab principle and the sheets are fed from the crown of the cylinder, a feature being the method of delivery of the printed sheet which is done in such a way that the newly printed work does not come into contact with anything that would be likely to smear the wet ink. This style of machine is capable of producing an average of about 2,000 copies per hour. One well-known machine is an adaptation of the two-revolution principle to a small press with automatic feeding attachment. The two-revolution make of machine is made with two cylinders, either for "perfecting," *i.e.,* printing both sides of the sheet, or for printing two colours before the sheet is delivered. These machines have two type beds, each with separate inking equipment. The demands for fine work, coupled with the need for speed have brought this style of machine to an extremely high degree of efficiency and accuracy.

A large number of small cylinder machines are built with the object of giving a large output, but quality and speed do not usually go together. Hand feeding of printing machines is rapidly being superseded by automatic feeding. There are two distinct types of machines for this purpose. One is known as a "pile feeder" where a large stack of paper is placed in a contrivance which automatically rises as the sheets are removed from the top by means of suction, placed on the feed board, and carried to the lays on to the printing machine. In the event of the sheet not reaching the lays, the machine stops. The other type is known as the "continuous feeder." In this case the sheets are "put up" a few at a time and while the printing machine is running they are "combed out" and mechanically controlled until they reach the lays, and should they not do so, the machine automatically stops.

Rotaries.—In this class of machine the impression is obtained by means of two cylinders, one of which carries the plate and the other the necessary packing, the paper passing between the two. The plates have to be curved to suit the cylinders and are secured by means of clamps. Where only one size of plate is printed on the machine, as in newspapers, two clamps are fixtures and the other two are movable in order to provide for the secure locking up of the plates. Where plates of various sizes are printed the plate cylinder is spirally grooved, into which movable clamps are fitted to suit the size of the plates to be printed.

There are two types of rotary machine: one of which prints single sheets (on one side), and the other where the paper is fed from a reel, printed on both sides and folded before delivery.

The inking mechanism on a rotary consists of an ink duct, a distributing drum, and a series of rollers to carry the ink from the drum to the rollers which ink the plates. The speed of a sheet-fed rotary being beyond the capacity of hand-feeding, makes automatic feeding an essential. On the reel-fed, or, as it is sometimes called, the web-fed perfecting rotary press, the travel of the paper through the machine and the folding of the pages are entirely automatic. Both sheet-ied and reei-fed rotaries are used for fine colour printing from half-tone plates.

The most effective multi-colour printing machines are those which consist of a large impression cylinder with four separate plate cylinders each with its own mechanism for inking. The plate cylinders are half the circumference of the impression cylinders and two sheets may be printed (on one side) at each revolution of the cylinder. The sheet is taken from the feed board by means of grippers attached to the cylinder, is carried under the first plate cylinder (where a yellow impression is printed on the sheet), then under the second set of plates (where a red impression is made on the top of the yellow impression), the sheet passing on to the two remaining plate cylinders (where blue and black impressions respectively are superimposed on the top of the previous colours), and the sheet is delivered with the picture completed in its full range of colours and tints. Electrotype plates are used for printing, these having to be curved to suit the circumference of the plate cylinders, it being impossible to use "overlays" on the impression cylinder. The impressions from the four sets of plates take place on the same section of the cylinder. As each set of plates requires a different "make ready," the plates are "bumped" (the surface graded in height according to the tones in the plate).

In America this is accomplished by the McKee process, in which the plate is "made ready" and the make-ready impressed into its back through hydraulic pressure. The back of the plate is then shaved to proper thickness and the plate curved to fit the rotary cylinder.

The rapid printing of the McKee four-colour machines made it necessary to devise a method for quickly drying the sheets to prevent offset or smudge. This was at first accomplished by interleaving the freshly printed sheets with specially prepared manilla paper. The device known as travelling offset prevents offsetting upon the impression cylinders of wet perfecting rotaries. It winds and unwinds (working backward and forward) around a reel which engages the second impression cylinder. This has given way to other methods, such as the spraying of a coat of powdered paraffin over the printed surface, so thin as to be imperceptible, but sufficient to prevent offsetting of the sheets.

Special inks are required for printing wet colours on the top of each other. The results cannot be said to equal those obtained when sufficient time is allowed for each colour to "set" before printing the following colour.

In newspaper production the reel-fed rotary has been brought to a high degree of efficiency. Although a newspaper machine is of great size and seems highly complicated, really it is simple. It comprises a number of units, each of which "perfects" a number of pages. If the pages exceed the number of plates which can be printed on a single unit, another unit or units can be linked up together, and the printed "webs" come to a point in proper sequence where they are folded and cut before delivery.

There is usually a blank space left on one or more pages of a newspaper for the purpose of publishing news which has arrived after the paper has gone to press. This late news is printed into the blank spaces by a contrivance called a "fudge box" which is circular in form and into which are secured linotype slugs. The "fudge" is fastened on to an auxiliary cylinder equipped with inking mechanism. This works in unison with one of the main impression cylinders and as the paper is printed an impression of the lines in the fudge box is made in the space left for the purpose. The "edition seals" and lines printed in colour in newspapers are produced by the same means.

There is in practice a very wide limit in the planning of a newspaper machine. Units can be arranged in a straight line or placed one on top of the other. The capacity is determined by the number of folders which it is possible to fit on the machine. Each of these can turn out 45,000 folded copies per hour. Not infrequently the paper is run through the machine at an approximate rate of 54 m. per hour and it is possible to join up new reels and change the fudge box without stopping the machine. (See BOOK; PRINTING TYPE; COLOUR PRINTING; PHOTO-ENGRAVING; also LITHOGRAPHY.)

BIBLIOGRAPHY.—C. S. Partridge, *Stereotyping and Electrotyping* (2 vols., 1908), a historical review and the working of the processes; F. J. Trezise, *Design and Colour in Printing* (1909), dealing with design, and the science of colour as applied to typography; *The Times, Printing Number* (1912); British Museum, *A Guide to the Exhtbition in the King's Library* (1913), a concise historical and descriptive account of early printed books, music-printing and bookbinding; H. R. Plomer, *A Short History of English Printing, 1476–1900* (1915); E. C. Gress, *The Art and Practice of Typography* (1918), a record of printing up to the 20th century, and a description of modern methods of production; J. C. Oswald, *A History of Printing, Its Development During Five Hundred Years* (1928); *The Linotype: Its Mechanical Details and Their Adjustments* (1920); V. Possnett, *Stonework* (1920); this deals with the imposition of pages for bookwork; T. L. De Vinne, *The Practice of Typography* (4 vols., 1920–21), a work dealing with title pages, book composition, plain printing types and correct composition; C. W. Hackleman, *Commercial Engraving and Printing* (Indianapolis, 1921), a comprehensive modern work; J. Southward, *Modern Printing* (1922), a work dealing exhaustively with the art and practice of typography; J. R. Rogers, *Linotype Instruction Book* (1925); T. F. Carter, *The Invention of Printing in China* (1925); G. P. Winship, *Gutenberg to Plantin* (Cambridge, 1926); R. W. Polk, *The Practice of Printing* (1926), a practical work for students of letterpress printing; E. St. John, *Practical Hints on Presswork* (1927), a technical work for letterpress pressmen; R. A. Peddie, ed., *Printing: A Short History of the Art* (1928), comprising articles on the history of printing throughout the world by various authorities. (J. R. R.; J. C. Os.)

PRINTING TYPE. At the time of the invention of printing, European scripts were changing. The ideas of the artistic and literary movement of the 15th century, known as the Renaissance, were drawn from the classics of old Rome, and as many of the texts were preserved in the beautiful caroline hand, scribes learnt to copy the letters as well as the text of the original. The resulting "neo-caroline" hand was probably first seen at Florence, where Niccolò Niccoli, a celebrated humanist, directed a school of copyists about 1425 and trained scribes to write a very neat, round letter, which was in fact a revised and, in certain respects, more beautiful version of the old 9th century hand. The new letter won a great success in literary circles, and by the middle of the 15th century a company of scholars, artists and nobles, passionately interested in the culture of pre-Christian civilization, enthusiastically practised it. They thought the old heavy black-letter most objectionable, and invented for it the nickname "gothic" (*i.e.*, barbarous) by which it has been known ever since. Thus the neo-caroline letter, or "littera antiqua" as it was then called, became accepted for secular manuscripts. Moreover, just as there had been for centuries a formal and an informal "gothic," the modern-antique writing was upright for formal text and sloping for informal current use. These are the originals of our so-called "roman" and "italic" types.

By the time of Gutenberg, therefore, the scripts in use in Europe consisted of the old so-called "gothic," and the new so-called "humanistic." The former showed national peculiarities according as it was handled by German, French or English scribes, but the "humanistic" was for some time confined to Italy. This, then, was the calligraphic situation when in the north men were straining their ingenuity to invent some form of multiplying texts by means of impressions from movable types.

Leaving it for specialists to determine the priority of invention as between the Dutch "Costeriana" and productions of Johann Gutenberg of Mainz, we may note that printing type began with that pointed black-letter design to which the scribes, secular and monastic, had long accustomed the librarians and readers of Europe. There can be no doubt that Gutenberg's pointed text is a magnificent type, not perhaps as fine as others of later date, but well cut, harmonious and very pleasantly conscious of its discipline and integrity. His informal Italianate bookish type (of the Indulgence) is also successful.

The Churches and the Printer.—The current demand for ecclesiastical works produced a number of exceedingly handsome founts of formal pointed text. Inevitably the Church's permanent need of books made her the early printer's best customer, and the finest types were cut for use in mass-books, psalters, breviaries, rituals, etc.

The uncompromising joints of typical German black-letter are rounded in early Italian printing, and angles give place to curves. Rounded scripts were characteristic of Italian book-making in the two centuries preceding the introduction of printing into Italy by Conrad Sweynheim and Arnold Pannartz at the Benedictine monastery of Subiaco near Rome in 1464. These two Germans used a type based upon the common round bookhand neither "gothic" nor "humanistic." Other Germans migrated south, coming through what is now the Austrian Tyrol, followed the road to Venice, and printed in "gothic" letters of the rounded kind. Four years after the printing at Subiaco of Sweynheim and Pannartz' *Lactantius* in *fere humanistica* type there was cut in Venice a letter which may positively be described as a pure humanistic letter—or, in printers' language, a pure *roman*. The design was first used in Italian printing in 1469 by two Germans who had come to Venice from Speier in the Rhineland, and is so well made that it presents a modern appearance to our eyes. In fact, with Johann and Wendelin da Spira we come into contact with the modern book, although the title-page and other preliminaries have yet to develop. It must be noted, however, that a good roman was still earlier used in Germany by Adolph Rusch of Strassburg, in a *Durandus* issued not later than 1464. Had this example been followed, Germany might have followed. up the "gothic" triumphs of Gutenberg, Sensenschmidt and Stuchs with no less notable roman founts. But Rusch's isolated and barren achievement lay outside that main line of development which, beginning with the da Spira fount, held within it the promise of a brilliant future which was to place Venice above any other printing centre. The da Spira letter was surpassed the next year by the design of the Frenchman, Nicholas Jenson. This is an even more distinguished type, so elegant and readable that the authorities in typography have pronounced it to be the most perfect type ever cut. Jenson also used more than one gothic letter whose technique rivalled that of his famous roman, and which found great contemporary favour. His roman was much copied in Italy and 25 years passed before the appearance of any rival which might be regarded as having the slightest right to dispute its primacy.

The Aldine Press, 1495.—But in 1495 there was founded in Venice a press whose reputation for scholarship was destined to become unique. Aldus Manutius Romanus was both a scholar and a business man, but it does not appear that he took great interest in the technical problems of printing. His passion was for pure scholarship, and he devoted himself to the printing of inedited Greek and Latin texts. Some diversity of opinion exists with regard to Aldus's merit as a typographer. The late Robert Proctor says roundly that his founts "whether Greek, Roman or Italic are in each case lamentably devoid of any beauty of form other than that conferred on them by good cutting." Proctor was upset by Aldus's patronage of cursive Greek hands as type-models, so full of unnecessary flourishes and ligatures; and the unfortunate effect of Aldus's prestige was to perpetuate a sloped Greek calligraphic lower-case. But it is more than doubtful whether the romans of Aldus can reasonably be lumped in with the Greek and Italic as equally bad in design. The contention that such beauty as they have is that conferred upon them by good cutting is also a little wide of the mark, in view of the fact that none of the Aldine types possesses anything like the technical excellence of Jenson's. It may also be suggested that the design of one of the Aldine romans equals Jenson's in point of design, but a liberally linked page of Jenson's shows that the capitals are unnecessarily assortive.

The press began with an *Erotemata* which Constantinus Lascaris brought out in March, 1495, the capitals of which fount reappear later in the year in conjunction with a lower-case which is of prime historical importance. The complete fount first appears as a short tract, *De Aetna,* by one of the leading Italian humanists, Pietro Bembo, afterwards Cardinal. The *Erotemata* capitals, though well designed, are too roughly cut to combine agreeably with the very beautiful lower-case letters. The type of the *De Aetna* represents, as it were, only a "first state." Aldus retained it for the *Diario* of Alexander Benedictus in 1496. In June of the next year he issued the work of a local physician, Nicholaus Leonicenus, entitled *De Epidemia,* which was set in a letter of similar design but on a smaller body. In the famous *Hypnerotomachia Poliphili* the same face appears in a lighter, more graceful and more harmonious cutting. It is not claimed that the final form of this is perfect: at least the "L" is inferior in design to that of Jenson, and the "G" almost ugly, but the type does present a very distinguished appearance, which would have gained had a first-class pressman been entrusted with the printing.

The type of the *Polifilo* made another appearance in the next year (1500) in the preliminaries of a folio Politian of 500 or more pages composed in the type of the Bembo. In the preliminaries referred to, a commendatory epistle is composed in the "Bembo" lower-case, joined to a new and much larger series of capitals. The fact seems to be—not exactly as Proctor would have it, that Aldus was a "man of phenomenal bad taste for his time"—but that his interest was rather less in typography than in scholarship. Before passing to the Aldine Italic, we may point out that the type of Bembo's *De Aetna* is the origin of that style of letter known to English printers as "old face." We have only to compare the founts of Jenson, Aldus, Garamond and Caslon to see that the forms of our present letters derive immediately from Aldus through Garamond, and that the latter did not copy from Jenson.

Italic.—In 1500, Aldus' office was cutting the sloping character described by himself as *Chancery,* and which we have grown accustomed to call *italic.* It is not a very satisfactory letter from the point of view of design, or indeed in its suitability as type; no fewer than 68 ligatures have been counted in the early volumes of the library of classics for which Aldus specified this type. It was engraved by the same Francesco (Griffi) da Bologna who cut the type of the De *Aetna* and the *Polifilo.* Owing to the warm welcome that greeted the low prices and novelty of the Aldine classics, the type in which they were set made an undeserved reputation, with the result that, though Aldus did what he could to protect it, the design was copied in many other Italian printing centres and in England, the Netherlands and France. Its artistic merit is very slight, but it "takes in" extremely economically, a supreme quality in the series for which Aldus employed it. The calligraphic deficiencies of the Aldine italic are apparent when it is placed side by side with that designed in Rome by one of the scribes employed in the Vatican Chancery, Ludovico Arrighi, alias Vicentino, and cut by the goldsmith, Bartholomeo dei Rotelli of Perugia. The fame of the Aldine italic arises from priority in time, but Arrighi's is infinitely better in design, more graceful, more legible, and more permanent in its influence. The form of italic which we employ as a companion to our "old-faces," descends from Arrighi. The extent of the use of "Italic" types cut on the Arrighi model in Italy, prepares us for its utilization by the greatest printers of Paris, Robert Estienne and Simon de Colines. A comparison of Arrighi's italic with that of Colines' shows that the French fount is directly indebted to Arrighi's design.

"Old Face."—Garamond, obviously had before him the ***De Aetna*** or the *Polifilo* as models for his roman, and Arrighi for the italic; and craftsmen of his generation merged these two originally independent founts into two mutually dependent constituents. Thus for France and England *roman* and *italic* were twin halves of one fount. These French designs are the originals of our "old faces'—the design which came into English printing with John Day, and which, by the medium of Voskens, van Dyck, and Caslon, is characteristic of our work until the coming of Baskerville and the moderns. Whether or not the first "Garamond" letter was designed by himself or in association with Geoffrey Tory cannot be said, but it was certainly sponsored by very high authority. The fine folio Bible of Robert Estienne (1532), which must have taken some three or four years in going through the press, contains probably the finest use of this letter.

The "Garamond" type steadily acquired influence, and in a short time actively affected the typography of Venice and Florence. Indeed, by the middle of the 16th century the Garamond letter had succeeded in deposing the Venetian design which, as we have seen, was originated by the da Spiras and Jenson. It is not easy to account for the progress of the Garamond design in Italy. Guillaume Le BC, Garamond's pupil, was in Venice between 1546 and 1550, and doubtless supplied a certain quantity of French type to Venetian printers; but it remains curious that the merits of the Jenson design should have been overlooked in favour of the work of a newcomer. It was another Frenchman who cut punches for a new printing office attached to the Holy See: Robert Granjon went to Rome at the invitation of Gregory XIII., and remained there several years, cutting numerous orientals and romans on the Garamond model. The italic is generally of the flowing Arrighi design. Garamond made one experiment, and perhaps more, with types which deliberately reproduced the Aldine italic, and himself printed three or four books about 1545 in this face. It would appear that the taste of the day approved his effort.

Italic, in fact, from this time, tends to be reserved for preliminary matter, citation and emphasis. It should be observed, too, that by 1540 the upper case of italic founts is sloped, whereas Arrighi's and Estienne's texts were invariably worked with upright capitals.

From the middle until the end of the 16th century there was little change in type-design. The great successes in Italian printing were won between 1470 and 1520, and in French between 1525 and 1550 Christophe Plantin of Antwerp, working with types of Garamond and Granjon, produced a number of handsome works; and, though the artistry of this printer has perhaps been overrated, his Polyglot Bible is a notable achievement alike in scholarship and in typography. He contributed nothing to roman or italic type design. The range of type varieties characteristic of incunabula narrowed with the opening of the 16th century, typographical supremacy passed to Paris, and the Garamond design was stabilized for 150 years. The 17th century did little beyond reproducing these and Estienne's types, generally with some loss of beauty—an exception being the types of Christopher van Dyck, a freelance punch-cutter in Amsterdam who worked for several foundries, cutting types certainly less important to the historian than those of Gararnond, but obviously more beautiful—not the only instance of types designed after the model of a historic letter being superior in design to their prototype. Thus, Garamond's design was improved upon, first by Robert Granjon, and next by Christopher van Dyck.

The reputation of Dutch types is intimately connected with van Dyck, largely because his types were used by the Elzevirs. The editions of the famous Leyden firm have not the interest of the work of the preceding century, but their types are undeniably finer in design and technique. Other engravers, such as Bartholomew Voskens and his brother Dirck, contributed to the renown of Dutch typefounding, while English craftsmanship, owing to repressive legislation scarcely existed. Books were commended by advertising that they were printed in Dutch letter. Moxon thought van Dyck's the best of all, and made a fount of similar design. When in 1660 Bishop Fell took in hand the task of procuring types for the use of the press of Oxford university he immediately turned to Holland. His agent, Thomas Marshall, procured punches and matrices from the Voskens, but unfortunately he secured none of van Dyck's. The 18th century brings us to the types called "modern" of which Bodoni is the most notable protagonist. Giambattista Bodoni of Parma was an innovator, but he did not, as often assumed, create the "modern" serif, for the same thin, flat serif is found in codices written 300 years before Bodoni was born. Some of the letters modelled upon manuscripts of this time — those of da Lignamine — themselves possess flat, unbracketed serifs, though they are heavier in weight. The thin, flat serif is to be seen in the copybooks of several professional Venetian writing-masters; for instance, the *lettera antiqua tonda*, drawn by G. A. Tagliente, exhibits it; as do other Italian and French writing-books which we need not specify. The "modern" serif is, indeed, only a forgotten renaissance trick contemporary with the short, stubby and bracketed serif which we find in the Bembo type.

Romain du Roi.—When that most important printing institution, the Imprimerie Royale, was established in the Louvre by Richelieu in 1640, its sole types were cuttings and re-cuttings of the "old-face" originals of Garamond, Le BC, and Granjon. The next sovereign, however, Louis XIV., approved the creation of an entirely new set of roman and italic types to be absolutely reserved to the office of the Louvre. The project was sanctioned in 1692, and a commission of experts was appointed by the Académie Royale des Sciences to study the formation of perfect roman letter. The chairman of the commission, one Jaugeon, embodied the findings in a bulky report, and a set of elaborate geometric designs in which the traditional roman forms were once more disciplined by rule and compass. Jaugeon's letters were drawn upon a field subdivided into no fewer than 2,304 small squares. The royal road to a perfect roman letter was in theory a mathematical one, but when Philippe Grandjean came to cut the punches, he elected to work with a considerable degree of independence, preferring the guidance of his own trained eye. The *romain* du *roi Louis XIV.*, as the new letter was called, when compared with Garamond's roman shows a sharper contrast between its thick and thin strokes, it is more regular, and better in its justification. The most important general differences are in respect to a certain condensation of form and the novelty of serif. For the first time the thin, flat, unbracketed variety appears in a type-form. In the top of the roman lower-case 'b', 'd', 'i', 'j', 'k', 'l', and 'h' the new feature extended both sides.

An interesting feature of Grandjean's italic is his departure from the ancient old-face form of the lower-case 'b' which is derived, of course, from that modification of roman square capital writing known as uncial. It is, perhaps, not so generally realized that the hooped forms of Garamond's and Caslon's italic lower-case "h" go back to a fourth century original, while the other form is no older than Louis XIV.'s time.

The *romain du roi* inevitably exercised a considerable influence. The enterprise of trade type-founders, nevertheless, was obstructed by a decree forbidding any counterfeiting. Fournier-le-jeune's way out was to narrow the proportions of his letter and slightly to modify the serifs. His italic modifications can be seen in the fine oblong folio specimen published 1742. Though the crown monopoly of the *romain* du *roi* was safeguarded by the enactment of penalties against its reproduction by trade type-founders, the advantage of a narrow-bodied letter was quickly observed, and Grandjean's methods were followed by Dutch founders.

J. M. Fleischman cut a new series for the Enschedés at Haarlem, 1730–68; some 20 of his alphabets were of an elongated character, with thin hair lines and thin serifs. Fournier copied these, as he admits in his description "Goût Hollandois." When Bodoni commenced to print he used these and other of Fournier's letters and ornaments. Later he made copies of his own, and later still cut new varieties in which the contrast between the thicks and thins was accentuated. There is much to be learnt from Bodoni's careful presswork and sense of style in typography, and his influence was rightly considerable on the continent and in England towards the end of the 18th century. At the same time, François Ambroise Didot, the founder of the great dynasty of printers, publishers and paper-makers, was experimenting with types cut in the style of Grandjean and of Louis Luce, cutter at the Imprimerie Royale of the first of all condensed letters.

England, slow in following new fashions, was using the founts of Caslon and Baskerville. The types which William Caslon I. cut between 1720 and 1726 were, and are, very fine renderings of the "old-face" design which came down from Aldus. The sizes—english, pica and brevier — are brilliantly cut. Certain of the larger bodies cut by William Caslon II. are at least agreeable, though every size above two-line pica contains more than one ill-formed sort. Caslon undeniably made a very handsome letter out of the Dutch models, which he manifestly had before him; but credit for initiative must go to John Baskerville — his roman is an open, legible and expressive letter pcssessing a great deal of individuality though the wiry, thin and pinched italic which he drew for companion use is less successful.

The refinement and precision of the Baskerville type were not much valued in England during his lifetime. Bodoni and the Didots, however, admired his presswork and paper; later the influence of Baskerville's forms was considerable in Britain, as witness the types of Fry and Wilson. One of the Caslons, also, who split away from the parent firm, made a letter similar to Baskerville's. These types are round and, though sharing sharp contrasts as between their thicks and thins, remain in the "old-face" tradition. Nevertheless, their nicety and precision of cut reflect the "modern" invention of Grandjean. In making a comparison of the merits of Caslon and Baskerville, perhaps we may summarize by saying that while Baskerville shows greater originality and personality in design than does Caslon, the latter was undoubtedly a more expert engraver. Baskerville's "modernity" lay in his printing methods rather than in his typefounding technique.

The first of the Didots who took typography as a career was François Ambroise Didot (1730–1804) who directed the French national printing office for a time, and to whom the continent of Europe owes its authoritative point system. His light-faces were engraved by the punch-cutter Waflard and take the original design of Grandjean a step farther than Fournier or Bodoni. His sons and their successors drew and redrew upon the same models, first increasing their brittle and attenuated aspect, next fattening and condensing them.

English Designs. — English modern-faces are to be early found in the books of William Bulmer (1758–1830) of the Shakespeare Press. Here is to be found a close-set, narrow-bodied letter with fine hair-lines. It possesses the curly-tailed capital "R" which never occurs in the genuine old-faces and which Grandjean, Baskerville and Bodoni preferred. These types were well cut by William Martin, and after Bulmer came many other modern-faces, all possessing extremely thin hair-lines. Ever since the days of Caxton, England had depended upon foreign types, Netherlandish or French. The first original English design of any kind to make an impression abroad was Thorne's "fat grotesque" — produced during 1800–03. It was a distinct novelty, and was taken up with great enthusiasm in France, Germany and Holland. The Imprimerie Nationale itself in 1840 commissioned Thorne to cut a like face. Bodoni fattened his large sizes, and the Paris trade was supplied with a *gras* instead of a *maigre* Didot.

After Thorne (1803) came a heterogeneous swarm of fat and lean faces. The unexampled successes of English industrialism staggered the world, and the continent, while cursing British "hypocrisy," bought British machines and copied British types. Consequently from 1820 to 1860 all printing was in a sorry condition, though, by way of exception, the London publisher, William Pickering, and his printers, the Whittinghams, produced some comely books in "modern" and "old-face" types.

But the return to decent standards was slow. Abroad, the work of a scholar-printer and publisher at Lyons is to be noted. In 1846 Louis Perrin cut the first types designed since the Renaissance upon the model of Latin inscriptions — plentiful in an ancient Roman foundation, like Lyons (Lugdunum). The lower-case roman resembles Caslon's, but the italic, deriving from Grandjean and Fournier, gains elegance by reason of Perrin's inclusion of swash capitals. Perrin's handsome printing in these *Caractères Augus-*

taux, gave the types an important influence in France. They were copied by Beaudoire (Paris), who called them by the arbitrary and confusing name "Elzevir," since applied by continental convention to all "old-faces." Beaudoire's capitals, imported by the Chiswick Press in the 'sixties while that illustrious establishment was managed by Whittingham and Wilkins, are to-day in use at their printing works in Tooks Court under the name "Lyons capitals," a curious survival unfair to Perrin.

William Morris.—The Oxford Movement in the Church of England, and Scott's novels, mediaevalism and the pre-Raphaelites, opened the way for William Morris, poet and craftsman. He had secured the printing of his *Roots of the Mountains* (1889) in an old Chiswick Press type cut by William Howard in 1858, but he now created an entirely new formula of the printed book. 1891 saw the first Kelmscott book, *The Story of the Glittering Plain.* Morris, as a typographer at least, was a mediaevalist; he admired the early printing and, naturally, his types were archaistic; he thought Jenson's the finest roman and drew a fount therefrom, the *Golden* type. The *Troy* type and the *Chaucer* came later. There followed similar experiments by others: Mr. Charles Ricketts made the *Vale* with its individualistic 'g'. 'e', 'b', 'y'. and obtrusive capitals. The *King's* fount, also cut for the Vale Press, is a strongly personal design. Mr. Ashbee's *Endeavour* (1901) is perhaps the most extreme of these idiosyncratic founts. Mr. Lucien Pissaro's *Brook* type is less eccentric than sophisticated, but serves to throw into welcome relief the elegance and simplicity of the *Doves* type designed on the basis of Jenson by Cobden-Sanderson and Emery Walker. Another fine letter, but too closely following an ancient model, is Mr. C. H. St. John Hornby's *Ashendene* type (1902) which reproduces the *fere-kzcmanistica* of Sweynheim and Pannartz (Rome, 1465). Italian models were also followed by Herbert P. Horne, who cut three types between 1905 and 1909. The first, the *Montallegro,* was cut for Mr. Updike and first used in the *Life of Michelangelo Buonarroti* by Condivi (1905). The *Florence* type, cut for Chatto and Windus, came in 1909, as also the *Riccardi* for the Medici Society. All three types are agreeable and restful in composition. The capitals are better in design than the lower-case. In all the latter, the poor forms are the 'a', 'e', 'y', always difficult letters to draw. Not one of these experimenters made an italic, and an unbreakably conservative mood seems to have settled upon the English private presses after the insurgent individualism of the *Vale* and *Endeavour* types.

In the United States a similar reaction is to be noticed. Mr. Bruce Rogers, who made a new type for an edition of Montaigne's "Essays" published by Houghton, Mifflin of Boston (1903) succeeded in constructing a readable and dignified letter, though even here an unhappy lower-case 'e' may be detected. The capital 'R' varies from the Jenson model (accepted as the basis of the fount), and not for the better. There can be no two opinions, however, about the same artist's *Centaur* (1916), again based upon Jenson but improving at many points upon the Venetian model, notably in the capital 'M.'

German printing, mean and even horrible since the extinction of the Frankfurt school headed by Egenolff, improved with Unger. His quasi-Didot *frakturs,* however, depended for their effect upon better presswork than they ever received. The roman (antiqua) acquired influence when used by Karl Tauchnitz in 1825. Ever since then the *fraktur* and *schwabacher* types have been slowly undermined by the *antiqua* and *kursiv* until at the present time there is used perhaps more roman than *jraktur. A* number of the modern German roman types are excessively personal—witness the fount designed by the architect Eckmann for the Klingspor foundry. It is a fair example of the kind of type which the intelligent German put out before the introduction to Germany in 1905 of the teaching of the English calligrapher, Edward Johnston. The fine school of calligraphers which arose from this source greatly influenced all those- crafts in which lettering plays any part; and the German typefounders, led by the house of Klingspor, quickly applied the skill of several masters of the new calligraphy to the designing of new roman and gothic founts. Peter Behrens, Rudolf Koch and F. H. Ehmcke are perhaps the best-known of these artists. Their types have raised the typography of German private presses from a low to a very high place in the esteem of collectors; but for the bulk of German printed books, types drawn from older English and French models prevail, varied by the occasional use of the more conservative of the new founts. Unlike ourselves, the Germans less strenuously resist experiment in books: it is perhaps for this reason that the English typefounders have ignored the new calligraphical movement. Certain it is that the English dislike novelty in typography, and many years must elapse before any British design influences the continent of Europe. It was not always so. About 1802 certain Scottish printers originated the crisply cut modern face now known by the name of *Scotch Ronzan.* The type remains in constant employment in Great Britain, and to an even greater extent in the United States. In 1850 Miller and Richard evolved their *Revived old-style,* which is not a revival, but an insipid original design. It found immediate favour in England, and is widely used to-day at home, in Scandinavia, Germany and the United States. These two Scottish faces represent the most popular designs in the English-speaking world. They are book types. (S. Mo)

Advertising Type.—The rise of advertising gave a new opportunity to type designers, and it was to be expected that America. the home of advertising, would take full advantage of it. The most widely used face of the first quarter of the 20th century was the *Cheltenham* designed by Goodhue and Kimball in 1902. With its success, initiative in type design passed to the United States, and with the corps of fine designs made by the exceptionally able American designer, Mr. F. W. Goudy, and the justly appreciated *Cloister* (Jenson) and *Garamond* of the American Typefounders' Company, the English foundries become of slight consequence. The World War effectively postponed the production of new English designs and the following years witnessed advertising types imported in the main from America. Germany also led in this department for several years, and German typefounders, profiting by the liveliness of the intelligence of their designers, concentrated upon the production of grotesque and decorative advertising and publicity faces.

In America the Mergenthaler Linotype company, the Monotype company, the Intertype corporation, the Ludlow company and the various foundries have issued a profusion of type faces for advertising purposes, many of true artistic merit. Fashion in types is almost as cyclical as that in women's dress. For several years, especially after 1930, the various sans-serif faces *(Kabel, Vogue, Futura, Tempo,* etc.) were much in demand for their simplicity and modernistic appearance. Later *Girder* and *Stymie,* faces with pronounced serifs, rigidly straight, and with no variation in shading, came into prominence for both display and text, as did the script types such as *Trafton.* The Gothic faces and *Ultra Bodoni,* a heavy type based somewhat on the original *Bodoni,* are perennial favourites with advertisers. Soon or late, however, most designers of advertising return to the historic founts or modifications of them, especially *Caslon, Garamond, Baskerville, Scotch Roman,* and *Bodoni.* Among faces of late design are *Caledonia* (Dwiggins) and *Fairfield* (Ruzicka). *See* also TYPOGRAPHY. (X.)

BIBLIOGRAPHY.—Specimens of types in current use will be found in the catalogues issued by the typefounders and type-setting machine makers; specimens of superseded founts are conveniently given in the works of Updike and De Vinne. The following works should also be consulted: T. L. De Vinne, *Plain Printing Types (N.Y.,* 1900); Ch. Enschedé, *Fonderies de Caractbres dans les Pays-Bas* (Haarlem, 1908); P. S. Fournier, *Manuel Typographique* (2 vols., Paris, 1764–66); Edward Rowe Mores, *Dissertation upon Eng. Typographical Founders and Founderies* (1778; new ed., D. B. Updike, 1924); Stanley Morison, *On Type Faces* (1923); Talbot Baines Reed, *Hist. of the Old Eng. Letter-Founders* (1887; new ed., A. E. Johnson and Stanley Morison, 2 vols., 1929); Albrecht Seeman, *Handbuch der Schrzftarten* (Leipzig, 1926); D. B. Updike, *Printing Types* (2 vols., Cambridge, U.S.A., 1922); E. Wetzig, *Ausgewahlte Druckschriften* (Leipzig, 1920); H. H. Sparling, *The Kelmscott Press and William Morris* (1924). (S. Mo.)

HAND-PRESSES USED IN GRAPHIC ARTS

History.—In the beginning the only machines used by the graphic arts were hand-presses. These machines were used before either steam or electricity were thought of as a means of providing power. Of course, in modern times, the large machines used could not be operated by human power so it was necessary to invent something that was more powerful than the hand of man. The presses driven by steam and electricity were not expected to improve the quality of the work produced—nor have they improved it—but they were made to increase the quantity; hence, the power press.

When Alois Senefelder (1771–1834) invented lithography about the end of the 18th century, he was compelled to build some kind of a machine that would enable him to reproduce on paper what he had engraved or written on the limestone which he had used as a base for his work of printing music. He proceeded to make a machine which was called the pole-and-beam press, which, as the name indicates, was made of poles and beams. This first press that Senefelder made is said to have been completed during the year 1796. The pressure was applied by the workman standing on a treadle, his weight supplying the needed pressure—and the larger the pressman the better the impression he produced.

The pole-and-beam press was not an unqualified success and was soon discarded by the lithographic inventor and an entirely different machine was built in 1797. The new machine was called the "star press" and was patented in 1801, and, while very crude, was used by Senefelder for a number of years. Some of the parts of this press are followed in some of the hand-presses in use to-day. It was an improvement on the pole-and-beam press because of the use of a much larger stone. For many years this press was the "standard model in the lithographing business.

There is no record of a lithographic hand-press being built between the years 1798 and 1820, but during the last-named year a machine was turned out in England called "the English hand-press." This press and other similar ones were used until the power machines came into use in 1865. After the introduction of this power-press, which was called the "steam press," the hand-press was practically discarded except for pulling proofs and working off extremely short runs. While the "steam press" has been adopted all over the world as the standard lithographic machine, it is still maintained by many lithographers that better and more perfect work can be turned out by the hand-press.

The pressure that prints the image from the stone to the paper by the hand-press is entirely different from the pressure of any other printing machine in use. It is a scraping motion. After the paper is placed on the stone a piece of hard wood is drawn across the form to be printed, with sufficient pressure to make the paper take the ink. All other lithographic presses and type presses print by pressing down on the paper by some direct means.

About 1825 a hand-press was made of iron and its operation was entirely different from any previous ones. It had a roller made of brass and operated by a handle which caused a travelling carriage, on which the stone was placed, to run under a frame to which was attached the scraper. The pressure was regulated from beneath the carriage, which was forced up by a screw to give the correct amount of impression when the scraper was applied. After the print was made the pressure was released and the carriage drawn back by hand, thus giving the operation a saving of time and greatly increasing the output.

In 1846 there was constructed in Ireland a hand-press known as the Macbrair press. It was a great improvement on the English machine mentioned before, and did good work at what was considered in those days great speed. One of these machines was brought to America and a good-sized family was supported with it for several years. The largest edition worked on this machine ran about 500 copies in one colour. This press is now said to be in a museum on exhibition as a curiosity.

In reproducing the image to be printed by any make of lithographic hand-press the principle involved is the same—that of the scraper being forced across the plate. This scraper, no matter what kind of wood it is made from, must be perfectly straight and the face, which is V-shaped, must be carefully rounded so that it will not sag or bulge when pressure is applied. The bed of the hand-press, upon which the stone that is to be printed from is placed, must be level and neither concaved nor convexed for, while the stone is not supposed to bend, a convexed bed will cause the stone to balance and move slightly with every impression, thus making it impossible to register impressions on it; while a concaved bed will wear down the corners of the stone and put it out of plumb. More work has been spoiled by presses with uneven beds than in almost any other way.

In 1905 a new kind of lithographic press was invented in the United States called the "offset press." This was a steam-driven press, but it called for a hand-press to make the transfers to be used, and make them quickly and accurately. Several inventors started to make an offset hand-press. The first one offered resembled a washing machine wringer. The proof was pulled from a stone, laid on another piece of transfer paper, and the two were run through this wringer-like machine. Some work was turned out this way, but as there were no guides to feed the sheets to, it was next to impossible to make a sheet register properly, so this proposition was abandoned and other designs taken up. Finally, an offset hand-press equipped with a large rubber-covered cylinder was offered. This same principle has lasted to the present day. This large rubber cylinder travels over the stone or plate containing the image from which it takes an impression, and then it goes on to a bed upon which is laid the paper. As the cylinder goes over the paper the image is transferred from the rubber blanket to the paper and the work of printing is done, so far as the sheet is concerned.

It occasionally' happens that one wishes to pull a transfer of a piece of copper plate engraved work to use on a lithographic hand-press. From a purely mechanical point of view the construction of the copper plate press is an exceedingly simple matter. Its purpose is to produce a heavy and uniform pressure on the plate during the operation. To make a lithographic transfer from a copper plate engraving one should lay the plate face upward on the bed of the press, lay the paper on it and pass it between the two iron cylinders.

The material used in making lithographic transfers from copper plate engravings consists of transfer ink, whiting, transfer paper and a good supply of clean rags. The copper plate is first heated, but not enough to burn the ink; then the transfer ink is forced into the engraved parts until every part is fully charged. In cleaning the plate it should be carefully rubbed with a rag charged with whiting until all the surplus ink is removed. The transfer paper to be used is dampened--or commercial transfer paper may be used which is made to retain dampness—and the plate and paper used before the plate gets cold. Transfers made in this way may be used in lithographing on a hand-press.

(W. C. Br.)

PRIOR, MATTHEW (1664–1721), English poet and diplomatist, was the son of a Nonconformist joiner at Wirnborne Minster, East Dorset, and was born on July 21, 1664. His father moved to London, and sent him to Westminster, where he was enabled by the earl of Dorset to continue his education after his father's death. At Westminster he made friends with Charles Montagu, afterwards earl of Halifax. It was to avoid being separated from Montagu and his brother James that Prior accepted, against his patron's wish, a scholarship recently founded at St. John's college. He took his B.A. degree in 1686, and two years later became a fellow. In collaboration with Montagu he wrote in 1687 the *City Mouse and Country Mouse,* in ridicule of Dryden's *Hind* a d *Panther*. The satire made the fortune of both authors. Montagu was promoted at once, and Prior three years later was gazetted secretary to the embassy at The Hague. After four years of this employment he was appointed one of the gentlemen of the king's bedchamber. In 1697 he was secretary to the plenipotentiaries who concluded the Peace of Ryswick, and in 1698 he was sent to Paris in attendance on the English ambassador. At this period Prior could say with good reason that "he had commonly business enough upon his hands, and was only a poet by accident." His occasional poems during this period include an elegy on Queen Mary in 1695; a satirical version of Boileau's *Ode sur le prise de Namur* (1695); some lines on William's escape from assassination in 1696; and *The Secretary.*

After his return from France Prior became under-secretary of state and succeeded Locke as a commissioner of trade. In 1701 he sat in parliament for East Grinstead. He had certainly been in William's confidence with regard to the Partition Treaty; but when Somers, Orford and Halifax were impeached for their share in it he voted on the Tory side, and immediately on Anne's accession he definitely allied himself with Harley and St. John. After the return of the Tories to power in 1710, Prior was again employed, and until Anne's death he shared in all negotiations with the French court, sometimes as secret agent, sometimes in an equivocal position as ambassador's companion, sometimes as fully accredited but very unpunctually paid ambassador. His share in negotiating the treaty of Utrecht, of which he is said to have disapproved personally, led to its popular nickname of "Matt's Peace." When the queen died and the Whigs regained power he was impeached by Sir Robert Walpole and kept in close custody for two years (1715–1717). In 1709 he had already published a collection of verse. During this imprisonment, maintaining his cheerful philosophy, he wrote his longest humorous poem, *Alma; or, The Progress of the Mind.* This, with his most ambitious work, *Solomon,* and other *Poems on several Occasions,* was published by subscription in 1718. Prior died at Wimpole, Cambridgeshire, a seat of the ear! of Oxford, on Sept. 18, 1721, and was buried in Westminster abbey, where his monument may be seen in Poet's Comer. *A History of his Own Time* was issued by J. Bancks in 1740. The book pretended to be derived from Prior's papers, but it is doubtful how far it is authentic.

BIBLIOGRAPHY.—See *The Writings of Matthew Prior,* 2 vol. (ed. A. R. Waller, 1905–07); *The Poetical Works of Matthew Prior,* 2 vol. (ed. R. B. Johnson, 1892); *Selected Poems* (ed. Austin Dobson, 1889); *The Shorter Poems of Matthew Prior* (ed. F. L. Bickley, 1923); also F. L. Bickley, *The Life of Matthew Prior* (1914); and L. G. W. Legg, *Matthew Prior: a study of his public career and correspondence* (1921).

PRIOR, a title applied generally to certain monastic superiors, but also in the middle ages to other persons in authority. Under the Roman Empire the word *prior* is found signifying "ancestor." In the early middle ages it was commonly applied to secular officials and magistrates, and it remained all through the middle ages as the title of certain officials in the Italian city states.

In the Rule of St. Benedict and other early rules the titles *praepositus* and *praelatus (see* PRELATE) are generally used, but *prior* is also found signifying in a general way the superiors and elders in a monastery; afterwards the title prior (or *claustral* prior) was restricted to the abbot's vicegerent, who was generally charged with the details of the discipline of the monastery. With the foundation of the order of Cluny in the 10th century there appeared the conventual prior, who ruled as head of a monastery. The Regular Canons, and the Carthusians and Dominicans, later gave this title of prior to the heads of their houses.

See Du Cange, *Glossarium mediae et infimae latinitatis,* new edition by L. Favre (Niort, 1883, etc.); Sir William Smith and S. Cheetham, edd. *Dictionary of Christian Antiquities* (1875–80), and the article "Prior" in the *Catholic Encyclopedia.*

PRISAGE AND BUTLERAGE, the names of ancient English customs duties which survived until the beginning of the 19th century. The oldest was a wine duty. Later it became customary to levy upon wool, woolfells and leather. This "customs" duty was known as "prisage." The earliest known prisage was levied in kind; one tun of wine being taken from every cargo of from 10 to 20 tuns, and two tuns from every cargo exceeding 20 tuns; a tun being 252 gallons. The king's man took the liberty of sampling all the wine so that the king got his tun or tuns from the best on board. Later, importers were allowed to make a money composition instead of paying in kind. Prisage was payable both by British citizens and aliens.

In the reign of Edward I., by a charter known as *Carta Mercatoria,* aliens were given liberty of trading upon paying "to Us and to our Heirs, by the name of Custom, two shillings (for every hogshead of wine) over and above the antient customs due." This duty was made payable to the king's butler, and was consequently termed "butlerage." Later, kings of England granted the produce of the duties of prisage and butlerage to certain of their subjects. In 1785 it was recommended that these duties should be re-vested in the crown. Thus, the duties of prisage and butlerage in Ireland had been granted to the dukes of Ormond, but parliament purchased those rights for nearly £200,000. In 1809 the duties were abolished by the Customs Consolidation Act of that year.

PRISCIAN [PRISCIANUS CAESARIENSIS], the celebrated Latin grammarian, lived about A.D. 500. This is shown by the facts that he addressed to Anastasius, emperor of the East (491–518), a laudatory poem, and that the mss. of his *Institutiones grammaticae* contain a subscription to the effect that the work was copied (526, 527) by Flavius Theodorus, a clerk in the imperial secretariat. His title *Caesariensis* points, according to Niebuhr and others, to Caesarea in Mauretania. Priscian was quoted by several writers in Britain of the 8th century—Aldhelm, Bede, Alcuin—and was abridged or largely used in the next century by Hrabanus Maurus of Fulda and Servatus Lupus of Ferrières. There is hardly a library in Europe that did not and does not contain a copy of his great work, and there are about a thousand mss. of it. The greater part of these contain only books i.–xvi. (sometimes called, *Priscianus major)*; a few contain (with the three books *Ad Symmachum*) books xvii., xviii. *(Priscianus minor)*; and a few contain both parts. The earliest mss. are of the 9th century, though a few fragments are somewhat earlier. All are ultimately derived from the copy made by Theodorus. The first printed edition was in 1470 at Venice.

The *Institutiones grammaticae* is a systematic exposition of Latin grammar. It is divided into 18 books, of which the first 16 deal mainly with sounds, word-formation and inflexions; the last two, which form from a fourth to a third of the whole work, deal with syntax. He has preserved to us numerous fragments which would otherwise have been lost, *e.g.,* from Ennius, Pacuvius, Accius, Lucilius, Cato and Varro.

Priscian's three short treatises dedicated to Symmachus are on weights and measures, the metres of Terence, and some rhetorical elements (exercises translated from the Προγυμνάσματα of Hermogenes). He also wrote *De nomine, pronomine, et verbo* (an abridgment of part of his *Institutiones),* and an interesting specimen of the school teaching of grammar in the shape of complete parsing by question and answer of the first 12 lines of the *Aeneid (Partitiones xii. versuum Aeneidos principalium).* He also wrote two poems, not in any way remarkable, a panegyric on Anastasius and a translation of Dionysius's *Periegesis.*

The best edition of the grammatical works is by Hertz and Keil, in Keil's *Grammatici latini,* vols. ii., iii.; poems in E. Bahrens' *Poetae latini minores,* the "Periegesis" also, in C. W. Müller, *Geographi graeci minores,* vol. ii. *See* J. E. Sandys, *History of Classical Scholarship* (1908), vol. i.; and A. Luscher, *De Prisciani studiis Graecis* (Breslau, 1912).

PRISCILLIAN (d. 385), Spanish theologian and the founder of a party which, in spite of severe persecution for heresy, persisted in Spain and in Gaul until after the middle, of the sixth century. He was a student of the occult sciences and of philosophy. He was a mystic, and regarded the Christian life as continual intercourse with God. He argued that to make himself a fit "temple of God," a man must, besides holding the Catholic faith and doing works of love, renounce marriage and earthly honour, and practise asceticism. On the question of continence in, if not renunciation of, marriage, he came into conflict with the authorities. Priscillian and his sympathizers, who were organized into bands of *spiritales* and *abstinentes,* like the Cathari of later days, refused the compromise which by this time the Church had established. *(See* MARRIAGE: *Canon Law.)* This explains the charge of Manichaeism levelled against Priscillian and to this was added the accusation of magic and licentious orgies. Priscillian's friends included two bishops, Instantius and Salvianus, and Hyginus of Cordova; but, through the exertions of Idacius of Emerita, the leading Priscillianists, who had failed to appear before the synod of Spanish and Aquitanian bishops to which they had been summoned, were excommunicated at Saragossa in October 380.

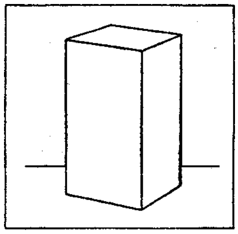
Meanwhile, however, Priscillian was made bishop of Avila, and the orthodox party appealed to the emperor (Gratian), who issued an edict (afterwards withdrawn) threatening the sectarian leaders with banishment. On the murder of Gratian and accession of Maximus (383) Idacius fled to Treves, and secured the summoning of a synod (384) at Bordeaux, where Instantius was deposed. Priscillian appealed to the emperor, with the unexpected result that with six of his companions he was burned alive at Treves in 385.

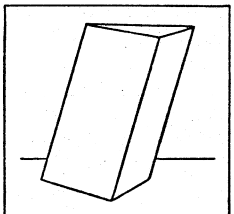
The heresy, notwithstanding severe repressive measures continued to spread in France as well as in Spain. As an openly professed creed it only disappeared after the second synod of Braga in 563.

At the Council of Toledo in 400, fifteen years after Priscillian's death, when his case was reviewed, the most serious charge that could be brought was the error of language involved in rendering ἀγένητος by innascibilis. It was long thought that all the writings of the "heretic" himself had perished, but in 1885, G. Schepss discovered at Würzburg eleven genuine tracts, since published in the Vienna Corpus. "They contain nothing that is not orthodox and commonplace, nothing that Jerome might not have written."

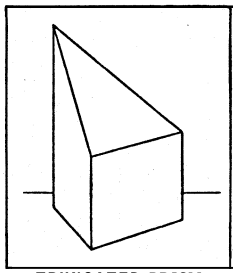
See E. Ch. Babut, Priscillian et le *Priscillianisme* (Paris, 1909).

PRISM, in geometry, a polyhedron having two of its faces, known as bases, congruent (identically equal) polygons in parallel planes, and the other faces parallelograms equal in number to the sides of the bases. The faces, excluding each base, are called the lateral faces, and the intersections of these faces are called the lateral edges, being all equal. The perpendicular distance between the planes of the bases is called the height or altitude of the prism. If the lateral edges are perpendicular to the planes of the bases, the prism is called a right *prism;* if they are oblique to these planes, it is called an oblique prism. Prisms are said to be triangular, quadrangular, pentagonal, and so on according as their bases are triangles, quadrilaterals, pentagons, and so on. A prism having parallelograms for its bases is called a *parallelepiped.* If the bases and lateral faces are all rectangles, it is called a rectangular *parallelepiped.* The part of a prism included between the base and a section made by a plane oblique to the base is called a truncated prism. A geometric solid which has for its bases two polygons in parallel planes, and for its lateral faces triangles or trapezia (Amer., trapezoids) with one side in one base and the opposite vertex or side in the other base is called a prismoid, a prism being a special case. In optics the word denotes a triangular prism. The volume of a prism of base B and altitude a is aB; of a prismoid with bases B and B', altitude a and area of a mid-cross-section M, is $\frac{1}{6}a(B+B'+4M)$. See CRYSTALLOGRAPHY, REFRACTION, LIGHT and SOLIDS (Geometric).





OBLIQUE TRIANGULAR PRISM



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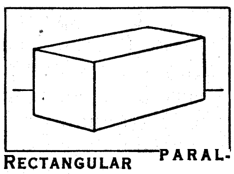


RECTANGULAR PARALLELEPIPED

PRISMOID, a solid bounded by any number of planes, two of which are parallel and contain all the vertices. The two parallel faces are called the bases. The volume V of such a solid was found by Thomas Simpson (1710–1761) as follows: Let M be a section made by a plane parallel to the bases B and B' and midway between them, and let h be the distance between the bases. Then $V=\frac{1}{6}h(B+B'+4M)$, a formula frequently used in finding volumes and applicable to most of the elementary geometric solids, and in general to any solid bounded by a ruled surface and two parallel planes.

PRISON. Only in comparatively recent times has the word "prison" come to denote the common penalty for acts hurtful to the community both grave and petty which the law forbids. In the old Roman law, *carcer* or prison was used only as the place for holding, not for punishing offenders.

The keep or dungeon of the lord's castle was usually the place of detention pending the payment of the fine or the execution of the sentence. Growth of population and the consequent increase in the number of offenders made it necessary to make special provision for their care; in 1166, the Assize of Clarendon directed the building of gaols in all counties and boroughs. While these gaols were for the most part under local authority, the king's courts at Westminster had, from time immemorial, maintained their own prisons of the king's bench, Marshalsea and the Fleet, almost entirely for debtors and others confined as a result of civil process or for contempt of court. By the middle of the 16th century the common gaol was supplemented by the workhouse or house of correction, established by virtue of an act of 1576 under the direct administration of the local justices of the peace. Modelled on the famous "Bridewell" (*q.v.*) organized in London in 1552, these institutions were commonly called by that name. Instituted for the humanitarian purpose of providing compulsory employment with pay for "sturdy beggars" and vagrants and for men and women thrown out of employment by depressed trade conditions, these houses of correction came to be employed more and more for the incarceration of petty offenders. This change was officially confirmed in 1720 by an act of Parliament.

Prison systems, in the sense they are understood to-day, cannot be said to have come into existence in any country till towards the end of the 18th century, though isolated experiments had been made in different parts of Europe, *e.g.,* in 1593 the protestants of Amsterdam built a prison for women, having for its object their moral reform by work and religious influences. There are records of similar establishments in Germany and Hanseatic towns. In 1703, Clement XI. built the famous prison St. Michel, at Rome, for young prisoners, and later on in the century the celebrated prison at Ghent was built.

In England it was not till 1729 that a report of a committee of the House of Commons brought to light the hideous cruelties practised in the Fleet and Marshalsea prisons. In the reign of Elizabeth (1561) these were the prisons of the Star Chamber and court of chancery respectively, and the office of warden was granted as a valuable bequest, or perquisite to be held through life. In course of time the reversion of this office was sold by auction to the highest bidder. Fees for safe custody were levied on the prisoners and were exacted by all forms of cruelty and oppression, until at last the scandal became so great that certain holders of this reversionary office were brought to trial for murder and cruel treatment.

As a result of the disclosures then made an act was passed (2 George II., 1729) but in spite of its enactment the system of payment by fees continued and no serious attempt was made to control the management, and it was not until fifty years later, that John Howard (*q.v.*), the sheriff of Bedfordshire, horrified by the conditions that he found to exist in his own county, entered upon his great crusade at home and abroad, to expose the terrible misery to which prisoners were made subject in England and foreign countries. The sudden stirring of the country's conscience by Howard's crusade was the dawn of prison reform, which at first with slow and halting steps developed into the great humanitarian movement of the present day.

In 1774 Howard received the thanks of the House of Commons and a Prison Act which was passed in 1778 is the beginning of the English prison system. The principle of separate confinement with labour and of moral and religious instruction was formally prescribed as a condition of imprisonment. It 1781 a further act was passed, making it compulsory for justices to provide separate accommodation for all persons convicted of felony.

It is difficult to say now, whether the formal adoption by Parliament of the "separate plan" at this date, anticipating by many years its world-wide adoption under American influences, would have taken place, but for the political necessity which arose for keeping British prisoners at home. The loss of the American colonies had closed the field for the deportation of the criminal classes—a policy of riddance easy of execution, which for a long time past had prevented serious consideration of the problem involved in the safe custody in English prisons of dangerous persons convicted of the more serious crimes; but the disclosures made as to the condition of treatment of all classes committed to local gaols, even those awaiting trial, and debtors, and young persons of both sexes, rendered it imperative that some formal prescription should be asserted by the Government.

But the principle, though laid down by statute, was not enforced, with a few notable exceptions. The justices, who then controlled the prisons of the country, paid small attention; but the justices of Sussex and Gloucester by building the local prisons of Horsham, Petworth and Gloucester on the "separate" plan furnish an interesting historical record of the formal adoption in this country of the new system, which was destined, though many years later, to become the sine quâ non of all civilized prison systems.

Although historically the British prison system may be said to date from the Prison Act of 1778, a long dismal history of ill-considered administration was destined to intervene before the principles of penal science, as now understood, obtained concrete expression. It is probable that the re-discovery of Australia by Captain Cook in 1770 was the circumstance which determined the prison history of Britain for nearly 50 years. The easy methods and means of transportation which this great colony afforded, relieved parliament of the necessity of devising any new and wise methods for the punishment of crime at home.

Early 19th Century Conditions.—The system instituted in 1788 for the transportation of offenders was regularly organized and extensively acted upon up to 1840. It could not, however, survive the condemnation of the parliamentary inquiry of 1837. It was denounced as being "unequal, without terror to the criminal class, corrupting to both convicts and colonists, and extravagant from the point of view of expense." This condemnation of the colonial system followed closely on another inquiry of the previous year into the hulks or "floating prisons" which had served to some extent as an alternative to transportation. These also were condemned.

In the meantime, in the early years of the 19th century, the declaration of parliament in favour of the "separate" or cellular system, had not been entirely lost sight of, and the best known plan is associated with the name of Jeremy Bentham. Previous to this, following on the Declaration of the Rights of Man in 1789, "imprisonment" had been formally installed, largely under the influence of Mirabeau, as the method for the expiation of an offence against the law in the French code of 1791.

Bentham's scheme known as the "panopticon" was based on cellular separation and hard labour, safe custody and diligence being guaranteed by close observation from a central standpoint. Although his professed desire to "grind rogues honest" has become proverbial, it was also a part of his plan to educate and classify and to make provision for discharge. He also laid great stress on the necessity of preventing crime by discovering and combating its causes. In this respect he was the founder of the modern school of "prevention." His writings exercised a considerable influence in France, where the jurists were busy preparing the penal code of the First Empire, and in Great Britain led indirectly to the purchase of lands by the Government for the erection of Millbank penitentiary, begun in 1813 and completed 1823. This was an important step forward, for though built for convicts only, it marked the acceptance by parliament of the principle that the reformation of prisoners could best be'secured by seclusion, employment and instruction.

To this end were labouring through these years a band of earnest and devoted workers, the "Prison Discipline Society," on whom the mantle of Howard had fallen, and who were determined that his work for the cleansing and purifying of gaols and houses of correction should not perish. These gaols were described by this society in 1812 "as relapsing into their former horrid state of privation, filthiness, cruelty and neglect." In London itself within easy reach of the new and much vaunted Millbank penitentiary, the chief prison of the City, Newgate, was in a disgraceful state. It was here that Elizabeth Fry entered upon her noble work. By her amazing courage and personality she transformed what was formerly described as a "hell above ground" to a scene, where in words of an eye witness "perfect stillness and propriety reigned." Her great success and example gave a stimulus to the movement of prison reform both at home and abroad. The Prison Discipline Society redoubled its efforts in the face of considerable criticism and opposition, for in those days, as sometimes now, the assertion of ordinary principles of humanity in dealing with captives and prisoners was sneered at as false sentiment.

At last, in the early years of George IV. (1823–24) a prison act was passed for all local gaols with the object over and above safe custody, of preserving health, improving morality and enforcing hard labour, and there was a curious provision that if each prisoner could not have a separate cell, he should at least have a separate bed. That such a provision should have been necessary only one hundred years ago, illustrates the advance in public sentiment and opinion since that date.

This particular act marked an advance, though its provisions were largely ineffective, owing to the reluctance of the local authorities to re-build or enlarge their gaols: and there was another reason. By the misconception of the teachings of Howard and of the Discipline society, it was a common belief that the secret of good prison discipline lay in "classification," which was deemed even more important than "separation." It was believed and very erroneously, that if priscners in the same categories, and therefore presumably of the same characters, were associated together in common rooms or dormitories, no evil results were likely to follow. Both Howard and Bentham were quoted as evidence in favour of classification as a means of facilitating labour. Many prisons were erected in conformity with the act—Maidstone, Derby, Westminster, Chelmsford and Leicester. The Governor's house was usually placed in the centre with blocks of cells radiating from it, the only inspection coming from a central office, according to Bentham's plan, and there was practically no interference with the unauthorised association of prisoners, according to the categories in which they were placed. It became more and more evident that there was no moral standard, by which "classification" could be regulated as a basis of prison discipline, and the reaction culminated in a system of almost solitary confinement.

Cellular Confinement.—It came about in this way. In 1831 a parliamentary committee went into the whole question, and advised that owing to the administrative difficulties of a good system of classification, all prisoners should be confined in separate cells and all prisons should be constructed accordingly.

America was at this time declaring that it had found the key to the solution of the great problem of all prison systems, which is that they shall be at once deterrent and reformatory, by the invention of the plan of strict cellular confinement by day and night in Philadelphia,—by night only in the rival system at Auburn in the State of New York, labour being in association by day, but under a strict rule of silence. The rival systems of Philadelphia and Auburn are the historic battle ground, concerning the comparative merits of the cellular and associated plans of imprisonment. The controversy excited great interest in England, France, Germany. Belgium. All these countries sent delegates to study the rival systems on the spot. They all travelled together through the United States: de Beaumont and de Tocqueville from France, Ducepetiaux from Belgium, Mittermeyer from Prussia, Crawford from England. The result was a strong endorsement of the principle of separate cellular confinement for all prisoners by day and night. In England the then home secretary (Lord John Russell) issued a circular to magistrates, calling attention to its advantages, and in 1839 an Act was passed, which, though permissive only, established the legality of the system; but the magistrates were at a loss how to proceed as the construction of existing prisons gave no facilities for the purpose.

Lord John Russell, then determined on the erection of a "model" prison, as an example of cellular construction and as a test of the merits of the separate or cellular plan. It was completed at Pentonville in 1842. The *corpus* on which this experiment was made, was first offenders between 18–3j sentenced to transportation. The period of isolation was for eighteen months and the separation was complete, even masks being worn to avoid recognition.

Five years later, the commissioners appointed to direct and observe the experiment gave, as their deliberate opinion, that "the separation of one prisoner frdm another was the only sound basis upon which a reformatory discipline could be established with any reasonable hope of success."

The effect on public opinion was immediate and striking—not only did the Pentonville plan become the basis of "penal servitude" then under the control of the Government, but it led directly to the establishment of the separate system throughout the country. For, though the secretary of State did not then directly control local prisons, recent legislation had provided that all rules should be subject to his approval, and the appointment of a surveyor-general of prisons in 1844 ensured that due attention was given by local authorities to the requirements of good prison construction.

Pentonville prison was built by Sir Joshua Jebb, the first surveyor-general. His report on its construction, "as a model to be appropriated for carrying into effect the separate system of discipline," was aptly designated as the model for the remainder of the 19th century, and the essential features of construction are still adhered to. Sir Joshua Jebb was succeeded by another eminent engineer, Sir Edmund Du Cane, R E. His largest undertaking was the construction of Wormwood Scrubbs prison for convicts by prison labour. The plan is what is known as the "separate block" system, and was adopted as an improvement on the "radial" or Pentonville plan, though many of the essential features of the latter were retained, *e.g.,* heating, ventilation, sanitation and size of cells. When the central authority took over control of all local prisons in 1878, the main building work consisted chiefly of alterations and additions, but these in many instances amounted to almost entire re-construction. Since then, the main building work has consisted of bringing old establishments up to date.

In addition great skill and ingenuity has been expended of recent years in the conversion of existing establishments into Borstal institutions, *e.g.,* the old convict prisons at Borstal and Portland, and the old reformatory school buildings at Feltham, Middlesex. All this work has been carried out under the direction of another able engineer, Colonel Rogers, R.E. who also designed the new prison at Camp hill, in the Isle of Wight, for the purpose of providing detention under the special conditions prescribed for habitual criminals under the Prevention of Crime Act, 1908.

But to revert to the history of the separate system, where we left it with the building of the model prison at Pentonville.

The English System.—It was at this period that the two principal features of the English system began to take shape, viz.: separate confinement and hard labour. The duration of the period of separate confinement and the regulation of the task of hard labour remained the problem of administration for many years and cannot yet be said to be finally settled. There will be found running through all this period an earnest attempt to reconcile the claims of the two admitted objects of imprisonment, viz.: deterrence and reform, and hard labour assumed a narrow and artificial meaning, great ingenuity being expended in devising forms of labour, which would not violate the sacred principle of separation, *e.g.,* cranks, treadwheel, shot-drill, stone-breaking, etc.

With these problems unsettled, with a strange and general ignorance of the true principles of punishments, with conflicting views and diverse authorities, the local prison system was in a very confused and chaotic state, until the parliamentary inquiries of 1850 and 1863 led formally to the establishment of a central authority in 1878, when the Government took complete control of all prisons, convict and local. In that year the prison commission was appointed.

It was the refusal of the colonies to become the dumping ground of transported convicts which led in 1857 to the introduction of the system of "penal servitude." Henceforth convicts were to be kept at home under a special form of discipline in what were known as "public work prisons," where opportunity existed for their employment on works of public utility, *e.g.,* the breakwater at Portland, docks at Chatham and Portsmouth, land reclamation at Dartmoor. The leading feature of the new convict discipline was the progressive stage system, borrowed from experience gained in the management of convicts in the Australian settlements. The rules prescribed a period of nine months' separate confinement, the remaining sentence being divided into three stages. Under the operation of the "mark" system, a considerable remission of sentence could be earned, not exceeding one fourth of the sentence imposed.

This system remains in its leading features the same to-day with many modifications, *e.g.,* the period of separate confinement and the increase of relaxations, and rewards in the differentstages. The opportunity for employment on public works no longer exists, and the comparatively few persons now sentenced to penal servitude would not provide a sufficient contingent of labour for the great operations carried on in former years. The fall in the convict population between 1854 and 1874 was from 15,000 to 9,000. Since then, the number of male convicts had fallen to 1,430 in 1926.

The introduction of the penal servitude system had a far-reaching influence and reaction on the local prison system and this was intensified when Sir E. Du Cane became chairman of the joint boards of directors of convicts, and commissioners of local prisons, in 1878. The State until now had had no experience in dealing with short sentences, and the problem was a new one, viz.: how to deal effectively with a man who was in prison for a few days or weeks or months, from whom during so short a period no useful productive labour could be exacted. Many of the features of the penal servitude system were introduced—the "mark" and progressive stage system, cellular confinement in the early stages, followed by associated industry so far as was practicable in the confined spaces of local prisons, built on the cellular plan. The new system was, however, justly credited with great administrative and financial success. But in spite of an admitted administrative success, the public conscience was uneasy. It was felt that too much had been sacrificed to the virtues of the separate system, to the passion for uniformity and that the "individuality" of the prisoner had been lost sight of and crushed under inflexible rule.

Modern Theories.—The re-action that became manifest towards the close of the last century against what is known as the "classical" conception of crime and punishments had an echo in England. This re-action came in the early 'eighties from a school of criminologists, known as the "Italian school," of which the chief was Lombroso. Theories of the "born criminal," *i.e.,* a human being foredoomed to crime by atavistic propensity, and distinguishable physical stigmata, created considerable sensation at the time and, though refuted by later enquiry, exercised a profound influence in Europe and gave a direct impulse to the scientific study of the causes predisposing to criminal acts. At this time, 1869, was founded on the continent of Europe "l'Union internationale de droit pénal"—chiefly under Belgian and German influences (Van Hamel, Liszt and Prins). It was an attempt to reconcile the extreme views of the Italian school with the modern doctrine which is known as "preventive treatment," *i.e.,* the scientific study of the causes of crime in each individual case, be they due to internal or external factors, either physiological, concerned with the mental or physical state of the offender, or external, *i.e.,* the result of social conditions.

This theory, which has been strongly endorsed by eminent French writers (*e.g.,* Saleilles), is known generally as that of *The individualisation of punishment.* Imprisonment, the one and only instrument for the punishment of crime, is flouted as an anachronism. In other words it is a protest in the general interests of humanity against the mechanical infliction of penalty with the resulting evil of a constant repetition of short sentences. Strangely enough, these controversies received but little attention in England, but their influence contributed to the criticisms made at the end of the century, against the English prison system.

A formal enquiry instituted by the Government in 1894 marks a new and distinct epoch in the prison history of Great Britain. It declared (a grave indictment) that "prisoners had been treated too much as a hopeless element of the community." These words may be said to mark the passage from the old to the new methods of punishment.

Among many and almost fundamental changes which were suggested, dealing with almost every branch of the administration, the principal was the grave importance attracted to the concentration of effort on the young or incipient criminal. At this time persons under 16 (even under 12) were being sent to prison in considerable numbers and the average number of youths 16–21 committed annually to prison was about 20,000.

At the same time, it was suggested that as a means of dealing effectively with crime in its later stages, technically known as "professional" crime, *i.e.,* with persons living systematically by crime and whom experience had shown not to be restrained by the fear of ordinary punishments, a new sentence should be placed at the disposal of judges, which supplementary to a sentence of penal servitude, might have a deterring or at least a protective effect.

At this time, 1890, on the retirement of Sir E. Du Cane, Sir E. Ruggles Brise succeeded as chairman of the prison commission. The following are the principal statutes which have altered the system since this date.

(1) **The Prison Act,** 1898.—The most notable changes introduced by this act are: (a) The triple division of prisoners according to degree and character of offence. (b) The power to earn remission of sentence. not exceeding one-sixth where the sentence is over a. month. (c) The power given to enable a prisoner whose sentence is in default of fine to obtain release by part-payment of the fine. (d) Provision against excessive or unnecessary exercise of the powers of corporal punishment. (e) Power given to secretary of State to effect any change in the system by parliamentary rule, without recourse to act of parliament. (f) The abolition of all forms of so-called hard labour, treadwheels, cranks, etc.

(2) **The Prevention of Crime Act,** 1908.—This act achieved two great and startling results. (a) The establishment of the Borstal system. (b) The system of preventive detention as a means of protecting society from the dangerous or habitual criminal.

These were the two objects on which special stress was laid by the inquiry of 1894, and since that date great and special attention has been given to effect the double purpose, viz.:—to check the criminal habit or tendency in the case of the young offender, and to increase the deterrence of punishments in the case of the older criminal, who could not be restrained by ordinary and repeated sentences.

(a) The *new* "Borstal" Act created an entirely new category of offenders between the age of 16–21, to be known colloquially as "juvenile-adult" or "adolescent" offenders. For these, where the court was satisfied that "criminal habit and tendency or association was proved," power was given to order detention for any period up to three years in a State reformatory, known as a "Borstal institution," taking its name from the village of Borstal on the Medway, where the first experiments, leading up to the system, were made. The successful efforts of the official staff have been aided by the Borstal association, a society created to safeguard and protect the case of every inmate, of either sex, on discharge from a Borstal institution.

(b) Preventive Detention.—Long experience had sufficiently demonstrated that successive sentences of imprisonment or penal servitude did not deter those who made a profession of the graver forms of crime from continuing their war on society with a cynical indifference to the methods devised for its protection.

Accordingly, the act provided that it is expedient for the protection of the public that where an offender is found by the courts, having regard to the numbers and characters of his previous convictions and sentences, to be an "habitual criminal," the court shall have power to pass a special sentence, ordering that on the determination of a sentence of penal servitude, passed for the particular offence, he may be detained for a period not exceeding ten, nor less than fire years under a system to be known as that of "preventive detention."

A new prison was constructed at Camp hill in the Isle of Wight, specially adapted to the custody and treatment of this new class of prisoner, for whom in conformity with the act, a novel system was devised, being less rigorous than penal servitude, and being based on the idea that by encouragement and hope and a progressive system of rewards, leading ultimately to conditional release, even a hardened criminal might be gradually induced to alter his mode of life and reinstate himself as an honest and industrious citizen.

At least, though the reforniatory results have been fitful and uncertain, there is reason to believe that a great deterrent value arises from the fear inspired in the mind of the dangerous and habitual criminal, that continued violation of law may entail the very unpleasant consequence of a long period of detention, supplementary to that inflicted for the particular offence.

(3) **The Criminal Justice Administration Act, 1914.**—This very important act, passed on the eve of the World War, has had a far reaching effect in providing a remedy for the admitted evil of mechanical commitment to prison in default of paying a fine. It is there laid down, that where any prisoner desires to be allowed time for payment, not less than seven clear days shall be allowed, in the absence of good reason to the contrary; and that in any case the imprisonment shall be without hard labour. It makes a breach for the first time in the old mechanical formula "with or without hard labour" which long custom had crystallized. without due regard to the circumstances of each case by giving a discretion to the court in all cases as to the imposition of hard labour.

As a provision against the admitted evil of short sentences of imprisonment, all commitment to prison for a less period than five days, is forbidden.

The act, moreover, gave a considerable extension to the Borstal system, removing the condition that a particular offence must be "indictable," raising the minimum period of detention and extending that of supervision after release.

The Children Act, 1908, **and the Probation Act,** 1907, have been called the "handmaids of the prison system" for it is by their operation that a way has been found not only to cut off crime at the source, but to provide the alternative to unnecessary commitment to prison, where the law can be adequately vindicated by other methods.

(1) The Children Act—This act, known as the "children's charter," revolutionized the penal law of Britain by prohibiting the imprisonment (except under very exceptional circumstances) of any person under the age of 16. It classified young offenders as "children" under 14, and "young persons" between 14 and 16; and various methods for dealing with them are prescribed. In lieu of prisons, the act created "places of detention," to be established by the police authority, for any period not exceeding a month. It consolidated. and amended the law relating to reformatory and industrial schools. Special courts called juvenile courts were created for dealing with charges against children and young persons.

(2) *The* Probation Act, 1907.—This act greatly extended powers already in existence for releasing on recognizance and gave power in any case either to dismiss the case or to bind the offender over for a period not exceeding 3 years, or to place him on probation—under the care of probation officers, appointed for the purpose.

This act was supplemented in 1925 by a very important measure, making it obligatory in all petty sessional courts (over 1,000 in number) to appoint one or more probation officers.

These acts, taken in conjunction with the Mental Deficiency Act of 1913, an invaluable measure far relieving prisons of the great burden and difficulty of providing for the custody under proper conditions of a very considerable number of persons of proved mental deficiency, practically complete the legislative changes of the last 30 years, and their salutary operation, aided of course by many other social causes making for the moral betterment of the community and the raising of the general standard of life, has had an almost phenomenal result, so far as the population of prisons is concerned

Fifty years ago the number of persons sent to prison in a year stood as high as over 600 per 100,000 of population A gradual, though not unbroken fall took place until the year before the war when it stood at 370. At the time of cessation of hostilities it reached its lowest point, 70, but with the return to ncrmal conditions it has not risen higher than 120 and the iast figure for

1926 was 115.

Before the war and the passing of the act of 1914, there had been nearly 100,000 sentences annually to two weeks or less. For the year ending Dec., 1926, there were under 7,000.

International Progress.—During the last 50 years, a remarkable movement has been in progress, having for its purpose, to internationalize certain principles or standards for the treatment and punishment of crime. The movement began in 1872 by the holding of an International prison congress in London. To America belongs the credit of having organized on British soil a movement which was the precedent and example of what has since grown into a well-established confederation of all civilized states for discussing and if possible, improving, a world-system of punishment. An international commission was created, which by means of quinquennial congresses, held in the different capitals of Europe, furnished the occasion for periodical discussion and exchange of views on all matters affecting both the régime of prisons and the reform of criminal law.

Great Britain and the United States did not adhere to this movement, until the Paris congress, 1895; at the congress of Washington, 1910, Sir E. Ruggles Brise was elected president and this led to an invitation of the British Government to hold the next congress in London, which took place accordingly in 1925, having been postponed from 1915 owing to the outbreak of the World War.

The leading note was struck by the resolution of the London congress 1872, viz., that "moral regeneration should be the primary aim of prison discipline and that hope should always be a more powerful agent than fear." Although before this date, there had been spasmodic movements in many countries of Europe for the reform of prisons and prisoners, prison "systems," so far as they can be said to have existed at all, were devised mainly with a view to repression or deterrence; and what has since become the leading principle in dealing with crime, viz.: *The individualization of punishment, i.e.,* the adaptation of punishment to the different degrees of moral guilt and the infinite variety of mental and physical attributes, affecting responsibility, found only a very limited expression in the penal law and prison management of different countries.

Twenty-four countries are now (1928) annually represented on the international prison commission, viz.: Great Britain, France, Germany, Italy, Spain, Belgium, Holland, Switzerland, Greece, Sweden, Norway, Denmark, Austria, Hungary, Poland, Bulgaria and Luxemburg, Yugoslavia, Czechoslovakia and, outside Europe, the United States of America, Union of South Africa, British India and New Zealand, and Japan. The frequent opportunity for intercourse and exchange of views, afforded by periodical meetings of the commission at their central bureau, Berne, Switzerland, has been now for many years slowly creating a *solidarité* between nations, resulting in a general agreement not only as to the fundamental conditions of imprisonment, but also as to those preventive measures which obviate the necessity for imprisonment at all.

The modern school of *l'hygiène préventive* to which succeeding prison congresses give increasing voice and impetus, holds the field today. It advocates prevention which will operate by the elimination of the social causes which create unhealthy environment and by the encouragement of scientific treatment of the weak in mind or in body, so that, if possible the germs of anti-social conduct may be diagnosed, before it is too late, and if possible destroyed by appropriate handling and treatment. These are counsels of perfection, which the future may see developed into actualities.

After 2,000 years we are coming back to the old Roman definition of prison, viz.: *ad continendos, non ad puniendos.* Prison will be primarily for safe custody and there will be no penal infliction beyond deprivation of liberty, which is, after all, the only and the greatest punishment. Subject to this, every possible effort will be made by industrial training, by education, moral and religious, by lectures and debates, by well-organized visitation, to create a sense of dignity and self-respect and of duty to the State and to all fellow creatures. (E. R -Br)

UNITED STATES

The establishment of prisons in America was associated with the Revolutionary War. The centre from which this innovation spread was Philadelphia, where the humanitarian influence of the Society of Friends was strongest. The movement towards the provision of prisons also owed something to the work of Beccaria and John Howard, with which the American reformers were well acquainted. The Pennsylvania constitution of 1776 ordered legislation introducing imprisonment and this was first actually provided by an act of 1786, which substituted for corporal punishment in case of certain crimes "continuous hard labour, publicly and disgracefully imposed."

The early history of American prisons centres chiefly in the struggle between the Pennsylvania and Auburn systems of prison discipline. The former, introduced in the Walnut street jail at Philadelphia in 1790 and applied in the Eastern penitentiary at Cherry Hill in Philadelphia from 1829 onward, soon followed in other States. It rested upon the principle of solitary confinement during the period of imprisonment, hoping that solitude would not only prevent vicious and degrading association with other criminals, but also promote earnest Christian reflection productive of efforts at self-reformation. The records show that it produced more insanity than reformation. The State penitentiary in Auburn, N.Y., established between 1816 and 1824, provided for separate confinement at night in small cells, but allowed congregate labour in the prison shops during the day and meals in common. Silence was enforced while the prisoners were congregated so that the Auburn system became known as the "silent" system, as contrasted with the Pennsylvania or "solitary" system. A prison on the Auburn plan was recommended as more economical to erect and administer. Due mainly to the efforts of Louis Dwight of the *Prison Discipline Society of Boston,* the Auburn system prevailed in the United States. The Pennsylvania system was experimented with briefly in Maryland, Massachusetts, Maine, New Jersey, Rhode Island, Virginia, as well as Pennsylvania; in Europe, however, it was much more highly esteemed than the Auburn plan.

The reformatory in Elmira, N.Y., in 1877 embodied most of the progress in penological thought and practice in Europe and America between 1825 and 1875, including, among other things, emphasis upon reformation, commutation of sentence for good behaviour, a system of grading, classification and promotion of inmates, a quasi-indeterminate sentence, and the provision of productive labour. The Elmira system was utilized for youthful first offenders guilty of the lesser felonies, and has not been extended to prisons for adults, except for the grading system. The inmates of the Elmira type of reformatories have usually been between the ages of 16 and 25.

The most notable innovation in prison discipline is found in the work of Thomas Mott Osborne, Auburn, N.Y. Undergoing voluntary servitude in the Auburn prison in 1913, he became convinced that no extensive reformation was possible in connection with the system of ruthless repression and corrupt politics which characterize the conventional prison administration. He saw that a convicted criminal could be taught habits of obedience and respect for order only while in prison, whereas the present prison system was designed to increase the anti-social tendencies of the convict. Accordingly, he introduced at the New York State prison at Sing Sing a system of convict self-government known as the "mutual welfare league." This aroused the bitter opposition of the exponents of harsh punishment and of the corrupt politicians and contractors, but it proved remarkably successful when applied by Mr. Osborne at Sing Sing and later at the U.S. naval prison at Portsmouth, N.H. The plan discards punishment and concentrates upon the objective of reformation.

A major phase of the progress of prison administration since 1800 has been the gradual differentiation of institutions according to the type of prisoner to be received. In 1790, in an institution like the Walnut street jail in Philadelphia, the same institution housed debtors, those accused of crime, those convicted of all types of crime, young and old, male and female, white, black and red, sane and insane. During the last century imprisonment for debt has been abandoned; those convicted of serious crimes are separated, though, pending trial, they are still housed with vagrants and others consigned to the county jail; separate institutions have been provided for the young, the youthful and adults; males and females are housed in separate institutions or in separate departments; in some States the races are segregated; and to an increasing extent the insane. Those convicted of misdemeanors and lesser felonies are sent to jails, houses of correction or reformatories, while those convicted of the more serious felonies are sent to State penitentiaries.

Prison labour has undergone many changes. It was first employed as a means of increasing the severity of punishment; from about 1830 to 1880 the chief emphasis was laid upon the economic aspects; in the last generation more concern has been shown with regard to teaching a useful trade and making prison industry an aid in reformation. At the outset the prison industries were conducted by the prison authorities; after about 1830 the labour of convicts was very generally sold to contractors subject to the disciplinary rules of the institution, About 1870 the labour leaders began a wide movement of protest against contract convict labour and restrictive legislation was passed in many States. Since 1880 there has been a gradual trend towards institutional control of all prison industries under either the public account or the State-use system. The start was made with crude work, like breaking stone and picking over wool and oakum. In the contract régime textile industries, tailoring, boot and shoe making, the manufacture of crude furniture and hardware, and making of cheap cigars were the common industries. Where the State-use system is employed the prison industries are devoted chiefly to manufacturing the clothing, furniture and hardware used in the State institutions and the registration plates used on automobiles. Many States have purchased large prison farms and carry on extensive agricultural enterprises; convict labour is also used on State and county highways. The attempt to provide types of labour which will train inmates for an improved economic status after discharge is still in its infancy

Prison architecture has made little progress. Leaving aside the archaic plumbing of that period, the Eastern penitentiary opened in Philadelphia in 1829 was the most spacious and habitable institution ever utilized for the detention of adult felons in the United States. The first prisons were composed of large rooms where congregate imprisonment was practised. After 1800 the trend was distinctly towards the cellular system. The Pennsylvania type of prison was constructed with a central corridor running down each wing, with cells opening off both sides of the corridor. The Auburn type of prison was constructed in the form of a cell-block of several storeys or tiers of steel and stone or brick cages. Practically all the modem American prisons are merely refinements of this original Auburn cage construction, the improvements being chiefly ingenious devices for opening and closing all the doors of an entire tier of cages with one motion. Illinois recently constructed a great new prison at Joliet on the circular plan, the cells opening on a large central space which makes the inspection of the cells relatively easy; it is but an adoption of the "panopticon" scheme proposed by Jeremy Bentham more than a century ago. Some of the institutions for juvenile delinquents have adopted the "cottage" system, first introduced from Mettray in France about 1855, but it has never been adopted for adult criminals. Almost without exception the American prisons are still surrounded by walls higher and thicker than those which protected ancient cities or mediaeval castles.

Imprisonment when introduced was both punitive and reformatory, designed to produce a mode of life markedly different from that led outside in the state of freedom; otherwise imprisonment would scarcely be punitive and painful. Mr. Osborne's plan was a humane effort to make the prison a school for social re-education. The more advanced criminologists would reconstruct prisons, making them hospitals for the socially sick or delinquent classes putting them under medical supervision comparable to the State hospitals for the insane. The prisons of the United States are to-day (1929) substantially what they were in 1830, as regards both architecture and disciplinary methods. There have been some improvements in construction and sanitation, but the old punitive system remains almost unimpaired, and any attempt to improve or mitigate it is attacked by the conservative judges and lawyers as a sentimental effort to coddle prisoners. Contemporary prison discipline is not supported by criminologists, and in time the system will change before the advance of knowledge. In October, 1933, Alcatraz Island in San Francisco Bay was assigned by the Federal authorities for use as a prison. There is accommodation for about 600 prisoners. (H. E. BAR.)

EUROPEAN COUNTRIES

A new chapter in the development of the prison régime has been opened in many countries in the years following 1918. There is on the European continent a certain movement away from the strict cellular system, where prisoners are separated entirely and all the time from one another, to a system of progressive stages, similar to the system in use in English prisons.

Austria.—Longer terms of punishment are undergone in different grades. The governor decides in his free discretion whether a prisoner is worthy to enter the next higher grade or not. There is no earning "marks." Only a small proportion of the prisoners is held in strict isolation; the bulk live and labour together. Prisoners of the highest grade are often occupied with work outside the prison, such as road building and farm work.

Belgium.—For decades the stronghold of the strictest cellular system, Belgium has recently acceded to some partial alterations. Prisoners, who are fit, still serve generally the first ten years of their sentence in strict isolation; but 10% of the prison population are working together. The "hood," meant to prevent the prisoners from seeing one another's face, is no longer compulsory. In one of the prisons part of the individual exercise yards has been pulled down. Remarkable efforts are made to individualize punishment. Nine anthropological laboratories have been created. There the offender is given a thorough physical and psychical analysis. The result is used to adapt the prison treatment as far as possible to the special need of the individual.

France.—Imprisonment up to 1 year is undergone in isolation as far as prison buildings permit. Longer sentences are served in common during day time, but separation during the night is aimed at. Recidivists and criminals sentenced to severe punishment are liable to transportation into the penal colonies.

Germany.—An agreement in 1923 between the different states of the German Republic has been animportant step towards entire unification of the prison system which is not reached yet. Germany has adopted the progressive system. Complete isolation is limited to 3 years. Prisoners convicted for mere political crimes, not arising from dishonorable motives, are to be kept in separate places of detention. There they enjoy practically every possible liberty and privilege.

Greece.—Greece has made considerable attempts in the period since the World War to develop a system of out-door labour for trustworthy prisoners, regardless of the length of the sentence to be served. Besides a few movable prison camps there were in 1928 four farm prisons. The moral influence of farming, road building and forest work on the prisoner is highly commended by the Government.

Holland.—Prisoners are kept in cellular separation for a period of not more than 5 years. There is a careful elimination of criminals who are for one reason or another unfit for the cellular régime. Corporal punishment for disciplinary purposes is provided but never used.

Italy.—Italy has a progressive system which starts with isolation of the prisoner for the first part of his sentence. He is compelled to earn a certain amount of "marks" in order to advance from one grade to the next one. In certain cases an intermediate prison with a sort of semi-liberty has to be passed through before final liberation. Irons are still in use as a disciplinary punishment.

Poland.—The prison regime was reformed basically in 1928. A progressive system, following the English example, is now in use. Strict cellular separation does not exist at all. A list of stimulating privileges, lectures and wireless performances of educational value are introduced to assist reformation.

Russia.—Attempts have been made in Russia to change the whole system of punishment into one of reformation and social protection. Even the name "punishment" has been eliminated. Prisons are gradually replaced by penal colonies where life in a free community is copied as far as possible. Prisoners in higher grades get a vacation of one or two weeks a year. Farmers who are imprisoned are able to get harvest leave up to 4 months. Political prisoners, on the other hand, are subject to a different, more severe, prison régime.

Sweden.—The penal system was reformed in 1921. A progressive system starts with cellular separation up to the first 3 years. A bigger cell for work besides the sleeping-cell is provided in many cases for prisoners in isolation. There are a few penal farms intended to be a link between prison and liberty for the promising prisoner. Three to four prisoners may sleep in one room in these farms. Corporal punishment is provided but strictly guarded against abuse.

Switzerland.—The different small cantons still rule the prison system, and there is as yet no unification. But there is a movement towards the development of farm-prisons following the example of the famous farm-prison at Witzwil in the canton of Berne. (E. M. F.)

BIBLIOGRAPHY.—J Howard, *State of the Prisons in England and Wales* (2 pts., 1777); J. Bentham, *Letter to Lord Pelham* (1802); B. C. Thomson, *Story of Dartmoor Prison* (1907); R. Saleilles, *The Individualisation of Punishment,* trans. R. S. Jastrow (1911); G. Ives, *History of Penal Methods* (1914); C. Goring, *The English Convict* (1915); E. Ruggles-Brise, *English Prison System* (1921) and *Prison Reform at Home and Abroad* (1924); S. A. Mosely, *The Convict of To-day* (1927); T. W. Trought, *Probation in Europe* (1927); Sidney and Beatrice Webb, *English Prisons Under Local Government* (1922); S. Hobhouse and A. F. Brockway, *English Prisons To-day* (1922). *See* also *The Annual Report of the Commissioners of Prisons* and the *Journal* and *Annual Report* of the Howard League. *See* bibliographies of HOWARD; LOMBROSO.

UNITED STATES.—T. M. Osborne, *Society and Prisons* (1916), *Prisons and Commonsense* (1924); H. E. Barnes, *A History of Penal, Reformatory and Correctional Institutions of the State of New Jersey* 1918), *The Repression of Crime* (1926), *The Evolution of Penology in Pennsylvania* (1927); F. H. Wines, *Punishment and Reformation* (new ed. W. D. Lane, 1919); P. Klein, *Prison Methods in New York* (1920); L. N. Robinson, *Penology in the United States* (1921); O. F. Lewis, *The Development of American Prisons and Customs, 1776–1845* (1922); F. Tannenbaum, *Wall Shadows* (1922); E. H. Sutherland, *Criminology* (1924); M. Liepmann, "American Prisons and Reformatory Institutions," in *Mental Hygiene* (1928).

EUROPEAN.—Armingol y Cornet, *Prisons and Prison Discipline in Spain* (1874); Stevens, *Régime des établissements pe'nitentiaires en Belgique* (1875); F. V. Holtzendorff and von Jagemann, *Handbuch des Gefängniswesens* (1877); Scaglia Beltrani, *Reforma penitenzaria in Italia* (1879); Braco, *Estudos penitenciarios e criminaes* (Lisbon, 1888); Garofalo, *Studio sul delitto, sulle sue cause e sui mezzi di repressione* (1890); Salillas, *Vida penal en España* (Madrid); Cesare Lombroso, *L'Uomo delinquente,* etc. (1899); K. Hafter and E. Zürcher, *Schweizerische Gefangniskunde* (Bern, 1925); A. Mosse, *Les Prisons* (1926); E. Bumke, *Deutsches Gefangniswesen* (1928).

PRISONERS OF WAR: see LAWS OF WAR.

PRIŠTINA, a town in South Serbia, Yugoslavia. Pop. (1931) 16,948, about three-fourths being Albanians, and the remainder Serbs and Vlachs with a few Jews. Priština was the seat of government of Stephen Nemanya, founder of the Serbian empire, and to the west lies the famous Field of Blackbirds (*Kosovopolje*) where it was destroyed by the Turks in 1389.

To the south-east is the monastery of Grachanitza founded by King Milutin of Serbia (1275–1321), with some remarkable frescoes.

Priština was occupied by German troops in 1941.

PRITCHARD, CHARLES (1808–1893), British astronomer, was born at Alberbury, Shropshire, on Feb. 29, 1808. He was educated at St. John's College, Cambridge, elected a fellow of his college in 1832, and became a schoolmaster. On his retirement in 1862 he settled at Freshwater, in the Isle of Wight, and took an active interest in the affairs of the Royal Astronomical Society, of which he became honorary secretary in 1862 and president in 1866. In 1870 he was elected Savilian professor of astronomy at Oxford. At his request the university determined to erect a fine equatorial telescope for the instruction of his class and for purposes of research, a scheme which, in consequence of Warren de la Rue's munificent gift of instruments from his private observatory at Cranford, expanded into the establishment of the new university observatory. By de la Rue's advice, Pritchard began his career there with a determination of the physical libration of the moon, or the nutation of its axis. In 1882 Pritchard commenced a systematic study of stellar photometry. For this purpose he employed the "wedge photometer" (see PHOTOMETRY: Celestial, and Mem. R.A.S. xlvii. 353), with which he measured the relative brightness of 2,784 stars between the North Pole and about −10° declination.

The results were published in 1885 in his *Uranometria* Nova *Oxoniensis,* and their importance was recognized by the bestowal in 1886 upon him, conjointly with Pickering, of the Royal Astronomical Society's gold medal. He applied photography to the determination of stellar parallax, publishing the results of his systematic measurement of the parallaxes of second-magnitude stars, in the third and fourth volumes of the Publications of the Oxford University Observatory. When the great scheme of an international survey of the heavens was projected, the zone between 25° and 31° north declination was allotted to him, and at the time of his death some progress had been made in recording its included stars. Pritchard became F.R.S. in 1840 and received many scientific honours. He died on May 28, 1893.

See *Proc. Roy. Soc.* liv. 3; *Month. Notices, Roy. Astr. Soc.* liv. 198; W. E. Plummer, *Observatory,* xvi. 256 (portrait); *Astr. and Astrophysics,* xii. 592; J. Foster, *Oxford Men and their Colleges,* p. 206; *Charles Pritchard, D.D., Memoirs of his Life,* by Ada Pritchard (London, 1897).

PRIVAS, town of France, capital of department of Ardèche, 95 mi. S.W. of Lyons. Pop. (1936) 5,999. It is first heard of in the 12th century, as a possession of the counts of Valentinois, and later as the seat of a separate barony. As a Protestant stronghold, it suffered during the Wars of Religion. It passed in 1619 to the vicomte de Lestrange, a Roman Catholic noble. A general rising followed, and in 1629 it was besieged and destroyed by Louis XIII, but in 1632 the inhabitants returned. Privas is the seat of a prefect. Confectionery is its chief industry.

PRIVATEER, an armed vessel belonging to a private owner, commissioned by a belligerent State to carry on operations of war. The commission is known as letters of *marque.* Acceptance of such a commission by a British subject is forbidden by the Foreign Enlistment Act 1870. Privateering is now a matter of much less importance owing to the Declaration of Paris, 1856 (*q.v.*), by which it was abolished. The declaration binds only the powers who were signatories or who afterwards assented, and those only when engaged in war with one another. Privateers stand in a position between that of a public ship of war and a merchant vessel, and the raising of merchant vessels to the status of war-ships has in recent wars given rise to so much difficulty in distinguishing between volunteer war ships and privateers that the subject was made one of those for settlement by the Second Hague Conference (1907). By Convention vii. a converted merchant ship cannot have the status of a war ship unless it is placed under the direct authority, immediate control and responsibility of the power the flag of which it flies (art. 1). Converted merchant ships must bear the external marks which distinguish the war ships of their nationality (art. 2). The commander must be in the service of the State and duly commissioned, and his name must figure on the list of the officers of the fighting fleet (art. 3). The crew must be subject to military discipline (art. 4). A converted merchant ship must observe the laws and customs of war (art. 5); and such conversion must be announced in the list of war ships of the belligerent country.

The effective use of privateers made by the United States in the Revolutionary War and the War of 1812 bred reluctance on its part prior to the Civil War to agree to foreign proposals to abandon the practice. The United States, however, was willing to accede to the Declaration of Paris upon the condition that the right to capture enemy property, other than contraband, on the high seas should be abolished, but such an amendment was unacceptable to the European powers. In 1863, during the Civil War, Congress authorized the president to commission privateers, but the power was not to be exercised unless the Confederate States were successful in commissioning privateers in Europe. No occasion appeared for the commissioning of privateers. During the Spanish-American War of 1898, despite the fact that neither Spain nor the United States had acceded to the Declaration of Paris, no use was made of privateers. The rise of the United States to the position of an important naval power, together with the realization that privateering belongs to the warfare of an earlier day, has disposed the U.S. to cease to incline favourably towards recognition of the practice as a method of modern warfare. Under the constitution issuance of letters of marque and reprisal is forbidden to the states and is vested solely in the national government.

PRIVET, any shrub of the genus *Ligustrum,* belonging to the family Oleaceae, and containing about 50 species, natives of temperate and tropical regions of the old world; only the common privet is a native of Europe and northern Africa. They have evergreen or nearly evergreen opposite entire leaves, and dense clusters of small, white, tubular four-parted flowers, enclosing two stamens and succeeded by small, globular, usually black fruits, each with pendulous seeds. The best-known species is the common European privet, *L. vulgare,* which makes good hedges; there are numerous varieties with variegated leaves. The so-called California privet *(L. ovalifolium),* native to Japan, is widely planted in the United States and thrives in Great Britain. L. *japonicum,* the wax privet, L. *lucidum* and *L. massalongianum* are fine evergreen species, hardy only in warm regions. Mock-privet, *Phillyrea,* a member of the same family, is an ornamental evergreen shrub, hardy only in warm places.

PRIVILEGE, in law, an immunity or exemption conferred by special grant in derogation of common right. The term is derived from *privilegium,* a law specially passed in favour of or against a particular person. In Roman law the latter sense was the more common; in modern law the word bears only the former sense. Privilege in English law is either *personal* or real—that is to say, it is granted to a person, as a peer, or to a place, as a university. The most important instances at present existing in England are the privilege oi parliament *(see* PARLIAMENT), which protects certain communications from being regarded as libellous *(see* LIBEL AND SLANDER), and the privilege of the client by which counsel and solicitor are protected from disclosing, in judicial proceedings, information which has come to them in that relation. This does not extend to clergymen or medical attendants *(see* Observations by Mr. Justice McCardie in *The Times,* July 19, 1927). Privileged copyholders were those held by the custom of the manor and not by the will of the lord. There are certain debts in most countries which are said to be privileged —that is, such debts as must first be defrayed by the executor out of the personal estate of the deceased, in payment, for example, of funeral expenses or servants' wages. There are certain deeds and summonses which are privileged in Scots law, the former because they require less solemnity than ordinary deeds, the latter because the ordinary *induciae* are shortened in their case (see Watson, *Law Dict., s.v.* "Privilege"). The priority formerly possessed by specialty debts was abolished in 1869. *(See* DEBT.)

In the United States the term privilege is of considerable political importance. By art, iv. s. a of the Constitution, "the citizens of each State shall be entitled to all privileges and immunities of citizens in the several States." By art. xiv. s. 1 of the amendments to the Constitution (enacted July 28, 1868), "no State shall make or enforce any law which shall abridge the privileges or immunities of citizens of the United States." It will be noticed that the former applies to citizens of the States, the latter to citizens of the United States. "The intention of this clause (art. iv.) was to confer on the citizens of each State, if one may so say, a general citizenship, and to communicate all the privileges and immunities which the citizens of the same State would have been entitled to under the like circumstances" (Story, *Constitution of the United States,* 1806). The clauses have several times been the subject of judicial decision in the Supreme Court. With regard to art. iv. it was held that a State licence tax discriminating against commodities the production of other States was void as abridging the privileges and immunities of the citizens of such other States *(Ward* v. *State* of *Maryland,* 12 Wallace's Reports, 418). With regard to art xiv. 1, it was held that its main purpose was to protect from the hostile legislation of the States the privileges and immunities of citizens of the United States, looking more especially to the then recent admission of negroes to political rights. Accordingly it was held that a grant of exclusive right or privilege of maintaining slaughter-houses for 21 years, imposing at the same time the duty of providing ample conveniences, was not unconstitutional, as it was only a police regulation for the health of the people *(The Slaughter-House Cases,* 16 Wallace, *36).* The same has been held of a refusal by a State to grant to a woman a licence to practise law *(Bradwell* v. *The State,* 16 Wallace, 130), of a State law confining the rights of suffrage to males *(Minor* v. *Happersett,* 21 Wallace, 162), and of a State law regulating the sale of intoxicating liquors (*Bartemeyer* v. *Iowa,* 18 Wallace, 129). Suits to redress the deprivations of privilege secured by the Constitution of the United States must be brought in a United States court. It is a crime to conspire to prevent the free exercise and enjoyment of any privilege, or to conspire to deprive any person of equal privileges and immunities, or under colour of law to subject any inhabitant of a State or territory to the deprivation of any privileges or immunities *(Revised Statutes of United States,* ss. 5507, 5510, 5519).

It is sometimes difficult to distinguish between "privileges" and "rights" in the United States, but privileges are more general and the act of suffrage is considered a "privilege" rather than a ('right."

PRIVY COUNCIL. The privy council, like all the British institutions of central government, excepting the House of Commons, is descended from the court of the Norman kings. This *curia regis,* composed of the king's tenants-in-chief, the household officials, and anyone else whom the king chose to summon, performed all the functions of central government without differentiating between them. According to feudal theory, tenants owed suit to their lord's court; but every great lord had also his household officials, his chancellor, his treasurer, his chamberlain and his steward to transact his daily business. Thus, too, the *curia regis* expanded or contracted according to the nature of the business under consideration. The ordinary routine would be carried out by the officials, assisted by such barons as happened to be at court; for more important business the king would secure the attendance of a greater number of his tenants-in-chief; and on really vital matters the household officials would tend to become a numerically insignificant technical element in a large feudal assembly.

As time went by the larger and smaller gatherings came to be distinguished adjectivally; later, these adjectives developed a technical significance, until at last, although still remaining for a time merely different manifestations of a one and indivisible body, the larger assembly developed into the great council and the parliament, the smaller into the king's council. In early days the presence of many barons at conciliar meetings was the mark of a strong king; later, as the barons came lo realize that attendance was not merely a tiresome incident of feudal tenure but a source of political power, that obligation became a privilege. Thus, in the later middle ages there developed a struggle between king and greater barons for the control of the king's council. Was it to be feudal or expert? In the end the barons failed to secure their greater demands—exclusive membership and the control of appointment and dismissal—because they were unable to discover a means of adequately reconciling the principle of the right of all to attend with the actuality of a small assembly, because, though collectively anxious to control and individually willing to be appointed, they could never be relied upon for constant attendance, and because, with the passing of the feudal organization of society, baronial counsel ceased to be expert advice on matters of government. But the struggle was not entirely without fruit. A conciliar oath was instituted, membership became more determinate, and methods were devised, however primitive and clumsy, for enforcing responsibility.

By the time of Henry VII. this council had become the instrument of the Crown. It was composed of an inner ring of counsellors proper, who took the conciliar oath and sat at the council board, and of an outer ring of technical experts and dignitaries (later, in the reign of Henry VIII., known as ordinary counsellors), who, though they might occasionally be called upon for advice, were not members of the board, did not take the conciliar oath, but merely that of their respective offices, and performed the technical and routine work of the central and provincial courts of the council. It was the policy of the Tudors to rule the country paternally by the prerogative exercised through the medium of the council.

Star Chamber and Privy Council.—This conception of government necessitated precision, sub-division and specialization, and thus, just as in earlier times, for analogous reasons, the undifferentiated curia *regis* had given birth and place to a number of descendent courts and councils, so in Tudor times the king's council and its functions were split up and divided between the privy council, the courts of Star Chamber, of requests and of high commission (qqv.), and such local offshoots as the courts and councils of the North, and of Wales and the Marches. A distinction between the council with the king and the council at Westminster had appeared from time to time during the middle ages. It now became "sharper and more permanent." The body "following the king was commonly known as the 'council at court,' while the other continued to be called 'the king's council in the Star Chamber.' The former body became the privy council."

This conciliar government was admirably suited to a period of transition. But the need of this somewhat arbitrary, if paternal, government had passed with the Tudors. Moreover, this small but all-powerful bureaucracy depended for its efficiency on a resolute and discriminating sovereign, capable of choosing the right men and of superintending their labours. The Stuarts did not possess these qualifications. The House of Commons, hitherto accustomed to follow the leadership of privy councillors, had now, with increased experience of partnership in government, developed a mind and policy of its own. Of the judicial aspect of the council's activities the common lawyers were coming to show an even more threatening jealousy, a jealousy justified by the misguided action of the Stuarts in checking the natural evolution of these courts towards independence of executive control and in using them to enforce, not justice, but policy. No wonder, then, that as religious and constitutional controversies developed between Crown and parliament the attention of malcontents became focussed on conciliar jurisdiction, nor that, when the parliamentary cause at last triumphed, in 1641, the whole system of conciliar government was swept away. Only the privy council was spared. It was never legally abolished. It perished in the interregnum (though the name was resuscitated in 1657) and revived with the return of Charles II. in 1660.

The personnel of the council was recruited from clergy, peerage and commons. The baronage, as we saw, had failed in the middle ages to secure exclusive membership. The Tudors preferred to employ men of low degree who would be wholly dependent on their master, and could be rewarded inexpensively by promotion in the Church, to the judicial bench or to other State offices, where their dignities would not become hereditary. Indeed, so professional did the council become that even the peers on it were members by virtue of office rather than of birth. The ecclesiastics also, who in the middle ages had predominated in the great offices of State, now declined in numbers and influence, partly because they had no longer a monopoly of education, and partly because, since the Reformation, they had ceased to be officials of an international hierarchy, semi-independent of secular control. Thus the majority of the council came to consist of lay commoners, and the proportion may fairly be illustrated from the council of Edward VI., which consisted of 17 commoners, two prelates and seven peers, only one of whom held a peerage of more than 12 years' creation.

Members.—Both in the middle ages and for several centuries later contemporary opinion favoured 20 as about the ideal total of conciliar membership. But seldom did practice conform with theory. When the privy councillor register begins, in 1540, we do, indeed, find 19 members, but by Henry VIII.'s death there were 29 In Edward's reign the record was 40, in Mary's 44, and, although Elizabeth reduced the numbers to between a dozen and a score, the Stuarts, as usual, were less successful. By 1623 the total had increased to 35, and Charles I.'s council averaged at about the same figure. The nucleus of principal officers, if a rough generalization be permitted, comprised the archbishop of Canterbury, the lord chancellor, the lord treasurer, the lord president (when there was one), the lord privy seal, the lord admiral, the lord steward, the lord chamberlain, the two secretaries of State, the chancellor of the Exchequer, the treasurer and the comptroller of the king's household, and the chancellor of the duchy of Lancaster. At the Restoration the problem of numbers became even more acute. Gen. Monk, we are told, presented Charles with a paper containing "the names of at least three score and ten persons, who were thought fittest to be made privy counsellors." Charles had also to remember the survival of his father's council and his own advisers, whom he had brought with him from beyond the seas. All things considered, it is not surprising that, though he managed to begin with only 28, the total had reached 47 by 1679. Temple's abortive attempt at conciliar reform temporarily reduced the figure to 33, but by 1688 it was back again at 48, by 1707 it had reached 60 and, by 1723, 67.

The Pre-eminence of the Cabinet.—In proportion as the numbers of the privy council rose, so did its powers decline. Even in Tudor times the increasing membership and the volume of work had led to the institution of committees, and already, under the early Stuarts, one of these committees, out of which was to develop the cabinet, was beginning to usurp the functions of the council. (For the development and extent of this usurpation see CABINET.) Unpopular as this tendency was, it could not be checked. The petition of Lords and Commons in 1642 "that matters of State proper for the privy council might be debated and concluded there" is only one instance of many unavailing protests. Charles II., after his restoration, carried caballing on official and unofficial committees beyond the limits of the nation's endurance, and was at last, in 1679, forced to submit to the first serious attempt to restore the powers of the council. Sir William Temple was the reputed father of the scheme, but it seems that the king played a, for him, not unusual part in the begetting of it. The reformed council was to consist of 15 "who shall be privy councellours by their places" and of 15 others representing the various sections of parliamentary opinion, plus princes of the blood, a lord president, and a secretary for Scotland when in England—33 in all. The scheme was, in fact, a failure from the start. Membership was still too numerous for efficiency, too diverse in opinion to be able to pursue, much less to dictate, a consistent policy; worse still, the experiment was received with cold suspicion by parliament. Charles, in spite of recent professions of loyalty to the new council, began flouting it at once. He prorogued the parliament without consulting it, dissolved the parliament contrary to the advice of a large majority, and finally, in spite of it, prevented for a year the meeting of the new parliament. Once more he had resort to caballing. Not unnaturally, the opposition members of the council ceased to attend meetings which were nothing but a farce, and with their disappearance the council may be said to have reverted to its former constitution.

The last serious attempt to restore the privy council to its former position and influence may be found in the clause of the Act of Settlement (1701), which enacted that, on the Hanoverian accession, "all matters and things relating to the well-governing of the kingdom, which are properly cognizable in the privy council by the laws and customs of this realm, shall be transacted there, and all resolutions taken thereupon shall be signed by such of the privy council as shall advise and consent to the same." But the proposal was by that date impracticable, and the clause was repealed in 1705 before it even came into force. The council board had been not merely short-circuited by the cabinet, it had even lost the power of debating such measures as came before it. In 1711 a debate on the subject in parliament elicited the remark that "the privy counsellors were such as were thought to know everything and knew nothing. Those of the cabinet council thought nobody knew anything but themselves." And the last occasion on which the council asserted its former rights was when, in 1714, as Queen Anne lay dying, certain Whig lords forced their way in at a meeting of the lords of the committee (see CABINET), claimed their right to be present as counsellors of the Crown, converted the meeting into a session of the privy council and, reinforced by their conciliar colleagues, ushered in the Hanoverian succession. From the accession of George I, the privy council may be described as a purely formal body meeting on purely foimal occasions to transact purely formal business. There are now (1928) nearly 300 "right honourable lords and others of His Majesty's Most Honourable Privy Council." They are mostly dignitaries who have held, or hold, high political, judicial or ecclesiastical office in Great Britain, the dominions, or the colonies; though the list, we are told, "occasionally" includes "eminent persons in science or letters." Office lasts for the life of the sovereign and six months after, but it is the modern custom for the new sovereign to renew the appointment.

FUNCTIONS

The curia *regis* performed all the functions of central government without differentiating between them. Later, with the multiplication and elaboration of business, as old methods became too stereotyped and cumbersome to meet new needs, the one court gave birth and place to many. But, since differentiation was along the lines of procedure rather than of function, every true offspring of the curia, however much it might come in time to specialize in one particular function, tended to retain at least some traces of the others as well. Thus, by the end of the mediaeval period the king's council was coming to be thought of mainly as an executive body, but it still retained extensive judicial, fiscal and legislative powers, and portions of all these (except the fiscal) have, in diminishing quantities, descended through the ages to, and been inherited by, the modem privy council, along with certain other duties which still defy expert analysis as exclusively executive or judicial or legislative.

Executive. — The consultative and advisory functions formerly exercised by the privy council were usurped, as shown above, by a committee of counsellors, who came to be known collectively as the cabinet (*q.v.*). The duties of the other committees of the council have been handed over, to a large extent, to State departments, such as the Board of Trade, the Local Government Board, the Board of Education and the Board of Agriculture, presided over by ministers responsible to parliament. The privy council itself now acts merely as the formal medium for giving expression, by Order of Council or by Proclamation, to the measures determined on by the Crown on the advice of its ministers, in the exercise of those executive functions which it possesses either by virtue of the prerogative or by statutory authority. Orders in Council are used when new rules and regulations are approved and passed by the King in council, or for proclamations to give publicity to such matters as the summons, dissolution, or prorogation of parliament, or the declaration of peace or war. These formal meetings are attended by a few councillors, generally ministers or officials, three of whom form a quorum, and the orders of the council are authenticated by the signature of the clerk to the council.

Nevertheless, there are still committees in existence exercising important functions of a mixed kind. For instance, it not infrequently happens that parliament, faced with the difficulty of enacting long and intricate legislation, confines its attention to general outline and principle, at the same time authorizing, under the act, the privy council to fill in the details. These powers are exercised usually by committees to which matters are referred by the Crown in council. Thus two applications in connection with the attention of the statutes of the universities and colleges of Oxford and Cambridge came before the universities' committee. And it is obvious that the work of such committees involves all the functions of government, administrative, judicial and legislative.

Fiscal. — The curia provided no machinery for national taxation, since the latter had no place in feudal society. It was the accepted doctrine that "the king should live of his own," that is, on the rents and services due to him: and these were adequately dealt with by the Exchequer. So exclusively was it an affair between lord and tenant that Magna Carta attempted to check, or regulate, the raising of exceptional revenue by providing that whenever the sovereign wanted more than his ancient feudal dues, he should consult a gathering of his tenants-in-chief. Only with the coming of the Commons to parliament and with the growth of the idea that money is granted in exchange for redress of grievances does national direct taxation find a place in the constitutional scheme, and that place, of course, is in parliament, and in parliament alone. But in the matter of indirect taxation the position was not so clear. The regulation of trade and the vicissitudes of foreign policy necessitated, in early times, the imposition and manipulation of customs duties by the Crown in council.

Later on, the growing jealousy of parliament led to the passage of statutes which did something to restrict, but very little to define, the royal powers in this direction. For two centuries or more, however, the issue was compromised. As long as the Crown was content to leave the question of the prerogative in abeyance, certain duties were annexed to the Crown in perpetuity and others voted to every new sovereign by his first parliament for life. It was James I. who violated this understanding by issuing a new Book of Rates, placing impositions upon articles produced and sold within the kingdom, and making other alterations, not, as the Tudors had done, in the interests of trade and foreign policy, but for purely fiscal purposes. Charles I., in consequence, was not voted tunnage and poundage, for life, on his accession, and the whole question of prerogative levies came up for discussion and decision. At the end of a struggle in which neither party had either the law or honesty completely on its side, parliament, by the Petition of Right (1628), and the Tunnage and Poundage and Ship Money Acts (1641), finally secured absolute control over all taxation, indirect and direct.

Legislative. — Many of the so-called statutes of the middle ages have no better authority than the Crown in council. By the end of the 15th century, however, statutes are quite distinct from ordinances or proclamations (as they were coming to be called). Conciliar legislation was vaguely considered to be subordinate to statute and common law, and less permanent also, its duration being apparently limited to the life of the enacting sovereign. Nevertheless, the legislative powers of the Crown in council were still wide and undefined. The Statute of Proclamations (1539) did something temporarily to regulate them on a firm basis and with a limited range, but was repealed at the accession of Edward VI., and as, later on, parliaments became less docile, there was a natural tendency on the part of the sovereign to claim greater authority and a wider scope for proclamations. "When the common state or wealth of the people require it," it was said in the Star Chamber, "the king's proclamation binds as a new law and need not stay a parliament." Finally, the ambitious pretensions of the first Stuart king brought the matter to a head. In 1610 the Commons complained that the number and range of recent proclamations made them fear "that proclamations will, by degrees, grow up and increase to the strength and nature of laws." And Coke, consulted as to the answer to be given, laid down in the Case of *Proclamations* an authoritative limitation. "The king cannot," he said, "change any part of the common law nor create any offence by his proclamation which was not an offence before, without parliament. . . . But a thing which is punishable by the law, by fine and imprisonment, if the king prohibit it by his proclamation . . . and so warn his subjects of the peril of it . . . this as a circumstance aggravates the offence." It was too much to expect either James I. or Charles I. to observe these principles, but the later Stuarts kept to the limits laid down, mainly, perhaps, because there was no longer a Star Chamber to enforce the ultra-legal acts of a sovereign.

But there is another aspect of the legislative functions of the council. It was completely, once, and is still, in part, a component of the legislature. Parliament was originally only the fullest assembly of the curia *regis*, a re-fusion, as it has been called, of all the elements into which the old, undifferentiated curia was coming to be resolved. As the king was the core of the council. so the council was the core of the parliament. Those members of the council who were lords, spiritual or lay, sat among their peers on the benches along the side walls, to right and left of the king respectively; the commoners sat on four woolsacks in the midst of the chamber. Their exact positions were regulated later by the Act for Placing the Lords (1539). But already, in the 14th century, as the parliament chamber began to develop into the House of Lords, peers and bishops began to regard the commoners present as inferior persons, with inferior, if any, rights.

As the commoners lost influence, so they lost interest, and in Wolsey's time began to seek election to the House of Commons; and this practice had become the rule for privy councillors, who were not bishops and peers, by the middle of the 16th century. The lord chancellor remained in the House of Lords because he was its presiding officer (only since Anne's reign has he been invariably made a peer), and thus retained his woolsack, but the other councillors — by non-attendance — have forfeited their seats, and even now a privy councillor, not being a peer or bishop, who wishes to attend the House of Lords, must content himself with standing on the steps of the throne. The so-called privilege of the Lords to require the attendance of the judges (who still sit on the woolsacks at the opening of parliament) is no more than a survival of the judges' regular attendance in the parliament chamber as members of the *curia* and counsellors of the Crown.

For the Judicial Committee of the Privy Council see below.

BIBLIOGRAPHY.—T. Erskine May, *Constitutional History of England,* continued to 1911 by F. Holland; W. Bagehot, *The English Constitution* (1867); *W.* E. Hearn, *The Government of England* (1867); W. Stubbs, *Constitutional History of England* (1874–78); F. Pollock and F. W. Maitland, *History of English Law* (1895); W. Anson, *Law and Custom of the Constitution* (1896); C. L. Scofield, *Court of Star Chamber* (1900); *A.* V. Dicey, *Law of the Constitution* (1902); *I.* S. Leadam, *Select Cases before the King's Council in the Star Chamber* (1903); *A.* L. Lowell, *The Government of England* (1908); F. W. Maitland, *Constitutional History of England,* ed. H. *A.* L. Fisher (1908); S. Low, *The Governance of England* (1908); J. F. Baldwin, *The King's Council in England during the Middle Ages* (1913); W. S. Holdsworth, *History of English Law* (1914–26); *A.* F. Pollard, *Evolution of Parliament* (1920); "Council, Star Chamber and Privy Council under the Tudors," *English Historical Review* (1922 and 1923); G. B. Adams, *Origin of the English Constitution* (1920); T. F. Tout, *Chapters in the Administrative History of Mediaeval England* (1920); *J.* R. Tanner, *Tudor Constitutioml Documents* (1922); *E.* R. Turner, *The Privy Council of England* (1927). (F. L. B.)

PRIVY COUNCIL, JUDICIAL COMMITTEE OF.

By the 19th century it had become apparent that the jurisdiction of the "King in council," wielded upon a wider and wider scale, must be regularized. In the year 1833 the judicial committee of the privy council, the present body, was constituted by the famous statutes 3 and 4 William IV. chap. 41.

While historically the existence of an approach by way of an appeal to his majesty had remained, a demand continually arose for systematizing the procedure of such appeal. This was accomplished and the whole institution was re-formed, methodized and regularized by the "Act for Administration of Justice in His Majesty's Privy Council," the authorship of which is attributed to Lord Brougham, and which was passed on Aug. 14, 1833. Much in that statute has been changed; in particular the admiralty jurisdiction has been wholly transferred to the court of admiralty, which, with the probate and matrimonial jurisdiction, has become one of the common law courts of the country under the Judicature Act of 1874. But the important work and sphere of the privy council in regard to the dominions of the crown finds its foundation in this statute.

Indian Business. — Before citing the Act, it may be well to pause and to consider not only how the jurisdiction of the council had extended (as we have seen) to various outlying portions of the king's dominions, but also how its authority over the East Indian possessions was originally established. The short history of this is as follows. By charter of George I. in 1726 courts were established in the three settlements — Madras, Bombay and Bengal, and an appeal to his majesty in council was given. Subsequent charters constituted supreme courts and these in time were replaced by various high courts created under the charter Acts 24 and 25 Victoria, chap. 104. These high courts were constituted by letters patent which contained rules providing for appeals to the privy council. Since then, further high courts have been established and these are also constituted by letters patent containing similar provisions as to appeals. The Civil Procedure Code also gives a right of appeal under prescribed conditions and there has followed an Order of Council of Feb. g, 1920, which replaces a much earlier one issued under the Judicial Committee Act of 1833. It is easily understood how upon a system thus developing in loyalty to the central jurisdiction and prerogative of the Crown, the Act of 1833 was completely in keeping with such development. So great has the growth of Indian judicial business before the committee become, that the committee has been divided into two working sections, one of which is entirely or almost entirely occupied with Indian appeals. By s. 30 of the Judicial Committee Act of 1833, two Indian retired judges are also eligible as members of the committee.

Before coming to the Statute itself, it may be well to apprize the reader of various items of privy council jurisdiction which stand quite apart from that exercised in appeals from India and the colonies and dominions.

Ecclesiastical Jurisdiction. — The ecclesiastical jurisdiction of the king in council is derived from the statute 25 Henry VIII. chap. 19, which followed the famous Act of the previous year, 24 Henry VIII. chap. 12, abolishing appeals to Rome. By the Act 25 Henry VIII. chap. 19 an appeal was given from the courts of the archbishop to the king in chancery and it was enacted that upon such appeal

> "A Commission shall be directed under the great seal to such persons as shall be named by the King's Highness his heirs or successors like as in case of appeal from the Admirall Court to hear and definitely determine such appeals and the causes concerning the same."

This commission in time became known as the High Court of Delegates, which was abolished by 2 and 3 William IV. chap. 92, and by 3 and 4 William IV. chap. 41, ecclesiastical appeals were transferred to the judicial committee. The result is that appeals from the two courts of archbishops (*i.e.,* arches court of Canterbury and provincial court of York) lie to the king in council.

With regard to appeals under the Clergy Discipline Act 1892 (dealing with morals), there is an alternate right of appeal from the consistory court of bishops either to the court of the archbishop or to the king in council direct. If the appellant elects the former there is no further appeal to the king in council. On the hearing of ecclesiastical appeals under the rules made under the Appellate Jurisdiction Act 1876, five bishops have to be summoned as ecclesiastical assessors, of whom three at least have to be present. Under the Endowed Schools Act, 36 and 37 Vic. chap. 87, appeals lie to his majesty in council from schemes prepared by the Board of Education affecting schools subject to the Endowed Schools Acts. Under the Union of Benefices Measure 1923 of the national assembly of the Church of England, an appeal lies to the king in council against a scheme of the ecclesiastical commissioners uniting two or more benefices.

The Statute of 1833. — The Act provides in its first section for the composition of the council headed by the president for the time being thereof, and the lord high chancellor and other learned dignitaries as there set forth. These "shall form a committee of his majesty's said privy council and shall be styled the judicial committee of the privy council." In later years the personnel of the committee has been changed and enlarged. It now consists of the lord chancellor, the lord president, the lord president of the council and the lords of appeal in ordinary, these being six in number, together with the two Indian members already mentioned. To them are added such other members of the privy council as shall from time to time hold or have held "high judicial office." These last render voluntary and valuable service, and without their assistance the increasing business of the committee would fall hopelessly into arrear.

It is provided by the third section:—

> "That all appeals or complaints in the nature of appeals whatever, which, either by virtue of this Act, or of any law, statute, or custom, may be brought before his majesty or his majesty in council from or in respect of the determination, sentence, rule, or order of any court, judge, or judicial officer, and all such appeals as are now

pending and unheard, shall from and after the passing of this Act be referred by his majesty to the said judicial committee of his privy council, and that such appeals, causes, and matters shall be heard by the said judicial committee, and a report or recommendation thereon shall be made to his majesty in council for his decision thereon as heretofore, in the same manner and form as has been heretofore the custom with respect to matters referred by his majesty to the whole of his privy council or a committee thereof (the nature of such report or recommendation being always stated in open court)!'

The British Dominions.—In 1867 the famous British North America Act was passed. It disclosed within its constitution questions of a high and delicate order. The principal of these questions was contained in the enumeration by s. 91 of the powers of the Dominion pariiament and by s 92 of the exclusive powers of provincial legislatures. It became at once evident that the task of clearing the boundary lines not only inter-provincially but between Dominion and province would be a task of severe strain. The authority of the judicial committee of the privy councii was clear from the Act of 1833, but the Canadian parliament thought fit to emphasize that situation by the 47th section of their Supreme and Exchequer Courts Act (38 Vic. chap, 11). That section is in the following terms:—

"The judgment of the Supreme Court shall in all cases be final and conclusive, and no appeal shall be brought from any judgment or order of the Supreme Court to any court of appeal established by the parliament of Great Britain and Ireland, by which appeals or petitions to her majesty may be ordered to be heard: saving any right which her majesty may be graciously pleased to exercise by virtue of her royal prerogative."

Under the powers vested in it, the judicial committee has pronounced a series of judgments the constitutional importance of which is recognized throughout the world. Every year appears to bring a fresh crop of questions to be solved, arising out of the construction of the British North America Act.

The settlement of the constitutional relations of the various States of Australia with each other, their federation into one commonwealth, and the adjustment of their reiations judicially with the imperial authority and royal prerogative were settled by the Commonwealth of Australia Constitution Act, 63 and 64 Vic. chap. 12. It has to be noted that in ordinary cases by force of the royal prerogative an appeal may be admitted to the judicial committee; but in constitutional cases such an appeal is only allowed on a certification of the High Court of Australia. Section 74 of the Act is in these terms:—

"No appeal shall be permitted to the queen in council from a decision of the High Court upon any question, howsoever arising, as to the limits *inter se* of the constitutional powers of the commonwealth and those of any State or States, or as to the limits *inter* se of the constitutional powers of any two or more States, unless the High Court shall certify that the question is one which ought to be determined by her majesty in council. The High Court may so certify if satisfied that for any special reason the certificate should be granted, and thereupon an appeal shall lie to her majesty in council on the question without further leave. Except as provided in this section, this constitution shall not impair any right which the queen may be pleased to exercise by virtue of her royal prerogative to grant special leave of appeal from the High Court to her majesty in council. The parliament may make laws limiting the matters in which such leave may be asked, but proposed laws containing any such limitation shall be reserved by the governor-general for her majesty's pleasure."

In 1909 there was passed on Sept. 20 an Act to constitute the Union of South Africa This Act was the result of severe parliamentary and constitutional struggles following the South African War. Judicial affairs were regulated substantially on the Canadian model. By s. 106 of the statute it was provided:—

"There shall be no appeal from the Supreme Court of South Africa or from any division thereof to the king in council, but nothing herein conrained shall be construed to impair any right which the king in council may be pleased to exercise to grant special leave to appeal from the appellate division to the king in council. Parliament may make laws limiting the matters in respect of which such special leave may be asked, but bills containing any such limitation shall be reserved by the governor-general for the signification of his majesty's pleasure: provided that nothing in this section shall affect any right of appeal to his majesty in council from any judgment given by the appellate division of the Supreme Court under or in virtue of the Colonial Courts of Admiralty Act 1899"

The effect of these provisions came prominently into view in the adjusting of the relations between the judicial committee and the Government of Ireland during the negotiations under which the constitution of the Irish Free State mas framed. By the Act of Dec. 5, 1922, the Irish Free State Constitution Act, the various articles of the constitution were set forth in schedule I. The 66th article is as follows:—

"The Supreme Court of the Irish Free State (Saorstát Eireann) shall, with such exceptions (not including cases which involve questions as to the validity of any law) and subject to such regulations as may be prescribed by law, have appellate jurisdiction from all decisions of the High Court. The decision of the Supreme Court shall in all cases be final and conclusive, and shall not be reviewed or capable of being reviewed by any other court, tribunal or authority whatsoever: provided that nothing in this constitution shall impair the right of any person to petition his majesty for special leave to appeal from the Supreme Court to his majesty in council or the right of his majesty to grant such leave."

It will be seen that the main lines of this judicial settlement followed almost precisely those applicable to the Dominion of Canada. And it will be further and particularly observed that there has not been granted to the legislature of Iieland the power granted to the parliaments of Australia and South Africa respectively, as just quoted, namely, to "make laws limiting the matters in which such special leave may be asked" with reservations by the governor-general

General Considerations.—No one considering this brief sketch of the widening of the scope of such a jurisdiction can fail to be impressed by several cardinal facts. In the first place, this jurisdiction has marked and kept pace with the development of the empire itself. Secondly, and in a singular degree, the judicial committee has formed a central and cohesive power attaching not Crown colonies alone, but the self-governing portions of the empire in homage to a jurisprudence which, developing from year to year and from precedent to precedent, has proved the adaptability of law under enlightened administration to circumstances and to peoples and even to stages of civilization, of infinite variety

The next consideration is of great import. It explains why the variety alluded to has been found compatible with the maintenance of law under conditions at once local and yet central and imperial. The reason is found in the genius of the British people, and the remarkable grasp within the sphere of iaw of the principle of self government. The difference between British jurisprudence and the jurisprudence of Rome or, say, in modern times, of Germany, is that to the world Rome gave Roman law, and io the modern world Germany desired to give German law; but the British empire gives to its component parts their own law. This imposes a task of great complexity. Systems of jurisprudence totally different in outward seeming, but respectively in entire accord with the historical and tribal traditions of the various populations and parts of empire, have to be administered in such a fashion as to accept and respect not only established local traditions, customs and laws but also the hereditary and prized rules of succession, rights of property and even of religion prevailing in various quarters of the globe To take India for an example, the appiication of Hindu law to the Mohammedans, or of Buddhist law to Hindus, instead of uniting the empire might break it to pieces.

In Canada the same variety in unity prevails. Each province feels safe. In 1774 the Quebec Act provided that in civil matters the old laws of Quebec should still apply. Among these were "First, the *coutumes de Paris* and the ordinances in force within the jurisdiction of Paris; second, the *arret du conseil du roi* and the ordinances published between 1663 and 1763." In short the legal situation in those respects in Quebec is that of Paris prior to the French Revolution, whereas in the other provinces the basis of law is the common law of England Each province of the Great Dominion developing its own provincial legislation, must have its statutes recognized by the Central Power and stands by its own system. The lines of function and jurisprudence of the provinces may thus differ from each other and each and ali from the Dominion itself. The resultant conflicts arouse in many cases the keenest feeling and these have been brought for settlement to the bar of the privy council administering and interpreting the law as laid down in the Act of 1867. These illustrations of variety in unity evolving into an imperial harmony need not be multiplied.

This principle of resolute and harmonious accord with local tradition, creed and custom extends as has been indicated even to the adoption and administration of whole systems of jurisprudence. As first noted, within Canada itself the range extends from modern English law to ancient French. Again, over no inconsiderable part of the empire it is a fact that Roman-Dutch law holds sway. This is shown in parts of the empire so wide apart as South Africa, Ceylon and British Guiana. Space forbids a further enumeration but sufficient has been said to indicate the stupendous difficulties which have to be overcome by this resolute respect for colonial and Indian jurisprudence. It is from quarters in which these difficulties have to be daily surmounted (Quebec and the empire of India being cited as examples) that the firmest support comes for the upholding of the dignity and jurisdiction of the Council as now existing.

This finally raises a problem as to future constitutional development. It is acknowledged that the rational foundations of the jurisdiction and administrative power of the judicial committee rest upon fundamental ethical principles which, finding varying expression under varying systems, are yet essentially the same. Simple illustrations occur such as these: that under the Roman-Dutch law one would naturally cite the old maxim, *sic utere tuo ut alienum non laedas;* when, in India, embarrassment is caused by the apparent failure to reach a common ground of principle, resort is had to "justice, equity and good conscience," and this principle finds its place in every Indian textbook; in Canada, the British North America Act expressly confers upon the Dominion confronted with provincial demands the province of preserving "peace, order and good government." Apart from these instances, no jurisprudence fortified by centuries of tradition can be finally found to rest on foundations less sure than the *recta ratio* of Cicero, the righteousness of ancient, and the justice tinctured with toleration of modern times.

Two points in conclusion may be noted. Section 4 of the Act of 1833 has been already cited, providing for a reference to the judicial committee of any such other matters as his majesty shall think fit. This nebulous and almost all-embracing provision has in spirit been followed in Canada by a reference to the courts of abstract questions for a guide to Government in its administrative policy. It must be said frankly that such provisions are received by courts, including the committee itself, with the greatest caution, for the simple reason that judicial tribunals should not be set to abstractions but to problems which have actually arisen and upon which *in foro contentioso* parties have argued out their differences. To forsake this principle would tend to turn a judicial tribunal into a mere philosophic academy. As a last resource however this branch of the prerogative may have to be resorted to. This was done in reference to the settlement of claims of compensation for civil servants who under statutory cessation of their British employment entered the service of the Irish Free State. A decision in a certain sense had been given by the privy council and had been challenged by the Free State, and thereupon s. 4 of the Act of 1833 was put into operation, substantially to reconsider a decided case. In these columns no discussion of such a point would be either possible or proper.

The rules of procedure and general methods of the conduct of business by the committee are found in books of practice.

In addition to the general constitutional authorities, *e.g.*, Hallam and others, on Privy Council, *see*, in particular, references to the work of the judicial committee in N. Bentwich, *Privy Council Practice* (2nd ed., 1926); Lord Shaw of Dunfermline, *The Law of the Kinsmen* (1928); J. H. Morgan, *The Law and Constitution of the Empire.*

(SH.)

PRIVY PURSE is the amount set apart in the civil list (*q.v.*) for the private and personal use of the sovereign in England. During the reign of Queen Victoria it was £60,000 a year, but on the accession of Edward VII. the amount was fixed at £110,000 a year, which was the amount paid to the last sovereign (William IV.) who had a queen consort. Under Queen Victoria the offices of keeper of the privy purse and private secretary were combined. These officials, with their subordinates, are of the king's *personal staff.*

PRIZE, in law, may be defined as the vessels or goods of the enemy or of a neutral, or of a subject of the captor's own State or of a subject of an ally, captured *jure belli* by a belligerent captor on the high seas, or in rivers, ports and harbours and even in some circumstances on land (*see* the *Roumanian,* 1914, I.B. & C.P.C. 75). For England the term "vessels" includes merchantmen, lighters, rafts, tugs, boats and all other naval craft together with their appointments, such as signalling instruments (*see* the *Anichab,* 1919, 3 B. & C.P.C. 611; 1922, A.C. 235). The term "goods" includes "cargoes" which covers "choses in action" (*q.v.*) (the *Fredrick VIII.,* 1917, *P.* 43); "bonds and securities" (the *Noordam* [No. 2], 1920, A.C. 904); and "moneys" (*Turkish moneys taken at Mudros,* 1916, 2 B. & C.P.C. 336). Not only goods shipped under a bill of lading (*Ten Bales of Silk at Port Said,* 1916, 2 B. & C.P.C. 13), but also goods despatched by parcels post are carried by the term (*see* the *Tubantia,* 1916, L.R.P.C. 282). The property in prize does not pass to the captor until it has been brought within the jurisdiction and adjudicated upon. But the property in captured war-ships passes, on capture, to the captor, and they are only brought into the prize court in order that the prize money may be determined.

United States.—The term prize is "used as a technical term to express a legal capture." (*Miller* v. *The Resolution,* 1781, 2 Dallas Reports, 1.) The courts "assume that 'capture' and 'prize' are not convertible terms, and that for the subject of capture to be made prize for the benefit of the captors the taking must meet the conditions imposed by the statutes." (*The Manila Prize Cases,* 1903, 188 U.S. Reports, 254.)

Captures made on inland waters of the United States are not "liable to condemnation as maritime prize." (*The Cotton Plant,* 1870, 10 Wallace Reports, 577.) The Act of Congress of July 17, 1862, "excludes property on land from the category of prize for the benefit of the captors." (*United States* v. *Alexander,* 1864, 2 Wallace Reports, 404.) The word "ship," however, "embraces her boats, tackle, apparel and appurtenances because part of the ship as a going concern, and, for the same reason, ship or vessel of war includes her armament, search-lights, stores, everything, in short, attached to or on board the ship in aid of her operations." (*The Manila Prize Cases,* 1903, 188 U.S. Reports, 254.) Non-seagoing boats such as barges propelled by sweeps and by poling, and boats having no means of propulsion are not regarded as maritime prize. (*Ibid.*) The United States long argued for the exemption from capture of private property at sea, but this doctrine was not accepted by other States or by the courts. The United States abolished prize money by an act of March 3, 1899. (30 U.S. Stat. 1007.)

Other Countries.—The French prize court will not adjudicate on the validity of captures of war-ships or on captures effected on lakes or other inland waters. Otherwise prize covers the same property as in England. In Italy prize extends to captures on the high seas and inland waters which include captures in ports, quays, docks and other places in which maritime traffic is carried on. According to the German Prize Code, 1909, prize includes enemy and neutral vessels and goods thereon, but not neutral public vessels. Enemy public vessels are confiscatable without other proceedings. German ships and cargoes and German goods on neutral or enemy vessels are excluded. During the World War the German prize courts declared themselves incompetent if the prize was destroyed without being first captured. Thus claimants were deprived of their legal remedy for the sinking at sight of their vessels, which was contrary to the accepted customs of war.

PRIZE COURTS AND PRIZE LAW. In England the admiralty court had jurisdiction in matters of prize from very early times, and although since the middle of the 17th century the *instance,* or ordinary civil jurisdiction of the court, has been kept distinct from the *prize* jurisdiction, they were originally both administered and regarded as being within the ordinary jurisdiction of the lord high admiral. The early records of the admiralty show that the origin of the prize jurisdiction is to be traced to the power given to the court of the admiral to try cases of piracy and "spoil," *i.e.,* captures of foreign ships by English ships.

Although the courts of common law hardly ever seem to have interfered with or disputed the admiralty prize jurisdiction, its exclusive nature was not finally admitted till 1782; but long previously royal ordinances (1512, 1602) and statutes (1661, giving an alternative of commissioners, 1670, 1706) had given the admiralty court the only express jurisdiction over prize. The statute of Anne and acts of 1739 and 1744 give prize jurisdiction to any court of admiralty, including the courts of admiralty for the colonies and plantations in North America.

Prior to the Naval Prize Act 1864, it was necessary for the Crown to confer prize jurisdiction upon the admiralty court by a special commission at the commencement of a war; this practice although no longer necessary has, however, been continued since on the outbreak of every war (see the Zamora, 1916, A.C. 77 96). By the Naval Prize Act 1864, the high court of admiralty and every admiralty or vice-admiralty court, or any other court exercising admiralty jurisdiction in British dominions, if for the time being authorized to exercise prize jurisdiction, were made prize courts. The high court of admiralty was given jurisdiction throughout British dominions as a prize court, and, as such, power to enforce any order of a vice-admiralty prize court and of the judicial committee of the privy council in prize appeals—this power *mutatis mutandis* being also given to vice-admiralty prize courts. An appeal was given from any prize court to the sovereign in council. Prize courts were given jurisdiction in cases of captures made on land by naval or joint naval and military forces or an expedition made conjointly with allied forces, and power to give prize salvage on recaptured ships and prize bounty; and a form of procedure was prescribed. The high court was also given exclusive jurisdiction as a prize court over questions of ransom and petitions of right in prize cases, and power to punish masters of ships under convoy disobeying orders or deserting convoy. By the Naval Discipline Act 1866, power to award damages to convoyed ships exposed to danger by the fault of the officer in charge of the convoy was also given to the high court. Under other statutes it had power to try questions of booty of war when referred to it by the Crown, in the same way as prize causes, and claims of king's ships for salvage on recaptures from pirates, which could be condemned as *droits* of admiralty, subject to the owner's right to receive them on paying one-eighth of the value, and also power to seize and restore prizes captured by belligerents in violation of British neutrality, or by a ship equipped in British ports contrary to British obligations of neutrality.

All jurisdiction of the high court of admiralty has since passed to the High Court of Justice, which is made a prize court with all the powers of the admiralty court in that respect; and all prize causes and matters within the jurisdiction of that court as a prize court are assigned to the probate, divorce and admiralty division; and an appeal from it as a prize court lies only to the king in council (Judicature Acts 1873 and 1891).

By the Prize Court Act 1894 further provision is made for the constitution of prize courts in British possessions. A commission, warrant or instruction from the Crown or the admiralty may be issued at any time, even in peace; and upon such issue, subject to instructions from the Crown, the vice-admiral of the possessions on being satisfied by information from a secretary of State that war has broken out between Great Britain and a foreign State, may make proclamation to that effect, and the commission or warrant comes into effect. The commission or warrant may authorize a vice-admiralty court or colonial court of admiralty to act as a prize court, or establish a vice-admiralty court for that purpose, and may be revoked or altered at any time.

By 4 and 5 Geo. V. c. 13 the provisions of the act of 1864 specified in the schedule to the act of 1914 relating to practice and procedure were repealed and rules in substitution in pursuance of 57 and 58 Vict. c. 39, s. 3, were made by Order in Council, with the proviso that nothing shall extend s. 16 of the act of 1864 to ships of war taken a prize, see *Rules* of Court in Prize Proceedings, Order in Council, Aug. *5, 1914,* which were subsequently amended by Order in Council issued as "Statutory Rules" on Nov. 28, 1914; Feb. 3, 1915; April 29, 1915; and Dec. 21, 1917.

British Prize Law.—The law to be administered by British prize courts is laid down in the commissions issued from time to time to the lord high admiral (now the lords of the Admiralty) "to empower the high court of admiralty (now the High Court of Justice and the judges thereof) to take cognizance of and judicially proceed upon all and all manner of captures, seizures, prizes and reprisals of all ships, vessels and goods that are or shall be taken, and to adjudge and condemn the same according to the course of the admiralty and law of nations; as also ships and goods liable to confiscation pursuant to the respective treaties with His Majesty and other princes and States" (Burchett's Naval History, 1719). The "course of the admiralty" was understood to mean the maritime law and customs of the sea, as recognized and applied by the maritime nations of Europe. "The law of nations" was wider. It included also treaties, the decisions of courts and the writings of jurists. Later it included international conventions, such as the Geneva Convention of 1906, Hague Conventions of 1899 and 1907, the Declarations of Paris 1856, and London 1909. Consequently British prize courts are bound to administer international law, but since they are municipal courts drawing their authority from the king in the parliament, they are bound by an act of parliament, even if it be contrary to the law of nations. They are not, however, bound by Orders in Council although they will act on them when they amount to a mitigation of the rights of the Crown in favour of the enemy or neutrai (see the Zamora, 1916, 2 A.C. 77; 2 B. & C.P.C. 1). Precedents are followed, but not blindly. As Sir Samuel Evans said in the Odessa (1914) 1 B. & C.P.C. at p. 175, they "should be treated as guides to lead and not as shackles to bind." By the Prize Court Rules 1914, captors may support their case by any evidence derived from extrinsic sources. In many cases of continuous voyage, for instance, it was only possible to detect and prove contraband trading by the interception of letters, cables and wireless messages.

See also Prize Cases Decided in the *United* States *Supreme* Court, *1789–1918* (1923). (X.)

The United States.—The Constitution of the United States vests the judicial power of the United States "in one Supreme Court and in such inferior courts as the Congress may from time to time ordain and establish." The judicial power shall extend "to all cases of admiralty and maritime jurisdiction" and the Supreme Court has appellate jurisdiction in prize cases. (Constitution, Art. III.) The Federal district courts have original jurisdiction "of all prize brought into the United States; and of all proceedings for the condemnation of property taken as prize." (42 U.S. Stat. 634.)

Art. I., section 8, of the Constitution provides that Congress shall have power "to declare war, grant letters of marque and reprisal and make rules concerning captures on land and water." Under this provision Congress has from time to time acted. On Jan. 15, 1780, even before the Constitution was adopted, it was resolved that a court of appeal be established which should hear appeals "in case of capture." The U.S. courts in the early days followed the recognized precedents as Mr. Justice Wilson said in 1796: "When the United States declared their independence, they were bound to receive the law of nations, in its modern state of purity and refinement." (Ware v. *Hylton,* 3 Dallas, 199.)

This applied to maritime capture as was said by Chief Justice Marshall in 1815: "The law of nations is the great source from which we derive those rules, respecting belligerent and neutral rights, which are recognized by all civilized and commercial states throughout Europe and America." (Thirty Hogsheads of *Sugar* v. Boyle, 181j, 9 Cranch, 191.) An early decision, in 1795, had said: "A prize court is, in effect, a court of all the nations in the world, because all persons, in every part of the world, are concluded by its sentences, in cases clearly coming within its jurisdiction." (*Penhallow* v. Doane, 1795, 3 Dallas, 54.) Mr. Justice Story in 1815 stated in the opinion of the Supreme Court: "The Court of Prize is emphatically a court of the law of rations, and it takes neither its character nor its rules from the mere municipal regulations of any country." (The Adeline, 9 Cranch, 244.) The aims of prize courts from the American point of view were stated from time to time by the Supreme Court in later decisions, as in 1882, when Justice Gray said: "Prize Courts are not instituted to determine civil and private rights, but for the purpose of trying judicially the lawfulness of captures at sea, according to the principles of public international law, with the double object of preventing and redressing wrongful captures, and of justifying the rightful acts of the captors, in the eyes of other nations." (*Cushing* v. *Laird,* 107 U.S. 69.)

The United States has also negotiated many treaties with the States of Central and South America which contain articles similar to the following of 1887 with Peru:—

Article XXV.

It is further agreed, that in all prize-cases, the courts especially established for such causes in the country to which the prizes may be conducted shall alone take cognizance of them. And whenever such courts of either party shall pronounce judgment against any vessel, merchandise, or property claimed by the citizens of the other party, the sentence or decree shall set forth the reasons or motives on which the same shall have been founded; and an authenticated copy of the sentence or decree, and of all the proceedings connected with the case, shall, if demanded, be delivered to the commander or agent of the said vessel, merchandise, or property, without any excuse or delay, upon payment of the established legal fees for the same. (25 U.S. Stat. 1444.)

In 1900 the Supreme Court, speaking through Justice Gray in regard to exemption of coast fisheries in time of war, said: "This rule of international law is one which prize courts, administering the law of nations, are bound to take judicial notice of, and to give effect to, in absence of any treaty or public act of their own government in relation to the matter." *(The Paquete Habana,* 175 U.S. 677.) In this same case it was said:—

"International law is part of our law, and must be ascertained and administered by the courts of justice of appropriate jurisdiction, as often as questions of right depending upon it are duly presented for their determination. For this purpose, where there is no treaty, and no controlling executive or legislative act or judicial decision, resort must be had to the customs and usages of civilized nations; and, as evidence of these, to the works of jurists and commentators, who by years of labour, research and experience, have made themselves peculiarly well acquainted with the subjects of which they treat. Such works are resorted to by judicial tribunals, not for the speculations of their authors concerning what the law ought to be, but for trustworthy evidence of what the law really is." (G. G. W.)

Other Countries.—The French court is an administrative not a judicial tribunal, with a *conseiller d'État* as president and six members chosen from the *maîtres des requêtes* and officials of the Ministries of Marine and Foreign Affairs. An appeal lies to the *conseil d'État.* The law is contained in treaties, national laws and decrees, custom and practice and in decisions of the prize courts. The latter are not regarded as binding and are not followed if they would entail inconvenient or inequitable results. The law has been codified in the "Instructions to Naval Officers" of Dec. 9, 1912 and Jan. 10, 1916 (see *Revue générale de Droit Inter. Public,* vol. 25, 1918; Fauchille, *Jurisprudence Française en Matière de Prises Maritimes,* 1919). Prize courts were established in Belgium during the World War. The court of first instance consists of two judges of the court of appeal and four members representing the navy and commerce. In cases exceeding 20,000 francs an appeal lies to the court of appeal, Brussels. The law administered is similar to that in France. The Italian prize court is also only partly judicial. It is composed of members appointed on the recommendation of the Ministries of Justice, Marine and Foreign Affairs. Appeal lies to the Supreme Court of Cassazione. The law administered is that contained in the law merchant and the naval instructions, the latest of which were issued on March 25, 1917. The court is bound by decrees duly promulgated *(see* Fauchille and Basdevant, *Jurisprudence Italienne en Matière de Prises Maritimes,* 1918). In Portugal the tribunal of commerce at Lisbon enjoys jurisdiction in prize automatically. Appeals lie to the Supreme Court of Justice.

During the World War prize courts were established for the German empire at Hamburg and Kiel composed of a judge as president and one legal member, a naval officer and two members representing shipping and commercial interests. Appeal lay to the superior court of prize sitting in Berlin, consisting of three judges, a naval officer and two lay members representing shipping and commercial interests. The law to be administered is contained in the prize code (*Prisenordnung*) of Sept. 30, 1909, and the prize court ordinance (*Prisengerichtsordnung*) of April 15, 1911, both of which were promulgated on Aug. 3, 1914, the latter being amended by an ordinance of March 26, 1916. By article 440 of the Treaty of Versailles, 1919, the Allied and Associated Powers reserved the right to examine all decisions and orders of the German prize courts whether affecting their own subjects or those of a neutral Power *(see* Fauchille and De Visscher, *Jurisprudence Allemande en Matière de Prises Maritimes,* 1922).

During the World War, prize courts were established by the Russian Government at Sebastopol, Kronstadt and Viadivostock. Each court was composed of an official of the Maritime Judicial Administration, two naval officers, two officials nominated by the minister of justice and one by the Foreign Office. An appeal lay to the admiralty council. The law to be administered was that contained in the prize code of 1895, amended in 1904 and revised in 1914. By an imperial ukase of Sept. 1, 1914, the Declaration of London, subject to some modifications, was declared obligatory and was, subject to some further modifications, applied by the courts. The Japanese prize court at Sasebo was composed of a judge as president and eight councillors selected from the navy and from the naval, legislative, foreign and diplomatic departments. Appeals lay to the higher prize court at Tokyo composed of a privy councillor and eight councillors. The law administered is contained in the Regulations issued in 1894, 1904 and 1914. The latter enacted that the principles of international law should be applied, subject to any national law, regulation or treaty, and in any event to reciprocal treatment (see *Rules of Naval War of Japan; Bulletin de l'Institut Intermédiaire International,* vol. XI. p. 9, 1924; Hurst and Bray, *Russian and Japanese Prize Cases,* 1912). By the Chinese Prize Courts Rules of Oct. 30, 1917, district prize courts were established with a personnel similar to that of the Japanese courts. An appeal lay to the high prize court composed of the president of the Supreme Court and eight members, representatives of the judicial, naval and administrative departments. The law to be administered is contained in the Chinese Prize Court Rules and Regulations, and when these are silent in the "law, treaties and international usage." The Hague Conventions II. and VI. were found by the courts to be binding (see *Chinese White Book,* 1918; *F. T.* Cheng, *Judgments of the High Prize Court of China,* 1919). Prize courts were established in Siam by the law of July 20, 1917. It was held by the Bangkok prize court that the law to be administered was the law of nations and not the municipal law (see *Reports of Prize Decisions* in the Fry library, London School of Economics).

An International **Prize** Court.—After much discussion, more particularly by the Institute of International Law and the International Law Association, a Convention for the institution of an international prize court was adopted by the Hague Peace Conference of 1907. By Convention XII. the court was to be a court of appeal from the prize court of a belligerent captor "upon the ground that the judgment was wrong either in fact or in law." In the absence of a treaty by the parties to the proceedings the court was to apply the rules of international law, and if no generally recognized rule existed, the court was to give judgment in accordance with the general principles of justice and equity. Owing, however, to the alleged uncertainty of the law the Convention was not ratified by any of the Powers, and a naval conference was held in London in 1908 for the purpose of codifying "the acknowledged principles of international law." The resulting Declaration of London purported to embody these principles in the rules which it formulated on blockade (*q.v.*), contraband (*q.v.*), unneutral service, destruction of neutral prizes, transfer to a neutral flag *(see* NEUTRALITY), enemy character, convoy (*q.v.*) resistance to search *(see* VISIT AND SEARCH), compensation.

BIBLIOGRAPHY.—R. Touch, *Jurisdiction of the Admiralty of England Asserted* (1686); *C.* Robinson, *Collectanea Maritima* (1801); *R.* J. Phillimore, *International Law,* vol. i., vol. iii., pt. xi. (1854–61); R. *A.* Pritchard, *Admiralty Digest* (1865); *R.* G. M. Browne, *Admiralty Procedure* (1887); R. G. Marsden, *Select Pleas of the Court of Admiralty* (1892); *J.* A. Hall, *Law of Naval Warfare* (1921); *E.* S. Roscoe, *History of the English Prize Court* (1924); C J. Colombos, *A Treatise on the Law of Prize* (1926); *J.* W. Garner, *Prize Law During the Wmld War* (1927); *H.* Hull, *Digest of Cases decided in British Prize Courts* (1927).

PRIZREN, a town of S. Serbia, Yugoslavia. Pop. (1931), 18,952, chiefly Albanians, with some Serbs, Greeks and Vlachs, Prizren is beautifully situated 1,424 ft. above sea level among the Shar Planina mountains, and has an excellent water supply. The city is the seat of a Roman Catholic Archbishop, and a Greek bishop, and there is also a Serbian theological seminary. Its chief buildings are the citadel and many mosques, one of which is an ancient Byzantine basilica, originally a Serbian cathedral.

Prizren has sometimes, though on doubtful evidence, been identified with the ancient *Tharandus* or *Theranda.* In the 12th century it was the residence of the kings of Serbia. From the 13th century to the 16th Prizren had a flourishing export trade with Ragusa. The town was taken by the Serbians in 1912, and assigned to them by the Treaty of Bucharest (1913). Soon after the outbreak of World War I the government and the Serbian army retired there, followed by thousands of homeless refugees. Italy occupied Prizren during World War II.

PRJEVALSKY [PRZHEVALSKY] , **NIKOLAI MIKHAILOVICH** (1839–1888), Russian traveller, born at Kimbory, in the government of Smolensk, on March 31, 1839. He was educated at the Smolensk gymnasium, and in 1855 became a subaltern in an infantry regiment. In 1856 he became an officer, and four years later he entered the academy of the general staff. From 1864 to 1866 he taught geography at the military school at Warsaw, and in 1867 was admitted to the general staff and sent to Irkutsk, where he explored the highlands on the banks of the Usuri. This occupied him until 1869, when he published a book on the Usuri region, partly ethnographical in character. Between Nov. 1870 and Sept. 1873, accompanied by only three men, he crossed the Gobi desert, reached Peking, and explored the Ordos and the Ala-shan, as well as the upper part of the Yangtsze-kiang. He also penetrated into the then closed country of Tibet, reaching the banks of the Di Chu river.

On his second journey in 1877, while endeavouring to reach Lhasa through east Turkestan, he re-discovered the great lake Lop-nor (*q.v.*). On his third expedition in 1879–80 he penetrated, by Hami, the Tsai-dam and the great valley of the Tibetan river Kara-su, to Napchu, 170 m. from Lhasa, when he was turned back by order of the Dalai Lama. In 1883–85 he undertook a fourth journey in the mountain regions between Mongolia and Tibet. On these four expeditions he made valuable collections of plants and animals. He discovered the wild camel and the early type of horse, now known by his name (*Equw prjewalskii*). In Sept. 1888 he started on a fifth expedition to Lhasa, but on Nov. 1 he died at Karakol on Lake Issyk-kul. A monument was erected to his memory on the shores of the lake, and the town of Karakol (*q.v.*) was renamed Przhevalsk.

The English translation of the account of his first journey, *Mongolia, the Tangut Country, and the Solitudes of Northern Tibet (1876)* was edited by Sir Henry Yule; the account of his second journey, *From Kulja, across the Tian-Shun, to Lop-nor,* was translated into English in 1879.

PRQA (Malay, *prau*), the general term in the Malay language for all vessels, from the *sampan* or canoe to the square-rigged *kapal,* but in western usage confined to the swift-sailing craft that the pirates of the Indian Ocean made familiar to sailors in eastern waters. The chief points which characterize these vessels are that while the weather-side is rounded the lee-side is flat from stem to stern, that both stem and stern are exactly similar in shape, and that there is a small similarly shaped hull swung out from the side of the main hull on poles, which acts as an outrigger and prevents the vessel heeling over. The main hull carries the mast rigging and an enormous triangular-shaped sail.

PROBABILISM, a term used both in theology and in philosophy with the general implication that in the absence of certainty probability is the best criterion. Thus it is applied in connection with casuistry for the view that the layman in difficult matters of conscience may safely follow a doctrine inculcated by a recognized doctor of the church. This view was originated by the monk Molina (1528–1581), and has been widely employed by the Jesuits. In philosophy the term is applied to that practical doctrine which gives assistance in ordinary matters to one who is sceptical in respect of the possibility of real knowledge: it supposes that though knowledge is impossible a man may rely on strong beliefs in practical affairs. This view was held by the sceptics of the New Academy (*see* SCEPTICISM and CARNEADES). Opposed to "probabilism" is "probabiliorism" (Lat *probabilior,* more likely), which holds that when there is a preponderance of evidence on one side of a controversy that side is presumably right.

PROBABILITY (in Logic) is commonly contrasted with certainty. Some of our beliefs or judgments are entertained with certainty, others there are of which we are not so sure. The degrees of confidence with which the logic of probability is concerned are those which are correlated with different kinds of objective evidence, different degrees of objective cogency, not with the confidence which depends on mere feeling, or arises we know not how. In other words, we are concerned with degrees of *rational* belief or confidence. Again, the degrees of confidence attach to the beliefs or the judgments, or the propositions expressing the beliefs or judgments, so that strictly speaking the probability refers to the judgments or propositions, not to the things or events to which these refer. Things just are, and events just happen — there is no certainty or probability in *them.* Only our judgments about them can be more or less probable.

Cases of calculable probability are of two main types, namely, those which can be calculated a *priori,* or deductively, and those which can only be calculated *a posteriori,* or inductively. The *a priori* type is that in which the calculation can be made by reasoning deductively from the nature of the case, and without reference to actual observations of the kind of events under consideration. The *a posteriori* type consists of those cases in which the calculation can be made only with the aid of previous observations of similar events.

The A Priori Calculation of Probability. — In order to be able to calculate the probability of an event deductively from the nature of the case, the following conditions must be satisfied: (*a*) We must know the total number of mutually exclusive possibilities, one or other of which must be realized. (b) These possibilities must be equally likely. And (c) we must know how many of these possibilities are favourable to the event contemplated, that is, in how many of them it will be realized. The probability of the event in question is then expressed by means of a fraction in which the numerator gives the number of possibilities favourable to the event, and the denominator states the total number of equally likely possibilities. Clearly, the greater the total number of possibilities, the smaller is the probability (or chance) of any special one of them being realized; that is, if p represents the probability of an event and t the total number of equally likely events of which it is one, then p and t will vary inversely. For example, the chance of throwing head when tossing a coin is greater than that of throwing face six when throwing a die, because the former result is one of two possibilities, whereas the latter is only one of six. On the other hand, the greater the number of possibilities that are favourable, the greater is the probability. For instance, when throwing a die the probability of getting an even number is greater than that of throwing face six in particular, because there are three even numbers and only one six on a die. In this way, if the number of favourable possibilities be represented by f, we get the following general formula for probability: $p=f/t$.

A word may also be said about "odds" and "chances," terms which are more in popular favour than is the term "probability." The term "chances" is used sometimes for "probability" and sometimes for "odds." By "odds" is meant the ratio of favourable to unfavourable possibilities. By the odds *against* an event is meant the ratio of the unfavourable to the favourable possibilities.

In the case of simple events, like those of throwing a die or tossing a coin, there is no difficulty whatever in determining the values of favourable possibilities and of the total number of equally likely events and therefore of probability. With complex events (that is, those in which two or more separate events can be distinguished) care has to be exercised. The total number of possibilities in such cases is not the *sum* of the possibilities of the separate events, but their multiple, *e.g.,* if a die is thrown twice the total number of possibilities is not $6+6$, but 6×6 or 36, because for *each* possible result of the first throw there are six possibilities with the second throw. Now, the probability of a complex event may, according to circumstances, be either greater or less than the probability of the separate component events. The probability is less if the complex event contemplated is one in which certain component events must occur in a certain order, say *1* followed by *6* in two throws of a die, for either of the component events might happen without the other also happening, and then one of the component events would be there but not the compound event. In such cases the probability is obtained by multiplying the fractions expressing the separate probabilities of the several component events. On the calculations of probability *see* PROBABILITY AND ERROR.

Equally Likely Possibilities. — Why is it stipulated that the alternative possibilities must be equally likely? The point can be made clear by comparing two simple cases. Suppose one were to argue that a properly balanced coin when tossed must either throw head or not, so that there are two alternatives, of which head is one, and therefore its probability must be *1/2*. The answer would be true, but the reasoning would be wrong, as may be seen from the next case. Suppose one were to argue that a properly constructed die, when thrown, must either show face six or not, so that there are two possibilities of which face six is one, and therefore its probability is *1/2*. Here the answer is obviously wrong. But why? Because the possibility "not-six," that is, of face six not showing, really represents five different possibilities against the one "six," and must therefore be weighed accordingly as having a value five times that of "six." The probability of "not-six" is really *5/6*, while that of "six" is *1/6*. It was a mere accident that in the case of the coin "not-head" happened to represent only one alternative, namely, "tail." If no attention were paid to the equality of the alternative possibilities, then any statement, the truth of which we are not in a position to judge, would be judged to be as likely to be true as not—some logicians have actually assigned it a truth-probability of *1/2!* It would be just as accurate to say that there is a probability of *1/2* that an unknown marksman will hit the bull's eye—an absurd estimate when it is remembered that there are innumerable places, on and off the target, which are all included under "not bull's eye" as against the very limited area of "bull's eye." If the available data are insufficient, why estimate the probability at all? Why not suspend judgment? There is no particular virtue in emulating Bagehot's village maiden who must have an opinion about everything under the sun.

The next question is, how is one to make sure whether the alternative possibilities really are equally likely, or at least approximately so? Sometimes this is not very difficult to determine. In the case of a coin, or a die, *e.g.,* it is not impracticable to examine them sufficiently closely and ascertain whether or no they are properly balanced. And if properly balanced, the possibilities which they offer would be adjudged to be equally likely. But suppose one cannot be sure. Is there not some other way of testing the equality of the possibilities? Well, there is — namely, by actually tossing the coin, or throwing the die, a great many times, and noting the results. If, on an average, each side of the coin, or of the die, appears approximately an equal number of times, then the alternative possibilities would be regarded as equally likely. But the significance of this kind of test must be noted carefully, if only because of its bearing on the inductive, or a *posteriori* calculation of probability.

This kind of test is not direct but indirect, or inverse, in the sense in which induction is said to be inverse deduction. The logic of the test is this. We argue that if the possibilities represented, say, by the several faces of the die, are really equally likely, then when the die is cast a sufficiently large number of times, each face should, on an average, and in the long run, appear approximately once in six throws. This rate of appearance is called its *frequency.* So that this mode of procedure may be described as consisting in testing the equality of the possibilities by reference to the frequency which seems to be implied in the probability calculated on the assumption of their equality.

Now, in calculations of probability, "frequency" and "probability" are so frequently identified or confused that it is important to mark their difference. When the a *priori* probability, say, of face six appearing when a die is cast, is given as *1/6,* what this really means is that "the appearance of face six is one of six equally likely possibilities"; and so always f/t simply has reference to possibilities, which may never be tested at all. One never thinks of adding the expression "in the long run" to the fraction expressing a probability. On the other hand, when a frequency is stated, even or especially when it is expressed by the same fraction as the corresponding probability, the phrase "in the long run" is essential, otherwise the frequency given would be wrong, in view of the series of long runs of some one number, which are so common.

We may now turn to the a *posteriori* calculations of probability, a method the true character of which has already been suggested in the preceding remarks.

THE A POSTERIORI CALCULATION OF PROBABILITY

In many and most important cases, it is impossible to calculate the probability a *priori,* because the alternative possibilities cannot be regarded as equally likely. Take, for instance, the case of a sick man. What is the probability of his recovery from his illness? This cannot be calculated a *priori.* It is true, of course, that there are only two alternatives — either he will recover or he will not. But these two alternatives cannot be regarded as equally likely, without special evidence. If they could be so regarded, why then the chance of recovery from cerebral meningitis would be the same as that of recovering from a common cold—which is belied by actual results. And if the alternative possibilities are not equally likely, as indeed they are not, then the probability cannot be estimated a *priori.* How, then, shall it be calculated? Well, it can still be calculated a *posteriori* if the results of a sufficiently large number of cases have been observed, that is to say, if we know the *frequency* of the type of case under consideration. For then, just as it is possible, as we have seen it is possible, to derive the frequency of an event from its probability, where the probability can be calculated a *priori,* so it is possible by a *reverse process* to derive the probability of an event from its observed frequency, even in cases in which the probability cannot be obtained a *priori* at all. Suppose, for instance, that, in the above-mentioned case of the die, face six did not in the long run appear in approximately one out' of six throws, but, say in one out of nine throws. Then by treating this frequency as an index to its probability we should say that the probability of face six turning up is *1/9,* which means that it behaves *as if* it had an a *priori* probability of *1/9,* or as if it had been one of nine equally likely possibilities — which, of course, it is not. In this way, provided we have sufficient data to determine their frequency, the calculus of probability can be applied to all sorts of otherwise incalculable events, such as birth, marriage, death, and the thousand and one ills that flesh is heir to.

Writers on probability are frequently inclined to regard the a *posteriori* method of calculating probability as the fundamental method. They would either like to banish a *priori* calculations altogether or only tolerate them as more or less intelligent anticipations, or frequencies. But this theory (known as the frequency theory) of probability is hardly tenable. Frequencies show considerable variations with the number of cases observed, *e.g.,* when tossing a coin the proportion of heads to tails varies remarkably, accordingly as one stops at the 100th, 1,000th, 10,000th or 20,000th toss. One might obtain almost any proportion by stopping at the right moment. Hence the need of the saving clause "in the long run"—*in the long* run a die will throw six in one of the six throws, and so on. Even so the element of arbitrariness is not entirely disposed of. As here conceived, the fundamental form of the calculus of probability is the a *priori* form, of which, as already explained, the *a posteriori* method is simply an inverse process, which treats frequency as a measure of probability, although the two are really different things. There is nothing unusual in the use of the inverse process, or the resort to "as if" fictions. Our view of the calculable cases of probability makes it possible to keep together all types of probability without any artificiality or straining. In all cases alike the uncertainty arises from the presence of other possibilities than those contemplated.

In some cases these other possibilities can be allowed for by some direct or indirect calculation; in other cases they cannot be estimated at all, except in a very rough and unpractical manner. On the other hand, the frequency theory of probability does not really apply to non-measurable cases. Even in its modified form, in which frequency is taken to mean the truth-frequency of certain classes of propositions, it seems unsatisfactory. One is asked to determine the probability of a judgment by ascertaining the probability of the class of propositions to which it belongs. But suppose the proposition cannot be assigned to its proper class unless its probability is known?

The Use of the Calculus of Probabilities.—One may ask, in conclusion, what is the practical use of calculations of probability? Some people have exaggerated ideas on the subject. The exaggeration is due in great part to the common confusion of probability with frequency. Frequencies, when treated with the necessary precautions, may be of great practical value when we are dealing with large numbers of facts of the same kind. This is evident from their use in connection with all varieties of insurance schemes, etc., in which the certainty of large numbers can be relied upon to atone. in some ways, for the uncertainty in the lot of the individual. But whereas frequencies are always concerned with large groups, or with long series of events, or with what happens "in the long run," probability is also concerned with individual cases, or small groups of events. This makes all the difference, as may be seen, say, in roulette. The bank, doing business with a great many players, can rely on frequencies. The individual player, limited to a comparatively small number of hazards, relies on the ambiguous calculus of probability (when he is not guided by sheer superstition). The calculus is always right, even when the player loses. For the actual events are matters of frequency, not of mere probability. There are ingenious gambling systems based on frequencies; but even these systems have their day and cease to be. The best of them depend on "the long run," which easily outruns the resources of the average individual. For similar reasons, even in legitimate insurance business, the company has a great advantage over the individual client. But the practical exigencies of life induce responsible individuals to prefer high risks for comparatively small amounts rather than small risks for large amounts. No mere calculation can eliminate the uncertainty of the probable when individual cases are involved. Here, in the last resort, the only safe, or least unsafe, method of ascertaining its probability consists in a close examination of the actual conditions by a suitable expert. Even life insurance companies probably put more faith in the medical report on each case than in their statistical life-tables.

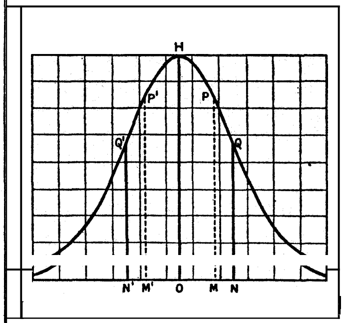
BIBLIOGRAPHY.—J. Venn, *The Logic of Chance* (1890); J. M. Keynes, *A Treatise on Probability* (1922); A. Wolf, *Essentials of Scientific Method* (1928). (A. Wo.)

PROBABILITY AND ERROR. The theory of probability is that branch of mathematics which deals with the objective numerical measurement of probability. The theory of error, or the consideration of the frequency-distribution of errors, is the main link between the theory of probability and the theory of statistical frequency.

THEORY OF PROBABILITY

1. Rough estimates of relative probability are often easily made. I draw a ball from a box containing one red ball and four white ones: if I say that I am more likely to draw a white than the red, the statement is intelligible. But can I be more precise? Can I give a numerical measure to the probability of drawing the red ball?

A question of this kind might perhaps be parried by the question: Why should anyone want a numerical measure of the probability? The answer may be, in some cases, that it is a matter of scientific interest; or it may be, in other cases, that questions of this kind are important in games of chance. The study of the theory of probability was, in fact, in the first instance, the scientific study of gambling; though the primary question was not the numerical measure of a chance but its money value. Suppose, in the case of the five balls, that I am to receive £50 if I draw the red ball, but nothing if I draw a white; then (subject to certain conditions) my chance is worth £10. This suggests a numerical measure of probability. Suppose there is a prize W in a lottery, and my chance of winning it is worth V; then V is pW, where p is some fraction between 0 and 1. If the prize W were doubled, the conditions remaining the same, the value V of the chance would be doubled, and so on. Thus, the conditions of the lottery remaining the same, V bears a constant ratio to W; and this ratio, which is a fraction between 0 and 1, might be called the chance, or probability, of my winning the prize. The value of my chance is then found by multiplying the prize by this chance or probability. This definition, however, is not entirely satisfactory; for, the value V being based on, at best, a general agreement, its ratio to W cannot be regarded as a definite objective measure. We need some method of measurement that is based on facts, not on opinions. Two methods have been suggested (secs. 2 and 4).



STANDARD NORMAL FIGURE OF FREQUENCY
The relative frequencies of deviations are from the mean value, ON or N'O representing the "standard deviation." The ordinates M' P', OH, MP divide the area of the figure into four equal portions

2. Unitary Method.—The first method to be considered involves a definition which is stated in various ways, but can perhaps be best stated as follows. If an event will happen in one, and only one, of c ways, all of which are equally likely, and if a of these ways are called favourable, then the probability or chance of the event happening favourably is a/c. Thus, in the case of a ball being drawn from a box containing one red and four white balls, the event is the drawing of a ball, and the ways of the event happening are the drawing of a red ball and the drawing of one of the white balls; if all the balls are equally likely to be drawn, the probability of the red being drawn is $1/5$, and the probability of a white being drawn is $4/5$. Since the basis of the method is the supposition that the happening of the event can be subdivided under a number of ways, each of which is equally likely, and the chance of the event happening favourably is found by counting the number of the favourable ways, we can call it the *unitary* method.

3. Defects of the Method.—While the definition is a simple one as regards a good many problems, it has defects, of which the following may be mentioned.

(i.) It applies only to probabilities of subsequent events, not to those of concurrent or antecedent events (sec. 12).

(ii.) The phrase "equally likely" is not defined. If this means that the probabilities of the different ways are all equal, we are working in a circle. If it means that we do not see any reason why one way should occur rather than another, we are basing the definition on ignorance.

(iii.) There are a great many cases in which the possibility of an event happening cannot be split up into a number of ways all of which are equally likely, however this may be defined. If a box contains an equal number of red balls and white balls, and the red are of the same size as the white but are slightly heavier, the statement that a white is more likely to be drawn than a red is intelligible, but it is difficult to bring the case under the definition. A statement as to probability can here only have a statistical meaning, as explained in sec. 4.

4. Statistical Method.—The alternative to the unitary method is the *statistical* method. Suppose that an event (or fact or set of conditions, etc.) C might occur in a large number N of cases, and that whenever it might occur it would necessarily be associated with one of two or more mutually exclusive events E, E', E'' . . . ; "mutually exclusive" meaning that on each occasion only one of these events can occur. Of the total number N of cases, suppose that E would occur in pN cases, E' in $p'N$ cases,

E'' in $p''N$ cases .... Then p, p', p'' ... are said to be the probabilities of C being associated with E, E', E'' .... It is clear that $p+p'+p''+ \ldots = 1$.

In reference to cases of this kind we should use the word '(probability" rather than "chance," since the question is not necessarily as to the happening of some future event. The definition can be applied equally to the probability of a future or a present or a past event. The numerical probability is in each case the result of grouping the C-cases into classes according as they are associated with E or with E', etc., and taking the probabilities to be proportional to the numbers in the different classes. If, for instance, in the case considered in sec. 1, we say that the probability of the red ball being drawn is $1/5$, we mean that in the long run (sec. 8), or on the average, the red ball will be drawn about once in five times.

If an event E occurs in m cases out'of n, m is called the *frequency* of occurrence of E, and the ratio m/n is its relative *frequency*. Thus the probability of an event is the same thing as its relative frequency when the number of cases considered is very large.

5. Observations on the Definition.—The following are points in reference to the definition.

(i.) We say that the red ball will be drawn "about" once in five times, because we can never know the exact probability of any event; and it is, indeed, doubtful whether there is any exact probability of anything. We may throw a die 100,000 times, and note the number of cases in which a 6 occurs; but if we throw another 100,000 times we shall get a slightly different result. The study of variations of this kind forms part of the theory of error, which, again, is part of the general theory of frequency distributions.

(ii.) We proceed, however, as if any probability with which we are dealing has a definite value. For practical purposes, therefore, we should not use actual observations as the means for determining a probability unless we have made a fairly large number of observations; until we have done so, we may have to depend on a *priori* considerations.

(iii.) The determination of the probability of an event, on the statistical basis, involves a process of classification. A man comes to have his life insured for a year. We require, at least, to know his age. Knowing this, we put him into a certain class or category, namely, the category of men of that age; and we find that, of men of that age, 99 out of 100, on the average, survive for a year. We therefore say that his chance of surviving is 99/100. But this does not imply that there is such a thing as chance, in the ordinary sense; nor is it a statement as to the individual, as distinct from the rest of the class. We do not treat him as an individual, but as one of the class, taken at random. Further information may alter the chance. We find that he will be working in an unhealthy climate: this means a further limitation, defining more strictly the class in which he is to be placed; and so on. The ultimate probability assigned to him is the probability of survival for a year in the class in which he is ultimately placed.

6. Illustrative Example.—As a basis for illustration of the statistical definition, let us take a concrete case. A man being called short or tall according as his height is under or over 67) in., suppose that, in a community in which every man has one son who attains maturity, the statistical relation between height of father and height of son, in a representative (sec. 15) 1,000 pairs of father and son, is given in Table I. This table, if our supposition is correct, provides us with various statements as to probability, of which the following are examples.

TABLE I.
(Adapted from K. Pearson and A. Lee, *Biometrika* ii. [1903], 415)

	Father short	Father tall	Total fathers
Son short .	250	89	339
Son tall . .	215	446	661
Total sons .	465	535	1,000

(i.) The probability that a father is tall is 535/1,000. (This is a short way of saying: if a father is taken at random, the probability that he will be one of the tall fathers is 535/1,000. The phrase "at random" is considered in sec. 9.)

(ii.) The probability that a son is tall is 661/1,000.

(iii.) The probability that a tall father has a tall son is 446/535.

(iv.) The probability that a short son has a tall father is 89/339.

7. Relation Between the Two Methods.—To some extent the two methods—unitary and statistical—supplement one another. On the one hand, as was stated in sec. 5, a priori considerations may have to be brought into account in order to obtain a rough value of a probability. On the other hand, we may use the results of experience to check our a priori estimate of a probability. Consider, for example, the throwing of a die. The die is approximately a cube; it has six faces, so that, on the unitary system, we should say that the chance of a 6 being thrown is 1/6, or at any rate is about 1/6. But it should be observed that what is really of importance to us, if we are frequently risking. money on the throwing of a die, is not the probability, as estimated by the unitary method, of a particular face appearing, but the proportion of cases in which, in the long run, it actually does appear. If we record these, we may find that the 6 appears rather oftener than we had expected. We can then do either of two things. We can base our probability on the actual experience, or we can consider in what respect our original estimate was faulty. We must then take account of the fact that the pips of the die are hollowed out, so that the die is lighter on the 6-side and heavier on the opposite side. It would be very difficult to estimate the effect of the hollowing-out of the pips, and we should thus be driven to the statistical method, *i.e.*, to basing our probability on experience.

It will be assumed, throughout this article, that we are dealing with probability according to the statistical method. If, for example, we say that there are five balls in a box, and that they are all equally likely to be drawn, this is to be interpreted as meaning that in N drawings, where N is very large, each ball is drawn approximately $1/5 \cdot N$ times. Similarly, if it is said that the probability that a man will survive for a year is p, this is to be taken as meaning that, out of N men who would be put into the same class, the number who will survive for a year is about pN.

8. "The Long Run" and "Series."—The use of the phrase ('in the long run," and the description of a number of events as a "series" (*e.g.*, "a Poisson series"), are not to be taken as implying a definite arrangement, in time or otherwise. We might, of course, wish to observe the succession of observations, *e.g.*, the succession of colours at roulette; but in this case the succession is the event we are observing, and the order in which the individual events occur is not relevant. Phrases such as "in the long run" merely imply that the number of cases observed is very large.

9. Randomness.—In the statement of a problem in probability the expression "random" or "at random" is often used. Thus, in the case of balls in a box it may be stated that "a ball is drawn at random from the box." This may be regarded as merely an indication that we are dealing with a question in probability. On the other hand, the idea of randomness is implied in any statement as to the numerical measure of a probability. When we say "If a card is drawn from a pack, the probability that it will be a court card is 3/13," we really mean "If a card is drawn at random from a pack, the probability that it will be a court card is 3/13."

10. Addition and Multiplication of Probabilities.—The mathematical treatment of probabilities involves the addition and multiplication of their numerical measures. These are performed according to certain rules.

(i.) The rule for addition is as follows. Let E and E' be two mutually exclusive events which might be sssociated with C, and let the probabilities of their being so associated be p and p'

respectively: then the probability that either E or E' will be so associated is $p+p'$. This follows easily from the definition.

(ii.) The rule *for* multiplication is that, if C and D are two separate events, both of which occur, and if the probability of C being associated with E is p, and if, in the cases in which C is associated with E, the probability of D being associated with G is r, then the probability that C will be associated with E and D with G is pr. For, if N is the total number of cases in which C and D both occur, the number in which C is associated with E is pN, and the number of these in which D is associated with G is $r\times pN=prN$.

For an illustration of the multiplication rule, we can have recourse to Table I. If we take a father at random (which is the same thing as taking a pair, father and son, at random, since father and son go together), the probability that he will be short is 465/1,000; and, if a father is short, the probability that he has a tall son is 215/465. Hence, if we take a pair, father and son, at random, the probability that the pair consists of a short father and a tall son is 215/1,000; which agrees with the table.

If r has the same vaiue whether C is associated with E or not, or, to put it differently, if the probability of C being associated with E and D with G is the product of the separate probabilities of C being associated with E and D with G, the associations of C with E and of D with G are said to be independent.

11. Scope.—The earlier studies of probability led to the development of the theory of combinations and permutations; and the more simple problems of chance are largely concerned with applications of this theory. Many such problems are dealt with in text-books, as well as in previous editions of this work, and it is not necessary to give examples here. The part of the subject with which we are more particularly concerned may be taken as beginning with the theory of error, its stages being marked by the successive inclusion of frequency-distributions generally, and of correlation. Before dealing with these aspects, it is necessary to give brief consideration to the theory of probability of causes.

PROBABILITIES OF CAUSES

12. Direct and Inverse **Probability.**—Questions as to the respective probabilities of a specified event having been due to various possible causes have in the past produced a good deal of difficulty, and have been placed in a separate category as questions of inverse probability; questions as to probabilities of a specified cause leading to different events are then described as questions of direct probability. That difficulties should have arisen is not to be wondered at, as no clear definition of the probability of a cause seems to have been given: until we know what we mean by "probability," we cannot give a numerical value to it. A more serious cause of difficulty, in many cases, was the absence of sufficient information as to the antecedent probabilities of the causes themselves. The final death-blow to the classification of questions of probability under the heads of "direct" and "inverse" was given by the statistical treatment of correlation, which led to the study of probabilities of concurrent phenomena. What is the probability that a tall man has a tall wife? What is the probability that a boy who is good at arithmetic is good at composition? What is the probability that a girl with fair hair has blue eyes? Questions such as these found no place in the earlier classification. These difficulties have been met by the adoption of a statistical basis for the measurement of probability.

13. Typical Example.—The following may be taken as a typical question in inverse probability. A box contains 5 balls, and it is known that 1 of the balls is white and 3 are red, and that the remaining one is either white or red. A ball is drawn and is found to be white. What is the probability that the box contained 2 white and 3 red balls? It is impossible to answer this question without further information. The box has been filled in some way: the method of filling having led to the box containing 1 white and 3 red balls, we require to know the probability that it has led to the other ball being white or red, respectively. When we know this, the problem is a straightforward one.

Let us call the box a "W-box" or an "R-box" according as the other ball is white or red; and let us suppose that the probabilities, or relative frequencies (sec. 4), of W-boxes and of R-boxes are in the ratio of 3:2. Then the problem can be stated as follows. There are W-boxes containing 2 white and 3 red balls, and R-boxes containing 1 white and 4 red balls; their frequencies being in the ratio of 3:2. A box is taken at random; and a ball is drawn from it and is found to be white. What is the probability that the box is a W-box?

The ordinary method of answering the question is an application of the rule that, if an event E has happened which may be due to any one of the causes $C_1, C_2\ldots$, and if the *a priori* probability of occurrence of the cause C_f is P_f, and if whenever C_f occurs the probability that it will lead to E is p_f, then the probability that E is due to Cj is proportional to P_fp_f, *i.e.*, is $P_fp_f/(P_1p_1+P_2p_2+\ldots)$. In the present case we have $P_1=3/5$, $P_2=2/5$, and $p_1=2/5$, $p_2=1/5$; whence $P_1p_1:P_2p_2=6:2=3:1$, *i.e.*, the probability that the box is a W-box is $\frac{3}{4}$.

For statistical treatment, a tabular arrangement is useful, as in Table II. This table shows a representative frequency-distribution (sec. 15) for 1,000 drawings. The figures in brackets indicate the order of entry in the table. Of the total 1,000 boxes, 600 will (on the average) be W-boxes and 400 R-boxes. Of the 600 W-boxes, 240 (on the average) will give a white ball at a single drawing; of the 400 R-boxes, 80 will give a white ball. In the cases, therefore, in which a white ball is drawn, the probability of the box being a W-box is $240/(240+80)=\frac{3}{4}$.

TABLE II.

	From W-boxes	From R-boxes	From all boxes
White ball drawn . .	(3) 240	(3) 80	(4) 320
Red ball drawn	360	320	680
Total drawings	(2) 600	(2) 400	(1) 1,000

If the question had been "There are W-boxes containing 2 white and 3 red balls, and R-boxes containing 1 white and 4 red balls, their frequencies being in the ratio of 3:2; a box is taken at random and a ball is drawn from it; what is the probability that the ball will be white?" the question would have been a "direct" one; but the one table would have been applicable to the two questions. We have already seen this in reference to Table I. (sec. 6); the same table enables us to answer the two questions, "What is the probability that a tall father has a tall son?" and "What is the probability that a tall son has a tall father?" though one of these might be regarded as a question of direct and the other of inverse probability.

FREQUENCY-DISTRIBUTION OF ERRORS

14. Frequency-distribution and Frequency-polygon.—Suppose that, when an event happens, it may happen in either of two ways, which, in G. U. Yule's notation, we will call A and α; so that α is an abbreviation for "not-A." Let the event happen n times, and let the result be A in m cases and α in $n-m$ cases. Then this distribution of the n cases as m A's and n—m a's is called afrequency-distribution. More generally, suppose that the event may be classed under the $k+1$ heads $A_0, A_1, A_2 \ldots A_k$, and that, out of the total n, the numbers coming under these $k+1$ heads are respectively $m_0, m_1, m_2 \ldots m_k$; then the distribution of the n in this way is called a frequency-distribution. The number of heads is taken to be $k+1$ because the sum of the numbers $m_0, m_1, m_2 \ldots m_k$ is necessarily n, so that if we know k of the $k+1$ numbers we know the remaining one. The numbers $m_0, m_1, m_2\ldots$ are the frequencies of $A_0, A_1, A_2\ldots$; their ratios to n, *i.e.*, the ratios m_0/n, m_1/n, $m_2/n\ldots$, are the relative frequencies (sec. 4).

If on a line OX we take points M_{-1}, M_0, $M_1,\ldots M_k$, M_{k+1}, at successive intervals h, and at the points M_0, $M_1,\ldots M_k$ erect ordinates M_0P_0, $M_1P_1,\ldots M_kP_k$ whose ratios to a unit of measurement U are m_0/n, $m_1/n,\ldots m_k/n$, these ordinates constitute the graph of the relative frequencies. If we draw lines joining the points M_{-1}, P_0, $P_1 \ldots P_k$, M_{k+1}, we get a closed figure whose area (see MENSURATION) is

$$h(M_0P_0+M_1P_1+\cdots+M_kP_k)=hU$$

This figure may be called the frequency-polygon. It is not, of course, a graph of anything; the graph of the relative frequencies consists of the ordinates. It is usual to omit the units of measurement h and U, and say that the area of the figure is 1.

15. Representative Distribution.—Let the probability of occurrence of A_0, considered alone, *i.e.*, its probability when the division of cases is into A_0 and not-A_0, be p_0. Then, by the definition of probability, we should expect that in a very large number N of trials the number of cases of A_0 would be about Np_0. Provisionally—for reasons which will be seen later (sec. 18)—we might similarly expect that when the smaller number n of trials is made the number of cases of A_0 would be about np_0; and similarly for A_1, $A_2 \ldots$ with probabilities p_1, $p_2 \ldots$. The frequency-distribution which gives the numbers under the heads $A_0, A_1, A_2 \ldots$ as np_0, np_1, $np_2 \ldots$ is called a representative distribution. The definition applies whether these numbers are integers or not. The differences between these numbers and the actual numbers m_0, m_1, $m_2 \ldots$ which occur when n individuals are taken at random are the errors or errors of *random* sampling of m_0, m_1, $m_2 \ldots$.

We might have defined a representative distribution as a distribution in which the numbers under the different heads are proportional to the numbers which would "in the long run" come under these heads.

16. Law of Frequency of Error (Simplest Case).—Denoting, as before, "not-A" by a, suppose that the probability of A is p, and that that of a is $q \equiv 1-p$. Then as the result of n trials the number of A's might be any number from n to 0, the number of α's being the remainder out of the n. What are the respective probabilities of these different numbers?

Consider the probability of m A's and $n-m$ a's. For a simple example, take $n=6$, $m=4$. Then the probability of 4 A's and 2 α's occurring in the order $AAAA\alpha\alpha$ is $ppppqq=p^4q^2$; and the probability of their occurring in any other specified order is similarly p^4q^2. But there are ${}_6C_4$ orders in which they may occur; ${}_nC_m$ denoting the number of combinations of n things m together. Hence the total probability of 4 A's and 2 a's is ${}_6C_4p^4q^2$. Similarly the probability of m A's and $n-m$ a's is ${}_nC_mp^mq^{n-m}$. Taking the values of m from n to 0, we see that the probabilities of n, $n-1$, $n-2 \ldots 0$ A's (and 0, 1, 2 $\ldots n\alpha$'s) are the successive terms in the expansion

$$(p+q)^n={}_nC_np^n+{}_nC_{n-1}p^{n-1}q+{}_nC_{n-2}p^{n-2}q^2+\cdots+{}_nC_0q^n. \quad (16\cdot1)$$

If ${}_nK_m$ is the probability that in n trials there will be m A's and $n-m$ a's, then

$${}_nK_m={}_nC_mp^mq^{n-m}. \quad (16\cdot2)$$

In a representative distribution of N sets of n trials the numbers of cases in the $n+1$ categories (n A's, $n-1$ A's and 1 a, ...) would be found by multiplying the terms in (16·1) by N; *i.e.*, the number of cases of m A's and $n-m$ a's would be $N \times {}_nC_mp^mq^{n-m}$.

Suppose, for example, that $p=0\cdot6$, $q=0\cdot4$, $n=6$. Then it will be found that in a representative distribution of 1,000,000 cases the numbers of cases in which there are 6, 5, 4, 3, 2, 1, 0 A's would be 46656, 186624, 311040, 276480, 138240, 36864, 4096. The respective probabilities (relative frequencies in a representative distribution) are the ratios of these numbers to 1,000,000. A distribution of the above kind, showing the frequencies (theoretical or actual) with which an event happens n, $n-1$, $n-2 \ldots$ times out of n, is called a binomial distribution.

17. Mean, Standard Deviation, and Mode.—Suppose that the categories of a frequency-distribution correspond to values Y_0, Y_1, $Y_2 \ldots Y_k$ of a variable Y; thus, in the case we have just been considering, the Y's are the numbers n, $n-1, \ldots 0$ of A's or the numbers 0, 1, 2 $\ldots n$ of a's. Then the mean value of Y is found by multiplying Y_0, Y_1, $Y_2 \ldots Y_k$ by the numbers m_0, m_1, $m_2 \ldots m_k$ in the corresponding categories, adding the results, and dividing by the total number $m_0+m_1+m_2+\ldots+m_k$; *i.e.*, if $\overline{Y}$ is the mean Y, and $m_0+m_1+m_2+\ldots+m_k=n$, then

$$\overline{Y}=(m_0Y_0+m_1Y_1+\ldots+m_kY_k)/n. \quad (17\cdot1)$$

Similarly the *mean* square of Y is the mean value of Y^2, *i.e.*, is

$$(m_0Y_0^2+m_1Y_1^2+\ldots+m_kY_k^2)/n. \quad (17\cdot2)$$

The mean cube, mean fourth power, etc., are defined in the same way.

The deviation of Y from $\overline{Y}$ is $Y-\overline{Y}$. The mean square of the deviation from the mean is therefore

$$\begin{aligned}\{m_0(Y_0-\overline{Y})^2&+m_1(Y_1-\overline{Y})^2+\ldots+m_k(Y_k-\overline{Y})^2\}/n\\ &=(m_0Y_0^2+m_1Y_1^2+\ldots+m_kY_k^2)/n\\ &-2\overline{Y}(m_0Y_0+m_1Y_1+\ldots+m_kY_k)/n\\ &+(m_0\overline{Y}^2+m_1\overline{Y}^2+\ldots+m_k\overline{Y}^2)/n\\ &=(\text{mean square of } Y)-2\overline{Y}\overline{Y}+\overline{Y}^2\\ &=(\text{mean square of } Y)-(\text{mean of } Y)^2. \quad (17\cdot3)\end{aligned}$$

The square root of this quantity is called the standard deviation or dispersion: in the cases in which the Y is an error, it was formerly called the error of mean square. The above definitions apply, and (17·3) holds good, whether we are dealing with a representative distribution or with an actual distribution.

In some cases the numbers n_0, n_1, $n_2 \ldots$ in the categories of a representative distribution gradually increase up to a value n_f and then decrease. In such a case n_f is the *maximum* frequency; and the corresponding value of Y, namely Y_f, is called the modal value or mode. Thus in the example in sec. 16 the modal number of A's is 4. There might in some cases be two or more modes; in other cases there might be none—if, *e.g.*, the frequencies decreased throughout the whole range.

18. Mean, etc., for Binomial Distribution.—For a representative binomial distribution (sec. 16) in which ${}_nK_m$ is the probability that in n trials there will be m A's and $n-m$ a's, it is not difficult to show that, the probability of A at each trial being p:—

(a) the mean value of m is np, that of $n-m$ being $n-np=nq$;
(b) the mean square of m is n^2p^2+npq; and therefore
(c) the standard deviation (dispersion) of m is $\sqrt{npq}$.
(d) To find the modal value of m, we have

$${}_nK_m/{}_nK_{m-1}=\frac{n-m+1}{m}\,\frac{p}{q},\quad {}_nK_{m+1}/{}_nK_m=\frac{n-m}{m+1}\,\frac{p}{q}.$$

These ratios decrease as m increases; and the first ratio will be >1, and the second <1, if $(n+1)p$ lies between m and $m+1$, *i.e.*, if m is the integral part of $(n+1)p$. Taking m to have this value, ${}_nK_m$ is greater than ${}_nK_{m-1}$ and also greater than ${}_nK_{m+1}$, *i.e.*, it is the maximum frequency. Thus in the example in sec. 16 we have $p=3/5$, $n=6$, and therefore the modal value of m is 4. If $(n+1)p$ is an integer, and we take $m=(n+1)p$, then ${}_nK_{m-1}$ and ${}_nK_m$ are equal, each having the maximum value.

19. Errors of Frequencies of Error.—In Sec. 16 we really began with a representative distribution, namely, that in which the number of cases of "A" was np out of a total number n; and we considered the probabilities of the various possible deviations from this distribution, *i.e.*, we considered the entries in a representative frequency-distribution of the errors. We found that the frequencies, for N sets of n trials, would be given by the terms of a certain binomial expansion, each multiplied by N. Thus the frequency of the cases of 3 A's and 3 a's, p being 0·6, would be $N \times \cdot276480$. But it is to be observed that this is a representative distribution: we should not expect, in any particular group of N sets of n trials, to find exactly $N \times \cdot276480$ of these cases, just as in n of the original trials we should not expect to get exactly np A's and nq a's. If we took $\underline{N}$ groups of N sets of n trials, we should again get errors of random sampling. But these errors become relatively less as the numbers involved become greater.

20. Frequency for Continuous **Variation.**—(i.) We have hitherto been considering the frequency of occurrence of some

definite number of events, *e.g.*, of m events out of n. This is a case of discontinuous variation, and the graph of variation is composed of a limited number of ordinates. We shall presently have to consider the class of cases in which Y is a quantity which varies continuously, the number of its possible values being indefinitely great, and the probability of occurrence of any particular value indefinitely small. For these cases we require a different treatment of frequency. Let the probability that the value of the variable lies within limits $Y\pm\frac{1}{2}dY$, *i.e.*, lies between $Y-\frac{1}{2}dY$ and $Y+\frac{1}{2}dY$, be $U'dY$; and let U be the limit of U' when dY is made indefinitely small. Then the expression of U in terms of Y is the equation to the *frequency-distribution* of Y. The graph of U with respect to Y will then be a plane figure with a continuous boundary, which can be regarded as drawn on such a scale that its area is 1. The area of the portion of this figure which lies between ordinates corresponding to any values Y_1 and Y_2 of Y will be proportional to the probability that Y lies between Y_1 and Y_2. This figure is the *figure of frequency* of Y.

To represent an actual distribution graphically, suppose that we have observed the number of cases in which Y lies between Y_r and Y_{r+1}. Let M_r and M_{r+1} be points on the base-line Oy corresponding to Y_r and Y_{r+1}. Then the ratio of this number of cases to the total number can be represented by a rectangle whose base is M_rM_{r+1} and whose area is this ratio. The aggregate of these rectangles is a figure called a histogram: its area is 1, *i.e.*, is the same as that of the figure of frequency. This latter figure may be regarded as the limit of the histogram of a representative distribution when the intervals M_rM_{r+1} are made indefinitely small.

(ii.) But instead of expressing U in terms of Y, we might express Y in terms of certain total probabilities. The usual method of doing this is to regard the figure of frequency as divided into 100 equal parts by ordinates: the values of Y corresponding to these ordinates, with the two extreme values of Y, are called the percentile values. The important values, on this system, are the median and the quartile values. If M_1P_1, M_2P_2, M_3P_3 are ordinates dividing the figure of frequency into four equal parts, the value of Y which corresponds to M_2P_2 is the median value, and the values which correspond to M_1P_1 and M_3P_3 are the quartile values.

21. **The** Normal **Law** of Error.—(i.) The result obtained in sec. 16 gives the true law of frequency of error for the type of case considered, namely the law that ${}_nK_m$, the probability of occurrence of m A's and $n-m$ a's, is ${}_nC_mp^mq^{n-m}$. When n is small there is no difficulty in calculating any particular value of ${}_nK_m$ or even all the values; thus in sec. 16 we have seen that, if $p=0{\cdot}6$, the probabilities of occurrence of the values 6, 5, 4, 3, 2, 1, 0 of m are 0·047, 0·187, 0·311, 0·276, 0·138, 0·037, 0·004. But, when n is large, the single probabilities are very small, and we have to take them in groups. We therefore require a formula which will enable us to calculate the sum of the probabilities in any particular group, *i.e.*, the probability that the value of m will lie between any two stated values. An approximate formula—less or more correct according as n is smaller or larger—is given by the normal *law* of error. This law is also known as the *Gaussian* law of error, though it was discovered by Laplace: or as the law of large numbers. It would more correctly be called the normal *law of frequency of error* or the *law* of large frequencies.

(ii.) The method consists, essentially, in replacing a sum by an integral. To see how this happens, let us take p to have some definite value, and let us see how the form of the frequency-polygon (sec. 14) for a representative distribution alters as n increases. There are $n+1$ ordinates; as n increases, the number of ordinates increases, and their size decreases. If the interval between successive ordinates is always h, the frequency-polygon becomes wider and flatter. If, on the other hand, we take the interval to be h/n, so that (n being large) the breadth of the polygon is practically constant, it becomes higher and narrower in the middle. We can obtain regularity by adopting a middle course. We have seen in sec. 18 that the standard deviation, which is a convenient measure of the dispersion of the values about their mean, is $\sqrt{npq}$, *i.e.*, is proportional to dn. For purposes of comparison let us keep the maximum ordinate fixed in position, and take the interval between consecutive ordinates to be $h/\sqrt{npq}$ instead of h, the ordinates themselves being multiplied by $\sqrt{npq}$, so as to keep the area of the polygon unaltered. Then it will be found that the heights of the ordinates in any particular position, fairly near the maximum ordinate, alter comparatively slowly, and that the tops of the ordinates tend to lie on a certain curve, which is the limit of the upper boundary of the frequency-polygon. This curve is the normal curve of *error;* and the figure bounded by it, which is the limit of the frequency-polygon, is the normal *figure* of frequency.

The following short table (Table III.) illustrates this, so far as the maximum ordinate is concerned; p being taken to be 0·6.

TABLE III.

n	6	20	100	1,000
Max. prob.	·311	·180	·081	·026
$\sqrt{npq}\times$ max. prob.	·373	·394	·398	·399

The ordinate, in each case, is the unit U multiplied by the probability or relative frequency and by $\sqrt{npq}$. The actual limit of the numbers in the last line is (see sec. 22) $1/\sqrt{2\pi}=\cdot 399$.

(iii.) Algebraically, we proceed as follows: We want to find the sum of a number of consecutive values of ${}_nK_m$: let us say, the values for which m lies between $s-\frac{1}{2}$ and $t+\frac{1}{2}$. We therefore want to find a convenient expression for

$$S\equiv{}_nK_s+{}_nK_{s+1}+\ldots+{}_nK_{t-1}+{}_nK_t. \qquad (21{\cdot}1)$$

We can do this, subject to certain assumptions as to the magnitudes of n, p, q, and m; it being remembered that (see ii. above) the standard deviation of m from its mean value np is $\sqrt{npq}$. We assume that

(1) n is very large;

(2) neither p nor q is very small, so that np and nq and npq are very large;

(3) m is very large, but

(4) m−np (taken positively) is, at its greatest, not a large multiple of $\sqrt{npq}$.

On these assumptions, it may be shown that S is approximately equal to the area, from $m=s-\frac{1}{2}$ to $m=t+\frac{1}{2}$, of a figure whose ordinate corresponding to m is

$$u=\frac{1}{\sqrt{2\pi npq}}e^{-\frac{1}{2}V}, \qquad (21{\cdot}2)$$

where

$$V=\frac{(m-np)^2}{npq}; \qquad (21{\cdot}3)$$

i.e., approximately,

$$S=\int_{s-\frac{1}{2}}^{t+\frac{1}{2}}\frac{1}{\sqrt{2\pi npq}}\,e^{-\frac{1}{2}(m-np)^2/(npq)}dm. \qquad (21{\cdot}4)$$

The figure given by (21.2) and (21·3) is the normal figure of frequency.

(iv.) The figure is symmetrical about a central ordinate; and it admits of any value of m, positive or negative, so that its range is from $-\infty$ to $+\infty$. In these respects it differs from the (discontinuous) graph of ${}_nK_m$; and, as already stated, it is only for moderate values of m−np that a portion of its area represents the sum of a number of K's. It may, however, be noted that the figure agrees with the graph of ${}_nK_m$ in the following respects:

(a) the mean value of m, for the figure, is np;

(b) the standard deviation of m is $\sqrt{npq}$;

(c) the complete area of the figure is 1.

(v.) Since (sec. 15) m−np is the "error" of m, we denote it by the symbol ϵ; and (21·2) can then be written

$$u=\frac{1}{\sqrt{2\pi npq}}\,e^{-\frac{1}{2}\epsilon^2/(npq)} \qquad (21{\cdot}5)$$

We can also write it in another form. For a representative distribution of n cases between A and a, let n_0 and n_1 be the numbers of A's and of α's respectively; and let the actual numbers be $n_0+\epsilon_0$ and $n_1+\epsilon_1$, so that $\epsilon_0+\epsilon_1=0$. Then $n_0=np$, $n_1=nq$, $n_0+\epsilon_0=m$, $n_1+\epsilon_1=n-m$. With this notation, (21·2) and (21.3) give

$$u=\frac{1}{\sqrt{2\pi}}\left(\frac{n}{n_0 n_1}\right)^{\frac{1}{2}}e^{-\frac{1}{2}\chi^2}, \tag{21·6}$$

where

$$\chi^2=\frac{\epsilon_0{}^2}{n_0}+\frac{\epsilon_1{}^2}{n_1}. \tag{21·7}$$

(vi.) The equation to the figure can be written in the general form

$$u=\frac{N}{\sqrt{2\pi}\cdot c}\,e^{-\frac{1}{2}(Y-a)^2/c^2}, \tag{21·8}$$

where Y is the variable, a and c are its mean and standard, deviation, and N is the area of the figure. A variable Y, of which this represents the frequency, is said to be normally distributed.

22. Standard Normal Figure.—(i.) For practical application of the above result, we usually write—

$$Y=a+cx,$$

where x is numerical. If we make this substitution in (21.8), and treat x as the abscissa in the resulting figure, we are altering the unit of measurement of abscissa in the ratio of c:1, and must therefore alter the unit of measurement of u in the ratio of 1:c. Writing

$$u\equiv z/c,$$

we get

$$z=\frac{1}{\sqrt{2\pi}}\,e^{-\frac{1}{2}x^2} \tag{22·1}$$

which is the equation to the standard normal figure. The figure extends from $-\infty$ to $+\infty$; it is symmetrical about the axis of z; and its central (or maximum) ordinate is approximately ·39894.

(ii.) The portions on the two sides of the central ordinate are bisected by the ordinates for which $x=-·67449$ and $x=+·67449$ respectively; these are the quartile values of x. Similarly, for the more general form in (21·8), the quartile (including the median) values of Y are $Y=a-·67449c$, $Y=a$, $Y=a+·67449c$.

The form of the figure, with ordinates increased in the ratio 10:1, is shown on page 531. OH is the central ordinate; M'P' and MP are the quartile ordinates. $N'Q'$ and NQ are the ordinates at $x=-1$ and $x=+1$; Q' and Q are points of inflexion on the bounding curve.

23. Second Approximation.—In obtaining the above results we have assumed that n is so large that we can regard $1/\sqrt{n}$ as a small quantity, and have ignored terms in $1/n$. For a closer approximation we should take account of these latter terms. This gives as the equation to the figure of frequency

$$u=\frac{1}{\sqrt{2\pi}.D}\left\{1-\tfrac{1}{2}k\left(\frac{X}{D}-\tfrac{1}{3}\frac{X^3}{D^3}\right)\right\}e^{-\frac{1}{2}X^2/D^2},$$

where X is the deviation from the mean, D is the standard deviation, and k is (mean cube of deviation from mean)$\div D^3$. This is sometimes called the generalized law of error. It should be observed that the figure is skew, *i.e.*, unsymmetrical.

24. Frequencies of Improbable Events.—In secs. 21–23 we have been dealing with cases in which the probability of an event happening is neither very small nor very large, *i.e.*, is neither very nearly 0 nor very nearly 1. We have now to consider the class of cases in which the probability of an event happening is very small, and yet, in consequence of the number of trials being very large, we should not be surprised if it happened occasionally. As before, we take p to be the probability of A, so that $q\equiv 1-p$ is the probability of not-A or a; we assume that p is very small but n is so large that np is not negligible; and we want to see what is the probability of A occurring occasionally in n trials.

The probability of no A's is q^n, that of one A is npq^{n-1}, and so on; the probabilities being the terms in the expansion of $(q+p)^n$. Now

$$q^n=(1-p)^n=\{(1-p)^{1/p}\}^{np},$$
$$npq^{n-1}=np\{(1-p)^{1/p}\}^{(n-1)p},$$

and so on. But, since p is small, $(1-p)^{1/p}$ is approximately equal to $1/e$. Hence the terms in the expansion are approximately

$$e^{-np},\ npe^{-np},\ \frac{(np)^2}{1.2}e^{-np},\ \ldots$$

If therefore we write $\mu\equiv np$, so that (sec. 18) μ is the mean number of times that A occurs in n trials, then the probabilities of A occurring never, once, twice, three times ... are (approximately) the terms of the series

$$e^{-\mu}+\mu e^{-\mu}+\frac{\mu^2}{2!}e^{-\mu}+\frac{\mu^3}{3!}e^{-\mu}+\ldots$$

This theorem is due to Poisson; it is known as Poisson's exponential law or as the law *of* small numbers.

We can easily verify that the formula is consistent with the statement that μ is the mean number of times that A occurs; for this mean number is found by multiplying the terms of the series by 0, 1, 2, 3... and adding; and the result is

$$\mu e^{-\mu}+\frac{\mu^2}{1!}e^{-\mu}+\frac{\mu^3}{2!}e^{-\mu}+\ldots=\mu e^{-\mu}\left(1+\frac{\mu}{1!}+\frac{\mu^2}{2!}+\ldots\right)=\mu.$$

OTHER FREQUENCY-DISTRIBUTIONS

25. Genesis of Normal Distributions.—The normal figure of frequency has been obtained as the limit of the frequency-polygon for errors of random sampling from two categories. But it has other important relations.

(i.) If a quantity Y is distributed according to the normal law about a mean value a with mean square of deviation c^2, and n values of Y are taken at random, the mean of these values is distributed according to the normal law about the mean value a with mean square of deviation c^2/n.

(ii.) If a quantity Y is distributed according to (almost) any law whatever about a mean value a with mean square of deviation c^2, and ft values of Y are taken at random, the mean of these values is distributed about the mean value a with mean square of deviation c^2/n, and the distribution is approximately normal; the approximation being less or more close according as n is smaller or greater and according as the original distribution of Y is less or more similar to a normal distribution.

(iii.) In the frequency-distribution of a quantity Y, suppose that the deviation of any individual value of Y from the mean Y is the total effect of a very large number of very small deviations, due to causes which operate independently of one another. Then (in general) the distribution of Y is approximately normal.

26. Observation of Distributions.—The pioneer in the systematic study of actual frequency-distributions was L. A. J. Quetelet, the Belgian astronomer. In works published in and after 1835 he showed that variations in many kinds of phenomena—temperature, price of grain, astronomical observations, heights and chest-measurements of men—were distributed about a mean value in a manner similar to the binomial distribution (sec. 16). His standard distribution, with which distributions of the above kind were to be compared, was that due to drawing 999 balls from an urn containing white and black balls in equal proportions; it n-as therefore a symmetrical distribution, very close to the Gaussian distribution, but discontinuous. As an example of the frequency-distributions to which Quetelet called attention, we may take the following table (Table IV.) of chest-measurements of 5,732 soldiers in Scottish regiments.

TABLE IV.

Chest in inches .	33	34	35	36	37	38	39	40
Number of men .	3	19	81	189	409	753	1,062	1,082
Chest in inches	41	42	43	44	45	46	47	48
Number of men	93j	646	313	168	50	18	3	1

27. Laws of Distribution.—For comparisons similar to those made by Quetelet, the normal law was usually taken as a basis. But it had two obvious defects (*cf.* sec. 21 [iv.]). One was that it assumed the possibility of an infinite range of variation. The more serious defect was that it implied symmetry, whereas in many cases there was a definite asymmetry or skewness. The generalized law, mentioned in sec. 23, allows for skewness, but does not provide for restricted range of variation. Provision was therefore required for other types of frequency-distribution. This was necessary for two reasons. When we are studying a particular distribution, it is desirable to obtain a formula which fits it as closely as possible: for, when we have obtained a closely-fitting formula, the actual distribution can conveniently be represented by the constants of this formula. But there is a further question. We are studying, let us say, the distribution of men's heights in a fairly homogeneous population; the variations of height being produced by a number of small variations which are distributed by intermarriage and are being supplemented by new variations of the same kind. We find a formula, containing a few parameters or "arbitrary constants," which can be fitted very closely to the observations by obtaining suitable values for these parameters. But we are at any time studying only a limited number of persons, though this number may be a large one; and the result of this limitation of number is some irregularity as between the numbers in the various categories of classification—*e.g.*, the numbers of men of different heights, measured in inches. As the number of persons measured increases, these irregularities become relatively smaller. The question which thus arises may be stated as follows. We adopt the hypothesis that, as the number of observations is increased, not merely actually, but also potentially by supposing the causes of variation to be extended to a very large number of individuals, there is a tendency to a definite statistical law of variation. The question then is: Can the irregularities which appear in our data for n individuals be regarded as due to errors of random sampling of the n individuals from a hypothetical universe of this kind?

Thus the study of a frequency-distribution falls mainly under the following heads: (1) the choice of a suitable formula, (2) the determination of the constants of this formula from the data, (3) enquiry whether the data may reasonably be regarded as the result of random sampling from a universe in which the variations are distributed according to the formula chosen. There are also certain minor matters of consideration: in particular, the question (4) whether the data can really be regarded as homogeneous, or whether individual excessive variations—giants or dwarfs—ought to be excluded, either as not really belonging to the universe we are postulating, or as being sports, or, possibly, as being the result of incorrect observation.

28. Some Types of Formula.—The most familiar types of formula which have been fitted to observations are those given by Karl Pearson's extension of the Gaussian formula. This latter formula is essentially based on the differential equation

$$\frac{1}{u}\frac{du}{dx} = (\text{const.})x.$$

Pearson's extension takes

$$\frac{1}{u}\frac{du}{dx} = \frac{x+a}{b_0+b_1x+b_2x^2}$$

This gives a great variety of forms; and the increase in the number of arbitrary constants gives greater elasticity.

Pareto's formula

$$u=(\text{const.})x^{-c}$$

is included in Pearson's types.

Another form, of importance in vital statistics, is Makeham's formula, obtained from the differential equation

$$-\frac{1}{u}\frac{du}{dx} = a+bc^x.$$

29. Determination of Constants.—(i.) There are various ways of fitting a formula to a particular distribution by finding suitable constants. The most usual method is that of equating moments. The number of individuals being n, and the equation of the figure to be fitted being $nu=nf(X, a, b, c\ldots)$, so that $f(X, a, b, c\ldots)\,dX$ is the proportion of individuals for which X lies within the limits $X\pm\frac{1}{2}dX$, and a, b, c... are the constants to be determined, we equate the 1st, 2nd, 3rd... moments of nu to those of the actual distribution, and thus obtain equations for determining a, b, c.... In doing this, it must be remembered that the values of X are (usually) not given exactly for the observed individuals, since these latter are grouped in classes, *e.g.*, in the case of heights, they may be given to the nearest inch. The individuals in each class are therefore treated as having all the same X, and certain corrections are applied (see MENSURATION).

(ii.) If we want to find the most probable values of the constants, the problem becomes one of inverse probability, and we have to make some assumption as to the a priori probabilities of different values of the constants. When the number of individuals is large, this presents no difficulty. If, for instance, the distribution is of heights of men, and we require the most probable value of their mean, the range of practically possible values is small, and we can assume that within this range all values are equally likely. But caution is necessary when we are dealing with small numbers. In the case of a Gaussian distribution, the most probable values, on the above assumption, are obtained by taking first and second moments; subject to some qualification in view of the fact that measurements are grouped.

(iii.) When a value g has been found for a parameter, note should be made of the "probable error" of g. This is a quantity e such that it is an even chance that the true value of the parameter lies between $g-e$ and $g+\epsilon$.

30. Test of Closeness of Fit.—When we have chosen a formula, we have still to satisfy ourselves that it is a suitable one. The method of doing this belongs properly to correlation (sec 33), since it deals with the probability of joint occurrence of a number of variations. There are two classes of cases, In the one class the formula is completely settled a *priori*, and there are no constants to be determined. In the case of throwing a die, for instance, our hypothesis may be that all faces are equally likely to be uppermost; we test the hypothesis by comparing the actual numbers of throws of 1, 2...6 with the theoretical numbers, namely $1/6{\cdot}N$ for each face, and see whether the *discrepancies* between hypothesis and fact are such as might be due to random sampling. In the other class of cases there are unknown constants. Whatever values are taken for these constants, there will be discrepancies between the theoretical frequencies calculated from them and the actual frequencies; and there will be the same enquiry as to these discrepancies. Both cases are usually dealt with by a method due to K. Pearson, and known as the "χ^2" method.

31. Exclusion of Extreme Values.-Occasionally, in a set of observations of a group supposed to be homogeneous, extreme variations—giants or dwarfs—will occur. If the probability of their occurrence as the result of random sampling is extremely small, regard being had to the total number n, are they to be excluded? Their inclusion or exclusion may make a good deal of difference not only in the deduced values of the constants but also in the measure of closeness of fit. Several forms of criterion for exclusion have been proposed. But these relate to exclusion from a particular distribution. If we deal statistically with a number of distributions of the same kind, the extent to which these extreme variations occur may be an important element in our enquiries.

CORRELATION

32. Regression.—The importance of correlated variation in individuals was emphasized by Darwin, and the correlation of deviations from the average in parents and in offspring must have long been a matter of common observation, but it was

Francis Galton who, in papers leading up to his Natural Inheritance (1889), first stated a law governing the frequencies of such deviations. The special aspect to which he called attention was regression towards the mean. The sons of tall men are—on the average- all, but not so tall: the sons of short men are short, but not so short. But this does not mean that the parents of tall men are taller, or the parents of short men shorter. The regression works both ways.

Suppose, for simplicity, that heights, in both generations, are distributed about the same mean value a with the same standard deviation c, the distribution in each case being according to the normal law. Then, if we group together all the fathers whose heights are $a+\xi$, the average height of their sons (one son to each father) will not be $a+\xi$ but $a+r\xi$, where r is (in this case) somewhere about 0·5. And, if we group together all sons whose heights are $a+\eta$, the average height of their fathers will not be a+q but $a+r\eta$, where r has the same value as in the preceding sentence.

In the general case, suppose there are a large number of individuals having measurable attributes A and B, their measures being X and Y, and that the values of X are distributed about a mean value a with standard deviation c, and those of Y about a mean value b with standard deviation d; subject to an assumption mentioned below. (In the case considered above, the individual is the pair, father and son, and the attributes are the height of the father and the height of the son.) Then Galton's law of regression is that, if we group together all individuals for which X has the value $a+xc$, the mean value of Y for these individuals is $b+rxd$; and also, if we group together all individuals for which Y has the value $b+yd$, the average value of X for these individuals is $a+ryc$: where r is the same in the two cases and is between -1 and $+1$. The ratio $rxd/xc=rd/c$ (which is not necessarily a numerical ratio, since A and B may be different kinds of quantities) is the *coefficient* of regression of B on A, and the ratio $ryc/yd=rc/d$ is the coefficient of regression of A on B.

The whole of the above is based on the assumption that the values of X and of Y are normally distributed and normally correlated. The algebraical expression of normal correlation is considered below: its general character can be seen from Table V., which is a correlation-table showing the relation between brother and sister as regards span.

TABLE V.—*Correlation of brother and sister*
(Adapted from K. Pearson and *A.* Lee, *Biometrika* ii. [1903], **449.**)

Sister's span in inches	Brother's span in inches								Total brothers
	58-61	61-64	64-67	67-70	70-73	73-76	76-79	79-82	
52-55.	..	1	2	4	..	..	..	..	7
55-58.	..	2	10	11	1	..	..	..	24
58-61 .	..	15	78	121	44	9	3	..	270
61-64 .	1	8	87	193	173	52	5	..	519
64-67 .	..	..	31	122	171	69	11	2	406
67-70.	..	..	2	19	62	51	11	..	145
70-73 .	..	..	..	2	4	5	4	3	18
73-76 .	..	..	..	..	..	1	3	..	4
Total sisters	1	26	210	4 7	4	187	37	5	1,393

33. Normal Correlation.—The form of the equation to a normal frequency-distribution was obtained (sec. 21 [iii.]) by considering the frequencies of deviations from a representative distribution in the case of alternatives A and a. The normal law of distribution of these latter frequencies having been obtained, we can easily deduce the corresponding formula for distribution in any number of categories, and thence obtain the general formula for a normal frequency-distribution of any number of variables. For the present we can limit ourselves to the case of two variables, which means three categories.

(i.) Suppose there are three categories P, S, T, the relative frequencies of which are p, s, t, so that a representative distribution of n individuals would give np, ns, nt in the three categories. Denote these by n_0, n_1, n_2, so that $n_0+n_1+n_2=n$. Then the probability of joint occurrence of numbers $n_0+\epsilon_0$, $n_1+\epsilon_1$, $n_2+\epsilon_2$ in the three categories (so that $\epsilon_0+\epsilon_1+\epsilon_2=0$) is approximately proportional to $e^{-\frac{1}{2}\chi^2}$, where

$$\chi^2=\frac{\epsilon_0^2}{n_0}+\frac{\epsilon_1^2}{n_1}+\frac{\epsilon_2^2}{n_2}.$$

By replacing ϵ_0 by $-\epsilon_1-\epsilon_2$, we get χ^2 as an expression involving ϵ_1^2, $\epsilon_1\epsilon_2$, ϵ_2^2.

(ii.) We therefore define the normal law of *correlation* of two attributes A and B as being such that the frequency of joint occurrence of deviations X and Y from the respective means a and b is proportional to $e^{-\frac{1}{2}U}$, where U is of the form

$$U=FX^2-2GXY+HY^2;$$

F and H being positive, and $FH>G^2$.

(iii.) By taking mean squares c^2 and d^2 of X and Y, and mean product of X and Y, it will be found that U can be expressed in the form

$$U=\frac{1}{1-r^2}\left(\frac{x^2}{c^2}-2r\frac{XY}{cd}+\frac{Y^2}{d^2}\right),$$

where $r=$ (mean product of X and Y) $\div cd$. Hence it follows (by fixing X in the one case and Y in the other) that the coefficient of regression of B on A is rd/c, and that of A on B is rc/d. Thus r is the same r that we considered in sec. 32. It is called the *coefficient* of correlation; its value is between -1 and 1. The correlation is said to be positive or negative according as r is positive or negative.

34. Determination of Constants.—When the joint distribution of two variables X and Y is supposed to follow a certain law, we proceed in exactly the same way as for the distribution of a single variable. We find values for the constants from the data; and we examine the discrepancies between the data and a corresponding distribution deduced from chosen values of the constants, in order to see whether these discrepancies can be reasonably regarded as due to errors of random sampling.

In the case of normal correlation, where the data are distributed in a sufficient number of categories formed by taking values of X at equal intervals, and values of Y also at equal intervals, the values of the means and standard deviations as found from the data are taken to be those of the distribution, and the mean product of the deviations from the means is taken to be the product of the standard deviations and the coefficient of correlation. Values of the constants having been determined, we must pay attention to the "probable errors" of these values. There are, however, numerous kinds of cases in which this method cannot be adopted. We can only consider them briefly.

3j. Other Kinds of Cases.—The assumptions we have hitherto made are that

(i.) the measures X and Y are normally distributed and normally-correlated, so that the regression is linear;

(ii.) the number of observations is very large;

(iii.) they are distributed into a fairly large number of categories, by tabulation at intervals in X and Y.

Actual cases, in which the attributes under consideration are clearly correlated, in the general sense of the term, and we should like to have some measure of the correlation, may present difficulties, especially in one or more of the following ways.

(1) The distributions may not be normal; or, even if they are normal, the correlation may not be normal;

(2) In addition, the regression may not be linear;

(3) The number of cases may be small;

(4) The number of categories may be very small;

(5) The attributes considered may not be continuously varying quantities.

36. Special Methods.—The following are some special methods for treatment of cases of the kind mentioned in sec. 3j.

(i) If we are dealing with quantities which have continuous variation, but the correlation is not normal, we can still define r as the ratio which the mean product of the deviations from the respective means bears to the product of the standard deviations. This applies whether the regression is linear or not.

(ii.) The definition may still hold, even if the number of categories is so small that we cannot determine the means, etc. Table I., for instance (sec. 6), gives sufficient data for us to find r on the assumption that the two sets of heights are normally distributed and normally correlated.

TABLE VI.—*Correlation of Hair-colour and Eye-colour in Men*

Eye-colour	Hair-colour				Totals
	Fair	Brown	Black	Red	
Blue	1,768	807	189	47	2,811
Grey or Green	946	1,387	746	53	3,132
Brown	115	438	288	16	857
Totals	2,829	2,632	1,223	116	6,800

(iii.) A common class of cases is of the kind shown in Table VI. (quoted from Yule, p. 61). Here there is clearly some correlation; the number of men with fair hair and blue eyes, for instance, would, if hair-colour and eye-colour mere independent. be about $2829 \times 2811 \div 6800 = 1169$; actually it is 1768, and the discrepancy is far too great to be due to error of random sampling. But there is nothing to suggest continuous variation of the measure of an attribute. For cases of this kind—usually called *contingency* cases—we must fix some definition of the ratio which is to be the measure of correlation. The usual ratio is K. Pearson's *mean square contingency coefficient,* which may be defined as follows. Divide the square of the number in each compartment of the main table by the product of the corresponding subtotals (*e.g.,* divide 1768×1768 by 2829×2811), and add the results. Let their sum be S. Then the coefficient is defined as being $\sqrt{\frac{S-1}{S}}$.

(iv.) A particular case of contingency is *association,* which is the relation exhibited by a *tetrachoric* classification, *i.e.,* one in which there is only a distribution of A and not-A under B and not-B. The contingency coefficient defined in (iii.) can be used for these cases; but various other methods have been suggested.

(v.) The last class of cases to be mentioned is that in which we are concerned with two attributes A and B which can be approximately represented by magnitudes X and Y, but the number of individuals is so small, and the laws of frequency of X and Y are so doubtful, that we cannot apply ordinary statistical methods. If, however, the individuals can be arranged in order according to their values of X, and also according to their values of Y, C. Spearman's "rank" method can be adopted. Suppose, as an example, that there are n boys, and that we want to calculate the correlation between their abilities in subjects A and B. Arrange them in order according to their ability in *A,* and give them the ranks 1, 2, 3...n. Do the same for B. Let d denote, for each boy, the difference between the ranks in the two subjects. Then the *rank coefficient of correlation* is

$$\rho = 1 - \frac{6\Sigma d^2}{n(n^2-1)},$$

where Σd^2 denotes the sum of the squares of the n d·s.

37. **Multiple Correlation.—The** methods which we have been using for dealing with correlation between two attributes can be extended to cases in which there are three or more correlated attributes. The normal formula expressing frequency of joint occurrence of deviations x, y, z...from the respective means involves an expression $e^{-\frac{1}{2}U}$ where U is a quadratic function of x, y, z....This leads to the consideration of partial correlation, *i.e.,* correlation between two of the variables when the remaining variables are taken to have fixed values.

BIBLIOGRAPHY.—Isaac Todhunter, *History of the Theory of Probability* (1865); John Venn, *The Logic of Chance* (3rd ed., 1888); Francis Galton, *Natural Inheritance* (1889); Wm. A. Whitworth, *Choice and Chance* (5th ed., 1901); Robert S. Woodward, *Probability and Theory of Errors* (4th ed., 1906); Willford I. King, *Elements of Statistical Method* (1912); Arne Fisher, *Mathematical Theory of Probabilities* (1915); David Brunt, *The Combination of Observations* (1917); John M. Keynes, *Treatise on Probability* (1921, bibl.); H. E. Soper, *Frequency Arrays* (1922); Truman L. Kelly, *Statistical Metlzod* (1923, bibl.); Chester H. Forsyth, *Mathematical Analysis of Statistics* (1924); Godfrey H. Thomson, *How to Calculate Correlations* (1924); Edmund T. Whittaker and G. Robinson, *The Calculus of Observations* (1924, historical refs.); Wm. Brown and G. H. Thomson, *The Essentials of Mental Measurement* (3rd ed., 1925); Julian L. Coolidge. *Introduction to Mathematical Probability* (1925); Arthur L. Bowley, *Elements of Statistics* (5th ed., 1926); W. P. Elderton, *Frequency-Curves and Correlation* (2nd ed., 1927, classified bibl.); George U. Yule, *Introduction to the Theory of Statistics* (8th ed., 1927, classified bibl.). (W. F. S.)

PROBATE refers to the formal proof of a will, which in England has to take place at Somerset House, London, or at a district registry. The early jurisdiction of the English ecclesiastical courts over the probate of wills of personalty is discussed under WILL and ECCLESIASTICAL JURISDICTION. The Court of Probate Act 1857 transferred the jurisdiction both voluntary and contentious of all ecclesiastical, royal peculiar, peculiar and manorial courts to the court of probate thereby constituted, created a judge and registrars of that court, abolished the old exclusive rights in testamentary matters of the advocates of Doctors' Commons, and laid down rules of procedure. Contentious jurisdiction was given to county courts when the personal estate of the deceased was under f 200 in value. The Judicature Act 1873 merged the old court of probate in the probate divorce and admiralty division of the High Court of Justice. Probate may be taken out either in *common* or *solemn* form. In the former case, which is adopted when there is no dispute as to the validity of the will, the court simply recognizes the will propounded as the last will of the deceased. This formality is necessary to enable the executor to administer the estate of his testator. Probate in this form is granted simply as a ministerial act if the attestation clause declares that the formalities of the Wills Act have been complied with, or if other evidence to that effect is produced. Such grant is liable to revocation, but it is provided that any person dealing with an executor on the faith of a grant of probate in common form, shall not be prejudiced by its revocation. The executor may within 30 years be called upon to prove in solemn form. A person who doubts the validity of the will propounded may enter a caveat which while in force prevents any probate other than in solemn form. Separate representation may be granted in respect of real estate since the administration of Estates Act 1925, and of a trust estate only, but except or regards trust estates a separate representation may be granted of a known insolvent estate. Under the Law of Property Act, 1925, S. 11, probate and letters of administration convey the legal estate to the personal representative, and this makes the real estate directly available for payment of debt. Probate in solemn form is a judgment of the court in favour of the will propounded, and is only revocable by the discovery of a later will. In order, therefore, to obtain such grant proceedings have to be taken by action, and witnesses produced in support of the will, and the action proceeds in the usual way.

The principal rules now obtaining as to probate are these. Probate, which since the Land Transfer Act 1897 (*see* New Administration of Estates Act, 1925, ss 79, 80) must be taken out for wills of realty as well as wills of personalty, may be granted either in the principal or in a district registry, and should be obtained within six months after the testator's death. When no executor is named the will is not now invalid, as was once the case, but administration *cum testamento annexo* is granted. The same course is pursued where the executor renounces or dies intestate before administering the estate of the deceased. After probate, the probate itself (as the official copy of the will is called) becomes evidence, the original will being deposited in the principal registry at Somerset House, London. On grant of probate, estate duty is payable on the gross value of the personal estate and the English real estate (*see* ESTATE DUTIES). The act of 1881 enables any officer of inland revenue to grant probate where the personal estate does not exceed £300.

In 1867 an act on lines similar to the English act was passed for Ireland and under the Irish Judicature Act of 1877 the then existing court of probate was merged in the High Court of Justice.

In Scots law Confirmation includes both the probate and letters of administration of English procedure. It forms the executor's legal title to ingather the estate. Originally confirmation of testaments of movables fell, as in England, under the cognizance of the Church courts. It is now part of the jurisdiction of the sheriff courts and is regulated by statutes, the principal of which are, the Confirmation and Probate Act 1858, the Sheriff Courts Act 1876, and Executors Act 1900. When the will is attested and probation alluding to sects, forms for the execution of deeds, it proves itself, and the onus is on the person challenging it. In other cases the executor may be required to prove the validity of the will in the proceedings for confirmation.

UNITED STATES

Special Courts.—Probate is granted in some States by the ordinary chancery or common law courts, but more frequently by courts of special jurisdiction, such as the prerogative court in New Jersey, the surrogates' court in New York, the orphans' court in Pennsylvania.

"In a great majority of the States the original equitable jurisdiction over administrations is in all ordinary cases—without any special circumstances such as fraud, or without any other equitable feature such as trust--either expressly or practically abrogated. The courts of equity, in the absence of such special circumstances or distinctively equitable features, either do not possess or will not exercise the jurisdiction, but leave the whole matter of administrations to the special probate tribunals" . . . so that "unless the case involves some special feature or exceptional circumstances of themselves warranting the interference of equity, such as fraud, waste, and the like, or unless it is of such an essential nature that a probate court is incompetent to give adequate relief, or is one of which the probate court having taken cognizance has completely miscarried and failed to do justice by its decree, the courts of equity will refuse to interpose and to exercise whatever dormant powers they may possess, but will leave the subject matter and the parties to the statutory forum which the legislature plainly regarded as sufficient and intended to be practically exclusive" (Rice's Probate *Law,* pp. 4 and 5). For the old law on probate, see *G.* W. Marshall, Ancient Courts of Probate (1895).

Jurisdiction as to wills and their probate as such is neither included in nor excepted out of the grant of judicial power to the courts of the United States (*i.e.,* the Federal as distinguished from the State courts). So far as it is ex *parte* and merely administrative it is not conferred, and it cannot be exercised by them at all until in a case at law or in equity its exercise becomes necessary to settle a controversy by reason of the (diverse) citizenship of the parties. An action to set aside the probate of a will of real estate may be maintained in a Federal court when the parties on one side are citizens of a different State from the parties on the other side (Ellis v. Davis, 109 U.S. Reports, 485). Probate in solemn form, *i.e.,* after due notice to all parties in interest is the almost universal form in use in the United States. One reason for this no doubt is that all documents affecting title to real estate must be recorded and probate in solemn form concludes all parties to the proceeding and thus tends to establish the title to all real estate passing under the will.

In the United States wills of real property must be separately proven in the proper probate court in each State in which the real property is situated, unless statute dispenses with separate probate (each State being "foreign" to every other for this purpose). Copies of such will and probate should be filed also in the office of the register of deeds of each county in the State in which any real property belonging to the testator is situated.

In the State of New Jersey it has been held that an unprobated will is capable of conveying an interest in the property devised, and when a conveyance is made under a power in the will before probate, a subsequent probate validates the conveyance (1906, Mackey v. Mackey, 63 Atl. Rep. 984).

In Illinois a court of equity has no inherent power to entertain a bill to contest a will (1906, *O'Brien* v. *Bonfield,* 220 Ill. Rep. 219).

In Missouri a foreign (New York) will of real estate in Missouri, probate of which was duly recorded in Missouri, cannot be collaterally attacked, and cannot be set aside by direct proceeding after being filed for record more than five years in Missouri (1907; Cohen v. Herbert, 104 So. W. Rep. 84).

PROBATION. The principle on which the probation system is based originated in, and was a development of, the idea of the suspended sentence. Under this the accused person was adjudged to be guilty and his sentence determined upon, but it remained suspended, to be eventually cancelled, if the accused made a serious effort in the meantime to redeem his character. Some countries still retain this practice, but it is obvious that its efficacy must depend upon the reliability of the information furnished as to the conduct of the accused during the period of suspension. In order to provide this information it was essential to appoint some person who would be in a position to supply it accurately, and it soon became the function of this official, not only to keep observation, but to give advice, encouragement and assistance to those over whom he exercised supervision. These are precisely the duties which a probation officer now fulfils.

The credit for the earliest creation of these officers would appear to rest with the principal authorities of Boston, U.S.A., who appointed a number of them in the year 1878. The principle received legislative recognition in England in 1887, when the First Offenders Act became law. The value of the system was soon completely demonstrated. The Probation of Offenders Act of 1907 in Great Britain permitted the use of probation, not in the case of first offenders only, but also in that of persons who had been previously convicted, provided the circumstances justified such a course.

It is greatly to the credit of the Police Court Mission that its managers should have at once provided the required agents by offering their own missionaries for this purpose. The offer was accepted, and in very many provincial and in all the metropolitan police courts of Great Britain, the missionaries of the society are appointed to act as probation officers. In London, and a few other cities, special probation officers are appointed to devote themselves solely to the children's courts. In the metropolis these officers are appointed and paid directly by the Home Office, and are subject to no religious tests. A uniformity of system in this respect would seem to be ultimately necessary. There is a National Association of Probation Officers which exists to safeguard the interests of its members and to strengthen and standardize the system.

Under the act of 1907 the appointment of probation officers was not compulsory and, as many districts made inadequate provision, and some no provision at all, full advantage was not taken by the act. This defect has now been remedied by the Criminal Justice Act, 1925, which renders obligatory the appointment of a probation committee for every probation area. This area may be either that comprised in the jurisdiction of a single petty-sessional court, or a combined area of several such courts, approved by the secretary of State.

It is impossible at present to give statistics, of any real value, of the success of probation, but that it has been successful to an extraordinary degree is unquestionable. It would, however, be most helpful if a uniform test of "success" or "failure" could be adopted as applicable to each individual case. If the test used is only good behaviour during the probation period, the number of successes would, of course, be very much greater than if the period were extended to a term of years after the order had ceased. The terms "success" and "failure" likewise need definition. A single relapse does not necessarily imply failure.

Probation work amongst children (see JUVENILE OFFENDERS) differs materially from that amongst adults and is of even greater importance. It is essential that a child offender should, at first, be under very careful supervision; that his mental, physical and psychological characteristics should receive the closest study; that most friendly relations should be established between the parents and the probation officer; that the child should be brought in touch with outside agencies, such as boy scouts, clubs, etc., and that he should feel that in his own officer he has a real friend to whom he can always look for advice, sympathy and help. About half the number of children charged before the juvenile courts are now placed on probation. Where, however, this fails, there should be no hesitation on the part of the probation officer in bringing the child again before the court in order that he may be sent to a certified school. (W. C. HA.)

United States. — Every State in the union now has probation in more or less successful operation. The results obtained vary and are dependent largely upon whether trained probation officers are employed and upon whether these officers have assigned to them more cases than can be handled at one time with efficiency. Fifty cases are generally considered a maximum for a single officer. Rural communities are generally backward in providing probation officers. Generally speaking, however, the results of probation, as a principle, have been excellent. Apparently 75 to 85% of probationers do well while subject to probation, according to official reports. Adequate statistics are not available on the extent to which further relapses occur after the probationary period ends, but studies made seem to show that only a negligible portion of those who do well under probation subsequently succumb to criminal tendencies.

Probation has more than justified its value as an instrumentaiity of preventive penoiogy and has received increased pubiic approval. In this regard it is in marked contrast with parole with which it is closely related and with which it should not be confused. Probation, as stated, is an outgrowth of the suspended sentence and is a substitute for punishment, while parole is a part of penal discipline, akin to probation in its methods, to be employed after punishment is partly accomplished. Probation has obviously the larger chance of success.

In the first place, probation cases are generally those in which the prospect of social rehabilitation is more hopeful. Its cases, moreover, are more likely to co-operate with probation officers' services with a gratitude born of a consciousness of punishment avoided rather than, as in the case of those paroled, resentful in a present recollection of punishment endured. As a social agency in human reformation, probation still has great undeveloped possibilities and constitutes one of the great experimental fields for all the forces which deal with the understanding and prevention of crime.

PROBLEM, a question proposed for discussion and answer. (Greek *πρόβλημα,* from *προβάλλειν,* to throw before; a question placed before one for consideration.) In mathematics, a solution to be effected, such as that of the construction of an equilateral triangle having a given line segment as a side, or the finding of the mean proportional between two given numbers. In geometry it is usually a statement of a construction to be effected, whereas a theorem is a statement which is itself to be proved, as that the angles opposite the equal sides of an isosceles triangle are equal. The Greek geometers divided their propositions into theorems (*q.v.*), problems and porisms (*q.v.*). Pappus (*q.v.*) tells us that they recognized three classes of problems: (1) plane, (2) solid and (3) linear. The construction lines permitted were respectively (1) the straight line and the circle, (2) the conic sections ("solid loci") and (3) such higher curves as the conchoid, cissoid and quadratrix. (See CURVES, SPECIAL.) In solving a problem there is usually given (1) a statement of the construction to be effected with respect to a certain figure, (2) a statement of the steps in the construction and (3) a proof that the construction is correct.

PROBOSCIDEA, the scientific name of an order of Eutherian mammals represented at the present day by the African and Indian elephants. These animals (see ELEPHANT) differ very widely in their structure from all other living mammals but fossil remains of similar structure have long been known. Only during the past 20 years, however, have primitive Proboscidea been discovered capable of comparison with other mammalian forms. The leading characteristics of the living elephants are as follows.

The animal is of large size with pillar-like limbs. The neck is short and the large head is provided with a proboscis, a long flexible muscular organ capable of being turned freely in all directions, and provided with one or two finger-like processes at its tip which can be used to handle articles as small as a penny. The trunk can also be employed as a prehensile organ by being wrapped as a whole round a large object. It is capable of very considerable accuracy of movement and is used in feeding. The trunk represents the whole anterior part of the face, that is the nose and also the upper lips, the strip of skin along its ventral surface being essentially a part of the palate. The two nostrils lie at the extremity of the trunk and lead into great canals which perforate the whole of that organ opening into olfactory chambers at its base. The mouth is short, placed below the trunk and provided with thick fleshy lower lips meeting anteriorly so as to form a short spout. The eye is small, laterally directed and provided with a pair of eyelids often bearing stiff eyelashes. The pinna of the external ear is large, becoming enormous in certain races of the African elephants. It is usually carried close to the side of the neck but can be erected so as to stand out perhaps a yard from the side of the head. The female bears two teats placed on the pectoral surface just between and behind the forelegs. Most living adult elephants possess very few hairs; there are normally a certain number on the forehead and cheek and always a tuft of long extremely thick hairs at the end of the short tail.

The skeleton of an elephant is as peculiar and characteristic as his externai appearance. The skuli is very short from back to front, deep, and built up of spongy bone full of air-spaces. Within the great mass of bone there lies a relatively small, though actually large brain cavity, and the olfactory chambers form great perforations which with the naso-pharyngeal ducts penetrate obliquely through the skull uniting only quite posteriorly. The skull of the new-born elephant differs from that of the adult in that whilst the head increases greatly and disproportionately in size, the brain undergoes much less expansion. Thus during the period of growth of the animal the external surface of the skull, by the development of the great air-spaces in its middle layer, becomes more and more widely separated from the layer of hard bone which surrounds the brain. The bony lamellae which separate these air-spaces run radially so as to buttress the external surface. The great size of the adult skull is necessary in order to give adequate areas for the attachment of the immense neck-muscles which support and move the very heavy trunk and tusks, and take the great strains which are produced when these structures are used in digging up and tearing down trees.

The jaw-bones of the elephant and the whole structure of its palate are modified so as to receive and afford adequate support to the tusks and cheek teeth. The bony nostrils lie very high up and are overhung by very small nasal bones to which some of the muscles of the base of the trunk are attached. This attachment is brought as far back as possible in order to increase the range of action of the proboscis.

The dentition of an adult elephant consists of a single pair of exaggerated incisors, the tusks, and either one or two molars on each side of the upper and lower jaws. These molars are built up of a series of plates each composed of a core of dentine surrounded by a layer of enamel; the individual plates, continuous with one another at their base, are held together and supported by an infilling of cement. In the elephant the milk incisors, little teeth about two inches in length, are shed and replaced by the permanent tusks, but the milk molars instead of being pushed out by a permanent pre-molar which develops underneath them, replace one another from behind as follows. The new tooth is developed deep down in the posterior part of the jaw and travels obliquely forwards and towards the mouth, so that more and more of it cuts the gum as the preceding tooth is worn down to its root, until finally the latter is shed and its successor is well in wear. A living elephant in this way works through six teeth in each side of each jaw during its lifetime, wearing down a total thickness of nearly a yard of tooth over an area which increases from about half a square inch to nearly 30 sq. in. on each side of its mouth. This extraordinary dentition is unparalleled, but the process by which it came into existence is fortunately completely known from fossil material.

The elephant's backbone possesses a neck of seven very short vertebrae, the number of dorsals varies from 19 to 21, the anterior having exceedingly long neural spines for the attachment of the nuchal ligament which passes forwards to the back of the skull. There is a short lumbar region of three or four vertebrae and the sacrum is a compact bone built up by the fusion of four vertebrae: there are about 30 caudals. The ribs are of enormous length surrounding the very capacious thorax. The shoulder girdle consists of a very large triangular scapula placed vertically on the side of the thorax. The humerus is longer than the forearm so that the elbow of an elephant lies at a point relatively only a little higher than the wrist of a horse. The radius and ulna are peculiar in that their surfaces of articulation with the carpus are nearly equal, whilst the upper end of the radius is relatively small and lies in front of the ulna, the two bones crossing one another as they are traced downwards. The carpus of an elephant is unusual in that the bones of the two rows of which it is composed do not alternate but are superimposed on one another. In this feature the elephants resemble the Hyraxes. The elephant walks on the extreme tips of his fingers and toes, but the palm of the hand and the sole of the foot are swollen out into great pads of connective tissue which transmit the weight of the animal to the ground directly and so reduce the load carried by the phalanges. The elephant's pelvis is remarkable for its extraordinary width, the ilia being expanded into transversely placed sheets of bone from whose posterior surface muscles pass down to the hind-leg, whilst their margins give attachment to the muscles of the body-wall which support the weight of the viscera within the abdominal cavity. As in the fore-limb the upper segment of the leg is considerably longer than the lower one, and in the tarsus the astragalus is flattened, as a weight carrying adaptation, whilst the calcaneum is produced into a short heel directed backwards and downwards.

The anatomy of the soft parts of the elephant has been repeatedly described but presents few features of special interest except those which result from the modification of the nose and upper lips into the trunk. The animal is peculiar in that there is no pleural cavity. The fact that the testes are abdominal, the uterus bicornuate, and the placenta zonary and deciduate are of importance because similar conditions occur in the Sirenia which may have sprung from an early Proboscidean stock.

The most primitive and earliest known ancestors of the elephant belong to the genus *Moeritherium* and are found in Upper Eocene deposits in the Fayûm of Egypt. *Moeritherium* was an animal resembling in its external appearance and size the living tapir. The eye was placed far forward and the head was low and elongated, probably the end of the snout was slightly flexible and it may have been produced into a short proboscis. The legs were considerably more bent than those of the modern elephants but are still rather incompletely known. *Moeritherium* possesses three upper and two lower incisors of which the second pair are enlarged, those in the upper jaw projecting straight downwards, whilst the lower teeth are directed forwards so that their tips bite against those of the upper incisors. There is a small and very reduced canine tooth; three pre-molars are present in each jaw and there is evidence that each of these vertically replaced a milk predecessor. Three permanent molars occur in both upper and lower jaws, each consisting of two transverse ridges.

The next stage, represented by *Palaeomastodon* from the Lower Oligocene of Egypt, presents a great advance on *Moeritherium*. There are several species of which the largest is not very much smaller than a small elephant, whilst the smallest is little bigger than the largest *Moeritherium*. The back of the skull begins to show the separation of the outer surface from the brain-cavity by air-spaces, which is carried to an extreme in the living elephants. The bony nostril has shifted backwards to a point in the middle of the cheek-teeth, and in front of it the pre-maxillae form an open channel in which lay the base of the trunk. The second incisor is very much enlarged and directed forwards and downwards. The lower jaw is so much longer than the skull that the incisors, which lie horizontally, project forwards several inches in front of the upper jaw, and even extend beyond the tips of the upper incisors. The single "second" lower incisor is enlarged, and with its fellow forms a shovel-shaped termination to the lower jaw. The shape of this tooth is such as to show that its upper surface was worn by contact with some part of the animal and the only explanation of its structure is that the nose, upper lip and palate projected so far forward as to overhang the front of the lower jaw and form there a movable proboscis. The lower incisors are, however, worn all round in a way which suggests that the creature used them for grubbing about in the ground to secure food. There are three upper pre-molars each of which replace a milk tooth, whilst in the lower jaw the three milk molars are replaced only by two pre-molars. Both upper and lower molar teeth have three transverse ridges, thus differing from those of *Moeritherium*. The body of the animal was much like that of a small elephant but the neck was longer.

In the next stage, which is represented by *Tetrabelodon angustidens* from the Lower and Middle Miocene of Europe, North Africa and Baluchistan, we have an animal somewhat larger than the largest *Palaeomastodon*, with a completely elephant-like body, though with a somewhat longer and more flexible neck. The skull is much more elephant-like than that of *Palaeomastodon* because of the increased bulk of the air-cavities in its bones. It supports a pair of immense incisors, which, unlike the tusks of living elephants, are still down-turned and are provided with a belt of enamel lying on the outer surface of the ivory of which they are composed. The lower jaw is even longer than in *Palaeomastodon* nearly half its length projecting in front of the bony skull. The lower tusks are directed forwards and bear a wear facet on their upper surfaces made by friction against a pad on the flexible and unsupported anterior part of the face, soon to be, if it had not already become, a true trunk. *Tetrabelodon* still possesses milk molars which are replaced vertically by pre-molars, but these latter are comparatively small teeth soon displaced by the cutting of the second and third molars, which push their way forward from the cavity in the hinder part of the jaw in which they are formed. This process is carried so far that the adult has only two molars, the second and third, in position in each jaw. The individual teeth though larger than those of *Palaeomastodon* have still only three ridges, except in the case of the third, which has five. It seems evident that the enormously elongated jaws of *Tetrabelodon* developed as an adaptation to allow the animal to reach the ground, when as a whole it was increasing in height whilst its neck was becoming shorter.

In the next stage represented by such forms as *Tetrabelodon longirostris*, the elephants gave up the attempt to reach the ground and came to depend on their trunks both for eating and drinking. As the elongated lower jaw is thus no longer necessary, and must have interfered with the free use of the trunk, its anterior extension becomes very rapidly reduced in size so that it no longer extends in front of the bony upper jaw. In these animals only one milk molar is replaced by a pre-molar and the first two molar teeth have each four or five transverse ridges. The lower tusks are short and rounded whilst the upper tusks become still larger and outwardly directed. In these forms the shortening of the lower jaw allowed the trunk to fall down vertically, as it does in modern elephants and in external appearance they must have been entirely elephantine.

The later mastodons pass gradually into the elephants by a still further reduction of the lower jaw, the lower tusks becoming quite small and eventually disappearing altogether, finally the front of the lower jaw becomes reduced to a very small down-turned spout which is retained in the living elephants. In the later forms the milk teeth are no longer replaced vertically by pre-molars, whilst such teeth when they do occur must have been pushed out almost immediately by the forward movement of the molar teeth. At the beginning of the series, the second molar tooth in either jaw has four or five ridges, separated from one another by deep valleys in which there is no cement. In an intermediate stage, *Stegodon*, the number of ridges varies from 6 to 12 in different forms and the valleys between these ridges become filled up with cement. In the true elephants the ridges are not only more numerous but much higher and the cement forms a plate lying between them. Continuation of this process leads to the most highly specialized of all elephants, the mammoth, in which the number of ridges in the second molar may be as high as 16, and the whole tooth was extraordinarily deep.

The history of the evolution of the elephant set forth above is a mere outline. It is really greatly complicated by the existence of a large number of side branches, many of which migrated into North and some even into South America. Of these side branches much the most striking is that represented by *Dinotherium,* an animal with an elephant-like body, apparently with exceptionally long limbs and a trunk. This animal is remarkable because its molar teeth throughout the whole history of the genus have only two transverse ridges and are very low crowned. The upper tusks are completely absent whilst the large lower tusks are directed downwards at right angles to the lower jaw. This animal is probably of African origin and is found only in that continent and in Europe and India. (See ELEPHANT; MAMMOTH; MASTODON.)

(D. M. S. W.)

PROBOSCIS-MONKEY, a large, long-tailed, red Bornean species (*Nasalis larvatus*) characterized by the prolongation of the nose of the adult male, which hangs down in front of the upper lip. In the females and young the nose is less developed. This monkey is a leaf eater, nearly allied to the langurs. (See PRIMATES.)

PROBUS, MARCUS AURELIUS, Roman emperor A.D. 276–282, was a native of Sirmium in Pannonia. At an early age he entered the army. where he distinguished himself under the emperors Valerian, Claudius and Aurelian. He was appointed governor of the East by the emperor Tacitus, at whose death he was immediately proclaimed his successor by the soldiers. Florianus, who had claimed to succeed his brother, was put to death by his own troops, and the senate ratified the choice of the army. The reign of Probus was mainly spent in successful wars by which he re-established the security of all the frontiers, the most important of these operations being directed to clearing Gaul of the Germans. Probus had also put down three usurpers, Saturninus, Proculus and Bonosus. In time of peace he kept the soldiers at work such as planting vineyards, which made him unpopular, and while superintending draining operations at his native town he was killed by his own soldiers. Scarcely any emperor has left behind him so good a reputation; his death was mourned alike by senate and people, and even the soldiers repented and raised a monument in his honour.

Life by Vopiscus; Zosimus i. 64; Zonaras xii. 29; Aurelius Victor, *Caes.* and Epit. 37; H. Schiller, *Geschichte* der romischen Kaiserzeit (1883), vol. i.; E. Lépaulle, etude *historique sur M. A. Probus d'après* la *numismatique* (1885); Pauly-Wissowa, Realencyklopadie, ii. 2516 (Henze).

PROBUS, MARCUS VALERIUS, of Berytus, Roman grammarian and critic, flourished under Nero. His criticisms on Virgil may be preserved in the commentary on the *Bucolics* and Georgics which goes under his name. We possess by him part of a treatise De *notis,* probably an excerpt from a larger work. It contains a list of abbreviations used in official and historical writings (especially proper names), in laws, legal pleadings and edicts. Other works have been wrongly attributed to him.

See J. Steup, De Probis grammaticis (1871); Teuffel-Schwabe, *Hist.* of Roman Literature (Eng. trans.) 301.

PROCEDURE, in law. (See PRACTICE AND PROCEDURE.)

PROCELLARIIDAE: see SHEARWATER; FULMAR.

PROCESS: *see* PRACTICE AND PROCEDURE.

PROCESS ENGRAVING: see PHOTO-ENGRAVING.

PROCESSION, in general, an organized body of people advancing in formal or ceremonial manner (M. Eng. *processioun,* Fr. procession, Lat. *processio,* from procedere, to go forth, advance, proceed). This definition covers a wide variety of such progresses: the mediaeval pageants, of which the Lord Mayor's show in London is the most conspicuous survival; the processions connected with court ceremonies; those organized to demonstrate political or other opinions; processions forming part of the ceremonies of public worship. In a narrower sense of "going forth, proceeding," the term is used in the technical language of theology in the phrase "Procession of the Holy Ghost," expressing the relation of the Third Person in the Triune Godhead to the Father and the Son.

Greek and Roman Processions.—Processions are included in the ritual of many religions, and in many countries, both in the East and West, they accompany such events as weddings and funerals. Religious and triumphal processions are abundantly illustrated by ancient monuments, *e.g.,* the religious processions of Egypt, those illustrated by the rock-carvings of Boghaz-Keui (see PTERIA), the many representations of processions in Greek art, culminating in the great Panathenaic procession of the Parthenon frieze, and Roman triumphal reliefs, such as those of the arch of Titus.

Processions played a prominent part in the great festivals of Greece, where they were always religious in character. The games were either opened or accompanied by more or less elaborate processions and sacrifices, while processions from the earliest times formed part of the worship of the old nature gods (*e.g.,* those connected with the cult of Dionysus, etc.), and later formed an essential part of the celebration of the great religious festivals (*e.g.,* the processions of the Thesmophoria, and that of the Great Dionysia), and of the mysteries (*e.g.,* the great procession from Athens to Eleusis, in connection with the Eleusinia).

Of the Roman processions, the most prominent was that of the triumph, which had its origin in the return of the victorious army headed by the general, who proceeded in great pomp from the Campus to the Capitol to offer sacrifice, accompanied by the army, captives, spoils, the magistrate and priests bearing the images of the gods, amidst strewing of flowers, burning of incense and the like (Ovid, Trist. iv. 2, 3 and 6). Connected with the triumph was the *pompa circensis,* or solemn procession which preceded the games in the circus; it first came into use at the *ludi romani,* when the games were preceded by a great procession from the capitol to the circus. The praetor or consul who appeared in the *pompa* circensis wore the robes of a triumphing general (see Mommsen, *Staatsrecht* I., 397, for the connection of the triumph with the *ludi*). Thus, when it became customary for the consul to celebrate games at the opening of the consular year, he came, under the empire, to appear in triumphal robes in the processus *consularis,* or procession of the consul to the Capitol to sacrifice to Jupiter. After the establishment of Christianity, the consular processions in Constantinople retained their religious character, now proceeding to St. Sophia, where prayers and offerings were made; but in Rome, where Christianity was not so widely spread among the upper classes, the tendency was to convert the procession into a purely civil function, omitting the pagan rites and prayers, without substituting Christian ones (Dahremberg and Saglio, *s.v.* "Consul"). Besides these public processions, there were others connected with the primitive worship of the country people, which remained unchanged, and were later to influence the worship of the Christian Church. Such were those of the Ambarvalia, Robigalia, etc., which were essentially rustic festivals, lustrations of the fields, consisting in a procession round the spot to be purified, leading the sacrificial victims with prayers, hymns and ceremonies, in order to protect the young crops from evil influences. (See Preller, Rom. Mythologie, pp. 370–372.)

Processions in the Christian Church.—As to the antiquity of processions as part of the ritual of the Christian Church, there is no absolute proof of their existence before the 4th century, but as we know that in the catacombs stations were held at the tombs of the martyrs on the anniversary of their death, for the celebration of the eucharist, it is quite probable that the faithful proceeded to the appointed spot in some kind of procession. There are, indeed, early instances of the use of the word processio by Christian writers, but it does not in any case appear to have the modern meaning "procession." Tertullian (2nd century) uses processio and procedere in the sense of "to go out, appear in public," and, as applied to a church function, processio was first used in the same way as *collecta,* as the equivalent of the Greek *συνάξις, i.e.,* for the assembly of the people in the church (Du' Cange, *s.v.* "Processio").

For the processions that formed part of the ritual of the eucharist, those of the introit, the gospel and the oblation, the earliest records date from the 6th century and even later (see Duchesne, *Origines,* 2nd ed. pp. 77, 154, 181; 78, 194), but they evidently were established at a much earlier date. As to public processions, these seem to have come into rapid vogue after the recognition of Christianity as the religion of the empire. Those at Jerusalem would seem to have been long established when described by the authoress of the *Peregrinatio Silviae* towards the end of the 4th century (see PALM SUNDAY, for the procession of palms).

Litanies or Rogations.—Very early were the processions accompanied by hymns and prayers, known as litaniae (Gr. λιτανεῖα from λιτή, prayer), *rogationes* or *supplicationes* (see LITANY). It is to such a procession that reference appears to be made in a letter of St. Basil (*c.* 375), which would thus be the first recorded mention of a public Christian procession. The first mention for the Western Church occurs in St. Ambrose (c. 388, Ep. 40 § 16, Ad Theodos.: "monachos . . . qui . . . psalmos canentes ex consuetudine usuque veteri pergebant ad celebritatem Machabaeorum martyrum"). In both these cases the litanies are stated to have been long in use. There is also mention of a procession accompanied by hymns, organized at Constantinople by St. John Chrysostom (c. 390–400) in opposition to a procession of Arians, in Sozomen, *Hist.* eccl. viii. 8. In times of calamity litanies were held, in which the people walked in robes of penitence, fasting, barefooted, and, in later times, frequently dressed in black (litaniae nigrae). The cross was carried at the head of the procession and often the gospel and the relics of the saint were carried. Gregory of Tours gives numerous instances of such litanies in time of calamity; thus he describes (Vita S. *Remig.* I.) a procession of the clergy and people round the city, in which relics of St. Remigius were carried and litanies chanted in order to avert the plague. So, too, Gregory the Great (*Ep.* xi. 57) writes to the Sicilian bishops to hold processions in order to prevent a threatened invasion of Sicily. A famous instance of these penitential litanies is the litania *septiformis* ordered by Gregory the Great in the year 590, when Rome had been inundated and pestilence had followed. In this litany seven processions, of clergy, laymen, monks, nuns, matrons, the poor and children respectively, started from seven different churches, proceeded to hear mass at Sta. Maria Maggiore (see Greg. of Tours, *Hist.* Fr. x. 1, and Johann. Diac. Vita Greg. Magn. i. 42). This litany has often been confused with the litania major, introduced at Rome in 598 (vide supra), but is quite distinct from it.

Funeral processions, accompanied with singing and the carrying of lighted tapers, were from very early times customary and in some ways similar to these; also very early, were the processions connected with the translation of the relics of martyrs from their original burying place to the church where they were to be enshrined (see, *e.g.,* St. Ambrose, *Ep.* 29 and St. Augustine, De civitate Dei, xxii. 8 and Conf. viii. 7, for the finding and translation of the relics of Saints Gervasius and Protasius). From the time of the emperor Constantine I. these processions were of great magnificence.

Origin of Christian **Processions.**—Some liturgists maintain that the early Church in its processions followed Old Testament precedents, quoting such cases as the procession of the ark round the walls of Jericho (Josh. vi.), the procession of David with the ark (2 Sam. vi.), the processions of thanksgiving on the return from captivity, etc. The liturgy of the early Church as Duchesne shows (*Origines,* ch. i.) was influenced by that of the Jewish synagogue, but the theory that the Church adopted the Old Testament ritual is of quite late growth. What is certain is that certain festivals involving processions were adopted by the Christian Church from the pagan calendar of Rome. Here we need only mention the *litaniae* rnajores et *minores,* which are stated by Usener ("Alte Bittgange," in Zeller, Philosophische *Aufsätze,* p. 278 *seq.*) to have been first instituted by Pope Liberius (352–366). It is generally acknowledged that they are the equivalent of the Christian Church of the Roman lustrations of the crops in spring, the Ambarvalia, etc. The *litania* major, or great procession on St. Mark's day (April 25) is shown to coincide both in date and ritual with the Roman *Robigalia,* which took place *a.d. vii.* Kal. Mai., and consisted in a procession leaving Rome by the Flaminian gate, and proceeding by way of the Milvian bridge to a sanctuary at the 5th milestone of the Via Claudia, where the *flamen quirinalis* sacrificed a dog and a sheep to avert blight (robigo) from the crops (Fasti *praenestini,* C.T.L.T., p. 317). The litania major followed the same route as far as the Milvian bridge, when it turned off and returned to St. Peter's, where mass was celebrated. This was already established as an annual festival by 598, as is shown by a document of Gregory the Great (*Regist.* ii.) which inculcates the duty of celebrating *litaniam,* quae major ab *omnibus appellatur.* The *litaniae minores* or rogations, held on the three days preceding Ascension Day, were first introduced into Gaul by Bishop Mamertus of Vienne (c. 470), and made binding for all Gaul by the 1st Council of Orleans (511). The litaniae *minores* were also adopted for these three days in Rome by Leo III. (c. 800). A description of the institution and character of the Ascensiontide rogations is given by Sidonius Apollinaris (*Ep.* v. 14). "The solemnity of these," he says, "was first established by Mamertus. Hitherto they had been erratic, lukewarm and poorly attended (vague, *tepentes,* infrequentesque); those which he instituted were characterized by fasting, prayers, psalms and tears." In the Ambrosian rite the rogations take place after Ascensiontide, and in the Spanish on the Thursday to Saturday after Whitsuntide, and in November (Synod of Girona, 517).

Processions in the Modern Roman Catholic **Church.—**It is impossible to describe in detail the vast development of processions during the middle ages. The most important and characteristic of these still have a place in the ritual of the Roman Catholic Church. The rules governing them are laid down in the *Rituale Romanum* (Tit. ix.), and they are classified in the following way:—

(1) Processiones *generales,* in which the whole body of the clergy takes part. (2) Processiones *ordinariae,* on yearly festivals, such as the feast of the Purification of the Virgin (Candlemas, *q.v.*), the procession on Palm Sunday (*q.v.*), the Litaniae *majores* and minores, the feast of Corpus Christi (*q.v.*), and on other days, according to the custom of the churches. (3) Processiones *extraordinariae,* or processions ordered on special occasions, *e.g.,* to pray for rain or fine weather, in time of storm, famine, plague, war, or, in quacunque *tribulatione,* processions of thanksgiving, translation of relics, the dedication of a church or cemetery. There are also processions of honour, for instance to meet a royal personage, or the bishop on his first entry into his diocese (*Pontif.* rom. iii.).

Reformed Churches.—The Reformation abolished in all Protestant countries those processions associated with the doctrine of transubstantiation (Corpus Christi); "the Sacrament of the Lord's Supper," according to the 28th Article of Religion of the Church of England, "was not by Christ's ordinance reserved, carried about, lifted up, or worshipped." It also abolished those associated with the cult of the Blessed Virgin and the saints. The stern simplicity of Calvinism, indeed, would not tolerate religious processions of any kind, and from the "Reformed" Churches they vanished altogether. The more conservative temper of the Anglican and Lutheran communions, however, suffered the retention of such processions as did not conflict with the reformed doctrines, though even in these churches they met with opposition and tended after a while to fall into disuse.

Lutheran Church.—The Lutheran practice has varied at different times and in different countries. Thus, according to the Wurttemberg *Kirchenordnung* of 1553, a funeral procession was prescribed, the bier being followed by the congregation singing hymns; the Brandenburg *Kirchenordnung* (1540) directed a cross-bearer to precede the procession and lighted candles to be carried, and this was prescribed also by the Waldeck *Kirchenordnung* of 1556. At present funeral processions survive in general only in the country districts; the processional cross or crucifix is still carried. In some provinces also the Lutheran Church has retained the ancient rogation processions in the week before Whitsuntide and, in some cases, in the month of May or on special occasions (*e.g.,* days of humiliation, *Busstage*), processions about the fields to ask a blessing on the crops. On these occasions the ancient litanies are still used.

Church **of** England.—In England "the perambulations of the circuits of the parishes . . . used heretofore in the days of rogations" were ordered to be observed by the Injunctions of Queen Elizabeth in 1559; and for these processions certain "psalms, prayers and homilies" were prescribed. The Puritans, who aimed at setting up the Genevan model, objected; and the visitation articles of the bishops in Charles I.'s time make frequent inquisition into the neglect of the clergy to obey the law in this matter. With "the profane, ungodly, presumptuous multitude" (to quote Baxter's *Saint's Rest*, 1650, pp. 344, 345), however, these "processions and perambulations" appear to have been very popular, though "only the traditions of their fathers." However this may be, the Commonwealth formally put an end to them, and they only survived in some remote country parishes; Sparrow, in his *Rationale upon the Book of Common Prayer* (London, 1668), speaks of "the service *formerly* appointed in the Rogation days of Procession."

Among the processions that survived the Reformation in the English Church was that of the sovereign and the Knights of the Garter on St. George's day. This was until Charles II.'s time a regular rogation, the choristers in surplices, the gentlemen of the royal chapel in copes, and the canons and other clergy in copes preceding the knights and singing the litany. In 1661, after the Restoration, by order of the sovereign and knights companions in chapter "that supplicational procession" was "converted into a hymn of thanksgiving." Akin to this procession also are the others connected with royal functions; coronations, funerals. These retained, and retain, many pre-Reformation features elsewhere fallen obsolete.

The only procession formally prescribed in the Book of Common Prayer is that in the order of the burial of the dead, where the rubric directs that "the priest and clerks meeting the corpse at the entrance of the churchyard, and going before it, either into the church, or towards the grave, shall say, or sing" certain verses of Scripture. Tapers seem to have been carried in processions, not only at royal funerals, until well into the 18th century. Processions, with the singing of the litany or of hymns, appear also to have been always usual on such occasions as the consecration of churches and churchyards and the solemn reception of a visiting bishop. Examples of processions in use in the English Church are the processional litanies, and the solemn entry and exit of clergy and choir. The use of the processional cross, banners and lights has been largely revived.

BIBLIOGRAPHY.—See the article "Bittgänge," by M. Herold, in Herzog-Hauck, *Realencyklopädie*, iii. 248 (3rd ed., Leipzig, 1897); Wetzer und Welte, *Kirchenlexikon*, *s.v.* "Prozession, Bittgange Litanei" and Smith's *Dictionary of Christian Antiquities*, *s.v.* "Procession." For the early ritual *see* Duchesne, *Origines du culte chrétien* (3rd ed., Paris, 1903). *See* also G. Catalani, *Rituale romanum perpetuis commentariis exornatum* (1760); N. Serarius, *Sacri peripatetici de sacris ecclesiae catholicae processionibus* (2 vols., 1607); Jac. Gretser, *De ecclesiae romanae processionibus* (2 vols., Ingolstadt, 1606); Jac. Eveillon, *De processionibus ecclesiae* (1641); Edw. Martène, *De antiquis ecclesiae ritibus* (3 vols., Antwerp, 1763), etc. For the past usage of the Church of England, *Hierurgia anglicana*, ed. Vernon Staley, p. ii. pp. 3–22 (1903).

PROCESSIONARY CATERPILLAR or **ARMY WORM,** the name given to the larvae of the moth *Cnethocampa processionea*, which, when moving to a new feeding place, proceed in line, the head of each touching the tail of the caterpillar in front. The caterpillars feed upon pine-needles, and are common on the European continent, though not occurring in Britain.

See J. H. Fabre, *Souvenirs Entomologiques*.

PROCÈS-VERBAL, in French law, a detailed authenticated account drawn up by a magistrate, police officer, or other person having authority of acts or proceedings done in the exercise of his duty. In a criminal charge, a procès-verbal is a statement of the facts of the case The term is also applied to the written minutes of a meeting or assembly.

PROCIDA, an island off the coast of Campania, Italy (Gr. Προχύτη, Lat. *Prochyta*), 2 mi. S.W. of Capo Miseno, 2 mi. N.E. of Ischia on the west side of the Gulf of Naples, 12 mi S.W. of Naples. Pop. (1936) 9,452. It is about 2 mi. in length, and, reckoning in the adjacent island of Vivara, is made up of four extinct craters, parts of the margins of all of which have been destroyed by the sea. The highest point of it is only 250 ft. above sea-level. It is very fertile. Procida, the only town, lies on the east side; its castle is now a prison. It also contains a royal palace.

PROCLAMATION. In English law, a royal proclamation is a formal announcement, made under the great seal, of some matter which the king in council desires to make known to his subjects; *e.g.* the declaration of war, the statement of neutrality, the conclusion of peace, the annexation of territory, the summoning or dissolution of parliament, or the bringing into operation of the provisions of some statute the enforcement of which the legislature has left to the discretion of the king in council. Roya! proclamations of this character, made in furtherance of the *executive* power of the Crown, are binding on the subject "where they do not either contradict the old laws or tend to establish new ones" (Dicey, *Law of the Constitution,* 6th ed., 51). The Crown has often *legislated* by proclamation; and the Statute of Proclamations 1539 provided that proclamations made with the assent of the council should have the force of statute law, if they were not prejudicial to "any person's inheritance, offices, liberties, goods, chattels or life." But this enactment was repealed by an act of 1547; and it is well settled that the Crown cannot by proclamation make or remake any law unless the proclamation is issued under statutory authority. (*Ex parte Chavasse*, 1865, *1* De G. J. & S. 622; *Grieve* v. *Edinburgh, etc.*, 1918, *3*. C. [Scotland] 700; *see* also EMERGENCY LEGISLATION; MARTIAL LAW.) The Crown has power to legislate by proclamation for a newly conquered country (Jenkyns, *British Rule and Jurisdiction beyond the Seas*, pp. 95); and this power was freely exercised in the Transvaal Colony during the Boer War of 1899–1902. In the British colonies, ordinances are frequently brought into force by proclamation; certain imperial Acts do not take effect in a colony until there proclaimed (*e.g.* the Foreign Enlistment Act 1870); and proclamations are constantly issued in furtherance of executive acts. In many British protectorates the high commissioner or administrator is empowered to legislate by proclamation. Proclamations cannot be issued by private persons unless under customary or other valid authority, *e.g.* a proclamation by members of the Privy Council of the accession of a new sovereign.

(A. W. R.)

PROCLUS or **PROCULUS** (A.D. 410–485), the chief representative of the later Neoplatonists, was born at Constantinople, but brought up at Xanthus in Lycia. Having studied grammar under Orion and philosophy under Olympiodorus the Peripatetic, at Alexandria, he proceeded to Athens. There he attended the lectures of the Neoplatonists Plutarch and Syrianus, and about 450 succeeded the latter in the chair of philosophy (hence his surname Diadochus, which, however, is referred by others to his being the "successor" of Plato). As an ardent upholder of the old pagan religion Proclus incurred the hatred of the Christians, and was obliged to take refuge in Asia Minor. After a year's absence he returned to Athens, where he remained until his death. His epitaph, written by himself, is to be found in *Anthologin palatina*, vii. 451.

His great literary activity was chiefly devoted to the elucidation of the writings of Plato. There are still extant commentaries on the *First Alcibiades*, *Parmenides*, *Republic*, *Timaeus* and *Cratylus*. His views are more fully expounded in the Περὶ τῆς κατὰ Πλάτωνα θεολογίας (*In Platonis theologiam*). The Στοιχείωσις θεολογική (*Institutio theologica*) contains a compendious account of the principles of Neoplatonism and the modifications introduced in it by Proclus himself. the pseudo-Aristotelian *De causis* is an Arabic extract from this work, ascribed to Alfarabius (d. 950), circulated in the west by means of a Latin translation (ed. O. Bardenhewer, Freiburg, 1882). Other philosophical works by Proclus are Στοιχείωσις φυσικὴ ἢ Περὶ κινήσεως (*Institutio physica sive De motu*, a compendium of the last five books of Aristotle's Περὶ φυσικῆς ἀκροάσεως, *De physica auscultatione*), and *De providentia et fato*, *Decem dubitationes circa providentiam*, *De malorum subsistentia*, known only by the Latin translation of William of Moerbeke (archbishop of Corinth, 1277–1281), who also translated the Στοιχείωσις θεολογική into Latin. In addition to the epitaph already mentioned, Proclus was the author of hymns, seven of which have been preserved (to Helios, Aphrodite, the Muses, the Gods, the Lycian Aphrodite, Hecate and Janus, and Athena), and of an epigram in the Greek Anthology (*Anthol. pal.* iii. 3, *166* in

Didot edition). His astronomical and mathematical writings include Ὑποτύπωσις τῶν ἀστρονομικῶν ὑποθέσεων (*Hypotyposis astronomicarum positionum*, ed. C. Manitius, Leipzig, 1909); Περὶ σφαίρας (De *sphaera*); Παράφρασις εἰς τὴν Πτολεμαίου τετράβιβλον, a paraphrase of the difficult passages in Ptolemy's astrological work *Tetrabiblus;* Εἰς τὸ πρῶτον τῶν Εὐκλείδου στοιχείων, a commentary on the first book of Euclid's Elements; a short treatise on the effect of eclipses (De *effectibus eclipsium,* only in a Latin translation).

His grammatical works are: a commentary on the *Works* and Days of Hesiod (incomplete); some scholia on Homer; an elementary treatise on the epistolary style, Περὶ ἐπιστολιμαίου χαρακτῆρος (Characteres epistolici), attributed in some mss. to Libanius. The Χρηστομαθία γραμματική by a Proclus, who is identified by Suïdas with the Neoplatonist, is probably the work of a grammarian of the 2nd or 3rd century, though Wilamowitz-Mollendorff (Philolog. *Untersuch.* vii.; supported by O. Immisch in Festschrift *Th. Gomperz,* pp. 237–274) agrees with Suïdas. According to Suïdas, he was also the author of Ἐπιχειρήματα ιη κατὰ Χριστιανῶν (*Animadversiones duodeviginti* in christianos). This work, identified by W. Christ with the *Institutio* theologica, was answered by Joannes Philoponus (7th century) in his De aetern*itate mundi.* Some of his commentary on the Chaldaean oracles (Λόγια Χαλδαϊκά) has been discovered in modern times.

Bibliography.—There is no complete edition of the works of Proclus. The selection of V. Cousin (Paris, 1864) contains the treatises De providentia et *fato, Decem dubitationes* and De *malorum* subsistentia, the commentaries on the *Alcibiades* and Parmenides. The *Institutio* theologica has been edited by G. F. Creuzer in the Didot edition of Plotinus (Paris, 1855); the *In Platonis* theologiam has not been reprinted since 1618, when it was published by Acmilius Portus with Latin translation. Recent editions of individual works are: In the Teubner series, Leipzig, Commentary on Euclid (edit. G. Friedlein, 1878); Republic (edit. G. Kroll, 1899–1901); Timaeus (edit. E. Diehl, 3 vols., 1903–06); Cratylus (edit. G. Pasquali, 1908); *Hypotyposis* (edit. C. Manitius, with German trans., 1909); *Institutio Physica* (edit. A. Ritzenfeld, with German trans., 1912); also *Scholia* to Hesiod (edit. E. Vollbehr, 1844); Characteres epistolici (edit. A. Westermann, 1856); Hymns (edit. E. Abel, 1883); also A. Ludwich (1895); Λόγια Χαλδαϊκά (edit. A. Jahn, 1891); Commentaries on the Par*menides* (edit. A. E. Chaignet, French trans. and notes, also trans. of Marinus' Life, 1900–03). Thomas Taylor, the "Platonist," translated the Commentaries on Euclid, with the Life by Marinus and the Elements of Theology (2 vols., 1788–89); the Theology of *Plato* (1816); *Timaeus* (1820); Fragments of the Lost Works of Proclus (1825), and the three Latin treatises (1833).

On Proclus generally and his works see the article in *Suïdas* (edit. G. Bernhardy, 1853); Marinus, Vita *Procli* (edit. with Diogenes Laertius, *Lives* of the Philosophers, by C. G. Cobet, Paris, 1850); H. F. Muller, Dionysios, Proklos, *Plotinos* (1918) in *Beiträge zur Geschichte* der Philosophie des Mittelalters (edit. C. Baeumker, Münster; vol. xx., 1922) and Neoplatonism.

Extracts from the Χρηστομαθία are preserved in Photius (Cod. 239), almost the only source of information regarding the epic cycle; on the question of authorship, see Christ, sec. 637 and Sandys, p. 379; also D. B. Monro's appendix to his ed. of Homer's Odyssey, xii.–xxiv. (1901).

PROCOPIUS, Byzantine historian, was born at Caesarea in Palestine towards the end of the 5th century A.D. He became a lawyer, probably at Constantinople, and was in 527 appointed private secretary to Belisarius, whom he accompanied on his Persian, African and Italian campaigns. After the capture of Ravenna in 540 Procopius seems to have returned to Constantinople, since he minutely describes the great plague of 542 (*op. cit.* ii. 22). It does not appear whether he was with the Roman armies in the later stages of the Gothic War, when Belisarius and afterwards Narses fought against Totila in Italy; his narrative of these years is much less full and minute than that of the earlier warfare. Of his subsequent fortunes we know nothing, except that he was living in 559. Whether he was the Procopius who was prefect of Constantinople in 562 (Theophanes, Chronographia, 201, 202), and was removed from office in the year following, cannot be determined, though it is not improbable.

Procopius's writings fall into three divisions: the Histories (Persian, Vandal and Gothic Wars), in eight books; the treatise on the Buildings of *Justinian* (De aedificiis), in six books; and the Unpublished Memoirs (Ἀνέκδοτα, *Historia arcana*), so called because they were not published during the lifetime of the author.

The Histories are called by the author himself the Books about the Wars (οἱ ὑπὲρ τῶν πολέμων λόγοι). They consist of: (1) the Persian Wars, in two books, giving a narrative of the long struggle of the emperors Justin and Justinian against the Persian kings Kavadh and Chosroes Anushirvan down to 550; (2) the Vandal War, in two books, describing the conquest of the Vandal kingdom in Africa and the subsequent events there from 532 down to 546 (with a few words on later occurrences); (3) the Gothic War, in three books, narrating the war against the Ostrogoths in Sicily and Italy from 536 till 552. The eighth book contains a further summary of events down to 554. These eight books contain notices of some of the more important domestic events, such as the Nika insurrection at Constantinople in 532, and the plague in 542. They tell us, however, comparatively little about the civil administration of the empire, and nothing about legislation.

The De aedificiis contains an account of the chief public works executed during the reign of Justinian down to 560 which are of course ascribed to the personal action of the monarch. If not written at the command of Justinian (as some have supposed), it is evidently grounded on official information, and is full of gross flattery of the emperor and of the (then deceased) empress. In point of style it is greatly inferior to the Histories—florid, pompous and affected, and at the same time tedious Its chief value lies in the geographical notices which it contains.

The Anecdota (date probably 550) purports to be a supplement to the Histories, containing explanations and additions which the author could not insert in the latter work for fear of Justinian and Theodora. It is a furious invective against these sovereigns, with attacks on Belisarius and his wife Antonina, and on other noted officials. Owing to the ferocity and brutality of the attacks upon Justinian, the authenticity of the Anecdota has often been called in question, but the claims of Procopius to the authorship are now generally recognized. In point of style, the Anecdota is inferior to the Histories, and has the air of being unfinished, or at least unrevised. The history of Philip of Macedon by Theopompus probably furnished the author with a model.

The best complete edition of Procopius is by J. Haury (Teuhner Series, 1905–13). There are English translations of the History of the Wars, by H. Holcroft (1653), of the Anecdota (1674, anonymous), of the Buildings, by Aubrey Stewart (Palestine Pilgrims' Text Society, 1888) and by H. B. Dewing (Loeb Classical Library, 1914, etc.). Chief authorities: F. Dahn, *Procopius* von Casarea (1865); J. Haury, Procopiana (1891–93). On the genuineness of the Anecdota, see J. B. Bury (who agrees with Ranke in rejecting the authorship of Procopius), *A* History of the Later Roman Empire (1889), vol. i. and introd. to vol. ii. (p. 57) and appendix to vol. iv. of his edition of E. Gibbon, Decline and Fall (1925). See also C. Krumbacher, Geschichte der bysantinisclzen Literatur (2nd ed., 1897).

PROCOPIUS OF GAZA (c. A.D. 465–528), Christian sophist and rhetorician, was born at Gaza. What is known of him is to be found in his letters and the encomium by his pupil and successor Choricius. Of his rhetorical works only the panegyric on the emperor Anastasius alone is extant. His letters (162 in number) throw light upon the condition of the sophistical rhetoric of the period. The fragment of a polemical treatise against the Neoplatonist Proclus is now assigned to Nicolaus, archbishop of Methone in Peloponnesus (*fl.* 12th century). Procopius's theological writings consist of commentaries which are early examples of the catena (chain) form of commentary, consisting of a series of extracts from the fathers, arranged, with independent additions, to elucidate Scripture.

Complete editions of the works of Procopius in Migne, Patrologia graeca, lxxxvii.; the letters also in *Epistolographi* graeci, ed. R. Hercher (1873); see also K. Seitz, Die *Schule von* Gaza (1892); D. Russos, Τρεῖς Γαζαῖοι (Constantinople, 1893); L. Eisenhofer, Procopius von Gaza (1897); further bibliographical notices in C. Krumbacher, Geschichte der bysantinischen Literatur (1897), and article by G. Krüger in Herzog-Hauck's *Realencyklopädie* fur *protestantische* Theologie (1905).

PROCRUSTES, also called Polypemon or Damastes, in Greek legend, a robber dwelling in the neighbourhood of Eleusis, who was slain by Theseus (*q.v.*). The "bed of Procrustes" has become proverbial.

Bibliography.—*See* Diod. Sic. iv. 59; Hyginus, Fab. 38; Plutarch, *Theseus,* 11; Pausanias i. 38, 5.

PROCTER, ADELAIDE ANNE (1825–1864), English poetess, daughter of Bryan Waller Procter (*q.v.*), was born on Oct. 30, 1825. She began to contribute to *Household Words* in 1853. Her principal work is *Legends and Lyrics*, of which a first series, published in 1858, ran through nine editions in seven years, while a second series issued in 1860 met with a similar success (new ed.. 1914). She died on Feb. 2, 1864.

PROCTER, BRYAN WALLER (1787–1874), English poet, was born at Leeds on Nov. 21, 1787. By the death of his father in 1816 he became possessed of a small property, and soon after entered into partnership with a solicitor; but in 1820 the partnership was dissolved, and he began to write under the pseudonym of "Barry Cornwall." He was metropolitan commissioner of lunacy from 1832 to 1861. He died on Oct. 5, 1874.

His principal poetical works were: *Dramatic Scenes and other Poems* (1819), *A Sicilian Story* (1820), *Mirandola, a* tragedy performed at Covent Garden with Macready, Charles Kemble and Miss Foote in the leading parts (1821), *The Flood of Thessaly* (1823), and *English Songs* (1832).

PROCTOR, ALEXANDER PHIMISTER (1862–), American sculptor and painter, was born in Ontario, Canada, on Sept. 27, 1862. As a youth he lived at Denver (Colo.), spending much of his time in the Rocky Mountains, and his familiarity with the ways and habits of wild animals was supplemented later by study in the Jardin des Plantes, Paris. He was a pupil at the National Academy of Design and later in the Art Students' league, in New York, and first attracted attention by his statues of wild animals at the Columbian exposition, Chicago. In 1896 he won the Rinehart scholarship, which enabled him to spend five years in Paris, where he studied under Puech and J. A. Injalbert. Among his works of sculpture are: "Indian Warrior" (a small bronze); "Panthers," Prospect park, Brooklyn (N.Y.); "Quadriga," for the U.S. pavilion, Paris Exhibition (1900); the Princeton Tigers, for Princeton university; the equestian statue of Col. Roosevelt as rough rider, Portland (Ore.); and groups in the City park, Denver, and Zoological park, New York.

PROCTOR, RICHARD ANTHONY (1837–1888), British astronomer, was born at Chelsea, on March 23, 1837. He was educated privately, at King's college, London, and at St. John's college, Cambridge. He read for the bar, but turned to astronomy and authorship. His book, *Saturn and His System* (1865), though favourably received by astronomers, was a financial failure, and other financial losses obliged him to cultivate a popular style. He was for a time mathematical coach for Woolwich and Sandhurst.

In 1881 he founded *Knowledge,* a popular magazine, in which he wrote on a great many subjects. He became a fellow of the Royal Astronomical Society in 1866, and honorary secretary in 1872. He was an expert in map-drawing, and published two star-atlases. His most ambitious work, *Old and New Astronomy,* was completed after his death, by A. Cowper Ranyard, and published in 1892. Proctor settled in America in 1881, and died at New York on Sept. 12, 1888.

His many publications include *Half-hours with the Telescope* (1868); *Other Worlds than Ours* (1870); *The Borderland of Science* (1873); *The Poetry of Astronomy* (1880); *Mysteries of Time and Space* (1883); *Half-hours with the Stars* (1887). He contributed numerous papers to the *Monthly Notices* of the Royal Astronomical Society, and articles on astronomy to the 9th edition of the *Encyclopædia Britannica.*

PROCTOR, a variant of the word procurator (*q.v.*), very nearly equivalent in meaning to "agent" (*q.v.*). The title is used in England in three principal senses.

1. A practitioner in the ecclesiastical and admiralty courts. A proctor in this sense was formerly a qualified person licensed by the archbishop of Canterbury to undertake duties such as are performed in other courts by solicitors. The king's proctor is the proctor or solicitor representing the crown in the courts of probate and divorce. His power of intervening is limited, by the Matrimonial Causes act 1860, to cases of *collusion* only, but he may also, as one of the public, show cause against a decree *nisi* being made absolute (*see* DIVORCE). In the admiralty court a proctor or procurator was an officer who, in conjunction with the king's proctor, acted as the attorney or solicitor in all causes concerning the lord high admiral's affairs in the high court of admiralty and other courts. The king's proctor so acted in all causes concerning the king.

In the United States the term "proctor" is applied to practitioners in the admiralty and probate courts.

2. A representative of the clergy in convocation, A proctor in this sense represents either the chapter of a cathedral or the beneficed clergy of a diocese. In the province of Canterbury two proctors represent the clergy of each diocese; in that of York there are two for each archdeaconry. In both alike each chapter is represented by one.

3. The name of certain important university officials. At Oxford the proctors, with the vice-chancellor, supervise university business and appoint delegates for any particular affairs not otherwise provided for by statute. They are *ex-officio* members of nearly all the important delegacies. They also act as the assessors of the chancellor or his commissary. They supervise the voting at public meetings of the university and announce the results. They have jointly. power of veto in convocation and congregation: nc proposal can be passed into a statute or decree if twice vetoed by them. They are *ex officio* members of the hebdomadal council, the governing council of the university, and they are the assessors of the vice-chancellor when he confers degrees. They are empowered to punish undergraduates, or graduates under the degree of bachelor of civil law and master of arts, by fine or by confinement to their colleges or lodgings (familiarly known as "gating"). They have to see that all examinations are properly conducted. They are responsible for the good order of the streets at night, so far as members of the university are concerned, and perambulate the streets nightly, accompanied by the university marshal and two sworn constables, familiarly known as "bulldogs." The proctors are elected by the heads, fellows and resident members of convocation of each college in rotation.

At Cambridge the proctors are nominated annually by the colleges in rotation and elected (a formal proceeding) by the senate.

At present their functions are (1) taking part in all university ceremonials, (2) enforcing discipline in the case of members of the university who are *in statu pupillari* (*i.e.,* undergraduates and bachelors of arts and law). (1) The proctors are *ex officio* members of boards or syndicates such as those with which their duties are specially connected. But their presence is essential at all congregations of the senate, at which the senior proctor reads all the "graces" (already approved by the council of the senate). If any grace is opposed by any member of the senate saying *non placet* the proctors take the votes of those present and announce the result, and on very important occasions many hundreds of non-resident members of the senate come up to record their votes. (2) The proctors have authority to impose certain fines for minor offences. In the case of more serious offences the proctor generally reports the matter to the authorities of the offender's college to be dealt with by them, or brings the offender before the university court of discipline.

PROCURATION, the action of taking care of, hence management, stewardship, agency. The word is applied to the authority or power delegated to a procurator, or agent, as well as to the exercise of such authority, expressed frequently "by procuration" *(per procurationem)*, or shortly *per pro.*, or simply *p.p.* In ecclesiastical law, procuration is the providing necessaries for bishops and archdeacons during their visitations of parochial churches in their dioceses. Procuration is merely an ecclesiastical due, and as a consequence is suable only in a spiritual court. Procuration is also used specifically for the negotiation of a loan by an agent for his client, whether by mortgage or otherwise, and the sum of money or commission paid for negotiating it is frequently termed *procuration fee. See* also PROXY.

In French law, procuration means an authority given to an agent or representative, *e.g.,* a power of attorney.

The English criminal law makes the provision or attempted provision of any girl or woman under 21 years of age for the purpose of illicit intercourse an offence, known as procuration.

PROCURATOR, generally one who acts for another. With the Romans it was applied to a person who maintained or defended an action on behalf of another, thus performing the functions of a modern attorney. Roman families of importance employed an official corresponding to the modem steward and frequently called the *procurator.* Later, the name was applied especially to certain imperial officials in the provinces of the Roman empire. With the establishment of the imperial power under Augustus, the emperor took under his direct government those of which the condition or situation rendered a large military force necessary. Here certain officials, known as the *procuratores Caesaris,* took the place occupied by the *quaestor* in the senatorial provinces. They were either equites or freedmen of the Caesar and their office was concerned with the interests of the fiscus (the public property of the Caesar). They looked after the taxes and paid the troops. There were also officials bearing this title of *procuratores Caesaris* in the senatorial provinces. They collected certain dues of the *fiscus* which were independent of those paid to the *aerarium* (the property of the senate). This organization lasted with some modifications until the 3rd century. The *procurator* was an important official in the reorganized empire of Diocletian.

The title remained all through the middle ages to describe very different officials. Thus it was sometimes applied to a regent acting for a king, during his minority or absence; sometimes it appears as an alternative title to *seneschal* or *dapifer.* It preserved its legal significance in the title of *procurator animarum,* who acted as solicitor or proxy in the ecclesiastical courts, and was so called because these courts dealt with matters affecting the spiritual interests of the persons concerned. The economical significance remained in such titles as *procurator anniversariorum,* the exactor of dues for the celebration of anniversaries; this office was assigned to laymen. The *procurator draperii* was entrusted with the administration of matters pertaining to the art of cloth-making. The *procurator duplarum* was the collector of fines in certain churches from absent canons, etc. The officials entrusted with the administration of the goods of a church were called variously *procurator ecclesiae, procurator parcitatis, procurator universitatis.* Bishops and bishops-elect frequently described themselves by the title of procuratores ecclesiarum. The prior of a dependent religious house was sometimes styled *procurator obedientiae.* The official who represented the public interests in the courts of the inquisition was known as the *procurator fidei.* The administrator of the affairs of a large community was sometimes called the *procurator syndicus;* the administrator of goods left to the poor, *procurator pauperum.* In monasteries the *economus* was, and is, sometimes described as *procurator.* Thus the procurator has still the administration of material affairs in every Dominican priory. *Procurator di San Marco* was a title of honour in Venice.

The term procurator (Fr. *procureur)* is used in those countries whose codes are based on the Roman civil law for certain officials, having a representative character, in the courts of law. In Scotland the term procurator is now almost a law agent who practises in an inferior court. A procurator in the inferior courts has been, since the Law Agents Act 1873, exactly in the same legal position as other law agents. The procurator-fiscal is a local officer attached to the sheriff's court and charged with the duty of precognoscing witnesses regarding crimes, and with the prosecution of persons charged with a crime or offence in the sheriff's court. He also performs the duty of making enquiries into the circumstances of suspicious deaths. He was formerly appointed by the sheriff, but since 1907 has been appointed by the lord advocate. The procurator of the Church of Scotland is a member of the bar appointed by the general assembly as its legal adviser. A common English form of procurator is proctor (*q.v.*).

See Smith, *Dictionary of Greek and Roman Antiquities,* and *Du* Cange, *Glossarium mediae et infimae latinitatis.*

PROCYON, the brightest star in the constellation Canis Minor *(see* CANIS MAJOR), hence its Bayer equivalent, α Canis Minoris. It and Sirius (*q.v.*) in Canis Major were called the two dog-stars, though "the dog-star" refers to Sirius, which is the brighter of the two. Procyon is a double star consisting of one bright and one very faint component. *(See* STAR: *Double Stars.)*

PRODICUS OF CEOS (b. *c.* 465 or 450 B.C.), a Greek humanist of the first period of the Sophistical movement, was still living in 399 B.C. He came to Athens as ambassador from Ceos, and became known as a speaker and a teacher. Like Protagoras, he professed to train his pupils for domestic and civic affairs, and made ethics prominent in his curriculum. He advocated no hopeless resignation, but rather the remedy of work. The influence of his views may be recognized as late as the *Shepherd* of *Hermas.* As for the origin of the belief in the gods, he holds that first came those great powers which benefit mankind, and after these the deified men who have rendered services to humanity. Of his natural philosophy we know only the titles of his treatises *On Nature* and *On the Nature of Man.* Two of his discourses on words were specially famous; one, "On Propriety of Language," is repeatedly alluded to by Plato; the other, entitled Ὧραι, contained the celebrated apologue of the Choice of Heracles, summarized in Xenophon, *Mem.* ii. 1, 21 *seq.*

See Hummel, *De Prodico Sophista* (Leyden, 1846); Cougny, *De Prodico Ceio* (1858); and Überweg, *Grundriss der Gesch. der Philosophie,* Bd. I. (1926).

PRODIGY, an extraordinary or wonderful thing, person, event, etc.; something which excites amazement and astonishment. The term has been particularly applied to children who display a precocious genius, especially in music. The German expression *Wunderkind* has of late been often adopted by those who have found the name "infant prodigy" too reminiscent of the "infant phenomenon" familiar to readers of Dickens. Among the more notable of the almost countless number of musical prodigies who have excited wonder may be mentioned Mozart who composed minuets before he was four; Beethoven, who played in public at eight and composed works which were published at 10; Hummel, who gave concerts at nine; Schubert, who composed at 11; Chopin, who played a concerto in public before he was nine; Mendelssohn, who began to compose systematically at 12; Brahms, whose exceptional talents attracted attention from his earliest years; Dvořák to whom the like applied; Richard Strauss, who wrote a polka and a song at six; and last but not least the famous English composer and organist Samuel Wesley, who played the organ at three and composed an oratorio at eight.

In regard to prodigies of other kinds one of the most remarkable ever known was the boy William Henry West Betty (born at Shrewsbury in 1791, d. London 1874), who from his amazingly precocious talents as an actor was known as the Young Roscius (after the famous Roman actor Quintus Roscius). He appeared on the stage at 11 years of age in the heaviest Shakespearean parts, the vogue which he enjoyed being such that the House of Commons actually adjourned to witness his Hamlet.

PRODUCER GAS: *see* GAS MANUFACTURE.

PRODUCT INTEGRAPH. The product integraph belongs to that class of calculating machines which deals with curves and graphs rather than with numbers. It multiplies together any two given curves before the integration. Results are obtained by an automatically-drawn curve. It can be used, therefore, to determine the coefficients in the expansion of an arbitrary function into any chosen set of orthogonal functions. It can be extended to make the form of one or both of the curves to be integrated dependent upon the result of the integration by having the mechanism which operates the recording pencil also control the input curves as the operation of integration proceeds. The device is then capable of solving ordinary differential equations, and this is its most important use. The result of the first integration may be integrated again any number of times, thus raising the order of the equation solvable. In its most developed form, therefore, the product integraph is a machine for solving ordinary differential equations where the coefficients are given by means of curves. Hence the coefficients may be discontinuous or even multiple-valued without making the mechanical work any more involved, and the device allows the prompt solution of equations which are beyond formal treatment except by extremely labourious processes. The result given by the machine is in the form of a curve or family of curves, corresponding to numerically-chosen initial or boundary conditions.

The first product integraph constructed at the Massachusetts Institute of Technology is adapted for the solution of second-order differential equations of nearly, but not quite, general form. It will treat equations of the form: —

$$\frac{d^2z}{dx^2} = f_a(f_1+f_2)$$

where each of f_a, f_1 and f_2 may be functions of any one of the quantities z, x or $\frac{dz}{dx}$. By schemes of interpolation double-valued functions may be introduced, and any of the input functions may be functions of any two of the three quantities. Practically all of the second-order differential equations met in practice are therefore subject to treatment, with the reservation of course that graphical solutions, not formal solutions, are always obtained, The solution of equations having discontinuous coefficients has proved especially interesting.

To solve an equation such as the above, the procedure is as follows: The functions f_a, f_1 and f_2 are plotted and mounted on movable platens. Operators keep a movable pointer on each of the curves as the platens are moved by the machine. The ordinates given by the position of the pointers control the action of the device so that the necessary addition and multiplication are made, the two integrations performed, and the results plotted. The necessary operations are more clearly indicated when the equation is in the form: —

$$z = \int_a^x \int_b^x f_a(f_1+f_2)dx\,dx$$

the result curve thus being a plot of z as a function of x for chosen initial conditions a and b. The movement of the platens is controlled by the device itself. When all input platens are driven by the same mechanism which drives the result platen, the functions are evidently functions of x. A cross connection enables any input platen to be driven by the mechanism which operates the result pencil. Then an input function of z is being used. A drive can also be obtained from the result of the first integrations alone, giving an input function of $\frac{dz}{dx}$.

In this first instrument, multiplication and first integration are performed by a Thomson watt-hour meter, the second integration being mechanical. Servo mechanisms do the work of moving the parts without imposing load on the delicate integrating devices. Precision of 1–2% is attained, depending upon many conditions.

In the second instrument, now partially in operation, all integration, addition and multiplication is mechanical, servo mechanisms and torque amplifiers being utilized to enable precision apparatus to operate at practically no load. A unit system is adopted so that the range of the instrument may be extended at will. At present sufficient parts are made available to handle sixth-order equations, or a set of three second-order equations. The precision is much higher than in the first instrument.

The first instrument and some of its applications are described in detail in the following publications: V. Bush, F. D. Gage and H. R. Stewart, "A Continuous Integraph," *Jour.* of the Franklin Inst. (Jan. 1927); V. Bush and H. L. Hazen, "Integraph Solution of Differential Equations," *Jour.* of the Franklin Inst. (Nov. 1927). Early work on this type of instrument is presented in a series of articles by Sir William and Professor James Thompson, Royal Society Proceedings, Vol. **24**, 1875–76. *See* also MATHEMATICAL INSTRUMENTS (V. BU.)

PRODUCTION. For the meaning of this term see CAPITAL; ECONOMICS; VALUE; WEALTH.

PRODUCTION, CENSUS OF. In many countries no general survey of production is available. In countries mainly devoted to agriculture, the ascertainment of the distribution of the cultivated area, and of the quantities of the leading crops and the numbers of livestock maintained, gives information of the greatest importance Where the extraction of minerals is important, the quantities of such minerals produced are a necessary element in the survey of the country's industrial resources. In various countries in which manufacture has reached a considerable degree of importance, periodic returns of the output of various leading products of the manufacturing industries are added to the records of agricultural and mineral products obtained. These surveys are, however, not merely incomplete in that they fail to cover the productive activities of the country, but they also fail to furnish a satisfactory measure of the results of that activity. For that purpose a census not of products but of production is needed. For the extractive industries the record of products serves to measure production reasonably well, since the value of the products of other industries used up in the processes essential to the extraction of new products is, in general, comparatively small. Even in the instance of field crops, a sound estimate of the "production" of agriculture would need, indeed, a deduction from the gross total of crops harvested not only of the seed which has been required to produce those crops but also of the equivalent of manures used and of the requirements for the replacement of tools and equipment so as to maintain the stock of such tools, etc., undiminished. In dealing with animal products, allowances must, in like manner, be made for food consumed in the maintenance of the animals and for other supplies used up in the business of stock rearing, so far as these goods are obtained beyond the limits of the agricultural industries.

The distinction between a census of products and a census of production has special importance in reference to many manufacturing industries. Effective comparison of different industries, and of different divisions of the same industry, cannot be made on the basis of the aggregate value of the products of the industries compared. There are two important reasons for this. On the one hand, if industries were otherwise similar in character, but made use of different materials, they would yield aggregates of products, the value of which would be higher or lower according to the values of these different materials. Materials costing £50,000 might be worked up into products worth £100,000, and precisely similar operations on materials costing £75,000 might yield products worth £125,000. Measured by the value of products, the second industry appears to have a yield of 25% greater than the first, while the actual increments in value of materials used were the same in both cases.

On the other hand, the same materials may be advanced from stage to stage in manufacture in different establishments, and the products of the series of establishments will show values gradually increasing, the material of each being the product of the preceding. It would not be a sound conclusion from such a record that the productive importance of the successive establishments was in the order of the processes, and that the increasing values of the goods from stage to stage reflected the importance of the productive services of the series of establishments. In comparing establishments making use of different materials and conducting processes of manufacture dissimilar in character, as in the two types of cases dealt with above, no true comparison of the value of the productive contribution of each can be expected to result from a simple comparison of the values of their products.

A census of production must, accordingly, be something more than an enumeration of the products of the various establishments and industries surveyed and a record of their values. The products of other establishments or industries which have been used up in the productive processes surveyed must be ascertained if a true measure of the production carried on is to be secured. In strictness the effects of wear and tear, so far as not made good by the staff maintained within the establishment for that purpose, and also the effects of obsolescence on the plant and buildings, should be evaluated and included in the deduction from the value of the gross output needed in order to arrive at the value of the contribution made to production. In practice allowances for depreciation cannot be estimated with a precision approximating to that attainable with reference to cost of materials, and adjustments in respect of the consequent overestimate of the production have to be made by some means other than the simple aggregation of the depreciation suffered by each establishment. The result of deducting the value of materials used from the value of the products resulting from work on them is designated "net output" in the reports on the Census of Production in the United Kingdom and is dealt with under the title "value added in manufacture" in the reports on the Census of Manufactures in the United States.

In addition to an enumeration of the kinds and values of goods produced, there is needed, for a proper understanding of the significance of these data resulting from a census, a record of the numbers of persons employed in the production of those goods and of the mechanical aids to production at their disposal. Information as to the distribution of the value of the recorded production between wages, returns to capital, taxation, profits, etc., will also have much importance, in view of the reaction of distribution on productive efficiency; but inquiries regarding the distributive allocation of the values produced do not appear to be an essential part of the census of production itself.

Information on these matters, like information regarding the quantities and values of imports and exports of the various classes of goods with which the census is concerned, is of very great importance in the application of the results secured by means of the census. The comparison of the imports and exports of any class of products with the amounts and values of similar products made within any country affords information of fundamental importance. For the aggregate of all industries it furnishes measures of the dependence of the material welfare of the country on its foreign trade. Further, since the material income of a country consists in the goods produced and in those which are obtained from abroad in exchange, a census of production furnishes a basis for measuring the amount of, and the changes in, the total income of the community. In so far, too, as capital goods and consumption goods are capable of distinction, the total of products applied to capital purposes, replacement and increase together, can be ascertained. The formation of a reasonable estimate of what is required for maintenance of the existing stock of capital enables an estimate to be made, of a corresponding degree of reliability, of the increase of capital. Thus results of uncertain estimates formed on other principles can be submitted to useful tests.

CENSUSES OF PRODUCTION IN THE UNITED KINGDOM

In Dec. 1906 the legislative authority for the taking of a series of censuses of production in the United Kingdom was given in the Census of Production Act. (6 Edw. VII. c. 49) which provided for a census in respect of 1907 and for repetition of the enquiry as might be prescribed by the Board of Trade by an order to be laid before parliament. The order was duly made in 1911 and prescribed a series of enquiries at intervals of five years. The work of verifying and completing the particulars furnished in respect of 1912 was interrupted by the outbreak of war in 1914, and in 1917 an act was passed providing for the suspension of the series of enquiries, and for resumption on the making of a new order by the Board of Trade. On two occasions such orders were made and cancelled, but in 1923 the authority was given for a third census in respect of 1924. The preliminary results of this enquiry were published in 1927 and the early part of 1928.

The act of 1906, while providing for the collection of particulars of the output of each establishment of certain defined characters, of the total cost of the materials used, of the persons employed and of the mechanical power equipment in such establishments,. limited the range of the information obtainable by compulsion. While the details of the value of goods produced might be demanded in accordance with the forms prescribed by the Board of Trade, particulars of quantity can only be required in cases in which the goods to which they relate are such as, on importation or exportation, must be recorded, in the forms furnished to the Customs by the importers or exporters, in terms of quantity as well as of value; details of the kinds of materials used and their amount cannot be required to be furnished, but only the aggregate cost of all materials together; and while the numbers of persons employed may be demanded from the proprietors of the establishments liable to furnish returns, the wages paid are specifically excluded from the items of information to which powers of compulsion may be applied.

The enquiry of 1907 covered the United Kingdom of Great Britain and Ireland. Separate summaries of particulars relating to England and Wales, to Scotland and to Ireland were provided for, but the necessity for presenting results in a manner which should not reveal the particulars of any individual business (unless with the consent of the proprietors) rendered a complete separation of the information relating to Scotland and to Ireland impossible in the case of certain industries. The enquiry of 1924 was carried out for Great Britain separately, a parallel enquiry in Northern Ireland being made simultaneously on behalf of the Government of Northern Ireland by the Board of Trade. The necessity to preserve secrecy regarding the operations of individual businesses, and the lack of a separate summary of the results of the 1907 enquiry relating to Northern Ireland together form a serious obstacle in the way of satisfactory comparisons between 1907 and 1924 for Great Britain and Northern Ireland taken as a whole. For Great Britain taken by itself such a comparison can be made in respect of the more important results secured, but it will be obvious that it is far from satisfactory to compare production in Great Britain with the imports and exports of the United Kingdom (including Northern Ireland in 1924 and the whole of Ireland in 1907). For a few classes of products the non-comparability of the figures is of serious importance.

British Aggregates 1907 and 1924.—The following comparison of aggregate results for Great Britain in 1907 and 1924 excludes particulars for a few trades of very small importance in respect of which the enquiry made in 1907 was not repeated in 1924.

	1907	1924
	Thousands	Thousands
Persons employed.		
Operative staff:		
Males	4,658	5,159
Females	1,557	1,699
Administrative, clerical, etc., staff:		
Males	406	587
Females	67	168
Total employed	6,688	7,613
Production	£000,000	£000,000
Value of output	1,698	3,853
Cost of materials and work given out	1,009	2,155
*Net Output	689	1,698
	Thou. h.-p.	Thou. h.-p.
Mechanical power,		
Prime movers:		
In use	10,374	13,440
In reserve or idle		2,979
Electric motors driven by purchased electricity:		
In use	not ascertained	3,931
In reserve or idle		626
		Electric
	Thou. k.w.	Thou. k.w.
Electric generators,		
In use	1,704	4,969
In reserve or idle		1,538

*In order to render the particulars for different trades more comparable, these totals should be reduced by £14 million in 1907 and £93 million in 1924 in respect of duties included in value of output and not in cost of materials in certain cases. This has been carried out in the preparation of the table given later.

The numbers enumerated as at work, on the average of the prescribed days, in the establishments covered by the two enquiries showed, thus, an increase of 13·83 per cent. The aggregate population of Great Britain increased, between 1907 and 1924, by a little less than 10 per cent., and the numbers recorded as gainfully employed at the population census dates permit of an estimate for the dates of the census of production showing an increase of 13.87 per cent. The census of production thus covered practically the same proportion of the occupied population in 1924 as in 1907. Inasmuch as the totals recorded in the census of population as "gainfully occupied" include those not actually at work on the census date, and unemployment is known to have been much greater in 1924 than in 1907, and to have affected particularly those occupied in the industries covered by the census of production, these trades must, it would appear, have found employment for a definitely larger fraction of all persons earning a livelihood in 1924 than in 1907. If those actually at work in these trades and those connected with them but absent through unemployment, sickness, etc., on any or all of the specified days are taken together, their proportion to the total of the persons earning their living was, for the reason stated above, notably larger in 1924 than in 1907. If the figures for the two sexes be taken separately, the proportion of increase in the number of males at work as recorded in the census of production returns was somewhat smaller than that of all males having a gainful occupation, and that in the number of females definitely greater. It will be noted that the operative staffs have increased by only a little over 10 per cent. in numbers while the administrative, technical and clerical staffs have increased by 60 per cent. Among the former. taken as a whole, the proportion of females had not increased; it had, indeed, slightly diminished. Among the administrative and clerical staffs, the proportion of females had increased largely, and apart from this, the male members of these staffs have increased in proportion to the numbers of the operative staffs. The total of the controlling and clerical staffs amounted in 1907 to 7·1 per cent. of the total employed, and in 1924 to 9.9 per cent. The proportion of females to males in these staffs was 1 to 6 in 1907 and was 2 to 7 in 1924. An increase of clerical staff appears to be indicated as the principal element in this relative increase of females and a large element in the increased proportion to the operative staff of the other persons employed. Among probable reasons for these increases are the greater attention now given to cost accounting and other work of like nature, and some extension of the preparation for sale, and control of sales, carried out by the manufacturers' own staffs.

Increase of Mechanical Power.—Another feature of importance in the comparison of the two surveys is the increase of mechanical power provided. The information obtained regarding 1907 did not show what proportion of the engine power was not in use. In 1924 about 18 per cent. of the total was so classified. This percentage includes, in some cases if not generally, equipment that may never be taken into use again, as well as engines unused for the time being, whether maintained as necessary reserve power, or idle for lack of orders. Even without making any deduction from the 1907 total in respect of reserve plant, the figures show an increase from about 1.7 horse-power per operative in 1907 to practically 2 horse-power ordinarily in use per operative in 1924, taking all industries together, and including workshop employees as well as factory employees at both dates. The information obtained for 1924 shows, too, a large use of power in the form of electric energy, whether purchased or generated in the works. The details furnished for 1907 did not include data relating to electric motors used, but the information on this head furnished in respect of 1912 made it clear that the use of power in that form in 1907 was of comparatively small importance. The total capacity of electric motors installed reported for 1912 was, in round figures, 2,240,000 horse-power. In 1924 the capacity of the electric motors in use was nearly 7,000,000 horse-power, and motors of 1,100,000 horse-power were in reserve or idle. These figures show an important change in the type of equipment in industrial establishments and may be interpreted as meaning that, while the mechanical power available for direct application was not greatly diminished, there were important increases in the form of plant, the purpose of which was to provide electric energy for use in driving machinery, while installations of electric motors to be driven by purchased electricity represented a further increase of power available.

With this increase of mechanical power, it is important to compare the output per head. It is, however, difficult to make this comparison with any precision, the restrictions of the Census Act and the difficulty inherent in the nature of the problem combining to limit the comparison of the mass of products constituting the output in years so widely separated as 1924 was from 1907. The intervening period was one in which prices had undergone large changes far from uniform in different classes of products. The measurement of products in terms of quantity units presents obvious difficulties in such cases as machinery and clothing, as well as in such less important cases as furniture and fancy goods. The figures given above show a net output averaging £101 per head in 1907 and £211 in 1924. The proportion of increase shown by a comparison of these figures does not represent increase of quantity, since prices have advanced greatly. The advance in the case of finished manufactured products has been greater than in that of materials, and the ordinary indices of price change are based mainly on records relating to materials. It is, therefore, a matter of great difficulty to determine what is the measure of increase due to price change that should be applied in order to measure the quantitative change which is indicated by the increase of net output per head. The material at present available appears insufficient to solve completely the difficulties of this problem. Some increase in the volume of output per head, however, appears a probable interpretation of the figures.

Industrial Change.—The results of the enquiry relating to 1924 show a considerable change as compared with 1907 in the distribution of the productive energies engaged in industry in Great Britain. The following table summarizes some of the data relating to these changes, and relates to groups of manufacturing trades only, the numbers engaged in mines and quarries being omitted from the aggregates used in these comparisons.

Industrial Distribution of Persons Employed and of Net Output

(a) Operative and other staff

Groups of trades	Male operatives 1907	Male operatives 1924	Female operatives 1907	Female operatives 1924	Administrative, clerical, etc., staff 1907	Administrative, clerical, etc., staff 1924
Iron and steel, shipbuilding and engineering	28.6	30·2	4·7	8·0	20·8	26.3
Textiles	12·1	11·0	42·9	39.4	8.7	8·0
Clothing	5·0	4·5	29·2	24.2	15·8	10·9
Food, drink and tobacco	6·4	6·4	7·5	8·5	12·4	12·7
Paper, printing, etc.	4·7	4·7	6·3	6·8	7.9	7·6
Timber, etc.	4·7	4·0	1·3	1·6	4·7	4.5
Building and building materials	16·5	14·4	2·4	2·8	10·8	10·1
Public utilities	14·6	17·0	0·3	0·3	8.5	8.8
Other trades	7·4	7·8	5.4	7·1	10·4	11·1
Total manufacturing trades	100·0	100·0	100·0	100·0	100·3	100·0
Total numbers—thousands	3,727	3,897	1,551	1,693	455	727

(b) Total employed and net output

Groups of trades	All employed 1907	All employed 1924	Net output 1907	Net output 1924	Percentage proportion of net output per head in 1924 to that of 1907
Iron and steel, shipbuilding and engineering	21·5	23.8	23·4	21·8	189
Textiles	20·2	18·3	15·9	15·0	232
Clothing	12·4	10·5	8·1	7·5	244
Food, drink and tobacco	7.2	8·0	11·9	13·6	231
Paper, printing, etc.	5·4	5·5	5·8	6·8	259
Timber, etc.	3·7	3·4	3·2	3·0	227
Building and building materials	12·2	10·8	10·6	10·3	248
Public utilities	10·3	11·6	11·7	11·8	200
Other trades	8·1	9·1	9.4	10·2	213
Total, manufacturing trades	100·0	100·0	100·0	100·0	224
Totals	Thou. 5,733	Thou. 6,317	£ mn. 557	£ mn. 1,375	

The male operatives in manufacturing industry increased in number by 4½ per cent., the female operatives by 9 per cent., while the total numbers employed increased by just over 10 per cent., from 5,733,000 to 6,317,000. The great concentration of industrial employment for females in the textile and clothing trades is shown clearly in the table, 72.1 per cent. of all the female operatives being included in these groups in 1907 and 63.7 per cent. in 1924, the percentages in all other groups being increased. Only 17·1 per cent. of the male operatives were employed in these groups in 1907 and 15·5 per cent. in 1924. In these groups the female operatives exceeded the males in number in 1924 by 473,000 and in 1907 by 479,000. The largest numbers of males are shown in the iron and steel group of trades, which, as it includes engineering (the building of machines, ships, engines, motor vehicles, etc.), shows increased numbers in spite of the relative inactivity of certain sections in the trades concerned with building materials and building and in the public utility services (gas, water and electric supply, -constructional and repair work of government departments and public local authorities. These three groups included 59.9 per cent. of the male operatives engaged in manufacturing establishments in 1907 and 61·6 per cent. in 1924. The administrative, technical and clerical staffs were distributed, on the whole, in similar proportions in 1924 as in 1907 in the different groups distinguished in the table. The marked exceptions are a notable increase in the iron and steel group and a not less notable decrease in the clothing group. The transfer of much work in the garment-making trades from small workshops to factories may be a chief reason for this difference in the numbers included in the administrative class, in which proprietors of small enterprises are grouped.

When the distribution of net output is examined in comparison with that of persons employed, as in the second half of the table, the contrary movements of the relative numbers and the net output percentages stand out in the case of the iron and steel group. (A. W. F.)

CENSUS OF PRODUCTION IN THE UNITED STATES

The first census in the United States, taken in 1790, covered population alone and not until 1810 was any effort made to secure data on other subjects. As economic problems have grown in number and complexity, the data gathered through censuses of production have multiplied greatly and the figures are now put to a multiplicity of uses. Production figures gathered through regular censuses now cover manufacturing, mining, agriculture and forestry.

Manufacturing. — The first production statistics of any kind collected by a census in the United States were those relating to manufacturing for the year 1810. These data were collected in connection with the regular decennial census. Five items of manufacturing were included at this census, the kinds, quantities and values of manufactured goods, the number of establishments, and the number of machines. The data were inaccurate and incomplete, but for the first time a general indication of the extent and nature of the manufacturing industries of the country was available. In the census of 1820, the number of items on manufacturing was increased to 14. No manufacturing data were included at the census of 1830, but at the census of 1840, manufactures statistics were again introduced. The census of 1850, however, may be considered to be the first scientific enumeration of manufactures, the schedule calling for information as to the number of manufacturing plants, capital, value of materials, employees, wages, value of products, percentage of profit, home manufactures, as well as data relating to certain individual industries. Thereafter each decennial census saw a gradual expansion in the items for which information was collected.

Down through the census of 1900, which, like its predecessors, covered the quantities produced in the year previous, all the statistics on manufactures related to the output of industry, wherever made. These censuses thus covered goods made under the factory system and those made in the hand and neighbourhood industries. As the factory system expanded, the volume of goods produced outside of it declined in relative importance and the canvass of the non-factory industries added greatly to the cost of the census, on account of the great number of insignificant establishments to be covered. After 1900, the census was restricted to goods made in factories whose products during the year were valued at $500 or more. Furthermore, the census of manufactures was taken every five years instead of every ten years, so as to provide frequent information on the growth of industry. Thus censuses of manufactures were taken in 1905, 1910, 1915 and 1920, covering the output of the previous year in each case.

After the census of 1920 changes were made both in the interval between census periods and in the minimum size of reporting establishments. The World War of 1914–18 had shown the necessity for securing more frequent and prompt returns of manufacturing production, so the new census law provided for enumerations every two years. To facilitate the prompt issuance of these figures, the limit on establishments covered by the census was raised from a minimum of $500 value of product to $5,000. While this raising of the limit reduced the number of reports by 22% it reduced the number of wage earners and total value of products by less than 1%.

For the census of manufactures of 1939, the schedule called for the following information: the number of persons engaged, subdivided into five major groups, namely, (1) salaried officers; (2) employees whose duties were concerned wholly or chiefly with manufacturing; (3) employees who devoted all or the major portion of their time to selling, advertising, etc.; (4) those engaged in major construction and major repair work in the plant; and (5) all others. Those employees who were actually concerned with the manufacturing operations were further subdivided into three groups — (a) managers, superintendents, etc.; (b) clerks, stenographers and other clerical employees; and (c) wage earners. This detailed classification of the personnel was used for the first time in 1939. The separation of employees engaged in distribution and construction work, etc., from those actually engaged in the manufacturing processes is especially significant. The schedule also called for the number of wage earners employed each month; the salaries or wages of the various classes of employees; the cost of materials, fuel, etc.; the type of power equipment available; the types and amounts of fuel and electric energy used; expenditures for plant and equipment; a complete list of the major products made; quantity and value of such products; and finally, the value of all inventory goods. In addition, data were requested regarding the legal form of the organization — that is, individual proprietorship, corporation, etc., and the method of distributing the goods produced — that is, sales through manufacturers' own wholesale branch office or retail stores, sales to wholesalers and jobbers for resale, sales to consumers directly, and export sales.

The total value of products manufactured is often taken as a measure of manufacturing production, but this figure contains so many duplications that it is no longer considered the best for the purpose. The value of the product necessarily includes the value of the raw and partially manufactured materials which the manufacturer had to buy in order to fabricate his product. Of two products of the same value, one may be produced from expensive materials with little labour cost, while the other may require inexpensive materials but a large amount of fabrication. The value of the product does not show that the manufacturing process in the latter case is more important than in the former. Again, a manufactured product may in turn form the material for further manufacture in another industry, as, for instance, wood pulp, which goes into paper manufacture, while the paper or board produced from it may be used still further in the manufacture of boxes or in the printing industry. An industry in which the processes of manufacture are divided into different stages and result in separate products at each stage will show a relatively greater value of product than an industry where the processes are all within one organization, for in the latter case the product is counted only once, at the end of the line.

A better figure for measuring manufacturing output has been found to be the value added by manufacture. This is a figure computed by subtracting from the value of products the cost of materials used in making those products, and it thus represents the contribution of manufacturing to the value of the product. No matter how many industries an article must go through before reaching its final form, there is no duplication in value added by manufacture, for each industry's contribution is shown through these figures. As an example of the difference between the value of product and the value added by manufacture may be cited two industries with approximately equal value of products in 1939, namely, petroleum refining, and steel works and rolling mills. In the former, the value of products was $2,461,000,000, and the value added by manufacture (the difference between the value of products and the cost of materials) was $528,000,000, or 21·4% of the value of products. In the steel works and rolling mills industry, the value of products was $2,720,000,000 and the value added by manufacture, $1,148,000,000, or 54.6% of the value of products, the higher proportion resulting from the more complicated processes of manufacture in the latter industry.

Figures given for values, whether value of products or value added by manufacture, do not reflect true conditions when comparing years of different price levels, such as 1929 and 1933. When prices are high, as in 1929, totals given in values indicate a larger volume of activity or output than actually exists, while in a year of low prices industrial activity is minimized by using values. Figures on the number of employees give a measure of industrial activity that is not affected by price changes. The growth of mechanical power, however, has resulted in a continually increasing output of goods per employee, so that employment figures are liable to error on the conservative side. Power figures alone, on the other hand, show too rapid a growth to measure the increase in industrial activity, owing to the trend from hand to machine power. Thus it becomes necessary to resort to index numbers of the physical volume of production as a means for making such comparisons. These indexes are prepared by combining the production figures for each commodity for which quantity figures are available, weighing each commodity by its relative importance. (For an explanation of the method *see* census monograph *Growth of Manufactures* by E. E. Day and Woodlief Thomas.) Such indexes were included in the reports of the census of manufactures for the first time in the report for 1937. Similar indexes are computed by various agencies for dates more frequent than the biennial censuses.

The measure of physical volume of output for a commodity can be secured from the data on quantities of goods manufactured, which are given for most of the important industries. Such statistics have an added accuracy in that they represent, so far as possible, not only the goods made as primary products in one particular industry but also those goods made as secondary products in other industries. For instance, some steel castings are made directly in steel plants, while others are made in foundries, which are classified as a separate industry. The production of steel castings cannot be found without totalling the production in both industries. It will be seen from this example that the statistics for an industry do not always coincide with those for a commodity, since the element of secondary products has been given increasing importance in manufacturing in order to utilize the plant facilities to the fullest extent. Each plant is classified as a whole in some one industry according to its chief article of manufacture, and so it sometimes happens that an article belonging normally to one industry is made to a considerable extent as a secondary product in other industries.

As quantity figures have become increasingly important, not only as measures of growth of an industry but also as a means of securing basic information on the important commodities, more quantity production figures have been obtained at recent biennial censuses. In the census of 1939, 147 special schedules were used, covering 415 industries. The figures on quantity called for in these schedules have proved especially useful to trade associations and business firms interested in finding out what proportion of the industry their own operations covered.

The results of the census of manufactures are presented by states and for the larger cities and for important industrial areas in considerable detail, and in less detail for counties. The figures thus distributed indicate the growth and the relative importance of states and cities in manufacturing, the geographical movement of industries, and the relative importance of the several industries in each locality. These data serve as a guide in the location of new plants in those industries which produce materials for other industries. In many cases it is not possible to show details for all industries in a given state or city, as it is necessary to avoid revealing the operations of individual establishments, which is prohibited by the census law—the specific rule being that no separate figures are shown where fewer than three establishments would be covered by the tabulation.

Electrical Industries.—Closely allied to the data included in the census of manufactures are those in the census of electrical industries. This census was begun in 1902, although partial data covering various phases of the field had been secured in connection with some previous decennial censuses. Since 1902 this census has been taken at intervals of five years. It covers telephones and telegraphs, the electric light and power industry, and a group of transportation systems consisting of street railways and trolley bus and motorbus operations. It thus presents a picture of the electrical development of the United States. The statistics of telephone systems cover public systems only, excluding private lines--such as those within a mine, for example. Data are presented on the number of systems, miles of wire, number of telephones (classified as residence or business), number of calls, and financial operations. The telegraph statistics cover commercial land and ocean cable systems in the United States. Data similar to those given for telephone companies are presented for the telegraph companies. For the electric light and power industry there are presented data on generating facilities classified by type of prime mover, source of energy (whether generated, purchased or received from another source), fuel used in generation of electric energy, disposal of energy by class of service, employment, financial statistics and other relevant data. The census of street railways, etc., originally collected statistics only for street railways and interurban railways driven by other than steam power. When the motorbus came into use the street railway census included all such vehicles operated by street railway companies. The 1937 census included not only the motorbus and trolley bus lines operated by street railnays, but also other short-haul motorbus lines in cities having 100,000 inhabitants or more in 1930. The reports of this census classify the various aggregates by motor power and present statistics on their financial aspects, equipment, traffic and employment.

Mines and Quarries.—Incomplete and fragmentary data on the production of certain minerals were obtained at the census of 1810; but it was not until 1840 that any effort was made to collect data covering completely the production and employees of mines and quarries. These data were called for on the same schedule as those for manufactures, agriculture and fisheries. The mineral industries have been canvassed at each subsequent decennial census, with the exception of the 12th (1900), and a mines and quarries census was taken separately for 1902. Production figures are secured for all the minerals produced in the United States, including fuels (coal, petroleum and natural gas), metalliferous ores (iron, copper, gold, etc.), stone and miscellaneous minerals. Information from the 1939 census (which carries the designation "Mineral Industries," in place of the earlier "Mines and Quarries") includes the number of mineral enterprises; types of products; quantity and value of products; persons engaged, subdivided into salaried employees, wage earners, proprietors and firm members; the salaries and wages paid; wage earners classified by type of activity—that is, underground work, surface work, etc.; number of active and nonactive days; total man-hours worked during the year; quantity and cost of supplies, materials, fuels and electric energy consumed; amount paid to contracting corporations for work done during 1939; cost of buildings, machinery and equipment erected or installed during 1939; types of power equipment; and number of mechanical power loading machines. The collection of annual production data is carried on by the bureau of mines of the department of the interior.

In many establishments there are combined both mining and manufacturing operations, such as the mining and smelting of copper, or the mining of coal and the production of coke. These processes have been separated in the census returns as far as possible, the mining operations being covered by the census of mineral industries and the manufacturing operations by the census of manufactures. In certain cases where the "mining" is a very simple process, the entire activity of the establishment is included in manufacturing. This is done, for example, with respect to the process of securing clay, limestone, etc., as materials, when combined with the manufacture of clay products, lime, cement, etc.

Agriculture. — A beginning was made in the collection of statistics of agriculture in the census of 1840, when data were presented for the output of the principal farm products, and for the number of livestock and poultry on hand. At the census of 1850 the inquiries on agriculture were materially extended to include acreage of farms. value of farms and farm implements, and value of animals slaughtered, the schedule containing 46 items in all. The census of agriculture was taken decennially from 1850 to 1920, and has been taken every five years since 1920. The schedule has been expanded until, in 1940, it contained something over 300 questions concerning tenure, acreage and classification of farm land, value of farm property, mortgage debt, farm equipment, farm labour and various other miscellaneous items, crop acreage and production, the output of livestock products, and a detailed livestock inventory. By far the most important production items obtained through the farm census are the figures representing the quantities of crops harvested. The returns in the livestock industry are so classified by age and other characteristics, however, that they afford some basis for estimating the year's production of livestock. There are also questions with regard to the value of livestock sold and livestock slaughtered on the farm, though without specific classification or numbers of animals involved. The United States department of agriculture publishes each year estimates of the production of livestock, based in part on census figures and in part on information collected from a large number of representatives scattered throughout the country. This department publishes also annual estimates of crop production, farm income and other items having some relation to agricultural production.

From the census returns can be obtained figures representing the gross value of farm production. A rather detailed classification of farms by type, in combination with the gross value of farm production, is presented in the reports of the 1930 census of agriculture, and similar data will be presented for 1940. It is difficult, however, to get a figure representing the net value of farm production because of the fact that a considerable proportion of the production of several important crops, especially corn and hay, is fed to livestock on the farms, so that any figure obtained by adding the value of crops harvested to the value of livestock and livestock products would contain a very considerable element of duplication. The figures for gross sales contain far less duplication from this source than do the figures for gross value of production; but even these involve an appreciable amount of duplication from the point of view of the farming industry as a whole, growing out of the fact that farmers purchase large quantities of feedstuff for feeding to their livestock, this being particularly true of the dairy farmers in the northeast and of some stock feeders in the middle west.

The agriculture census figures are particularly useful to those selling articles used by farmers, in that the statistics on farm values, number of farms operated by tenants, kind of crops grown, etc., show the extent of the potential market by counties. Such figures enable manufacturers of corn-planters, for instance, to direct their sales efforts into the territory where corn is the major crop and to avoid sections farmed mainly by small tenants. Manufacturers of general articles also find these data of particular benefit in planning sales programs. Where the average value of farms is $30,000 to $40,000, for example, it will be possible to market a fairly expensive type of automobile, while in a section where the average value of farms is only $3,000 to $4,000, even the least expensive type of car may sell with difficulty. Bankers and mortgage companies use the census data to determine limits of territory or limits per acre for their loans. Location of the production of the various agricultural products, as shown by census returns, also plays a part in the location of manufacturing plants using these products, such as canners, manufacturers of condensed milk, etc.

Irrigation and Drainage. — A census of irrigation was taken in 1890 and decennially thereafter, also a special census in 1902. A census of drainage was made in 1920. While these are not strictly production censuses, they present data for crops grown in irrigated or drained areas. The irrigation census is confined to 19 states in the western part of the country, where irrigation is a recognized feature of agricultural practice. It covers the area of land under irrigation, capital invested in irrigation enterprises, character of irrigation, crops grown, prices of land and water rights, water used per acre and physical condition of irrigation works. The drainage census presents information concerning the amount of land reclaimed by drainage, crops produced thereon, land needing artificial drainage, character of drainage, capital invested in drainage enterprises, and the amount necessary to complete the work.

Fisheries. — Information regarding fisheries was collected at the decennial censuses from 1840 to 1890 and at a special census in 1908. Between that date and 1940, the bureau of fisheries of the department of commerce made statistical studies of certain districts from year to year to ascertain the fish catch. On June 30, 1940, the bureau of fisheries was consolidated with the bureau of biological survey, the two now forming the Fish and Wild Life service of the department of the interior. This service now conducts studies for the improvement of fishery methods, including the capture, preservation, utilization and merchandising of fishery products, and the compilation of statistics thereon, and provides current information on production, market movement and prices of fishery products.

Forest Products. — Statistical data pertaining to the production of lumber, lath and shingles are collected and published annually, as are also data for pulpwood consumption and wood-pulp production. The quantities of forest products used in various other manufacturing industries — such as wood distillation and the manufacture of dyestuffs and extracts, excelsior and veneers — and the amounts of cooperage stock and turpentine and rosin produced are shown in the reports of the biennial censuses of manufactures.

Methods of Collection. — The census figures described above are, except for the data on fisheries, collected at the intervals named by the bureau of the census of the department of commerce, in accordance with the census law, which specifies the years for which the various censuses are to be taken and their general nature and makes answers compulsory and confidential. The bureau of the census was established on a permanent basis in 1902, previous censuses having been taken by a temporary force recruited for the decennial censuses. Besides the production censuses mentioned here, the bureau also collects data on population, hospitals and benevolent and penal institutions, births and deaths; wealth, public debt and taxation; finances of cities and states; water transportation; distribution; and current business conditions. The census data on agriculture, irrigation and drainage are collected by means of a personal canvass by field agents and at the decennial censuses the same agents collect agriculture figures and population figures. The information is secured directly from the operator of each farm, from an official of each irrigation or drainage enterprise, or from each family and filled in on the forms provided. For the other censuses, most of the returns are secured by mail, so far as is practicable, since these are made out chiefly by organizations. Lists of organizations are kept up-to-date by means of directories, information from trade associations and chambers of commerce, trade papers and other sources, using the previous census list as a basis. Where returns have not been obtained within a reasonable time, field agents visit the delinquent firms.

Methods of Tabulation. — As the returns reach the bureau of the census, they are edited for omissions, errors, discrepancies, etc., and often correspondence must ensue with the individual firms to straighten out the matter. For the biennial census of manufactures alone, this correspondence amounts to over 100,000 letters. After the report has been edited, the information contained in it is taken off on to punch cards by operators trained in this kind of work. Each punch on the card by its particular place denotes certain information on the schedule. The punched cards are next run through an automatic machine which sorts them according to the various classifications to be used, and then they are run through an electric tabulating machine which mechanically counts the number of cards, adds the data recorded in each field of the cards and automatically prints the totals. In this manner a quick and accurate count is obtained.

Methods of Publication. — When a significant part of the tabulations is completed for a particular state or, in the case of manufactures, a particular industry, a preliminary statement is issued in processed form. Later, one or more printed bulletins are issued for each state or industry, and these separate bulletins are finallv collected into bound volumes which form the major part of the final report on the census, being in some cases supplemented by a general report or by additional reports on cities or other areas not completely covered by the state reports. The completed volumes for the censuses of manufactures and agriculture appear about two years after the end of the year to which the production figures relate, though the bulk of the figures are made available much earlier in the processed reports and the bulletins. The results of the 1935 census of agriculture were published in three volumes, the results of the 1937 census of manufactures in two volumes, and the results of the census of mines and quarries (mineral industries) in one volume. The reports of the decennial census of agriculture are more extensive, those for 1930 occupying four numbered volumes, two of which were bound in three parts.

Current Production Statistics. — Since the World War of 1914–18, there has developed an insistent demand for business statistics issued at more frequent intervals, in order to gauge the current trend of business. Production figures particularly have been demanded at monthly intervals, as indicators of the amount of commodities being supplied for consumption. The result of this demand has been the collection by government departments, by trade associations, and by other agencies of periodical data on production, stocks, shipments, orders, etc., for most of the important industries and many of lesser importance. Complete current data are collected by the bureau of the census monthly on cotton consumption and stocks, activity of cotton spinning, cotton-seed and cotton-seed products. Monthly reports of production are also collected on more than 50 other industries or commodities, including automobiles (manufacturers' sales); cellulose plastic products; hosiery; various phases of the clothing industry; wool stocks; wheat-milling products; and various phases of the steel and iron industry (including steel boilers, steel office furniture, malleable iron products, etc.). In addition, annual reports are issued on animal and vegetable fats and oils, clay products, farm equipment, etc. Among the most important of the periodic production reports of the census bureau are those relating to cotton ginned, which appear semimonthly during the ginning season, giving the amount of cotton ginned by counties and states. All of the current production reports are published in processed form shortly after the close of the period to which they relate. The current reports of the production of manufacturing industries do not in every case cover the entire industry to which they relate, but reports are received from a sufficient number of establishments to indicate satisfactorily the trends from month to month.

A large number of the monthly series of business statistics available from governmental and other sources is assembled in summary form in a monthly publication of the department of commerce called the Survey of Current *Business*, which is compiled in the bureau of foreign and domestic commerce. This publication presents, along with a wide variety of quantitative data representing current conditions in the fields of production, trade and finance, a number of monthly business indexes, including indexes of industrial production, factory employment and payrolls, freight car loadings, construction contracts, monthly income payments (with separate indexes for salaries and wages); cash farm income (with separate figures for income from crops and from livestock products); cost of living (with separate indexes for food, clothing, fuel and light, and housing), retail sales, foreign trade, wholesale prices (general and for specific commodities) and prices of industrial stocks. Weekly supplements are issued giving current data even more promptly and including weekly production figures for automobiles, bituminous coal, electric power, petroleum, steel ingots and market receipts of a number of farm products. There is also a special annual number in which is presented an economic review of the preceding year, comprising summaries of the various types of statistical data presented from month to month, these summaries often running back for a considerable period, together with analytical comment, discussion of interrelations and significant descriptive matter. Many of the indexes and series of production data are shown in graphic form both in the monthly numbers of the *Survey* and in the weekly supplements. (L. E. T.)

CENSUSES OF PRODUCTION IN VARIOUS COUNTRIES

While the taking of a census of industrial establishments, dealing with the numbers employed, the mechanical power used and the character of the industry in which they are engaged, is a fairly common practice, and is in some cases supplemented by particulars of the principal goods produced, only a small number of countries make a practice of carrying out a survey that will yield data relating to production, and not merely to products. In the United States that course has been long established, and has been carried out since the World War of 1914–18 at biennial intervals. The Dominion of Canada early adopted the practice of its powerful neighbour. Passing from a decennial to a quinquennial enquiry after 1900, the system of annual returns was established from 1917. The particulars obtained cover the total of wages and salaries paid as well as the particulars obtained in United States and information regarding materials used is obtained in some detail.

Annual enquiries of a similar character have been carried out in Australia since 1903, in New Zealand since 1918–19 (following quinquennial enquiries extending back to 1867) and in the Union of South Africa since 191j–16.

In Europe periodic enquiries of the character of the censuses of manufacturing industry in the leading Anglo-Saxon countries have not been carried out in the more important manufacturing countries. In Germany, before the war, certain industries were selected for special study, and annual particulars were obtained in respect of these from 1907 onwards. In Russia an enquiry on the Anglo-Saxon model was carried out for the year 1908. In Norway there was an incomplete enquiry for the year 1909 and in Sweden a very careful study of some of the country's principal manufacturing industries was carried out as part of a plan for dealing in a nine-year cycle with the whole of the industries. The results published were contained in three reports issued in the period 1914–1917. In Holland a census of production was found necessary in connection with war-time organization, and in 1918 an enquiry was made relating to 1916 and 1913. Later enquiries have been arranged on the principle of covering the principal industries by yearly instalments in periods of five years. In Norway the enquiry of 1909 was repeated in 1916 on a more complete basis, and a new inquiry was in progress in 1941.

More extended enquiries regarding production were begun or planned in a number of countries after 1918. In some cases the particulars to which the enquiry relates are sufficiently extensive to furnish not merely a census of products, but a census of production. This appears to be the case with the Bulgarian enquiry commenced in 1922, the summary results of which were published in 1924. The Irish Free State (Eire) commenced the publication of the results of a census of production in that state in 1926. The reports are distinguished from those of Great Britain in the detail furnished, which extends to particulars of leading materials used and wages paid, the larger and smaller establishments being generally grouped separately.

BIBLIOGRAPHY.—United States, *Census Reports on Manufactures and Agriculture, Survey of Current Business, Statistical Abstract, Minerals Yearbook;* United Kingdom, *Report on the First Census of Production, 1907 Preliminary Tables* Cd. 4,986 (1909); Cd. 5,005 (1910); Cd. 5,162 (1910); Cd. 5,254 (1910); Cd. 5,397 (1910); Cd. 5,463 (1910); *Final Report,* Cd. 6,320 (1912); Canada, *Census of Industry 1917,* 14 parts (1919); Australia, *Summary of Australian Production Statistics,* Commonwealth Bureau of Census and Statistics (1911); New Zealand, *Statistical Reports on Industrial Manufacture,* Census Office (1924); Union of South Africa, *Statistics of Factories and Productive Industries (excluding Mining and Quarrying) in the Union* (1924); Netherlands, E. W. van Dam van Isselt, "The Census of Industrial Production in the Netherlands" *Jour. of Royal Statistical Society.* (May, 1924); Sweden, *Textil och Beklädnadsindustrien Specialundersokningen av Kommerskollegium* (1914); *Lader, har-och gummivaruindustrien* (1915); *Bergshdntering* (1914–17); Norway: Industristatistik, *Norges offisielle statistik 1916–17* (1919). France: Enquête d'industrie, 1861–65, *Statistique gknkrale de la France. See* also A. *W.* Flux, The Census of Production, *Jour. Roy. Statistical Soc.* (May 1924); Irish Free State, *Irish State Journal,* Oct. 1928 and following issues. (A. W. F.)

PROFESSOR, a term now confined to a teacher of a special grade at a university or college (Lat. *profiteri,* declare publicly, profess). The educational use is found in post-Augustan Latin. In the universities of the middle ages the conferring of a degree in any faculty or branch of learning meant the right or qualification to teach in that faculty, whence the terms magister, "master," and doctor for those on whom the degree had been granted. To these names must be added that of "professor." The "three titles of Master, Doctor, Professor, were in the middle ages absolutely synonymous." (H. Rashdall, The Universities of Europe in the Middle Ages, 1895, i. 21.) The first endowed professorship at Oxford was that of divinity, founded by the mother of Henry VII. in 1502 and named after her the "lady Margaret Professorship." The foundation of the Regius Professorship by Henry VIII. in 1546 no doubt tended to the general modern use of the word. In England subordinate public teachers in faculties, or in subjects to which a professorial "chair" is attached, are known as "readers" or "lecturers," and these titles are also used for the principal public teachers in subjects which have not reached professorial rank. In colleges and universities of the United States, professor indicates a teacher of the highest rank, those next below being "associate professor" and "assistant professor" respectively. The title is often erroneously, if not fraudulently, used by magicians, "quack doctors" and faith healers generally.

PROFIT, a term used by business men to describe the result of their operations when that result is favourable. When the result is unfavourable the term loss is commonly used. Strictly speaking, the word profit means "result," whether favourable or unfavourable; but it is obviously more convenient to speak of an unfavourable result as a "loss" than as a "minus profit." As used by business men, the word profit must not be confounded with profits assessable to income tax or super tax. The rules for determining the liability of individuals or companies to these imposts are determined by statute, and are extremely artificial; similarly, profits in the business sense must not be confused with the economist's idea of profit.

If it were practicable for the business man to wait until his business was discontinued and wound up before attempting to arrive at any idea of what his profits were, it would be possible for him to accept the economic definition of profits as "the surplus remaining over from the employment of capital after defraying all the necessary expenses and outlay incurred in its employment, and after the capital has been replaced or provision made for its replacement." But the business man has to determine his profits as he goes along (1) because in no other way can he determine the most advantageous way in which to carry on his business; (2) because, in general, it would be impossible to obtain capital for business purposes, save upon the terms of distributing profits not less frequently than once a year, so that those contributing capital to enterprise may receive in return income by way of dividends. Hence the necessity of determining divisible profits from year to year.

It is absolutely impossible to determine the profits of a going concern from year to year with precision, because nothing more reliable than estimates can then be formed of the value of its outstanding obligations and unrealized possessions. But it would be unwise to distribute the whole of the profits year by year even if they were ascertainable, as were this to be done there would be no margin left to cover contingencies, and experience shows that unexpected losses are bound to occur from time to time. The problem that besets the business man year by year is not therefore how to ascertain the precise annual profits, but how to determine a figure of profit which can be divided without unduly jeopardizing the future prospects of the undertaking. Further, because distributions out of profits are made regularly at definite intervals and are treated by those who receive them as income, it is important that no kind of gain should be treated as divisible profits which by its very nature cannot be expected to recur.

Capital **Profits** and **Revenue** Profits.—The business man accordingly distinguishes between capital profits and revenue (recurring) profits, and pays dividends only out of the latter. Capital profits are increases of wealth arising from causes not directly connected with the carrying on of the business of the undertaking, *e.g.,* increases in the value of its fixed assets (*i.e.,* those assets held permanently as part of its equipment), a rise in the market value of which adds nothing to the fund out of which alone dividends can be paid. Indeed, a permanent rise in the value of fixed assets is a source of embarrassment rather than of congratulation, in that it increases the ultimate cost of replacements as and when such assets are worn out, and thus then at least tends to deplete the fund available for the payment of dividends. Conversely, capital losses arising from a fall in the value of fixed assets do not affect divisible profits so long as these assets continue to be equally effective as profit-earning equipment, while a fall in the cost of renewals is advantageous from a revenue point of view.

Of course, if and when a business is discontinued and wound up, capital losses and profits will materialize. If on balance there have been profits on capital, the fixed assets will realize more than they otherwise would have realized, and a correspondingly larger sum will be available out of which to make a return of capital or, rather, there will be a balance of capital profits to divide after capital itself has been returned in full. Conversely, if on balance there have been capital losses, the fixed assets will not realize a sum sufficient to enable the whole of the capital to be returned, and there will therefore be a realized loss on liquidation. Where the business is owned by a limited company, this means that the shareholders (or the holders of some class or classes of shares) will not receive the whole of their capital back; but if the business be owned by a concern not subject to limited liability, *e.g.,* a partnership, the members will have to contribute among them the ascertained loss pro rata, according to the shares in which they were entitled to participate in profits, and there will then be a sufficient fund to enable the whole of the capital to be returned to those who provided it.

In the case of a partnership, it is usual to divide the whole of the profits as shown by the annual accounts; but in the case of a company, it is not usual to pay away as dividend the whole of the profits shown by the annual accounts. A part of these profits is normally held back as a reserve against unforeseen contingencies, and another part is normally "carried forward" partly with a view to equalizing dividends in good and bad years, partly to avoid the inconvenience of paying away profits which have perhaps not entirely been received in cash.

PROFITEERING. This word came into colloquial use early in the World War, and, having been included in the title of an Act of Parliament in 1919, may be considered to have received official recognition as part of the English language. It signifies the making of an unreasonably large profit on the sale of goods or services, particularly those in common use. The practice has always been liable to arouse intense indignation among the public, and the word profiteer is a term of abuse deriving its sting partly from implied contrast with the word volunteer.

In normal times before the war, opportunities for making unreasonably large profits were to a great extent restricted by the play of competition, and in fact competitive prices were widely regarded as being prima facie reasonable. When competition was excluded, the possibility of unreasonably large profits being made was obviously increased, and there was a widespread tendency on this ground to regard monopolies with suspicion. Some industries which could not ordinarily be run on competitive lines, or which tended to become monopolies, were consequently carried on as public undertakings, or were controlled by public authority as regards rates and conditions of trading.

Before the war there had been a tendency for competition to be excluded to a greater or less extent in an increasing number of industries through the formation of trusts or combines. Though the selling prices fixed by such organisations were not in all cases higher than those which would have prevailed under competitive conditions, they were certainly higher in many cases; while even when they were not, a feeling was apt to arise where large profits were being made that the trust or combine in question was taking for itself an unduly large share in the economies effected by the elimination of the wastes of competition. The belief that unreasonably large profits were being made was undoubtedly the most powerful motive in the campaign for the control of trusts and combines in various countries.

Various measures were taken during the war to restrict profiteering, especially in belligerent countries. These included the fixing of maximum prices, and in some cases of profit margins at each stage of production and distribution. Rationing of prime necessaries served to distribute supplies evenly and to prevent them from being sold to the highest bidder. The weapon of taxation was also employed in the form of highly graduated income taxes, excess profits taxes, etc., to secure for the public revenue a substantial part of the high war-time profits made by private interests.

As the result of inflation, profiteering was in some cases more rife after the war than during its continuance. Under conditions of extreme inflation, such as occurred in Germany in 1923, profiteering became widespread. The rise of prices was so rapid that profits of hundreds or thousands per cent. could be made by holding goods even for a few days. That, however, was a profit in paper marks, and it was obvious that paper marks, while circulating as currency, were entirely untrustworthy as a standard of value. The true position did not become clear until after a stable currency had been reintroduced. It was then seen that while a comparatively small number of persons had made and retained fortunes, a vast mass of people had been reduced to penury.

British Government Measures.—In Great Britain, inflation reached comparatively small dimensions. After the Armistice, the general level of prices was for a time downwards, and during this period many war-time controls were withdrawn. Subsequently, prices began to rise and continued to advance until the spring of 1920, when a rapid fall began. Public apprehension led in the summer of 1919 to the passing of an act to check profiteering, commonly cited as the Profiteering Act 1919. This act conferred upon the Board of Trade powers (a) to investigate prices, costs and profits at all stages; (b) to receive and investigate complaints regarding the making of excessive profits on the sale of any article to which the act was applied by the Board of Trade, and after giving the parties an opportunity of being heard either to discuss the complaint or to declare the reasonable price for such articles, and to order the seller to refund to the buyer any amount paid in excess of such reasonable price, the Board also having power, where it appeared to them that the circumstances so required, to take proceedings against the seller in a court of summary jurisdiction; and *(c)* to obtain from all sources information as to the nature, extent and development of trusts and similar combinations. The act was to remain in force for six months only, but it was subsequently continued for a further three months, and later, by an amending act, for six months more until May 19, 1921.

To deal with retail trade, local committees, numbering in all over 1,800, were set up, and the Board of Trade delegated to them the bulk of their powers under the act relating to retail sale. There were also 108 appeal tribunals to which the seller had the right of appeal against the decision of a local committee. The task of dealing with larger transactions of wholesalers or manufacturers affecting whole trades or industries was entrusted by the Board of Trade to a central committee, which worked through three standing committees: the investigation of prices committee, the complaints committee and the standing committee on trusts. These standing committees in turn appointed sub-committees as required to deal with particular questions. The investigation of prices committee made investigations into the cost of production of various articles in all stages of their manufacture. Reports were published as parliamentary papers on agricultural implements and machinery, aspirin, biscuits, boot and shoe repairs, brushes and brooms, clogs, costings in Government departments, furniture, gas apparatus, matches, metal bedsteads, motor fuel, pottery, standard boot and shoe schemes, tweed cloth, worsted yarns, wool and the wool top-making trade. The complaints committee undertook the investigation of specific complaints and also investigated specific transactions brought to their notice.

The committee on trusts was responsible for obtaining information as to the nature, extent and development of trusts and combines. Numerous investigations were made. Mention may be made further of a provision contained in the Profiteering (Amendment) Act, 1920, which authorized the Board of Trade to approve suitable schemes submitted by persons representing a substantial proportion of those engaged in the production or distribution of goods to which the original act was applied limiting the profit to be allowed on such manufacture or distribution. Only two such schemes were actually approved.

Since the lapsing of the Profiteering Act in 1921, there has been no special legislation in Great Britain against profiteering except for the continuance of restrictions on the rent which may be charged for certain classes of houses. Public feeling, however, continued to be very susceptible on the question, especially when a rise of prices occurred. Various public inquiries have been conducted into costs of production and distribution of foodstuffs and other articles of common consumption, the most important of these being (a) the inquiry of a committee appointed in 1922 under the chairmanship of Lord Linlithgow to enquire into methods and costs of selling and distributing agricultural, horticultural and dairy produce in Great Britain and the diminution of the disparity between the price received by the producer and that paid by the consumer; (b) the inquiry of the royal commission on food prices appointed in 1925 and *(c)* the proceedings of the food council appointed in 1925 following the report of the royal commission on food prices to watch over food prices and supplies. It may be noted also that since 1923 an interdepartmental committee appointed by the Minister of Health and the president of the Board of Trade has been in being for the purpose of surveying the prices of building materials and receiving and considering complaints in respect thereof. (C. K. H.)

United States.—Figures gathered by the Federal Trade Commission show the situation in the United States during the World War period. In 1917 there was apparently no limit to the price purchasers were willing to pay, the condition being one of panic. In the next year profits were somewhat abated by government regulation.

During the war period oil companies circulated reports that the supply of gasolene was dangerously short, for the purpose of maintaining prices of that commodity while making "enormous" profits on fuel oil. Concerns bottling or canning vegetables, which had made future contracts, sometimes withheld portions of their output from delivery on such contracts and sold in the higher "spot" markets. In frequent cases licences were revoked by the Food Administration. The practice of such concerns in maintaining re-sale prices for jobbers contributed toward maintaining the general high level of prices and increased profits in some instances. The steel companies in 1917, prior to Government price-fixing, made abnormal profits, and a number continued to make unusually heavy profits thereafter. The United States Steel Corp., which made 5% before the war, received 25% on investment in 1917; and ten smaller concerns made from 30% to 319% on their investments. Certain sulphur companies took advantage of the war demand for sulphur to raise their prices to such an extent as to reap net profits of approximately $15 a ton, which meant over 200% on investment in one case. The profits of tanners increased from two to five times, as they took advantage of the enormous demand for leather and exacted very high prices. The price of hides was rapidly advanced, notwithstanding that at the same time "great supplies were withheld from the public."

High prices do not necessarily indicate excessive profits, but there is reason to believe that profiteering was common in cement, petroleum, lumber, farm implements, wool, clothing, sulphur, naval stores, rice, sugar, sand and gravel, raisins and other products, in addition to those already mentioned.

The U.S. Government attempted to deal with profiteering in three ways: (1) taxation; (2) price-fixing; (3) direct action under the Food Control Act. The first and the last methods proved largely ineffective.

By special taxes levied on profits, many thought that the spoils of the profiteers could be regained by the public. In 1916 a tax of $12\frac{1}{2}\%$ was levied on the profits of munitions manufacturers; and a general "war profits tax" and an "excess profits tax" were imposed in 1917. In 1918 these taxes were combined. But, unfortunately, it proved so easy for most corporations to increase their investment accounts, and to pad their expenses, that the worst profiteers often showed small excess profits. Moreover, a considerable part of the tax was shifted to consumers in the shape of higher prices, as was possible during the inflation period.

Government price-fixing, while it did not prevent profiteering, did moderate the evil, notably through such substantial reductions as were made in the prices of wool, coal, sugar, flour and sulphuric acid. Unfortunately, this means was not used as vigorously and thoroughly as it would have been had there not been an ill-founded reliance upon profits taxes.

On Aug. 10, 1917 the Food Control Act became law. Section 4 of this act made it unlawful for any person to hoard or to make any unjust or unreasonable charge in transactions relating to "necessaries" (foods, feeds, fuel, fertilizers, farm implements and machinery), but imposed no penalty. Sections 6 and 7, however, provided for penalties and seizure, in case of hoarding. Section 5 authorized the licensing of dealers in necessaries and the fixing of fair storage charges, commissions, profits or practices. The fixing of prices for coal and coke was authorized in section 25. It was under this act that the Food Administration operated, and, as already indicated, its control over prices was partly effective. On June 30, 1919, however, the activities of the Food Administration were suspended; and as the agitation concerning the "high cost of living" grew in volume, the Department of Justice assumed the task of enforcing the law, which remained in force while a state of war was only technically in existence. But the attorney-general found his efforts limited by the absence of a penalty clause in section 4 and the restricted definition of "necessaries," and, at the president's request, Congress re-enacted the law in Oct. 1919, with amendments to cover these defects. In the year following the re-enactment of the law there were over 2,000 indictments, arrests and sentences, involving chiefly the commodities just mentioned, together with meats, potatoes and meals at restaurants. The great majority could not be sustained under the law. The act was declared unconstitutional by the U.S. Supreme Court in Feb. 1921. In the meantime prices had declined and the public lost interest in the subject of profiteering.

In a sense the U.S. Government was to blame for much wartime profiteering. In the first place it was lax in letting contracts and making purchases, either directly, or indirectly, by placing authority in the hands of interested persons. The "cost-plus system" invited profiteering as well as inefficiency. In the second place its combination of excess profits taxes and price regulation was unfortunate. Taxation proved at best to be an inadequate means of reaching profits, and early laxity in defining cost and investment made this means nugatory.

See the various *Reports* of the Federal Trade Commission; the *Report of the Massachusetts Commission on the Necessaries of Life* (1920); and *Senate Document No. 248* (65 Cong., 2 Session). (X.)

In European Countries.—Periods of inflation in different countries were marked by measures designed to check speculation and prevent further rises of price. Legislation to mitigate profiteering by combines was consequently passed in several countries, including notably Germany, Czechoslovakia and Norway.

The German experiment, represented by the "decree against the abuse of economic power," which came into force in Nov. 1923, is of particular interest. The decree provided amongst other things that the German minister of economic affairs may, when he considers a cartel agreement or the method of putting it into operation detrimental to the public interest, apply to the Cartel court set up in accordance with the decree to have the agreement declared void or the particular method of carrying it out forbidden. The public interest or the common good is to be considered as detrimentally affected, particularly when supply or demand is restricted in a manner not economically justifiable; when prices are raised or kept high; or when, in the event of prices being quoted in a stable currency, extras for risks are included; or when economic freedom is unreasonably restricted by boycott in buying or selling or by the fixing of discriminating prices or conditions. Until the summer of 1923, action by the government was confined to unofficial intervention, and it was claimed that this was successful in bringing about a large number of price reductions and in preventing price increases. In the latter part of that year the Government made a number of applications to the court with regard to business conditions or methods of price fixing adopted by particular cartels. These cases, however, were settled by arrangement, without the Cartel court giving a decision; and the Government made no further applications to the court. (C. K. H.)

PROFIT-SHARING, the term applied to an arrangement under which an employer, in accordance with an agreement freely entered into, hands over to his workpeople as supplementary remuneration a share, fixed in advance, of the profits of the concern in which they are engaged. This definition, it should be observed, excludes many forms of profit-distribution and bonus payment to workpeople. The condition "fixed in advance," for example, rules out of profit-sharing proper those cases in which an employer makes to his employees, at his absolute discretion, a present out of his profits, even though the payment is made regularly year after year; for such presents are gratuities lacking the elements of pre-agreement and rightful title. Again, the supplement distributed must be dependent on profits. Systems of payment by results, such as piecework, individual premium bonus, collective or fellowship bonus, and the like, are not profit-sharing. In such systems the payment, as a whole or in some supplementary part, is dependent upon the *output* of the individual or of the group, without reference to whether the production culminates in greater or less profit or loss to the undertaking.

The sponsors and guardians of profit-sharing as a system similarly rule out of their field such systems as that adopted in the remuneration of share fishermen or as the French *métayage* system (*q.v.*). These are methods of dividing, not the profits, but the gross proceeds of an undertaking.

Far more elusive is the distinction between profit-sharing and co-partnership, the essence of which is the issue on favourable terms of share capital to employees; indeed, it is hardly possible to make any clear-cut differentiation, the more so as the terms are constantly used as synonymous.

Early Examples.—The earliest known example of profit-sharing in any country seems to be a scheme introduced by the French National Fire Insurance company in 1820, the year of the company's foundation. The British Union Fire Insurance company followed in 1838, and the General Insurance company in 1850. These three schemes are still in active operation. One of the best known of all profit-sharing schemes is that of the Paris house decorator, Leclaire, which was introduced in 1842 and is still in operation. It was at first confined to the nucleus (*noyau*) of permanent employees belonging to the firm's Mutual Provident and Benefit society; but in 1870 it was extended to all employees. Some other French schemes are hardly less famous. Godin, of Guise, introduced profit-sharing in 1876; in 1880 the business was turned into a joint stock company, and became something in the nature of a co-operative society with domiciles, in a model village, for some classes of workers. The Bon Marché have a scheme dating from 1880, under which the whole of the shares in the company are to-day in the hands of actual or former employees. It will be evident that the historical origins of profit-sharing are mainly to be found in France.

Great Britain.—The success of profit-sharing in France attracted much attention in Great Britain, particularly among the "Christian Socialists" (F. D. Maurice, Tom Hughes, Charles Kingsley, Vansittart Neale and others). From about 1850 onwards this group had exercised a very strong influence upon the nascent co-operative movement; hence profit-sharing was at this time widely adopted by co-operative societies, and the subject was constantly discussed at the annual co-operative congresses. At the present time (with one important exception: the workers' co-operative productive societies organised from the point of view not of the consumer but of the producer) profit-sharing is little practised in the co-operative movement.

Outside the co-operative movement the first important scheme in England was that of Henry Briggs, Ltd., a firm of coal owners in Yorkshire, which was introduced in 1865, and was at first very successful but later failed.

A scheme introduced by Messrs. Hazell, Watson and Viney, Ltd., in 1886 was discontinued in its original form in 1895; but a supplementary scheme, introduced in 1890, is still in force, and is of especial interest as the earliest instance in Great Britain of the co-partnership type of scheme enabling employees to share in profits by the purchase of shares on specially favourable terms.

In 1889 a scheme of profit-sharing was introduced by the South Metropolitan Gas company, providing for the payment of a cash bonus varying inversely with the price of gas. As the dividends payable to the shareholders under the company's acts also varied inversely with the price of gas, the workers' bonus was linked with the shareholders' dividends, and thus with the company's profits. The scheme was revised in 1894, in such a way that only half of the bonus was thenceforward payable in cash, the other half being invested in the purchase of the company's ordinary stock. By successive revisions, strong inducements were given to the co-partners to leave the withdrawable half of their bonus on deposit, with a view to eventual investment; and from July 1910 onwards it was provided that the withdrawable part of the bonus must be left in the company's hands to accumulate at interest, or invested in the company's stock with the trustees; or it might be withdrawn by giving a week's notice, but only under special circumstances. This capitalisation of the bonus is a feature upon which the advocates of this type of scheme—following the models specially approved in France—strongly insist. The name of the scheme was changed in 1903 from "profit-sharing" to "co-partnership," as being more descriptive of the nature and purpose of the new relationship that had been established between the company and its employees. In 1920 the scheme became for the first time statutory, under the company's act of that year; and the basis of the scheme was slightly changed. The surplus profits, after the payment of prescribed basic rates of dividend on the company's stocks, are now divided in the proportion of three-fourths to the consumers (in the form of a reduction in the price of gas) and the remaining fourth in equal parts to the ordinary stockholders, by way of increased dividends, and to the employee co-partners, by way of a bonus at a uniform percentage on their salaries and wages. As before, half of the bonus is capitalised, and the other half may only be withdrawn in special circumstances.

At the end of the year 1926, the employees of the company owned capital in the company to the extent of about £500,000 besides deposits at interest to the extent of nearly another £250,000. In another large gas company—in fact the largest gas company in the world, the Gas Light and Coke company—the employees at the end of 1927 owned £750,000 of the company's ordinary stock. Nearly all the leading, and many of the smaller, gas companies have adopted co-partnership schemes framed on the same general lines.

Other schemes deserving of special mention are those introduced by Messrs. Clarke, Nicholls and Coombs, Ltd., in 1890; by Messrs. J. T. and J. Taylor, Ltd., in 1896; by Messrs. Lever Bros., Ltd., in 1909; by the Bradford Dyers' Association, Ltd., in 1912; and by Messrs. Rowntree and Co., Ltd., in 1923; also the scheme foreshadowed by Imperial Chemical Industries, Ltd., in 1927. These six schemes contain two examples of each of the three principal types of profit-sharing and co-partnership: the cash bonus type, the bonus-capitalisation type and the share-issue type.

The following table shows the total numbers of schemes started in the various periods mentioned, the numbers of such schemes no longer in existence at the end of 1927, and the numbers and range of those still in existence at that date, as given in the *Ministry of Labour Gazette* for June 1928:—

TABLE I.

Period in which started	Total schemes started	Schemes discontinued (or suspended) by end of 1927	Schemes still in operation at end of 1927		
			Number of schemes	Total number of employees	Approx. number of employees entitled to participate
Before 1881	35	31	4	1,700	800
1881–1890	80	69	11	17,100	13,900
1891–1900	78	65	13	8,900	7,500
1901–1910	82	44	38	87,500	54,700
1911–1918	95	37	58	56,300	24,700
1919	57	18	39	35,000	22,400
1920	56	12	44	58,800	16,600
1921	14	1	13	27,900	11,800
1922	12	1	11	3,300	2,700
1923	18	1	17	29,000	22,800
1924	13	..	13	31,200	12,800
1925	12	1	11	31,100	5,400
1926	11	..	11	15,700	10,000
1927	14	..	14	5,900	2,400
Total	577	280	297	409,400	208,500

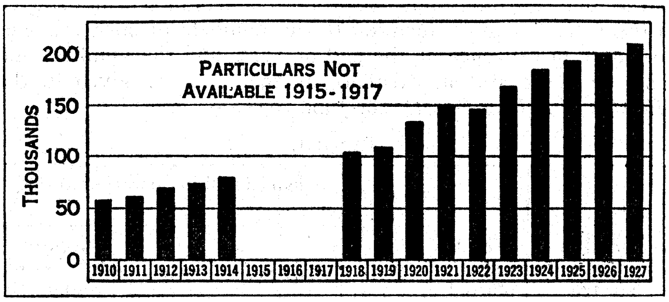
The following table, also taken from the *Ministry of Labour Gazette* for June 1928, shows how the schemes are distributed among the various industries:—

TABLE II.

Industry or business	Schemes in operation at end of 1927			
	Number of firms	Number of schemes	Total number of employees	Approx. number of employees entitled to participate
Agriculture	5	5	700	300
Glass, chemical, soap, oil, paint, etc.	15	1	52,000	29,700
Engineering, shipbuilding and other metal	42	44	67,700	23,900
Textile	29	29	46,800	19,900
Food and drink (manufacture)	31	33	43,400	28,500
Paper, printing, bookbinding, publishing, etc.	22	23	7,700	5,400
Gas, water, and electricity supply	53	53	49,500	41,900
Insurance, banking, and other financial businesses	9	9	37,200	33,000
Merchants, warehousemen and retail traders	44	45	40,400	11,200
Other businesses	40	41	64,000	14,700
Total	290	297	409,400	208,500

The growth of the movement, as will be seen, is irregular; indeed, the figures of new schemes started year by year show that the advance proceeds by spurts following periods of quiescence. The total of 208,500 employees entitled to participate in profit-sharing schemes is substantial, yet, considered relatively, it forms but a small proportion, less than 2%, of the total number of employees. Regarded industrially the proportion varies greatly and is insignificant, except in gas companies, in the banking, insurance and financial group, in the chemical trades and in food and drink manufacture; and in all these groups, with the one exception of gas companies, the profit-sharing statistics are dominated by the figures for two or three very large companies.

The growth in the number of employees known to be working under profit-sharing arrangements is illustrated in the following diagram:—



Discontinued Schemes.—It has already been pointed out that about half the schemes started have come to an end. Of the 192 schemes started before the beginning of the present century, only 28 were still in operation at the end of 1927. An analysis of the causes of discontinuance is attempted, on the basis of such material as is available, in the official *Report* already mentioned; and another more detailed analysis, supplemented by special enquiries, is made in S. Rowntree's *The Human Factor in Business.* Rowntree's final conclusion is that, taking all schemes, existing and discontinued, together, about 63% may be regarded as successes and 37% as failures; and in many of the cases written down as failures the causes of failure were obvious and might have been avoided. The statistics of discontinued schemes, taken as a whole, are thus somewhat inconclusive, but it is possible to draw some conclusions from the figures analysed *(a)* by industries, and *(b)* by types of schemes.

(a) The figures for industrial groups are given in the table (p. 559). Attention may be directed to the extremely unfavourable results in agriculture. Other industrial groups with a high proportion of schemes discontinued are paper, printing, bookbinding and publishing, while merchants, warehousemen and retail traders, show heavy casualties. On the other hand, all the schemes in banking, insurance and other financial businesses that had been started were still in operation at the end of 1927; and gas companies' schemes also had a remarkably high proportion still in operation.

(*b*) More value, perhaps, attaches to the analysis by types of scheme. The figures in the following table are taken from the 19th *Abstract of Labour Statistics,* and relate to the position at the end of 1927.

TABLE III.

	Total	Discontinued	In operation at end of 1927
Schemes consisting in the issue to employees of share capital on specially favourable terms	77	18	59
"Deposit" schemes, under which interest, varying with the profits, is allowed on deposits made by employees	32	6	26
Other schemes, analysed by method of paying bonus—			
(i) Bonus paid in cash, or credited to a savings or deposit account .	300	181	119
(ii) Bonus retained in a provident, superannuation, or other similar fund	23	10	13
(iii) Bonuses paid in shares, or invested in capital of undertaking .	50	16	34
(iv) Bonuses paid in other ways; combinations of above systems; and method of payment unknown .	92	46	46
Total	574	277	297

It will be seen that the best result is shown by the "deposit" schemes, followed by the two "co-partnership" types of schemes—the share-issue type, and the bonus-capitalisation type. Much the worst result is shown by the cash bonus type (which, however, remains much the largest single class)

Rate of Profit-sharing Bonus.—There is a remarkable uniformity in the average rate of bonus paid by profit-sharing firms to their employees, which works out at a little over 5% addition in ordinary earnings over a long period of years.

Although the average rate, for all industries is remarkably uniform from year to year, there is no corresponding uniformity in the rate of bonus for the several industries. The following table shows the percentage addition to wages made by the profit-sharing bonus in the various groups of industries in each of the three years, 1925, 1926 and 1927: the figures are taken from the 18th and 19th *Abstracts of Labour Statistics.*

TABLE IV.

Industry or business	Percentage addition of bonus to wages			
	1924	1925	1926	1927
Agriculture	1·4	2·1	0·9	0·2
Glass, chemical, soap, oil, paint, etc.	6·1	7·3	3·8	3·5
Metal, engineering, and shipbuilding	1·4	2·1	2.6	1·6
Textile . .	3·4	2·9	2·2	2·3
Food or drink (manufacture) .	7·1	6.3	5·6	3.9
Paper, printing, bookbinding, publishing, etc.	j.8	7·2	7·1	6.6
Gas, water and electricity* .	4.6	5·1	4·1	4·1
Insurance, banking, finance†	..			..
Merchants, warehousemen, or retail traders	9·7	13·3	11·0	10·4
Other businesses . . .	7·7	5·1	5·6	4·0
Total . . .	4·9	5·3	4·4	3·9

*Almost entirely gas companies.
†Cannot be stated.

Views of Employers and of Trade Unions.—It is impossible to make any general statement about the views of employers. It must be taken as significant, however, that, in spite of three-quarters of a century of active propaganda, only some 500 or 600 firms are known to have introduced any form of profit-sharing or co-partnership; and that a large proportion of this small minority have been dissatisfied with the results.

As regards the attitude of the trade unions to profit-sharing, there appears to be little doubt that this has been almost uniformly hostile, or at best indifferent. Naturally, the whole effort of the trade unions, in regard to remuneration, is directed to keeping the *general* level of wages *in an industry as a whole* as high as possible. They are not greatly concerned to secure special advantages for the workpeople in a works here or there, where the employers are exceptionally prosperous.

But further—and this is a point to which many critics of the movement attach great importance—it is conceived to be positively injurious to the trade union movement, as a mass organisation, to have the workpeople in a factory here and there isolated from their fellows by special privileges, since the workpeople so placed may be expected to be wanting in zeal for the defence of their less fortunate comrades, and averse from risking their employment if a dispute should come to the final arbitrament of a strike.

The practical importance of the fundamental distinction, referred to above, between profit-sharing and payment by results is that while payment by results offers a bonus based on factors which are wholly or largely under the control of the workers, profit-sharing offers a bonus based on factors which are in great part outside their competence, and which depend in great part on the judgment, skill and enterprise of the directors and the management. For this reason profit-sharing compares unfavourably with systems of payment by results, *if regarded simply as a method of industrial remuneration;* and it may be said at once that the shortcomings of profit-sharing as a method of remuneration are freely admitted by many modern advocates of the system. The emphasis is nowadays laid rather upon the means profit-sharing affords of giving the workers an assurance that they are receiving "a square deal."

The weakness of profit-sharing as a stimulus to effort lies partly in the remoteness of the connection between the individual effort and the reward accruing to the individual making that effort, partly in the length of time that usually elapses between the additional exertion and the receipt of the reward, and partly in the customary smallness of the reward.

France. — Reference has already been made to some of the historic French profit-sharing schemes.

The French Profit-sharing society published in 1924 a revised (third) edition of their monograph on profit-sharing, containing the names of 140 firms practising profit-sharing in France. This total shows a slight advance on the 114 given in the second edition of the monograph 12 years earlier; but it is to be noted that the definition of profit-sharing is much wider than that adopted in Great Britain; while schemes introduced by firms domiciled in Alsace-Lorraine are now included, which would, of course, not have been included in the earlier edition. Two points of special interest in the Report may be noticed. In the first place the historic schemes of Leclaire, Godin, the Bon Marché and others still appear in the list. Secondly, the preeminence of insurance companies' schemes is still very marked, a fifth of all the schemes in the list—28 out of 140—being in insurance companies.

The 1924 Report of the French ministry of labour on profit-sharing mentions two acts which make profit-sharing compulsory in two special cases, and a third which introduces a kind of permissive co-partnership. An act of Dec. 18, 1915, makes profit-sharing compulsory in workers' productive co-operative societies formed under the act. Particulars are given in the Report of 328 such societies, employing 12,000 workers, about half of whom are non-members. An act of Sept. g, 1919, makes profit-sharing compulsory under all mining concessions granted after that date, of which there were 51 at the date of the Report. An act of April 26, 1917, permits the formation of joint stock companies with labour co-partnership (*sociétés anonymes à* participation *ouvrière*) in the form of labour shares (actions de travail), which are the collective property of the employees organised in a co-operative society. Eleven companies had been formed under the act, at the date of the Report, of which six were actually working as joint stock companies with labour co-partnership; but it is stated to be too early to form any conclusion as to the success of the experiment.

So far as regards voluntary profit-sharing the inquiry covered 168 businesses; but 93 of these failed to satisfy even a very wide definition of profit-sharing. The remaining 75 undertakings employed 102,000 manual and non-manual workers, of whom 62,000 work for the Paris-Orleans Railway company. In more than one-third of the cases the adoption of profit-sharing was subsequent to the year 1919. The share in the profits varies from 5 to 70% and more; rates of 6 to 20% being commonest. Information regarding 62 establishments employing 99,550 workers indicates that, in 1921, nine of them, employing 63,050 workers, realised no profits, and there was consequently no distribution. Fifty-three establishments, employing 36,500 workers, distributed 25,743,000 francs among 20,415 workers, an average of 1,260 francs for each participant. The actual amounts varied between a minimum of 24 and a maximum of 4,169 francs. On the whole, profit-sharing appears to be on the decline.

Germany. — Profit-sharing had gained little ground in Germany prior to the War. The number of businesses known to be practising profit-sharing at that time was 21, with probably a little more than 15,000 workers. The most interesting of these schemes was that existing in the famous Zeiss works, at Jena.

The position after the War has been studied by the social attache to the Swedish legation at Berlin; and the following observations are largely based on the report of his investigation (*Sociala* Meddelanden, No. 11, 1923).

There was a revival of interest in profit-sharing in Germany after the revolution; and some of the leading industrialists, including Krupp and Stinnes, were among its advocates.

According to a report by Werner Feilchenfeld, secretary of the Berlin chamber of commerce, published in 1922, in which he carried his investigations as far back as 1824, a system of profit-sharing had existed in 95 undertakings; but of these only 29 were in operation in 1921.

The great majority of profit-sharing schemes in Germany provide for the payment of a bonus in cash, or for payments into savings bank accounts or into provident or benefit funds. As a rule, the distribution is based on the annual earnings.

Only two instances are apparently on record in Germany of the "co-partnership" type of scheme, both of which have been discontinued. The first was almost contemporaneous with the Briggs scheme in England, and was apparently modelled upon it. The latter was introduced in the great Krupp business in 1922, and discontinued in 1925, on the ground, it is stated, that it would not be possible in future years to pay the dividend (6% preferential) on the workers' shares. (J. H.)

United States. — Profit-sharing is a method of additional remuneration of employees under which the employees receive a share, fixed in advance in relation to profits. In other words the basis of distribution of the profits between the stockholders and the employees is predetermined. The actual amount distributed depends upon the profits earned and varies from year to year according to the company's ability to earn profits. The conception of profit-sharing in the Senate report of 1939, pp. 2–5 (which makes profit-sharing include "all payments to employees, regardless of the form in which they are allocated or distributed, which are in addition to the market rate") is incorrect.

Early Examples. — Experience with profit-sharing in the United States dates from at least 1867. The pioneer experiments were, however, short-lived. The first enduring plan appears to be that established by the Peace Dale Manufacturing Company of Peace Dale, R.I., in 1878. This company, which was engaged in the manufacture of shawls, worsted goods and woollen fabrics, employed about 450 workers. Its profit-sharing plan was typical of those most frequently adopted in subsequent years. It provided for the allotment of a percentage of the profits, after making certain deductions for depreciation, reserve and dividends, to be distributed among those employees who had been with the company for a specified time on the basis of their individual earnings. It was also provided that, if the profits were not sufficient to allow a distribution of at least 1% of the earnings, the profit-sharing bonus would not be paid. This situation arose in the first year of the plan's creation. Thereafter, for the succeeding 11 years, a share of the profits varying between 3 and 5% of earnings, was paid to all eligible employees.

Another conspicuous example of the early systems in the United States, and one similar to the Leclaire plan in France, was that adopted in 1886 by the N. O. Nelson Manufacturing Company of St. Louis, Missouri, which continued 49 years. Under the terms of this plan capital received the usual commercial return and the remaining profits, after setting aside 2½% for educational purposes and 5% for a provident fund, were proportionately divided between capital and labour on the basis of the relationship between the total pay roll and the total capital investment. Profit-sharing dividends from 8 to 10% were paid for a number of years. Until 1890 the employees were permitted a choice between payment in cash or in the stock in the company. After that time all payments were made in the form of stock. In 1894 it was decided to allow profit-sharing dividends only to those employees who invested 10% of their wages in the company's stock. During the dull years which followed, no dividends were paid, but in 1906 a total of $108,778 was distributed in the form of company stock to employees, customers and the provident fund.

Extent of Profit-Sharing. — Profit-sharing has never reached considerable proportions in the United States. Of 50 plans set up before 1896 only 12 remained in operation. in 1896. The United States Bureau of Labor Statistics found only 60 "true" profit-sharing plans in 1916; *i.e.* covering rank and file employees as contrasted with "limited" plans which apply only to "principal employees." There were probably not over 80 to go true profit-sharing plans in the United States in 1930 and some of those were discontinued during the depression years which followed. Seventy years' experience yielded a net growth of hardly more than one plan per year. The National Industrial Conference Board report on *Practical Experience with Profit-Sharing* (1920), which covered 41 true profit-sharing plans indicated two general conclusions: That profit-sharing is still in the experimental stage and may have more merit than its history indicates and that it has been successful thus far only in the hands of a minority of employers, men with social vision and unusual interest in policies of such a kind, and with workers of considerable intelligence and who have confidence in their employer.

The latest figures on the extent of profit-sharing in the United States are given in C. C. Balderston's *Profit-Sharing for Wage Earners, 1937,* which showed that 193 plans were known to have been initiated in the United States and Canada and 679 in Great Britain and Northern Ireland. Sixty-seven of these American and 266 of the British plans were in active operation in 1937. In a National Industrial Conference Board study published in 1928, which reported results of inquiries of 4,655 establishments in many industries, the percentages of profit-sharing establishments varied from 1·9% in the rubber industry to 12·7% in the case of mercantile establishments. Public utilities and the chemical industry ranked second and third, with 9·4% and 7·3%, respectively, of the companies investigated participating in plans of profit-sharing. Only six of the plans included in the survey began before 1916. The National Industrial Conference Board reached three conclusions in its report on profit-sharing:

(1) From experience with profit-sharing in the past and the plans now in operation, profit-sharing has been successful for limited periods.

(2) Judging from the long list of abandoned plans and the comparatively small number that have endured more than a few years, the effectiveness of profit-sharing in surviving the many vicissitudes of an industrial enterprise is decidedly uncertain.

(3) In the light of the high percentage of abandonment due to dissatisfaction among the workers, it is reasonable to conclude that wise and efficient management plays a very important part in the success of profit-sharing plans.

Analysis of Profit-Sharing Plans.—Profit-sharing plans introduced as an incentive for the employee to remain in the service of the company and to increase the loyalty and efficiency of the wage-earner almost always require a minimum period of employment as a pre-requisite for participation in the sharing of profits. In only 7 of the 41 cases included in the conference board's 1920 report were the workers permitted to share in the profits immediately after employment. The period of service specified ranged from three months to four years, with one year as the usual eligibility requirement.

Sharing of profits has been found to be most successful where a large proportion of workers are allowed to participate. In most cases after a certain period of employment no discrimination is made between employees on the basis of their efficiency or satisfactory service. The Barnett National Bank and the Oneida Community, Ltd., include all of their employees in the distribution of profits, although the share is increased in proportion to years of service.

The Hammermill Paper Company and the Charles Warner Company share their profits only with a limited number of their employees.

In a few instances employees share the losses of lean years, the most noteworthy example of this policy being the plan of the A. W. Burritt Company of Bridgeport, Conn., which was adopted in 1900 and abandoned in 1922. Under that plan 10% of the weekly wage of each employee electing to participate was held until the close of the current fiscal year. If no profits were earned, this fund was divided between the company and the participating employees on the basis of the ratio between capital stock and the annual pay roll of participants in the same way that the profits were distributed.

The payment of the profit-sharing bonus may be made in cash, stock or certificates which bear interest, or a combination of any two of these. Except where the payment is in cash the profit-sharing system is in effect a thrift or savings plan.

Some companies make a partial cash payment with a deferred share later in order to hold the employee after the period of distribution. Most plants make awards once a year, near the Christmas season.

Limited Profit-Sharing Plans.—In addition to profit-sharing plans of the general type, a number of establishments have plans limited to their principal employees and intended primarily to increase administrative efficiency. This policy has been adopted by the Dennison Manufacturing Company which also maintains a modified profit-sharing system for the wage-earners. The limited plan provides for the issue of industrial partnership stock solely to the principal employees in amounts based on total yearly profits after a guaranteed return to capital. This stock carries voting power provided that the dividends on first preferred stock have been paid, but the stock can be held only as long as its owner remains with the company.

When an employee leaves the company he is obliged to exchange his industrial partnership shares for second preferred non-voting stock.

Practical Difficulties.—Organized labour has been hostile to profit-sharing for a variety of reasons. Testifying before the Senate Committee, William Green said labour "is not opposed to principles involved in profit-sharing but . . . to the way in which it has developed and operated. . . . Labor cannot be asked to accept blindly management's decision on what constitutes profits." He insisted that all records ought to be equally available to both sides, that the company's sales policies, executive salary scale, financial policies, and wage structure should be mutually discussed as a basis for profit-sharing and that "collective bargaining should be extended to the field of profit-sharing." Under such conditions labour's attitude would be favourable. John Lewis maintained that labour could not accept as part of its just compensation a share in profits so long as the conditions which control the profits "are completely beyond its control or influence." Employers, too, have serious questions. They have established the plans for any one of several reasons: To promote social justice, reduce labour turnover, increase the interest and loyalty of their employees, encourage thrift, increase efficiency and decrease restriction of output. Often they cannot see that the end sought is achieved.

Many plans have failed to produce economies or increases in efficiency equal to their cost, others have been discontinued because of labour troubles.

A smaller percentage have been ended by the employees asking for higher wages in lieu of profit-sharing.

Uncertainty of profits is, perhaps, the most disturbing factor—uncertainty as to whether there will be any profits, how large they will be, and whether the distribution of them will be on a mutually satisfactory basis.

Present Status of Profit-Sharing.—Although profit-sharing has been successful in a number of instances, it is doubtful whether it is gaining ground at the present time. The underlying purpose of profit-sharing, which was to create a bond of mutual interest between management and workers and to promote greater co-operation and efficiency, has found expression in other forms, such as co-operative thrift and savings schemes, stock purchase plans, benefits for sickness and accident, group life insurance and pension or retirement plans. The profit-sharing systems of some companies have continued to exist through the years, although the details of the plans have been modified from time to time. The N. O. Nelson Manufacturing Company of St. Louis operated on a profit-sharing basis from 1886 to 1935. The Bourne Mills of Fall River, Mass., has continued to share profits with its employees each year, with the exception of 1904, since 1899. Although the plan of the Baker Manufacturing Company has been in existence since 1894, it was not until 1899 that profit-sharing actually became effective.

The most significant development in profit-sharing has been its application in unionized plants. At least seven companies now have profit-sharing in union plants. In all cases the control of profit-sharing is entirely in the hands of the companies but in three of them the unions have insisted upon discussion of the plan at bargaining time. A few unions have asked for profits-shares in addition to the wages provided by the agreement.

Other Countries.—The Dutch schemes, though mostly very small, present many interesting and original features; and Switzerland has the unique experiment of a scheme in the Federal postal service, which was, however, abandoned after four years, in 1873.

BIBLIOGRAPHY.—See *Monthly Labor Review*, U.S. Bureau Labor Statistics, April 1923, for bibliography up to that date. Industrial Co-partnership Association, *Co-partnership* (quarterly); "Profit-sharing and Co-operative Production," special supplement to *New Statesman* (1914); *Ministry of Labour Gazette* (1928); S. Rowntree, *Practical Profit-Sharing* (1922), *Industrial Unrest: A Way Out* (1922); J. A. Bowie, *Sharing Profits with Employees* (1922); *The 19th Abstract of Labour Statistics* (1928); A. Trombert, *La Participation aux Bénéfices* (1912, tr. 1920); *Enquête sur la Participation aux Btntfices*, Ministère du Travail (Paris); National Industrial Conference Board, *Practical Experience with Profit-Sharing* (1920), *The Wage-Earner in New York and Other States* (1928); G. James and others, *Profit-Sharing and Stock Ownership for Employees* (1926); L. A. Boettiger, *Employee Welfare Work* (1923); D. Bloomfield, *Financial Incentives for Employees and Executives* (1923); C. M. Winslow and Clark, *Profit-Sharing and Pension Plans* (1939); C. C. Balderston, *Profit-Sharing for Wage Earners* (1937); Metropolitan Life Insurance Co., *Sharing Profits with Employees*, Report No. 91 (1926); P. Monroe, "Profit-Sharing in the United States," in *American Journal of Sociology*, vol. i., pp. 685–709 (May 1896); Ralph E. Heilman, *Profit-Sharing*, American Management Association (New York 1925); Cleveland Chamber of Commerce, committee on industrial welfare, *Industrial Profit-Sharing and Welfare Work* (1916); National Civic Federation, *Profit-Sharing by American Employers* (1916); D. D. Lescohier and E. Brandeis, *History of Labor in the United States 1896–1932* (1935).

Hearings and report by sub-committee on finance, U.S. Senate, Seventy-fifth Congress, Third Session, on "Survey of Experiences in Profit-sharing and Possibilities of Incentive Taxation" (1939).

(D. D. L.)

PRO FORMA INVOICE. When a consignment of goods is made for sale on commission, or when goods are forwarded on approval, it is usual to invoice them in a form identical with that of an ordinary invoice but bearing the endorsement "Pro forma." The consignee is thus fully advised of the contents, descriptions, qualities and prices of the goods consigned.

PROGNATHISM, the term applied with its opposite *Orthognathism*, to describe the degree of projection of the upper jaw, which is determined by the angle made by the face with the brain-cap. (*See* CRANIOMETRY.)

PROGNOSIS, a term used in modern medicine, as it was in Greek, for an opinion, forecast or decision as to the probable course, duration and termination of a case of disease. It is to be distinguished from "diagnosis," the determination or identification of a disease in a particular case from an investigation of its history and symptoms.

PROGRAMME MUSIC, a nickname which is the only current term for instrumental music without words but descriptive of non-musical ideas. Musical sounds lend themselves to descriptive purposes with fatal ease. A chromatic scale may suggest the whistling of the wind or the serenades of cats. Reiterated staccato notes may suggest raindrops or the cackling of hens. Again, music is powerfully suggestive of emotion; and the emotions it calls up may fit some particular story, or may resemble those inspired by a sunset or a storm. But chromatic scales, reiterated notes, emotional contrasts and climaxes, are also normal musical resources; and nothing infuriates a musician more than the non-musical explanation of such things where the composer's aim was purely musical. Sound as it occurs in nature is too inorganic to form the raw material for art, and so there is no natural tendency in music to include, as a "subject," any item not inherent in the art-form. Explicit programme music has thus never been a thing of cardinal importance, though it has often been prominent and always popular. Rut the conditions of artistic creation are not to be confounded with any correct theory of art. The doctrine of art for art's sake is correct: but it concerns results, not processes; and many of the purest works of art have been produced for ulterior purposes

Until recent times no composer has written for the voice without words; for speech is a privilege which the human voice will not willingly renounce No doctrine of absolute music will prevent a good composer from shaping his vocal music to the words which he sets. Good literature will inspire him to explore and express its inner meaning. Bad literature may suggest to him the truths it misrepresents; and the great composers are quicker to seize the truth than to criticize its verbal presentation or to suspect insincerity. The earliest mature musical art was, then, inevitably descriptive, since it was vocal. While programme music derives many of its characteristics from ancient times, it cannot properly be said to have existed until the rise of modern instrumental music, based upon external ideas and independent of the use of words.

A complete code of musical symbolism came to maturity in the 16th century. Part of it was profoundly true and characteristic of moods; part was harmlessly mechanical; and a few details were manifestly false, as when "atra nox" is represented by a curiously jaunty rhythm because that rhythm is indicated by black notes. When symbolism, true or false, has thus arisen in vocal music it may be expected to retain its intention in music without words. But we must not expect too much descriptive power in early instrumental music; and when a scholar tells us that a funeral piece for organ by Froberger depicts in its final rising melisma the ascent of the soul to heaven, he unwittingly accuses Froberger of sinister intentions in a precisely similar funeral piece which ends with a descent to the lowest bass.

The resources of the modern orchestra can attain a realism which at first seems iess ridiculous than that of earlier descriptive music. But the expensive realism of the dozen muted brass instruments that in Strauss's *Don Quixote* accomplish in ten rehearsals what a flock of sheep achieve extempore, is not less, but more childish than the thunderstorm in the Fitzwillian Virginal Book.

Beethoven's Theory of Expression.—On the other hand when superior persons object to the childishness of the birds and the thunderstorm in Beethoven's *Pastoral Symphony* it is they who are childish in supposing that realism is in question at all. The real cuckoo, nightingale and quail happen to be musical birds whose themes are exactly what Beethoven wants for a break in the rhythm at a point of repose in the coda of his slow movement. Similar final digressions can be seen in slow movements with no programme at all, *e.g.*, in the violin sonata of 24, the pianoforte sonata in D minor (op. 31 No. 2), and the string-quintet in C major, op. 29. Not a bar of the *Pastoral Symphony* would be otherwise if its "programme" had never been thought of. The "merry meeting of country folk" is a subject that lends itself admirably to Beethoven's form of *scherzo* (*q.v.*); and the thunderstorm, which interrupts the last repetition of this scherzo and forms a tremendous introduction to the peaceful finale, is as musical as other unique features in Beethoven's pure art-forms.

Beethoven is recorded to have said that he always composed according to a "picture" he had in his mind; and he sometimes gave his friends an explanation, jocular or evasive, of some particular composition. But the word *Bild* is much more indefinite than "picture"; and Beethoven's dull Boswell, Schindler, often exasperated him into defending himself by saying the first nonsense that would serve to stop foolish questions. Composers who have much to express cannot spare time for translating it into other terms than those of their own art. The *Eroica Symphony,* though inspired by Beethoven's short-lived belief in Napoleon as the liberator of mankind, is not programme music at all. The funeral march represents heroic death and a mourning world, but not the obsequies of a biographical subject; and when critics tell us that the finale is ('an inappropriate concession to sonata form" they merely show themselves unmusical without thereby becoming literary. The profound and subtle sonata *Les Adieux, l'Absence et le Retour* is true programme music. It represents Beethoven's feelings on parting from the Archduke Rudolph when the royal family left Vienna shortly before its bombardment. It deals only with the parting, the absence and rejoining of the two mrn. Nothing is heard of war, and the sentiment is as deep as it is manly. Beethoven's private sketch-books record that the work is "written from the heart": no courtly formula, even if this was shown to the Archduke. Ingenuity is misplaced in tracing external details. (The end of the first movement of *Les Adieux* has been compared to the departure of a coach.) The real emotional basis is universal and musical.

Beethoven summed up the whole theory of great programme music in his note to the Pastoral Symphony; "rather the expression of feelings than sound-painting." Overtures to plays or operas cannot so easily dispense with story-telling; but Beethoven refuses to be drawn into a chronological series of illustrations. His overtures to *Coriolan, Egmont* and *Leonora* deal with salient emotions roused by their subjects. Wagner was able to place the substance of the *Coriolan* overture in Shakespeare's scene between Coriolanus and his mother and wife before the gates of Rome; but Thayer found that the forgotten poet Collin's play, which was Beethoven's subject, sheds far more light on the music. The music, however, once it took shape, could do without Collin or Shakespeare. The *Leonora* overture was at first (in the form known as No. 2) a huge prelude to the opera, with a gigantic exposition and development, and the shortest wind-up compatible with adequacy, after the trumpet-call behind the scene has relieved the tension. In the later version (*Leonora No. 3.*) Beethoven ruthlessly compresses the exposition until the trumpet-call becomes the middle point of the design, which afterwards expands in a further development, full recapitulation and a climax which makes this overture the first and greatest of all "symphonic poems" (*q.v.*). Critics who cavil at the trumpet-call as a weakness from the point of view of absolute music only show that they cannot tell absolute music from absolute nonsense. Distance is surely too elementary a phase of sound to be excluded from absolute music, nor can the fanfares of a trumpet be separated either from the instrument or from its associations. As a piece of absolute music *Leonora No. 3.* is a huge movement in sonata form rising steadily to a point at which the tension is relieved by the new incident of a distant trumpet-call, after which the music expands from sheer joy. Beethoven's maxim *mehr Ausdruck der Empfindung als Malerei* therefore holds here, and bridges the gulf between absolute and illustrative music.

Portrayal of Characters and Moods.—This is equally true with archaic and modern programme music; it is always characters and moods that are successfully portrayed, while chronology is useless and the illustration of incidents is apt to be ridiculous unless it contrives to be witty. Thus, the *Bible Sonatas* of J. Kuhnau (published in 1700) and their clever imitation in Bach's early *Capriccio on the Departure of a Beloved Brother* rely mainly on moods, and are successful with incidents only when these would be accompanied by music in real life or drama. If Kuhnau's music were half as vivid or inventive as his prose introductions it would be immortal. But much may be learnt from noting how his unconsciously humorous prose describes other things than the music attempts to portray and omits the very things in which the music is at its best. While Kuhnau strains himself, like a bad nurse telling bogey-stories, in his prefatory description of the size and appearance of Goliath, in the music it is the boasts (*le bravate*) of Goliath that are portrayed. The best movement in the Goliath sonata is a figured chorale (*Aus tiefer Noth schrei' ich zu Dir*) representing the terror and prayers of the Israelites. On the other hand the cast of David's sling, with the fall of Goliath, is not nearly so sublime as the fall of a tea-tray. Kuhnau's other subjects (*Saul cured by David's music; The Marriage of Jacob; The Healing of Hezekiah; Gideon,* and *The Funeral of Jacob*) are all thoroughly musical; more so than he succeeds in making them. Bach's *Capriccio* describes the anxiety and sorrow of the friends of the departing brother; and his utmost realism takes the form of a lively fugue on the themes of the postilion's coachhorn and cracking whip. Buxiehud illustrated the "nature and characters of the planets." This is an astrological, not an astronomical subject: the planets signify temperaments and their motions are the music of the spheres. No wonder, then, that this musical subject has been adopted in one of the outstanding masterpieces of modern orchestral music, *The Planets,* by Rolst.

Adaptability of Lyrical Music.—Instrumental music on the lyric scale lends itself to illustrative purposes more readily than larger forms. Nearly all the harpsichord pieces of Couperin have fantastic titles, and a few of them are descriptive music. His greater contemporary and survivor, Rameau, wrote important operas and much extremely graphic harpsichord music. *La Poule,* with its theme inscribed "co-co-co-co-co-co-cocodai," is an excellent movement in spacious form, and is also one of the most minutely realistic compositions ever written. French composers have always contributed *con amore* to music that takes advantage of external stimulus; and already in 1801 descriptive music was considered so specially French that Haydn apologized for his imitation of frogs in *The Seasons,* saying that this "franzosische Quark" (rubbish), had been forced on him by a friend. But throughout the growth of the sonata style, not excepting Haydn's own early work, the tendency towards gratuitously descriptive music often appears; partly because there was no definite distinction between early symphonic music and overtures or incidental music to plays (*e.g.,* Haydn's *Il Distratto).* Dittersdorf's symphonies on the metamorphoses of Ovid are excellent music in which the descriptive elements do not disturb the symphonic form until the metamorphosis which is then illustrated in almost Wagnerian breadth. For instance, the first three movements of the *Change of the Lycian peasants into Frogs* show the rusticity of the peasants, the gracefulness of the goddess, and the rudeness of the peasants to the goddess; and then the finale indicates an altercation ended, after a pause, in a low mysterious quivering sound as of frogs in a marsh.

Dittersdorf is not a great composer; but many more learned and resourceful artists have shown less than his common-sense in distributing the descriptive and the formal elements of their music. It seems incredible that any composer could be so foolish as to commit himself to describing a chronological sequence in a sonata-form which compels him to go through a full restatement of events which only happened once; yet many composers refused to abandon either the sonata form or the chronological sequence. Lyric forms presented no such difficulties.

Schumann and **Spohr.**—Schumann sometimes invented his titles after his pianoforte lyrics were finished, and sometimes wrote on the inspiration of literature. In either case, as with Beethoven, the music throws far more light on the programme than the programme throws on the music. Musical people may profitably study E. T. A. Hoffman and Jean Paul Richter in the light of Schumann's *Novelletten* and *Kreisleriana;* but if they do not already understand Schumann's music, Jean Paul and Hoffman will help them only to talk about it. In revising his early works Schumann sometimes made them more musical and sometimes destroyed grotesque touches that are musically as well as psychologically true. For instance, in the *Davidsbündler-tanze* (op. 6.) the hot-headed Florestan, having finished an impassioned tirade, feels that he has been making a fool of himself. His last note pauses unharmonized and he sits down awkwardly. In a later edition, with unnecessary scruple Schumann suppressed this detail together with the prose titles and signatures. The fashion of fantastic titles affected even the most formal composers during the romantic period.

No one wrote more programme music than Spohr; and, while Spohr's programme constantly conflicted with the externals of his form and ruined the latter part of his symphony *Die Weihe der Tone,* it did not broaden his style. Mendelssohn's Scotch and Italian symphonies, and his Hebrides overture, are cases of generalized local colour. His Reformation symphony, which he himself regarded as a failure, and which was not published until after his death, is a descriptive work less attractive but more coherent than Spohr's *Weihe der Ton.* The overture to the *Midsummer Night's Dreatn* is a marvellous musical epitome of Shakespeare's play and the comparative slightness and conventionality of its second theme closely correspond with Shakespeare's two pairs of lovers, though it does not illustrate their quarrels under the fairy spells.

Influence **of Berlioz.**—Berlioz made programme-music a vital issue in the 19th century. With an inextinguishable gift for voluminous composition he is utterly incapable of focussing his attention on either his music or his programme. The most trivial external detail may distract him at the height of his rhetoric. The moonshine and sentiment of the *Scène d'amour,* in his *Romeo and Juliet* symphony is charming; and the agitated sighing episodes which interrupt its flow, can be understood in the light of

Shakespeare's balcony scene, if not by their musical sense. But when Berlioz thinks of the nurse knocking or calling at the door, he makes a realistic noise without either musical or dramatic purpose. It does not interrupt the duet, nor increase the emotional tension, nor illustrate Juliet's artifices for gaining time, nor her agitation at the interruptions of the nurse. Perhaps this was the passage on which a lady once congratulated Berlioz for his vivid representation of *Romeo arrivant dans son cabriolet.* This piece of purely orchestral music has an introduction in which real voices are heard from convivial persons returning home from the ball. Berlioz complains that the public has no imagination and that therefore certain sections which presuppose an intimate knowledge of Shakespeare's play *avec le dénouement de Garrick* should be omitted. But what the public lacks for these sections is neither imagination nor familiarity with Garrick-Shakespeare, but a capacity to take the butterfly vagaries of Berlioz's mind as their basis of reference.

With all his absurdities, Berlioz's genius for composition carried him further towards a new music than Liszt was able to advance in his symphonic poems. These, as has been said in other articles *(see* MUSIC, sections 8–10, and SYMPHONIC POEM) are the beginnings of an instrumental music that achieves the same continuity as Wagner achieved in music-drama. But Liszt hardly even began to achieve the right sort of movement; and his conscientious plan of deriving the whole piece from transformations of a single figure was quite irrelevant even when it was effective. As a musical illustrator he is clever; but he ties himself down to chronological sequence, which, though it does not conflict with his forms, is always open to Weingartner's objection that it cannot control the pace of the listener's thoughts. The composer's first view-halloo may make one listener fancy himself in at the death of the Blatant Beast, while the mind of another will plod to the end, to learn that that event never takes place.

Strauss.—The symphonic poems of Strauss are invulnerable by this objection, even though it is often true of their details. Most listeners will probably identify Don Quixote's tilting at windmills with the passage in which Strauss uses a stage windmachine; but this represents a later adventure in which Don Quixote and Sancho are seated blindfoid on wooden horses and are persuaded that they are flying on winged steeds through the air. Strauss's music, however, does not really depend on this sort of thing at all. His earliest symphonic poems are masterpieces of new form and movement: *Don Quixote* is sectional only because its subject lends itself to an episodic treatment which Strauss has as much right as Humpty Dumpty to call variations, and in it, no less than in *Also sprach Zerathustra, Ein Heldenleben,* the *Sinfonia Domestica* and their aftermath the *Alpensinfonie,* single designs are triumphantly accomplished in music of Wagnerian continuity. It is not necessary that the designs should be perfect. Uncles and aunts may interrupt it to say that the baby is the image of its dada or mamma; and the wickedness of critics may devastate pages of the music of the hero who gave them their opportunity when he paused on a dominant chord to look round for applause; but local defects do not annihilate fundamental qualities.

Caricature. — One thread remains to be gathered into this account. Caricature is a rare and dangerous element in music, but it is as old as Orlando di Lasso. Mozart, besides the subtleties of *Cosi fan tutte* and the comic parts of *Die Zauberflöte,* produced in his *Musikalischer Spass,* a burlesque of village players and bad composers. On paper the work is a delicious study in the psychology of "howlers," and in its finale Mozart idealises all the nightmare stagnation of the composer whose *tempo* gets faster and faster while his phrasing gets slower and slower. In performance the effect is even more surprising than analysis would lead the reader to expect. But the Leipzig editors of the parts have crowned Mozart's farce by correcting the mistakes!

Caricature enters prominently into Strauss's *Till Eulenspiegel, Don Quixofe* and *Ein Heldenleben;* and also into many passages in Mahler's symphonies. Its danger is that it often opens these composers to suspicion when they intend to be touchingly simple.

But nothing is more vexatious than the laying down of *a priori* limits to what is legitimate for artists. If sermons in the mind of the painter help him to paint, and pictures in the mind of the composer help him to compose, by all means let them get on with the work. (D. F. T.)

PROGRESSIVE EDUCATION MOVEMENT, THE (in Europe called New Education) is the 20th century expression of new ideas inherited from Comenius, Rousseau, Pestalozzi and Froebel. Progressive leaders sprang up in both America and Europe simultaneously but independently at the end of the 19th century. In Chicago, Ill., Col. Francis W. Parker and Prof. John Dewey, each for himself, began teaching and practising the philosophy of education which forms the intellectual basis of the movement. In Europe three men inaugurated the movement in their respective countries: Cecil Reddie in England, 1889, Herman Lietz in Germany, 1898, Edmond Demolins in France, 1898. In the United States the Progressive Education Association and in Europe the New Education Fellowship have for ten years led the movement and promulgated its underlying ideals. Progressivism with its new spiritual element, its discontent with traditional practices, and its vision of a finer procedure, has notably affected American education, both private and public, from nursery school to university. The leaders of the movement advocate, and put into practice, the following beliefs: (1) education at any age should be a natural growth involving experiences — physical, mental, moral, social and spiritual — adapted to the age, health, interests and abilities of each pupil; (2) genuine education develops, not through imposed formal learning from books and lectures, but only through self-directed, spontaneous activities, preferably pursued in group situations; (3) interest aroused in an atmosphere of freedom is the proper incentive to effort, not the external compulsions of authority, penalties and rewards; (4) the finest education is that which through inspiration and opportunity stimulates and releases native power, resulting in original thinking, action or creation; and (5) educational processes, like processes of growth, involve continuing change and are subject to improvement through experimentation.

Four influences have contributed vigour to the movement: (1) the needs created by recent social-economic developments; (2) the rise of the human sciences — biology, physiology, psychology and psychiatry; (3) the challenge of democracy and individualism to the authoritarian traditions of mass education; and (4) the extension of altruistic idealism to include childhood and youth. (M. S.)

BIBLIOGRAPHY.—John Dewey, *Interest and Effort in Education* (1913), *School and Society* (1915) and *Schools of Tomorrow* (1915); Edward Yeomans, *Shackled Youth* (1921); Gertrude Hartman, *The Child and His School* (1922); Eugene R. Smith, *Education Moves Ahead* (1924); Bertrand Russell, *Education and the Good Life* (1926); Wm. H. Kilpatrick, *Education for a Changing Civilization* (1927); Stanwood Cobb, *The New Leaven* (1928); John Dewey, *Democracy and Education.*

PROGRESSIVE PARTY. The title Progressive party has been taken twice in the Cnited States by third-party movements, first in the presidential campaign of 1912 and again in 1924.

The Progressive party movement of 1912 was heralded by the "insurgent" outbreak among Republican members of Congress in 1910, which succeeded in reducing considerably the powers of the speaker of the House of Representatives. Opposition to the administration of Taft, then President, took concrete form early in 1911 when the National Progressive Republican League was organised under the leadership of Senator R. M. La Follette of Wisconsin. During the following year, however, Theodore Roosevelt placed himself at the head of the Progressive movement. Alleging unfair tactics on the part of the "Old Guard," his followers left the Republican national convention held in Chicago (June 1912), and Roosevelt was nominated for the presidency by a Progressive national convention also held in Chicago early in August of the same year. As a result the Republican party was hopelessly split, Roosevelt receiving a popular vote exceeding that of Taft by more than 600,000. Woodrow Wilson, Democratic candidate, was successful, obtaining the electoral vote of all except eight states.

In 1916 harmony was restored in the Republican party. Roosevelt declined a second Progressive nomination and supported the Republican ticket. During World War I partisanship was in abeyance, but upon its termination the old rift soon reappeared. The administration of Harding encountered increasing agrarian dissatisfaction, and this was true also of the first portion of the Coolidge administration. In 1924 the contingent from Wisconsin and neighbouring states, after sitting in the Republican convention at Cleveland, held a conference for progressive political action, made up chiefly of farmer, labour and socialist delegates. Senator R. M. La Follette was nominated for the presidency, and later Senator B. K. Wheeler of Montana for the vice-presidency. The platform promised a complete house cleaning in the executive departments, public control of national resources, public ownership of railways, tariff and tax reduction, agricultural relief, labour legislation, public referendums on peace and war, direct nomination and election of the president, extension of the initiative and referendum to the federal government, election of federal judges and a constitutional amendment providing that congress may by re-enacting a statute make it override a judicial veto. Republican strategy during the campaign of 1924 consisted largely in denouncing the alleged ultra-radicalism of the La Follette platform, particularly the planks concerning the judiciary, meanwhile for the most part ignoring Democratic attacks. This strategy was completely successful, Coolidge receiving an enormous majority both of the popular vote and in the electoral college. La Follette carried only his own state, but polled almost a sixth of the popular vote. No effort was made to continue the organization after the campaign. (See UNITED STATES: Hisfory.)

See B. P. DeWitt, *The Progressive Movement* (1915); F. E. Haynes, *Third Party Movements Since the Civil War* (Iowa, 1916); F. E. Haynes, *Social Polttics in the United States* (Boston, 1924); E. E. Robinson, *Evolution of American Political Parties* (1924); E. M. Sait, *American Politics and Elections* (1927); and H. R. Bruce, *American Parties and Politics* (1927). (R. C. B.)

PROHIBITION is a method for the legal regulation of the manufacture, sale and transportation of alcoholic beverages. It has such extensive and varied applications as to make its other uses in legal terminology of minor importance. National prohibition was adopted in the U.S.A. by the ratification of the 18th amendment to the constitution, Jan. 16, 1919, effective one year thereafter, and repealed by the ratification of the 21st amendment, Dec. 5, 1933. Both amendments were adopted by large majorities only after full and free discussion, with determined and well-directed opposition, and neither can truthfully be said to have been "put over" by a fanatical minority or selfish economic interest.

National prohibition was the logical result of nearly 100 years' experience with state and local prohibition. It was not adopted without due appreciation of the difficulties it would encounter, nor until other expedients were tried to avoid the necessity of this experiment. Some of these expedients and the legislative background of national prohibition and its repeal are more fully discussed in the article LIQUOR LAWS AND LIQUOR CONTROL (*q.v.*). Well-considered public opinion, pro and con, with respect to prohibition, cut deeper across the lines of political parties, rural and urban life, churches and families than any other question of the generation in which the 14 years 1920–33 fell. Its application on a national scale over an area so large as the U.S.A., and to a population living under such diverse racial and climatic conditions, made it by common consent the greatest social experiment of modern times.

Local Option and State Prohibition. — Local option started in Maine (P.A. 1829, c. 133), Indiana (L. 1832, c. 170) and Georgia (A. 1833, 125) in the first third of the 19th century, and state prohibition in Maine in 1851. Most local option statutes permitted the electorate in local political units, usually counties, but sometimes cities, villages, towns and even districts of a city, to vote "yes" or "no" on licences to sell "on" or "off" the premises for a limited period, usually one or two years. Some statutes embodied the local option principle by requiring a licence applicant to get the approval of a majority or two-thirds of the voters in the area to which the licence applies; or providing that no licence be issued, if a majority petitioned for its refusal. Other variations of local option were tried. Thus Arkansas (Digest Stat., 1884, par. 4515) had prohibition with a "licence" local option, and Iowa had prohibition for a time with selling permitted under the mulct law, Code (1897) par. 2448. (*Cf.* Clark Byse, "Alcoholic Beverage Control Before Repeal" [in "Alcoholic Beverage Control" (1940)], *Law and* Confemporary Problems, vol. vii, No. 4, Duke University Law School.)

Licensing systems date back to colonial times. Combined with local option they furnish for the U.S.A., in the light of its experience with both state and national prohibition, the best hope for the possible effective application of the principle of prohibition. A properly drafted high licence statute with local option for prohibition in well-defined areas, or a prohibition statute with local option for licence in carefully planned areas, would go far to remove the majority of the social evils of the liquor traffic without resort to absolute prohibition. State licence systems in the absence of similar legislation by congress have been upheld by the U.S. supreme court as a constitutional exercise of the state police power. (Cf. *The License Cases,* 46 U.S., 5 How., 504, 1847).

State prohibition stems from the development of the temperance movement of the second quarter of the 19th century. In the first quarter that movement was primarily individualistic. The thousands of temperance societies in the northern states, most of them in New England, resulted from a great religious revival and their efforts centred in personal regeneration and what the individual could do for himself. Its progress though encouraging was too slow to stem the rising tide of liquor consumption and its disastrous social consequences. The next logical step was to federate the temperance societies in strong state and national associations and exert political power to regulate or prohibit the production and sale of intoxicating beverages. The greater and more influential national organizations like the Woman's Christian Temperance Union (W.C.T.U.), the National Temperance society, the Total Abstinence brotherhood (T.A.B.), the National Prohibition party and others took up the cudgels after the Civil War; and the Anti-Saloon league with its powerful state and national organization, in the closing years of the century.

The continuous agitation of the temperance societies resulted in "limited" state-wide prohibition by an Indiana statute (1816) making sale of liquor on Sunday illegal, and the "15 gallon" law in Massachusetts (L. 1838 c. 157) prohibiting sale of "less than 15 gallons of spiritous liquor or mixed liquor part of which is spiritous (except for medicinal and mechanical uses) to be delivered and carried away at one time." This apparently accomplished little and was repealed in 1840. The first absolute state prohibition law, due to Neal Dow, organizer of the Maine Temperance Union, was an act "to restrict the sale of intoxicating drinks," approved Aug. 7, 1846. It was too weak in many of its provisions to be effective but was strengthened by the act "for the suppression of drinking houses and tippling shops" approved June 2, 1851. This act repealed all but 13 sections, those containing certain enforcement provisions, of the 1846 statute. The Maine law of 1851 remained substantially unchanged for 70 years and became the model in the next decade for no less than 13 state-wide prohibition laws. But by 1863 in all but five of these states the statutes were repealed or invalidated by state supreme court decisions.

(*Cf.* Ernest A. Grant, "The Liquor Traffic before the Eighteenth Amendment," in *Annals,* vol. 163, Sept. 1932.)

The second stage of organized effort for state prohibition was an outgrowth of reconstruction following the Civil War. It began with the organization of the National Prohibition party in 1869 at Chicago, and the Woman's Christian Temperance Union (1874); marked the return of sbme states that had tried prohibition in the first period and had given it up; and reached its zenith in the decade 1880–90. Eight states enlisted but only three remained by 1904.

The third and last stage of state prohibition before national prohibition was tried covers the first two decades of the 20th century, was largely due to southern and western rather than New

England forces, and was led by the Anti-Saloon League of America (1895) and the state anti-saloon leagues. Thus when national prohibition went into effect (Jan. 1920) state-wide prohibition under state laws was already in effect in 33 states (more than two-thirds of all the states), and in 18 of them by constitutional amendment adopted or ratified by referendum election. In addition Alaska, Puerto Rico, the District of Columbia and Hawaii were included in 1917–19 in the prohibition area. Ninety per cent of the townships and rural precincts, 85% of the counties and more than 75% of the villages of the United States were under prohibition by state legislation. Two-thirds of the members of the senate and house of representatives came from states or districts having state prohibition which together with local option had put 63.3% of the population and 95.4% of the land area under prohibition. These statistics and similar ones for local option alone may be misleading unless cautiously interpreted as to their real significance, as later experience with national prohibition amply demonstrated. They are not an exact measure of the dryness of a community because often they do not mean a desire to be rid of liquor altogether but only the ugly aspects of the saloon and the liquor traffic in a residential neighbourhood so long as ample supplies may be had from near-by wet areas. Many communities find the ubiquitous bootlegger the lesser evil, and "near-by" has been greatly extended by improved transportation facilities, roads and automobiles. (Cf. The *Local Option Fallacy,* Distilled Spirits Inst., Washington, D.C., rev. ed., Oct. 1942, p. 32; Raymond B. Fosdick and Scott, *Toward Liquor Control,* pp. 22–27.)

Federal Aid to State and Local Prohibition.—It has been said that "liquor consumption did not decrease during the period when the state-wide prohibition movement was strongest" (C. Byse, *op. cit.,* p. 561). The statistical support for such a statement is far from conclusive. Such evidence as does exist, like that regarding local option and state prohibition, must be examined with caution, and deductions and implications made with reserve. If per capita consumption of spirits, wine and beer be combined and some allowance be made for mounting illegal consumption in the years when state prohibition was strongest, possibly a fairly tenable case can be made for the assertion just quoted. but the implied charge that this is the measure of the so-called breakdown of state prohibition is far from true. The cost and difficulties of enforcement, and the protection of dry areas from the inroads alike of the liquor traffic and bootleggers from bases in near-by wet areas were objects of greater concern to the supporters of prohibition.

The states first sought in various ways to protect their dry areas by their own powers. For example, Texas in 1910 made the sale of liquors in no-licence territory a felony. All tried to check the flow of liquor having the constitutional protection of interstate commerce over which the federal government had exclusive jurisdiction. For 43 years the U.S. supreme court followed the rule laid down in the celebrated License Cases (46 U.S., 5 How., 504, 590, 1847) that state legislation could prohibit the sale of liquor without a licence even if imported in the original barrel brought in by interstate commerce. This reversed a ruling in 1827 that held a state law unconstitutional which imposed a licence tax on an importer of liquor. But the still more celebrated Original Package case in 1890 practically reversed the 1847 rule by holding that a state could not prohibit a liquor dealer from importing liquor in interstate commerce for resale in original packages (135 U.S. 100, *Leisy* v. *Hardin*). This nullified state prohibition and congress at once sought by the Wilson act (26 Stat. 313, 1890) "to divest intoxicating liquors of their interstate character" by providing that "liquors transported into a state . . . shall . . . upon arrival in such state . . . be subject to the operation and effect of the laws of such state enacted in the exercise of its police powers, to the same extent . . . as though such . . . liquors had been produced in such state." While this act presented grave constitutional difficulties, the supreme court upheld it in *In re Rahrer* in 1891 (140 U.S. 545), but in a later case (*Rhodes* v. *Iowa,* 170 U.S. 412, 1898) the court construed the word "arrival" to mean delivery to the consignee and not merely arrival in the state. So the mail-order business, skilful advertising and travelling salesmen still made the evasion of prohibition easy. The U.S. supreme court did try to help the states to find their own remedy, by upholding (1) a Missouri statute which imposed an inspection fee on all liquors shipped from other states into Missouri and offered for sale (190 U.S. 17, 1905), and (2) a South Dakota statute putting an annual licence charge on the business of soliciting orders to be filled from liquors at the time outside the state (*Delameter* v. *South Dakota,* 205 U.S. 93, 1907). In some other cases, however, the Wilson act was further emasculated, by refusing the state the right to prohibit C.O.D. shipments of liquor (*Adams Express Co.* v. *Kentucky,* 206 U.S. 129, 1907), and by not permitting a state to compel a resident-consignee to certify to a state official the quantity and kind of liquor to be imported, or a nonresident-consignor to attach a certificate to the package (*Vance* v. *Vandercock,* 170 U.S. 438, 1898).

The Webb-Kenyon Act.—Passed March 1913, over President William Howard Taft's veto, "An Act divesting intoxicating liquors of their interstate character in certain cases" (37 Stat. 699) was the most aggressive step that congress and the federal government had taken to aid state prohibition. Broader than the Wilson act which merely sought to remove the bar of the original package decision, it was intended to remove the federal protection which liquor enjoyed as an article of interstate commerce. It forbade the transportation of intoxicating liquors into a state by any persons interested therein "to be received, possessed, sold or in any manner used either in the original package or otherwise, in violation of any law of such state." Notwithstanding President Taft's own opinion, and that of his attorney-general, and able lawyers in the senate who advised him, to the effect that the act was unconstitutional, the supreme court sustained it in the Clark Distilling Co. cases, decided Jan. 8, 1917 (242 U.S. 311). This was further strengthened by the adoption of the Reed "bone-dry" amendment to the P.O. Appropriation act of March 3, 1917 (39 Stat. 1069, c. 162) which sought to eliminate completely the illegal mail-order liquor traffic.

The Webb-Kenyon law at first stimulated state prohibition. In 1914 state constitutional amendments were adopted by popular vote and substantial majorities in Arizona, Colorado and Oregon, but rejected by substantial majorities in California and Ohio. Statutory prohibition was adopted in Washington on an initiative measure by 18,632 majority, and in Virginia by a majority of 30,365 in 150,000 votes cast. Congress for the first time adopted in this year a resolution in one house by a majority vote (193–189), but it did not obtain the requisite two-thirds required for the submission of a prohibition amendment to the federal constitution. Considerable extension of dry territory under local option votes was secured in many other states. In 1915 Alabama re-enacted a prohibition law adopted in 1907 but repealed in 1911; and Idaho, Iowa. Arkansas and South Carolina adopted state prohibition statutes. Idaho also submitted to the people a constitutional amendment to the state constitution which was adopted the following year. The year 1916 also recorded the adoption of constitutional state prohibition in Michigan, Montana, Nebraska and South Dakota.

In 1917 the resolution for the submission of the prohibition amendment to the federal constitution received the necessary two-thirds vote in congress which also enacted prohibition for the District of Columbia and the territory of Alaska. A referendum on prohibition was voted on in Puerto Rico in July and adopted by 99,774 votes for prohibition to 61,295 against. Indiana, New Hampshire and Utah adopted state-wide prohibition statutes, and New Mexico, a state constitutional amendment. Minnesota voted also for a constitutional amendment by a majority of 15,932 of all the votes cast, but this was 756 short of the majority the state constitution required for its adoption. Missouri and California defeated constitutional amendments by substantial majorities. By the end of this year before the federal amendment was submitted for ratification, statutory or constitutional prohibition mas the law in 25 of the 48 states, and in the District of Columbia, Alaska and Puerto Rico. In nearly every state in one way or another dry territory had been greatly extended.

In 1918, while ratification was proceeding, Florida, Nevada, Ohio, Texas and Wyoming adopted state-wide prohibition statutes, and Utah a prohibition amendment to its state constitution. Congress enacted a prohibition statute for Hawaii, and passed the War Prohibition act as an amendment to the agricultural appropriation bill. Several states adopted constitutional prohibition amendments in 1919.

The 18th Amendment.—The text of the amendment ratified Jan. 16, 1919, by the 36th state making the necessary three-fourths of all the states required for its adoption is as follows:

> "Section 1. After one year from the ratification of this article the manufacture, sale, or transportation of intoxicating liquors within, the importation thereof into, or the exportation thereof from the United States and all territory subject to the jurisdiction thereof for beverage purposes is hereby prohibited.
>
> "Section 2. The Congress and the several States shall have concurrent power to enforce this article by appropriate legislation.
>
> "Section 3. This article shall be inoperative unless it shall have been ratified as an amendment to the Constitution by the Legislatures of the several States, as provided in the Constitution, within seven pears from the date of the submission hereof to the States by the Congress."

The amendment as ratified and proclaimed in effect on Jan. 16, 1920, was subsequently ratified by ten additional states, and in six of these (South Dakota, Idaho, Washington, Kansas, Utah and Wyoming) by unanimous vote in both houses of the legislature. Only two states (Connecticut and Rhode Island) did not ratify it. Dr. Ernest H. Cherrington in an article entitled "World Wide Progress Toward Prohibition Legislation" *(Annals,* vol. 109, p. 223, Sept. 1923) says: "No amendment to the Federal Constitution ever received as strong official sanction by the States as the 18th amendment. The original Constitution was adopted in the thirteen original States by a majority of about two to one. The aggregate vote in the State senates and State houses of representatives for the ratification of the 18th amendment shows a majority of more than four to one."

Forty-seven states enacted laws to help carry into effect the provisions of the 18th amendment, though one such law in Nevada was held unconstitutional because of a defect in title. New York, Montana and Wisconsin repealed their enforcement statutes by the end of 1929, but until then the great mass of state legislation tended to strengthen state efforts to enforce prohibition. In the next five years, however, by the end of 1934, all but nine states had voted to repeal their statutory or constitutional prohibition measures, or both, or they had enacted liquor control of the state monopoly or licence type, sometimes with local option for limited prohibition. After the repeal of the 18th amendment by the ratification of the 21st amendment, effective as of Dec. 5, 1933, and the repeal of the prohibition provisions of the Volstead act in Aug. 1935, there were only three states left (Kansas, Mississippi and Oklahoma) in 1942 with state-wide statutory prohibition.

THE ERA OF NATIONAL PROHIBITION

These 14 Years.—From Jan. 16, 1920, to Dec. 5, 1933, is 14 years lacking a few weeks, a short period in the life of a nation, but a momentous one in the social history of the American people. Not since the slavery issue of the middle years of the 19th century has any question been so widely debated, so bitterly contested or pursued with so much determination and idealism as national prohibition by the people of the United States. It came with surprising suddenness, yet the way had been prepared for over 100 years. The new techniques and devices of a greater variety of governmental agencies employed today in the work of liquor control, rather than prohibition, and a new reliance on scientific research for guidance on the complex problems of alcohol, as exemplified by the Research Council on Problems of Alcohol, of the American Association for the Advancement of Science, and as now carried on by temperance and educational organizations everywhere, and even by agencies of the liquor traffic itself, such as Distilled Spirits Institute, Inc.—these and other similar forces give some assurance that the "experiment noble in motive" of national prohibition may not have been in vain.

The Background Influences.—A sufficient indication of the long-time trends in prohibition legislation in state and nation has already been given lo account in part for the tidal wave of demand for action on a national scale. Social and economic factors played perhaps as great if not a more important role than the more noticeable moral, religious and political influences organized with increasing effectiveness. New scientific knowledge in the early years of the 20th century caused a mounting public interest in health and efficiency, and the new industrial economics of expanding large-scale produrtion brought increasing support, both moral and financial, to every effort to curb the liquor traffic and reduce the ravages of alcohol. New educational forces at work viewed with growing disfavour the saloon as the so-called poor man's club, and finally there was manifest everywhere increasing irritation with the saloon as a political menace.

World War I was not the cause of the demand for national prohibition though it probably did accelerate it. The absent soldier vote if cast at the time would not have made any substantial change in the decisions reached at the polls. As soon as the United States entered the war, two economic factors—the fear of the loss of manpower on account of intemperance, and the loss of food used in the manufacture of alcohol but needed to supply the army of the United States and that of its allies—served to crystallize an overwhelming sentiment in favour of permanent constitutional prohibition as well as war prohibition. The War Prohibition act of Nov. 1918, an amendment to the Agricultural Appropriation bill, enacted ten days after the Armistice was signed, did not go into effect until June 30, 1919, six months after the ratification of the 18th amendment, but it set a standard until the end of demobilization. It forbade the use of grain, cereals, fruit or other food products in the manufacture or production of beer, wine or other intoxicating malt or vinous liquor for beverage purposes, and made it unlawful to sell for any beverage purposes any such product or any distilled spirits from bond except for export. Such acts, together with earlier congressional enactments such as the Food Control act of Aug. 1917 and the act restricting or prohibiting the sale of liquor at military stations or to members of the military forces in uniform, or in or near military camps, all had a markecl effect in support of national prohibition.

The Volstead Act.—The National Prohibition act (41 Stat. 305), popularly known as the Volstead act, and sometimes referred to as the Prohibition Enforcement law, passed the house of representatives. July 22, 1919, by a vote of 287 to 100, three members voting "present." It passed the senate with slight amendments and without a roll call on Sept. 4, 1919. The conference report was adopted in the senate. Oct. 8, without roll call or record vote, and in the house by a vote of 321 to yo on Oct. 10. It then went to President Woodrow Wilson who vetoed it, and returned it Oct. 27. The house on the same day, by a vote of 176 to 55, passed it over the president's veto, and the senate did likewise the next day by a vote of 65 to 20. Therefore on Oct. 28, 1919, this measure became law applicable by its terms immediately for the enforcement of the War Prohibition act, and "when the 18th amendment to the Constitution goes into effect," intended to carry out the purposes of that amendment. The act is notable for its definitions, including the fixing of ½ of 1% of alcohol by volume as the test of intoxicating liquor, and the delegation of power to the commissioner of internal revenue to make regulations, with the approval of the secretary of the treasury, having the force of law, for carrying out the provisions of the act. The ½ of 1% definition was not new. It was in use in many state prohibition laws and had been the standard since 1902 for internal revenue taxation.

The constitutional validity of the adoption of the 18th amendment, and the constitutionality of the Volstead act with its definition of intoxicating liquor were tested in the U.S. supreme court and promptly sustained in the leading cases of *Hawke* v. *Smith,* decided June 1, 1920 (zj3 U.S. 221), and Rhode *Island* v. *Palmer,* decided June 7, 1920 (253 U.S. 350), in which the court disposed of several cases pending. Prohibition as embodied in the 18th amendment was held within the amending power, a part of the constitution, and "must be respected and given effect the same as other provisions of that instrument," and was "operative throughout the entire territorial limits of the United States . . . [and] of its own force invalidates every legislative act, whether by Congress, by a state legislature, or by a territorial assembly, which authorizes or sanctions what the [first] section forbids." The court had previously sustained the War Prohibition act and the ½ of 1% limit which it specified. The liquor interests hoped for greater latitude by construction of the first section of the 18th amendment which did not specify the content or define intoxicating liquor. The court, however, without stating or discussing this contention, cited the war prohibition cases in support of the conclusion that while "recognizing that there are limits beyond which Congress cannot go in treating beverages as within its power of enforcement, we think those limits are not transcended by the provisions of the Volstead Act."

THE WORKING OF THE NATIONAL PROHIBITION ACTS

Enforcement.—The Volstead act provided for drastic enforcement, and was intended to give the government ample powers, through the commissioner of internal revenue of the treasury department, to detect and suppress all manner of violations. Congress was at liberty to amend these administrative features and set up any agency of enforcement it chose. It did in fact put the prohibition unit of the treasury under a new assistant secretary, and by the act of March 3, 1927, created a bureau of prohibition in the treasury department with a commissioner of prohibition responsible directly to the secretary of the treasury.

The Supplemental Prohibition Enforcement act of Nov. 23, 1921, (42 Stat. 222) made the already drastic regulations for physicians' prescriptions, and for sacramental wine, more so. It provided that only spirituous or vinous liquor, the latter containing not more than 24% of alcohol by volume, could be prescribed, and that not more than ¼ gal. of vinous liquor nor any quantity of liquor containing more than ½ pt. of alcohol could be prescribed for the use of any one person within 10 days, and that no physician might have more than 100 permits within 90 days unless to meet emergency needs, to be demonstrated to the satisfaction of the commissioner who issues such permits. These restrictions on physicians' prescriptions were upheld as constitutional by the supreme court in *Lambert* v. *Yellowley* (272 U.S. 581). Other provisions of the Supplemental act gave the enforcing authorities control over importations for non-beverage purposes; provided that both the Supplemental and the National Prohibition acts applied not only to the United States but to all territory subject to its jurisdiction; that liquor laws in force when the National Prohibition act mas adopted, and not in conflict therewith, should continue in force; and also made it unlawful for any U.S. officer to search any private dwelling without a search warrant. The court, however, in 192; in *Carroll* v. *U.S.* (267 U.S. 132) upheld the search of an automobile or vehicle of transportation without a warrant where the search was not malicious or without probable cause. A Georgia statute which prohibited the possession of liquor which had been legally acquired before national prohibition went into effect was upheld as within the police power of the state, in another supreme court decision, *Samuels* v. *McCurdy* (69 L. ed. 371). The department of justice approved the wider use of the padlock and abatement of nuisance provisions of sec. 22 and other sections of the National Prohibition act. The methods employed in the enforcement of prohibition, as in the case of tariff and revenue laws generally, and in other laws where there is a strong motive to defeat their purpose, raise many nice questions of constitutional guarantees of liberty and the protection of innocent persons, but the supreme court decisions throughout the prohibition era went far to sustain the government and congress in the exercise of the fullest constitutional powers to enforce prohibition.

The Concurrent Power.—The second section of the 18th amendment clearly indicates by the grant of concurrent power "to congress and the several states" the joint duty and responsibility of the national and state governments to enforce prohibition through co-operation and each government performing that part of the task for which it was peculiarly fitted. In *Rhode Island* v. *Palmer* (253 U.S. 350) the court defined and interpreted "concurrent power" as the power to enforce prohibition by appropriate legislation, but not to enable congress or the several states to defeat or thwart it; that it is not joint power requiring that the legislation thereunder by congress to be effective should be approved or sanctioned by the several states or any of them; neither does it mean that the power to enforce is divided between congress and the several states along the lines which separate or distinguish foreign and interstate commerce from intrastate affairs. The court also added that concurrent power, "while not exclusive, is territorially co-extensive with the prohibition of the first section of the amendment, embraces manufacture and other intrastate transactions as well as importation, exportation and interstate traffic, and is in no wise dependent on or affected by action or inaction on the part of the several states or any of them."

As thus construed the concurrent power section of the amendment reserved to the states their police power over intoxicating liquors, with the single limitation that they could not exercise it to permit what the amendment prohibits. The former policy of strengthening the police power of the state by removing constitutional barriers was now changed to one of co-operation in which the states and the federal government had equal responsibility and power. It was not a grant of any new police power to the states, but an enlargement of the police power they possessed, by extending concurrent power to interstate commerce and to importation and exportation of intoxicating liquors. Neither did concurrent power impose any new obligation on the states, but merely emphasized an old one, as Governor Alfred E. Smith noted as follows: "After repeal there will still rest upon the peace officers of this State the sacred responsibility of sustaining the Volstead Act with as much force and as much vigor as they would enforce any State law or local ordinance" (memo accompanying his approval in 1923 of the repeal of the N.Y. Prohibition law).

If the plain intent and ideal of sec. 2, as interpreted by the U.S. supreme court, had been realized more fully, enforcement would not have broken down so soon nor would have come the demand for repeal with overwhelming force in 1933. The states, however, with few exceptions, refused to co-operate whole-heartedly; and partly on account of old conflicts under the federal-state system, but chiefly because of practical politics and partisan advantage, by so doing sealed the doom of the 18th amendment.

Administrative Difficulties.—The chief obstacles to efficient enforcement did not come from the courts, but rather from administrative difficulties arising from untrained and incompetent personnel, and the lack of enforcement machinery, or its location in several departments of the government. The failure at the outset to put all enforcement officers under civil service caused increasing trouble. Some conflict and overlapping in the efforts of the treasury and the department of justice led the judicial conference of the senior circuit judges, with the concurrence of Chief Justice William Howard Taft, to recommend in Nov. 1924 that the prohibition unit of the treasury be transferred bodily to the department of justice, and that all appropriations for enforcement be expended under the attorney-general. It was thought that a closer co-ordination of the experience and technique of the treasury department with prosecutions by the department of justice would avoid the prosecution of trivial, futile and unimportant cases which crowded the dockets, and would enable district attorneys better to prepare those cases which would really deter the principal offenders. Partly because of the nature of the proceedings in federal courts requiring jury trial, and partly due to the absence of federal police courts to dispose of petty cases, "the resources of the federal government in administration and judicial machinery were sufficient to cope successfully only with what might be called the 'wholesale' aspects of the enforcement problem—smuggling, including report of arrests, seizures, etc., made by federal prohibition officers, the withdrawals of bonded liquors, the diversion and conversion of industrial alcohol to beverage uses, interstate transportation of liquors and the major conspiracies to violate the law, some of which are of giant proportions" (*see* BOOTLEGGING AND SMUGGLING). For the rest, state and local machinery would have to be relied upon to enforce the law.

In response to these and many other suggestions, and to bring the problems of prohibition enforcement more directly under the eye of the secretary of the treasury and the president, congress reorganized the prohibition unit, and created by act of March 3, 1927, a bureau of customs and a bureau of prohibition in the department of the treasury. This was recommended by the secretary of the treasury and centralized responsibility for enforcement of prohibition in a commissioner directly responsible to the secretary of the treasury. It provided for the appointment of a staff under the commissioner, subject to the provisions of the civil service law. In the opinion of the commissioner the civil service requirement did bring about a marked improvement in personnel, and enabled the new bureau to continue more effectively the policy previously followed, namely, decentralization of the prohibition service, and concentration upon the things that federal enforcement could do best, whether the state and local authorities did their part or not.

Treaties to check liquor smuggling were negotiated with Great Britain in Jan. 1924 (ratified and proclaimed, May 22, 1924) and the principal countries of Europe, and Canada, Cuba, Panama and Mexico. These treaties embodied the so-called 12-mile limit, or one-hour run, for boarding and examination of private vessels under foreign flags. They were liberally construed by the U.S. supreme court. (*See* SMUGGLING.)

The major effort in the reorganization of prohibition enforcement was the Prohibition Reorganization act of May 27, 1930 (Pub. No. 273, 71st Cong.). This act, effective from July 1, 1930, established the bureau of prohibition in the department of justice, and the bureau of industrial alcohol in the treasury department. They were previously a single bureau in the treasury department. It was a functional change which greatly accelerated improved enforcement of the prohibition laws, but it came too late to repair the public's shattered confidence in the enforcement agencies, either federal, state or local. Albert E. Sawyer, technical expert of the National Commission on Law Observance and Enforcement, thought that there were losses as well as gains in the reorganization, and that "the undeniable improvement in the effectiveness of prohibition work since the transfer may be the direct result of the aggressiveness which has characterized the attorney-general and his assistants." (For chart and excellent discussion, *see* "The Enforcement of National Prohibition," *Annals*, vol. 163, Sept. 1932, pp. 10–29.)

National Commission on Law Observance and Enforcement.—President Herbert Hoover appointed May 20, 1929, a commission of 11 eminent citizens including one woman, the president of Radcliffe college, to make "a thorough inquiry into the problem of the enforcement of prohibition under the provisions of the 18th amendment of the constitution and laws enacted in pursuance thereof, together with the enforcement of other laws." Eight days later the commission with George W. Wickersham as chairman met at the White House and President Hoover emphasized that he wanted a broad inquiry dealing not only with one law or the laws of the federal and state governments separately, but with the enforcement of, obedience to, and attitude toward all law.

The commission performed its task ably, thoroughly and with commendable speed. Through public hearings in various parts of the country, by special studies of experts engaged by the commission, it assembled from both official and unofficial sources much valuable data not previously available in consolidated form. A preliminary report was submitted in Nov. 1929, and a supplementary report in Jan. 1930. Both dealt chiefly with legal and constitutional questions of procedure in law enforcement. The president sent both reports to congress on Jan. 13, 1930, with a message, accompanied by memoranda from the attorney-general and the secretary of the treasury, endorsing recommendations for more centralization of administrative responsibility for enforcement, more courts and better judicial and prosecuting procedure (H.R.Doc. No. 252, 71st Cong., 2nd Sess.). Congress and the public alike, however, awaited the appearance of the major report on the larger issues involved. This appeared a year later with the title: "A Report on the Enforcement of the Prohibition Laws of the United States," and was sent to congress with a message from the president on Jan. 7, 1931 (H.R.Doc. No. 722, 71st Cong., 3rd Sess.). After a time several volumes of documents and evidence followed.

Thus the commission under pressure for too great speed in making a full report had not quite achieved the larger purposes for which it was organized. It was courageous in its exposé of the weakness of the first seven years of what it called "imperfect enforcement," and sparing in its praise of the improvement of the three years of reorganization. The lack of a master plan, of skilful leadership, of proper co-operation and a united front between such important key agencies as the customs, coast guard, and prohibition bureau, and even the activities of the pressure groups and political forces, pro and con enforcement, are dealt with frankly and fearlessly, and if the report could have been issued five years earlier might have built up normal support of public opinion for normal observance of the prohibition laws. But in 1930 it was too late to expect that, and the commission seemed to think that some modification of the prohibition policy was necessary to restore public confidence in the enforcement agencies of government, either federal, state or local. Yet five of the nine major recommendations and conclusions of the report were squarely opposed to repeal of the 18th amendment; the restoration in any manner of the legalized saloon; the modification of the N.P. act to permit light wines and beers; authorizing federal or state governments to go into the liquor business; inadequate co-operation of the states. Condensed and authoritative statements and interpretation of the commission's report by its chairman, and chief technician, will be found: (1) *Amer. Bar Ass'n Jour.*, vol. 16, Oct. 1930, pp. 654, 660–61 (Wickersham, "Program of the Commission on Law Observance and Enforcement"); (2) two articles by A. E. Sawyer, *Michigan Law Review*, vol. xxx, Nov. 1931, and *Annals*, American Academy of Political and Social Science. vol. 163, pp. 10–29, Sept. 1932.

The Economic and Social Results of Prohibition.—Here is the nub of the controversy that raged so violently in the decade preceding repeal of the 18th amendment. That much more heat than light emanated from the millions of spoken and written words on this theme was to be expected. Scientific standards of measurement and scientific data on which to base sound judgment were, for the most part, lacking, even for such items as uniform records of arrests for drunkenness, of law violations, prosecutions, sentences, alcoholic morbidity and mortality, etc., on which the government should have been able to disseminate accurate information. Looking back it is clear that the prohibition "authority" of the federal government, wherever located, did a poor educational job, because in the last analysis it was the social and economic aspects of national prohibition, rather than the moral or legal, that decided the fate of the 18th amendment. In every state of the union there was a middle-of-the-road contingent, which cast perhaps 75% of the vote. It could have been lined up for or against national prohibition on clear-cut statements of fact concerning social and economic consequences of one policy or another.

The report of the Federal Council of Churches *(Research Bulletin No. 5,* p. 83, 1925) is one of the best of the unofficial inquiries and furnishes some significant conclusions based on good scientific handling and sampling of questionnaire testimony of social workers. This shows a preponderant opinion at that time that prohibition had helped secure better furnished homes for working people; better mental health of the home as shown by better family co-operation, respect of children for parents, and of parents for children, and by better educational ideals; also larger proportion of the husband's income going to wife and family, and improved marital relations. Favourable community effects were recorded in this special poll: less children's delinquency; less malnutrition; liquor for minors less accessible. But in contrast the inquiry also showed more drinking by young people, and a worse attitude toward law enforcement and respect for laws in general. The Federal Council report, however, does not support the theory that prohibition had caused a moral breakdown among young people. The report's most conclusive finding is that social legislation is no substitute for social education, and that "the illicit liquor traffic will be finally overcome only when and where education in temperate living strongly reinforces the arm of the law."

Similar reports, not all of them so well documented, appeared from many social agencies, business men's organizations, and civic groups, and some dealt more definitely with the wage-earner's stake in prohibition. Still other reports emanated from organizations and groups opposing prohibition: the Association Against the Prohibition Amendment, Repeal Associates, Women's Organization for National Prohibition Reform, the Moderation League, the Crusaders, etc., presented studies of the new evils, and their social and economic consequences, attendant on the failure to enforce, or as some contended, the unenforceability of national prohibition. Matters emphasized in these reports are: the speakeasy as a substitute for the saloon; the public disregard for all laws; public corruption for protection of illegal traffic; the effect on the administration of justice of overflowing prisons and courts cluttered with prohibition cases; the threat, to social and economic security, of huge revenues from the illegal liquor traffic in the hands of well-organized criminals.

Among the many individual studies of the social and economic consequences of prohibition, typical and well-balanced, are: (1) Prof. Irving Fisher's *Prohibition at Its Worst* (1926) and *Prohibition Still at Its Worst* (1928), and his report to the American Economic Association (1927, *A. E. Review,* xvii, No. 1, suppl. March) which claimed that the country was at least $6,000,000,000 better off as a result of prohibition. (2) Prof. Herman Feldman's *Prohibition: Its Industrial and Economic Aspects* (1927) based on a nine months' personal study of industrial plants, documentary material, and questionnaires sent to 1,200 concerns with over 1,250,000 employees. Feldman finds that "the economic benefits of legal prohibition are based upon substantial prohibition in fact; on the actual abolition of the saloons, or their reduction to a negligible quantity, not on the mere change in name; on a greatly lessened consumption of alcoholic beverages; on a general influence in promoting temperance and discouraging over-indulgence." (3) Dr. Clark Warburton's *Economic Results of Prohibition* (1932), and in briefer form, *Prohibition and Economic Welfare (Annals,* American Academy of Political and Social Science, vol. 163, pp. 89–97, Sept. 1932). This is an able study, but largely negative in its conclusions and results because of the lack of positive statistical evidence and unwillingness to weigh or consider any other kind of evidence. In general, Dr. Warburton concludes that "prohibition had little to do with the prosperity of the Nation from 1923 to 1929 and the increased purchases during those years of many types of luxury and semi-luxury goods."

To this brief statement of very general conclusions from many sources, and in rather sharp contrast to that of Dr. Warburton, just cited, should be added the statement of Secretary of Commerce Herbert Hoover in an address before the U.S. chamber of commerce, as quoted in the *Christian Science Monitor,* March 11, 1925, as follows:

"There can be no doubt of the economic benefits of prohibition. Viewing the temperance question only from this angle, prohibition has proved its case. I think increased temperance over the land is responsible for a good share of the enormously increased efficiency in production, which statistics gathered by the Department of Commerce show to have followed the passage of the dry law. Exhaustive study from many angles of production . . . indicates that while our productivity should have increased about 15% due to increase in population, the actual increase has been from 25% to 30%, indicating an increase of efficiency of somewhere from 10% to 15%. . . . There is no question in my opinion that prohibition is making America more productive."

REPEAL OF THE 18TH AMENDMENT AND THE POST-REPEAL ERA

The revolt against the 18th amendment, and the agitation for its repeal, did not assume serious proportions until the presidential campaign of 1932 when it became a national issue. Conscientious objectors, like Dr. Nicholas Murray Butler, had voiced their protest even before the amendment was ratified. In the Borah-Butler debate in Boston, April 8, 1927, Dr. Butler said:

"The 18th amendment must come out of the Constitution because it does not belong there. It affronts and disfigures it. It contradicts every principle upon which the Constitution rests, and the difficulties, the embarrassments, the shocking scenes reported daily from every part of the land are the natural and necessary result of the inner contradiction that has been set up between the Constitution as it was and the 18th amendment added to it in 1919. . . .

"We talk of law enforcement. You cannot enforce conflicting laws—something must give way; and, when it is the 18th amendment and the legislation based upon it on the one hand and the whole body of the Constitution, the Bill of Rights, the whole of political English and American History on the other, which do you suppose will have to give way? It must be this new and invading element in our public law."

Such was the moral objection which was intelligently and forcibly presented by a sincere small minority. It might have won more sustainers if it had shown greater recognition of the economic facts that underlie public morals, and of the effectiveness of the constitution and the government it set up, to deal with the social problems of modern democracy.

The Modificationists.—They were a second and more numerous group of less conscientious objectors. They wanted more alcohol, "light wines and beer" (or by any other name the people might prefer), than the 18th amendment allowed under the implementing Volstead act, or than the supreme court would sanction if that act were amended to increase the ½ of 1% standard of intoxicating liquor. Hence they advocated repeal of the Volstead act, leaving to the states the enactment of such prohibitory laws as their citizens might desire to implement the 18th amendment within their boundaries and provide varying degrees of dryness or wetness to suit local tastes. Prof. Howard Lee McBain *(Prohibition: Legal and Illegal* [1928]) considered this suggestion and others like it to circumvent the 18th amendment, but his conclusions gave scant encouragement to those who did not want to conform to the dictates and spirit of national prohibition while the 18th amendment remained a part of the constitution.

The political demand for repeal lagged behind the changes taking place in public opinion. In 1928 the national party platforms of both major parties pledged vigorous (Republican) and honest (Democratic) enforcement, but by 1930 the state party platforms in 21 states (14 Democratic and 7 Republican) demanded repeal of the 18th amendment, and in 1932, both national party platforms favoured repeal with safeguards to protect state prohibition territory, or the submission of a proposal to revise in a way to furnish such safeguards.

Supporters of the Experiment.— Opposed to repeal or modification were two groups: (1) the extreme and uncompromising upholders of constitutional prohibition as the only practical method of dealing with the organized liquor traffic and bringing it under social control. In the main the officials of the Anti-Saloon leagues and most of the temperance societies, and such political leaders as Senator Morris Sheppard and Congressman Volstead were spokesmen for this group; (2) a larger group of no less sincere but more moderate prohibitionists who were more keenly alive to the economic foundations and implications of national prohibition. This included such national leaders as Senator William E. Borah, Herbert Hoover and many captains of industry, like Henry Ford, Thomas A. Edison and others. This group favoured a longer trial and a greater effort to secure co-operation of both state and national governments, and enlist the active support of the great mass of law-abiding citizens, before saying that the 18th amendment and its supporting legislation could not be enforced. Many excellent suggestions offered in the W. C. Durant prize contest, Aug. 27–Nov. 30, 1928, "for the best and most practical plan to make the 18th amendment effective," showed conclusively that it was not lack of brains or technical skill on the part of the leaders who would and could have enforced the 18th amendment if they had had the strong support of a favourable public opinion such as caused its adoption. Countersuggestions showing the trend towards and the character of the demand for repeal, will be found in the W. R. Hearst temperance prize contest, Jan.–Apr. 1929, "for the best plan to repeal the 18th amendment and substitute in place of prohibition a more liberal and more American measure," later changed to "the best plan to achieve temperance." For a full account of these contests and the winning plans *see* W. C. Durant, ed., *Law Observance,* p. 573 (1929); and Francis J. Tietsort, ed., *Temperance or Prohibition,* p. 397 (1929).

The presidential campaign of 1932 settled the issue overwhelmingly for repeal. The plank in the Democratic platform was unequivocally for repeal, and the Republican plank, as recommended by the majority of the resolutions committee, apparently favoured the submission of a proposal to revise the 18th amendment with some safeguards attached. Dr. Butler, Senator Borah and other leaders claimed, however, that the minority recommendation of the resolutions committee favouring outright repeal more nearly represented the majority sentiment of the convention, but had been defeated by controlled votes. The *N.Y. Times* of June 7 and 9, before the Republican convention had acted, quoted two of the most influential supporters of the 18th amendment, John D. Rockefeller, Jr., and John R. Mott, as respectively in favour of repeal and resubmission.

Submission and Ratification of the 21st Amendment, Repealing the 18th.—The second session of the 72nd congress meeting within a month of the November elections lost no time in preparing a joint resolution which was adopted by two-thirds majority in both houses; in the senate, where the joint resolution originated, by a vote of 63 for, to 23 against, on Feb. 16, 1933, and in the house on Feb. 20 by a vote of 289 for, to 121 against. It was deposited in the department of state, Feb. 20, and the following day was sent by the secretary of state to the respective governors of the 48 states.

The proposed amendment, as subsequently ratified, becoming the 21st amendment to the constitution, reads as follows:

"Section 1. The eighteenth article of amendment to the Constitution of the United States is hereby repealed.

"Section 2. The transportation or importation into any State, Territory, or possession of the United States for delivery or use therein of intoxicating liquors, in violation of the laws thereof, is hereby prohibited.

"Section 3. This article shall be inoperative unless it shall have been ratified as an amendment to the Constitution by conventions in the several States, as provided in the Constitution, within seven years from the date of the submission hereof to the States by the Congress."

This was the first use to be made of the method of ratification by conventions instead of by legislatures, but in less than 10 months conventions did meet in 36 states which ratified and two (North Carolina and South Carolina) which rejected the amendment. On Dec. 5, 1933, the secretary of state certified the ratification. The president followed this certification on the same day with a proclamation, pursuant to sec. 217a of the National Industrial Recovery act, in which he declared the 18th amendment repealed. While the president did call on all citizens to co-operate with the government in getting rid of the illicit liquor traffic, and to note the new prohibition against wet states invading the territory of those who wished to remain dry, not even the president seemed to realize the full significance of the second section of the 21st amendment. That was left for Justice Louis D. Brandeis and the supreme court to reveal in two little-noticed but remarkable decisions: (1) *State Board of Equalization of California* v. *Young's Market Co., et al.* (299 U.S. 59) decided in 1936; and (2) *Finch & Co.* v. *McKittrick* (305 U.S. 395) decided Jan. 3, 1939. The gist of these two decisions of Justice Brandeis may be seen in two sentences. One taken from the first, speaking of the 21st amendment, says that the words of the amendment "are apt to confer upon the States the power to forbid all importations which do not comply with the conditions which it prescribes"; and the other, from the second decision, to the effect that: "Since that amendment (the 21st), the right of a State to prohibit or regulate the importation of intoxicating liquor is not limited by the commerce clause." Prof. Noel T. Dowling of the Columbia university law school noted within a month after the first decision was handed down, its revolutionary character in constitutional law and history. He raises the question whether it was the intent of the 21st amendment to go so far, and whether the court would go the whole way to permit the states to put themselves in a position of economic isolationism with respect to intoxicating liquors. The second decision gives an affirmative answer to both questions. (*See* Noel T. Dowling, "Liquor and the Constitution," *Independent Journal*, Dec. 18, 1936, Col. Univ.) The second section of the 21st amendment not only put the Webb-Kenyon law substantially in the constitution, and thereby placed it beyond the power of congress to change, but by the interpretation given to it in the Brandeis decisions "the states," as Prof. Dowling says, "seem to have been lifted to a new, surprising, extraordinary position of power in the American federal system."

After Repeal.—At the end of nearly a decade after repeal (1943) it was still impossible to predict how far the states would succeed with the new powers in doing what they failed to do before national prohibition, and what the federal government without their full co-operation failed to do during the era of national prohibition. The president's proclamation of repeal also promised federal aid, and among other things said: "The objective we seek through a national policy is the education of every citizen toward a greater temperance throughout the Nation."

Steady progress toward legal tax control has been made by the Federal Alcohol administration, and in the states through the "licensing" and "monopoly" control in all except the three "prohibition states" (Kansas, Mississippi and Oklahoma). (*See* LIQUOR LAWS AND LIQUOR CONTROL.) During 1942, local option elections in nearly 1,500 geographical areas showed more pronounced dry gains than in any one of the previous nine years, all of which showed some dry gain. It was reported that in that period in over 12,000 local option elections the drys won nearly two-thirds of them. Both the liquor interests and the temperance forces were suspicious of each other fearing that advantage would be taken of the war situation to renew old controversies. Polls indicated a rising tide of dry sentiment even to a reported 36% in one poll favourable to national prohibition. Although there was something in the pattern of World War II events to suggest the antecedents of prohibition in the years 1917–19, the background of legislative demands and action was radically different. The temperate statement of the executive committee of the Federal Council of Churches on Nov. 27, 1942 (*Information Service*, Dec. 5, 1942), presented positive measures to control and reduce the evil effects of beverage alcohol, with particular reference to the wartime situation. These probably fairly represented the attitude of the Protestant Churches, and indicated the trend of thought in most of the temperance societies, Protestant and Catholic.

Too great or sole reliance on legal compulsion defeated national prohibition. The better course that combines education and restraint, both legal and voluntary, in the suppression of the evils of the liquor traffic, was well illustrated in a broadcast of Prime Minister Mackenzie King of Canada, on Dec. 16, 1942, from Ottawa, on "Temperance and a Total War Effort." He asked the provinces to further restrict the hours of sale to eight per day; he lamented the increased consumption of alcoholic beverages as unseemly in wartime when so many are sacrificing so much; and he announced the decision of his government under its war powers to prohibit after Feb. 1, 1943, all liquor advertisements throughout Canada for the duration.

Whatever may be said of prohibition, law, enforcement or repeal, these facts remain: During the prohibition era, a vast, illicit and vicious business of bootlegging was active. It could not have existed without enormous purchases, *in toto*, of bootleg stuff by otherwise reputable citizens who not only resisted the law but defied it and disobeyed it, thus lowering the standards of civic honour.

When repeal came in, it proved to be no immediate remedy for the appalling disintegration of social, intellectual and moral ideals, caused in large part by the illegal practices connected with bootleg liquor. In 1942, war brought additional questionings and difficulties. Many were inclined to believe that certain strict governmental protective and prohibitory measures might still be necessary for social welfare, but that the real progressive solution of the liquor problem might lie in the acceptance of individual responsibility; in voluntary commitment to the temperance cause; in scientific study; in home training and parental example; in the teaching and nurture of the church; and in better social customs.

In a word, the solution might lie more in the educational and spiritual realm, than in the legislative and political.

A new pragmatic emphasis on social and economic results and less controversy about ideologies may characterize the post-repeal era.

BIBLIOGRAPHY.—In addition to references already cited: P. W. Wilson, *After Two Years: A Study of American Prohibition* (1922); Fabian Franklin, *What Prohibition Has Done to America* (1922); A. Newsholme, *Prohibition in America* (1922); American Academy of Political and Social Science, "Prohibition and Its Enforcement," *Annals*, vol. 109 (1923); "Prohibition: A National Experiment," *ibid.*, vol. 163 (1932); E. H. Starling, *The Action of Alcohol on Man* (1923); V. G. Vecki, *Alcohol and Prohibition in Their Relation to Civilization and the Art of Living* (1923); C. M. and G. Gordon, *A Study of North American Prohibition* (1923); Ernest H. Cherrington, *The Evolution of Prohibition in the U.S.A.* (1920); T. N. Carver, "The Greatest Social Experiment of Modern Times," *These Eventful Years*, vol. 2, ch. 80 (1924); Moderation League, Inc., *A National Survey of Conditions under Prohibition* (1925–26); H. W. Farnum, "The Law of the Land and Our Moral Frontier," *No. Amer. Rev.*, vol. 221 (1925); D. Leigh Colvin, *Prohibition in the U.S.; a History of the Prohibition Party and of the Prohibition Movement* (1926); J. A. Krout, *The Origins of Prohibition* (1925); F. Ernest Johnson and H. S. Warner, *Prohibition in Outline* (1927); R. E. Hose, *Prohibition or Control* (1928); Peter H. Odegard, *Pressure Politics: the Story of the Anti-Saloon League* (1928); *National Commission on Law Observance and Enforcement*, 5 vols. (1931); Raymond B. Fosdick and Albert L. Scott, *Toward Liquor Control*, with foreword by John D. Rockefeller, Jr. (1933); Leonard V. Harrison and Elizabeth Laine, *After Repeal*, with foreword by Luther Gulick (1936); "Alcoholic Beverage Control," *Law and Contemporary Problems*, vol. vii, No. 4 (1940); *State Liquor Legislation*, prepared by Marketing Laws Survey, U.S. Dept. Commerce, Works Progress Administration (1941); H. W. Haggard and E. M. Jellinek, *Alcohol Explored* (1942); publications and reports of: the Prohibition Unit (U.S. Treasury and Justice Depts.); annual reports of Attorney-General, Bureau of Int. Rev. (Treas. Dept.); also, Assn. Against the Prohibition Amendment, U.S. Brewers' Assn., Moderation League, Inc., Anti-Saloon League yearbooks, 1908–33; and other pubs., Intercollegiate Prohibition Assn., Nat. Woman's Christian Temperance Union, Scientific Temperance Federation, Women's Nat. Com. for Law Enforcement, Amer. Business Men's Research (formerly Prohibition) Foundation, Methodist Board of Temperance (Wash., D.C.), Distilled Spirits Institute (Wash., D.C.), Research Council on Problems of Alcohol (Bronxville, N.Y.) and the Council's *Quarterly Journal of Studies on Alcohol*.

See also: LIQUOR LAWS AND LIQUOR CONTROL; DRINK BILL; BOOTLEGGING AND SMUGGLING; SMUGGLING; TEMPERANCE; "GOTHENBURG" LICENSING SYSTEM; DISINTERESTED MANAGEMENT; LOCAL OPTION.
(S. McC. L.)

PROHIBITION IN LAW, a term meaning the action of forbidding or preventing by an order, a decree, etc. As defined by Blackstone, prohibition is "a writ directed to the judge and parties of a suit in any inferior court, commanding them to cease from the prosecution thereof, upon a surmise either that the cause originally or some collateral matter arising therein does not belong to that jurisdiction, but to the cognizance of some other court." A writ of prohibition is a prerogative writ—that is to say, it does not issue as of course, but is granted only on proper grounds being shown. Before the Judicature Acts prohibition was granted by one of the superior courts at Westminster; it also issued in certain cases from the court of chancery. It is now granted by the High Court of Justice. By the Judicature Act, 1873, s. 24, it is provided that no proceeding in the High Court of Justice or the court of appeal is to be restrained by prohibition, a stay of proceedings taking its place where necessary. In the case of courts of quarter sessions, the same result is generally obtained by *certiorari (see* WRIT).

In Scots law prohibition is not used in the English sense. The same result is obtained by suspension or reduction. In the United States the Supreme Court has power to issue a prohibition to the district courts when proceeding as courts of admiralty and maritime jurisdiction.

Most of the States have also their own law upon the subject, generally giving power to the supreme judicial authority in the State to prohibit courts of inferior jurisdiction. *(See* LIQUOR LAWS AND LIQUOR CONTROL; TEMPERANCE.)

Prohibition is a writ which lies to restrain the unlawful exercise of judicial functions on the part of a lower court, issuing from a court of higher jurisdiction. Again, it may be used to restrain an official from doing an administrative, ministerial or legislative act not falling within his province.

PROHIBITION PARTY, THE NATIONAL, a minor political party of the United States which has had for its primary objective the legislative prohibition of the manufacture and sale of intoxicating liquors. From time to time it has also proclaimed its interest in other reforms. The party was organized in 1869 and in 1872 placed its first candidate for President in the field. It has offered candidates for President and Vice-President in every succeeding Presidential election. Though one of the most persistent of the third parties it has polled fewer votes in most elections than some others of more radical character. Its highest figure, 255,000 votes out of a total of 12,000,000 cast, was in 1892. In 1920 it polled 192,000 votes, in 1928 20,101 votes, and in 1932 81,869 votes. While the amendment was in effect the party agitated the necessity for its enforcement, but growing hostility to prohibition and the amendment's final repeal forced the party to resume the political struggle within individual states.

PROJECTION, IN MATHEMATICS. Let A, B, C, D, etc., represent points of a straight line 1 and A', B', C', D', etc., points of another straight line 1' in the same plane with 1. If the straight lines, AA', BB', CC', DD', etc., are all perpendicular to the line l', the set of points A', B', C, D', etc., is said to be an orthogonal projection of the set, A, B, C, D, etc., (fig. 1). The correspondence between the two sets of points, by which A corresponds to A', B to B', etc., is called an orthogonal projection. In case the straight lines AA', BB', etc., are all parallel, without being necessarily perpendicular to l', we use the term parallel projection instead of orthogonal projection (fig. 2). In case the lines AA', BB', CC', etc., all meet in a point O we speak similarly of central projection. In all three cases we say that the two sets of points A, B, C, D, etc., and A', B', C', D', etc., are in perspective and that the points of one set are projected into the points of the other set. The point O is called the centre of perspectivity or the centre of projection of the two sets of points as indicated in the accompanying diagram (fig. 3).

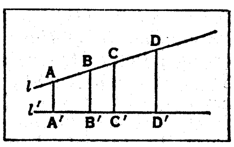


FIG. 1

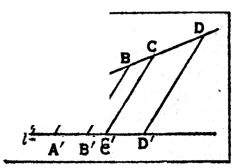


FIG. 2

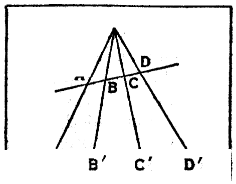


FIG. 3

These conceptions have been generalized in various ways. For example, let A, B, C, D, etc., be the points of any figure F in space and A', B', C', D', etc., be corresponding points of a figure in a plane π. If the straight lines AA', BB', CC', etc., are all parallel or all meet in a point O the figure in the plane π is called a projection of the other figure. If the lines AA', BB', etc., are all perpendicular to the plane π, the figure in π is called an orthogonal projection of the other figure. (*See* also PROJECTIVE GEOMETRY.)
(O. V.)

PROJECTIVE GEOMETRY. Projective geometry is a branch of mathematics which originated in the study of projections as applied to problems of perspective in the drawing of pictures and in optical instruments. These practical applications are now studied under the captions of descriptive geometry *(see* DESCRIPTIVE GEOMETRY) and geometrical optics (*q.v.*), while projective geometry itself is cultivated for its intrinsic interest. It is a well co-ordinated and symmetrical theory of considerable aesthetic merit, which on the one hand enables us to view elementary geometry as a completed whole, and on the other hand serves as the starting point of the higher algebraic geometry. For a more detailed study the reader is referred to one or more of the text books listed at the end of this article. The article itself attempts merely to state some of the general ideas, definitions and theorems in an introductory way and without proof.

One-dimensional **Projectivities.**—The notion of projection is defined in the article on that subject *(see* PROJECTION). Suppose that the points of a line a are projected into the points of a line b, and the points of b into the points of a line c, the points of c into the points of a line d, and so on, ending up with the points of the line k. Every point A of the line a then corresponds to a definite point K of the line k. This correspondence is called a *projective transformation* or *projectivity,* and is sometimes indicated symbolically by

$$\{A\} \barwedge \{K\}$$

The set of all points of a line l is called a ***range*** (or a ***pencil*** or ***row)*** of *points,* so that in the books on projective geometry there is often talk of projective ranges. In case we wish to discuss the correspondence, not of all the points of a, but only of certain ones, say A_1, A_2, A_3, A_4, we may write

$$A_1A_2A_3A_4 \barwedge K_1K_2K_3K_4.$$

The first theorem about projectivities is that any three points of a straight line can be projected into any three points of a straight line. In other words the statement

$$A_1A_2A_3 \barwedge K_1K_2K_3,$$

is true whenever it is true, (1) that A_1,A_2,A_3 are distinct and collinear, and (2) that K_1,K_2,K_3 are distinct and collinear. It is also true that if the points A_1,A_2,A_3 and K_1,K_2,K_3 are on different lines the projectivity can be brought about by the intervention of not more than two intermediate projections. That is, if the points A_1,A_2,A_3 and K_1,K_2,K_3 are given on different lines it is possible to find a line b such that A_1,A_2,A_3 can be projected respectively into the points B_1,B_2,B_3 of b, and these points into K_1,K_2,K_3, respectively. If A_1,A_2,A_3 and K_1,K_2,K_3 are on the same line, three intermediate projections may be needed.

A second theorem is that any projective transformation of a line is fully determined by the fate of three of the points of the line. In other words, if it is specified that A_1 goes to K_1, A_2 to K_2, A_3 to K_3, then for any point A_4 of the line A_1A_2 there is a uniquely determined point K_4 of the line K_1K_2 to which A_4 goes. This theorem is often referred to as the ***fundamental theorem of projective geometry.***

Points at Infinity.—From the point of view of elementary geometry, there are certain exceptions to these theorems, due to the existence of parallel lines. For example in fig. 1, the point A_0 is not projected into any point of the line b because the line from

A_0 to the centre of projection is parallel to b. This circumstance complicates the statement of the theorems about projections if we adhere to the point of view of elementary geometry. In projective geometry it is avoided by introducing the conception of *points* at *infinity*, or *ideal points*. To every straight line a there is attributed one point at infinity and every line parallel to a is said to meet a in the point at infinity of a. In fig. 1 the point A_0 is therefore said to be projected into the point at infinity of the line b. The points at infinity of the straight lines of a plane are said to constitute a straight line, the *line at infinity* of this plane. All the points at infinity of a three-dimensional space are said to constitute a plane which is called the *plane* at *infinity*.

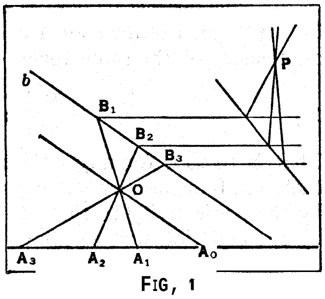


FIG. 1

We shall not attempt here to justify the conception of points at infinity. The question is discussed at length in the books on projective geometry. It may be remarked however that the ordinary points are just as much idealized as are the points at infinity. No one has ever seen an actual point or realized it by an experiment of any sort. Like the point at infinity it is an ideal creation which is useful for some of the purposes of science. With the aid of these conceptions we obtain great simplicity and symmetry in the statements of geometry. For example we have: (a) any two points have one and only one straight line in common; (b) any two straight lines in a plane have one and only one point in common; (c) any two planes have one and only one line in common; (d) a straight line and a plane have one and only one point in common, unless the line lies in the plane; (e) a straight line and a point are on one and only one plane, unless the point is on the line. Each of these statements would have to be split up into at least two propositions in order to state its full content in the language of elementary geometry; and each of the propositions would be more complicated to state than the more general projective proposition in which it is contained.

Principle of Duality.—If we restrict attention to the points and lines of a single plane there is a duality between the two propositions (a) and (b) in the list above. They can be written:

(a) Two points are on one and only one line.

(b) Two lines are on one and only one point.

Either proposition remains true if the words point and line are interchanged. The same thing is true of every theorem of the projective geometry of the plane. If it is properly formulated it remains valid when the words point and line are interchanged. This statement is called the principle of duality in the plane. (See DUALITY.) Its exact meaning depends, of course, on what we mean by a theorem of projective geometry. This is explained below with the aid of the notion of the projective group.

After the principle of duality in the plane has been comprehended it is necessary only to state one of each pair of dual theorems. The other one goes without saying. Indeed, after we have arrived at a number of propositions from which we are going to deduce all the rest by logical processes without appeal to other knowledge, and after we have verified the duals of these fundamental propositions, we know in advance that the principle of duality will hold for all the theorems which we are going to derive. This way of dealing with the principle of duality requires that the material of projective geometry shall be organized as a distinct body of knowledge (*see* the remarks on axioms, etc., below).

The principle can also be established by showing the existence of "duality transformations" which carry every plane figure into a dual figure in which the points and lines of the first are replaced by the lines and points of the second.

There is also a principle of duality in space, according to which the propositions of three-dimensional projective geometry when properly stated remain valid when the words point and plane are interchanged. In the list above, the propositions (a) and (c) are dual, (d) and (e) are dual, and (h) is dual to the proposition that any two straight lines with a point in common are in a common plane. In like manner there are principles of duality in spaces of any number of dimensions.

Pencils of Lines.—We must now understand that the statements which we have made about one-dimensional projectivities hold without exception, and therefore include all the special cases which arise when one or more of the points in question is a point at infinity. Glancing again at fig. 1, it is evident that there is a one-to-one correspondence between the points of the line a and the lines through the point O which are in the same plane with a, namely, each point corresponds to the line joining it to O. Such a system of lines is called a *pencil of lines* and the point O in which all lines of the pencil meet is called the *centre of the pencil*.

The notions of projectivity and perspectivity are now extended so as to apply to pencils of lines as follows: The correspondence between a range of points and a pencil of lines in which each point lies on its corresponding line is called a *perspectivity;* and any correspondence between two pencils of lines, or between a pencil of lines and a range of points, or between two ranges of points which is the resultant of any number of perspectivities is called a *projectivity*. This definition includes the definition previously given of a projectivity between two ranges of points as a special case. Under this definition, in fig. 1, the range of points on a is projective with the pencils of lines at O and P as well as with the pencil of parallel lines; and each of these pencils of lines is projective with the others; each of the projectivities being a one-to-one correspondence determined by the figure. Just as in the analogous case of ranges of points, if a_1,a_2,a_3 are lines of one pencil and b_1,b_2,b_3 are lines of another pencil, there is one and only one projectivity in which a_1,a_2,a_3 correspond to b_1,b_2,b_3 respectively.

Conic Sections.—The corresponding lines of two distinct projective pencils of lines in the same plane intersect in the points of a conic section (*q.v.*), provided the line joining the centres of the two pencils does not correspond to itself. For example, in fig. 2, the two pencils of lines at A and B are projective in such a way that corresponding lines are perpendicular, and they intersect in points of a circle. If the corresponding lines had not been perpendicular the corresponding lines would have intersected in an ellipse, or in a parabola, or in a hyperbola.

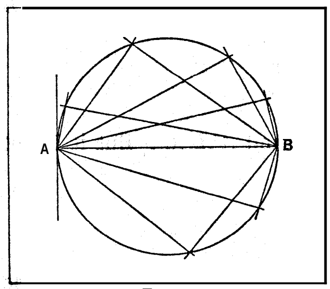


FIG. 2

This theorem of the generation of a conic by means of projective pencils makes it possible to deduce all the properties of conic sections from the theory of one-dimensional projectivities. For example, the fact that there is one and only one conic through five coplanar points, no three of which are collinear, is an immediate consequence of the fact that a projectivity between two pencils of lines is fully determined by the correspondence of three lines of the one pencil with three lines of the other. The theorem is a good example of the unifying power of projective geometry, for it includes as special cases a host of theorems about the construction of conic sections when the given five points are in special position from the point of view of elementary geometry. An equal number of additional theorems is obtained by applying the principle of duality in the plane; and a corresponding group of theorems about cones is obtained by space duality.

The Ruled Quadric.—Let A_1,A_2,A_3,A_4 be four points of a line a and B_1,B_2,B_3,B_4 four points of a line b which is not in the same plane with a. In case

$$A_1A_2A_3A_4 \;\overline{\wedge}\; B_1B_2B_3B_4,$$

then any straight line c which meets the three lines A_1B_1, A_2B_2, A_3B_3, will also meet A_4B_4. Hence there is a whole family of straight lines which meet the lines A_1B_1, A_2B_2, A_3B_3, A_4B_4. The lines of this family fill up a surface which is called a *quadric surface* because its equation is of the second degree. It is called a *ruled quadric* because of the straight lines which lie upon it. Indeed, the surface may be described as follows: let a, b and c be the three lines already described under these names. There is a family of lines each of which meets a, b and c and there is just one line of this family through each point of a, b or c. This family may be called the *first ruling* or *regulus* of the quadric. Any line which meets three lines of the first ruling meets all lines of this ruling, and the family of all such lines is a regulus just like the first ruling. The quadric consists of the points on the two rulings. There is one line of each ruling through each point of the quadric, and the plane containing these two lines is tangent to the quadric. But for further discussion of this question the reader must be referred to the article on surfaces (*see* SURFACE) and to the appropriate chapters in books on projective and analytic geometry. The ruled quadric from the point of view of Euclid is either a hyperbolic paraboloid or a hyperboloid of one sheet, according as the plane at infinity is or is not tangent to it.

One-dimensional Forms.—This by no means exhausts the list of seemingly complicated geometric figures whose theory can be deduced from the simple propositions about one-dimensional projectivities. The essential element in any such deduction is to find a family of geometric figures which are in such a correspondence with the points of a line that the theory of projectivities can be applied. Any such family of geometric figures is called a *one-dimensional form*. Examples are: a range of points, a pencil of lines, the set of all planes having a line in common, the points of a conic section, the lines of a regulus, the generating lines of a cone, the points of a rational cubic curve in space, the tangents to a conic section, the set of all conic sections having four points in common, and so on. When the general ideas about projectivities of one-dimensional forms are combined with simple theorems about the particular figures to which they are being applied, they often give us flashes of insight into unexpected branches of mathematics, such as, for example, quaternions (*q.v.*) and biquaternions.

Cross Ratio.—If two points, A,B, go by projection to two points, A',B', there is no general relation between the distance AB and the distance $A'B'$. The same remains true of the ratios

$$\frac{AB}{AC} \text{ and } \frac{A'B'}{A'C'}$$

of two sets of collinear points A,B,C, and A',B',C'. But it is not true of the ratio of two ratios

$$\frac{AC}{AD} \div \frac{BC}{BD}$$

(each ratio computed with proper regard to algebraic sign). The fact is that

$$ARCD \barwedge A'B'C'D'$$

if and only if

$$\frac{AC}{AD} : \frac{BC}{BD} \quad \frac{A'C'}{A'D'} : \frac{B'C'}{B'D'}$$

provided the points in each set of four are collinear. Such a ratio of two ratios is called a *cross ratio* or a *double ratio* or an *anharmonic ratio.*

A cross ratio of four collinear points is the same as the corresponding cross ratio of any iour points into which they are projected. This fact enables us to define the cross ratio of any four elements of any one-dimensional form, and in each case the cross ratio has a significant geometrical meaning. For example, we can define the cross ratio of four points of a conic as that of any four points of a straight line which are projective with the given four points of the conic. It then can be proved very simply that whenever the cross ratio $ABCD$ is -1 the tangents to the conic at A and B intersect on the line CD; and conversely, if the tangents at A and B intersect on the line CD then the cross ratio $ABCD$ is -1. Whenever the cross ratio $ABCD$ of any four elements of a one-dimensional form is -1 we say that the four elements form a *harmonic set* and that the elements AC *harmonically separate* the elements BD.

Co-ordinates in One-dimensional Forms.—If A,B,D are three elements of a one-dimensional form (*e.g.,* three points of a line) any fourth element C is uniquely determined by its cross ratio $ABCD$. That is, if C is given, the cross ratio is a unique number x, and if a number x is given, there is one and only one element C such that x is the cross ratio $ABCD$ (if $C=A$, $x=0$; if $C=B$, $x=\infty$; if $C=D$, $x=1$). The number x is what we call the *co-ordinate* of the element C of the one-dimensional form. A co-ordinate is a number which serves as a name for the element; and these names have been assigned in such a way that any two distinct elements have distinct names. It can be proved that any projectivity by which each element of a one-dimensional form corresponds to an element of the same form, can be represented by an equation

$$\bar{x} = \frac{ax+b}{cx+d}, \quad ad-bc \neq 0.$$

That is to say, for any projectivity of a one-dimensional form, there are four numbers a,b,c,d such that every element x is carried by the projectivity to that element whose name $\bar{x}$ is related to x by the equation written above.

Invariants of Binary Forms.—This theorem opens the way for a study of projective geometry by means of algebra. In practice it is found advantageous to use homogeneous co-ordinates (*see* CO-ORDINATES). An element whose non-homogeneous co-ordinate is x is represented by any pair of numbers x_1,x_2 such that

$$\frac{x_1}{x_2} = x.$$

In case $x_2=0$, the pair of numbers $(x_1,0)$ represents the element ∞ (represented by B in the discussion above). Homogeneous co-ordinates give a multiplicity of names for the same element, for whenever

$$\frac{x_1}{x_2} = \frac{y_1}{y_2}$$

(x_1,x_2) and (y_1,y_2) represent the same element. Any homogeneous algebraic equation represents a finite number of elements. For example

$$px_1^3+qx_1^2x_2+rx_1x_2^2+sx_2^3=0$$

represents three elements, because there are three values of the ratio x_1/x_2 which satisfy this equation. The left-hand member of a homogeneous equation of this sort, of any degree, is called a *binary form* (binary because there are two variables: *see* FORMS, ALGEBRAIC).

A projective transformation is represented in homogeneous co-ordinates by linear homogeneous equations of transformation

$$\begin{aligned} \bar{x}_1 &= ax_1+bx_2 \\ \bar{x}_2 &= cx_1+dx_2 \end{aligned} \qquad ad-bc \neq 0$$

and the projective geometry of one-dimensional forms reduces. algebraically, to the study of the effect of transformations of this sort upon binary forms This study centres about the theory of *invariants* (*see* ALGEBRAIC FORMS) of binary forms, an invariant being a function which is unaltered except for a factor by the transformations In geometric applications it is found, in general, that the vanishing of an invariant represents a geometric property which is unaltered by projectivities.

Two-dimensional Projective Geometry.— It is natural to call such collections of elements as the set of all points in a plane, or the set of all lines in a plane, or the set of all planes through a point, etc., *two-dimensional forms*. The concept of a projective transformation can be extended to two dimensions without difficulty. It turns out that any projective transformation of a two-dimensional form is fully determined by the 'fate of any four elements no three of which are in the same one-dimensional form.

Non-homogeneous co-ordinates are introduced in such a way that an element is named by an ordered pair of numbers $(x,y,$ the first and second names of the element). If the elements are points, then these co-ordinates are ordinary cartesian co-ordinates (*see* ANALYTIC GEOMETRY). Homogeneous co-ordinates are sets of three numbers (x_1,x_2,x_3) such that

$$x = \frac{x_1}{x_3}, \qquad y = \frac{x_2}{x_3},$$

and projective transformations of the points of a plane into points of the same plane are given by equations of transformation of the type,

$$\bar{x}_1 = a_1^1x_1 + a_1^2x_2 + a_1^3x_3$$
$$\bar{x}_2 = a_2^1x_1 + a_2^2x_2 + a_2^3x_3$$
$$\bar{x}_3 = a_3^1x_1 + a_3^2x_2 + a_3^3x_3,$$

in which the determinant of the coefficients is not zero. These transformations are also called collineations because they transform collinear points into collinear points.

Geometry of the Complex Domain. — Since it is possible to perform all the operations of algebra with complex numbers (see COMPLEX NUMBERS)—that is to say with the numbers of the form $u+v\sqrt{-1}$ where u and v are real—it is possible to work out the algebraic theory of projective transformations on the assumption that the co-ordinates, x_1,x_2,x_3, and the coefficients of the equations of transformations, are complex numbers. The objects which are transformed are sets of triads of numbers (x_1,x_2,x_3) where a given set contains all triads $(\rho x_1,\rho x_2,\rho x_3)$ obtained by letting ρ be any real or complex number except zero. We call these objects complex *points*. The collection of complex points which satisfy a homogeneous first degree equation

$$ax_1+bx_2+cx_3=0$$

is called a complex line, and the collection of complex points which satisfy a homogeneous second degree equation a complex *conic*, and so on The totality of complex points is called a complex projective plane Thus there is built up, by simple algebraic processes, a complex projective geometry.

The propositions of this geometry are, to a large extent, the same as those of the projective geometry of reals. Two points determine one and only one line; two lines meet in a point; five points, no three collinear, determine a conic; and so on But a great many propositions assume a simpler and more symmetric form than they do in the real geometry. For example, in the real geometry a line which is not tangent to a conic may meet it either in two points or not at all; in the complex geometry a line which is not tangent always meets the conic in two points. This is because the problem of finding the points of intersection of a straight line and a conic reduces to the solution of a quadratic equation. In general any geometric problem depending on the solution of an algebraic equation of higher than the first degree will assume a simpler form in the complex than in the real domain.

Among the complex points there is a sub-class consisting of those for which the ratios x_1/x_3 and x_2/x_3 (or x_1/x_2, if $x_3=0$) are real. The co-ordinates of these points can aiways be taken to be real, so that these points can be identified with the ordinary real points. Hence the real projective plane is habitually thought of by mathematicians as immersed in a complex projective plane. Every real straight line or real conic is thought of as containing not only all its real points but also a collection of complex points. Moreover, free use is made of Imaginary straight lines, conics, and so on. For example, if we were to limit attention to real figures we should have to say that from certain points of the plane it is impossible to draw lines tangent to a given conic. From the point of view of complex geometry we say that there are two tangents through any point not on the conic; if the point is exterior to the conic the two tangents are real lines, but if the point is interior they are conjugate imaginary lines. No attempt is made to visualize the "imaginary" complex elements We simply make such inferences about them as follow by the rules of logic from the definitions adopted. The results so obtained are bound to be as self-consistent as any theorems about numbers.

Geometry of N Dimensions. — Three-dimensional projective geometry can be approached from the point of view of elementary geometry much as we have approached one and two-dimensional projective geometry in the discussion above; or it may be derived by a purely logical process on the basis of its own axioms; or it may be taken up analytically in the manner explained above for the two-dimensional complex geometry. Points are then defined in terms of sets of homogeneous co-ordinates (x_1,x_2,x_3,x_4). If ihese co-ordinates are restricted to real numbers we obtain the real projective geometry of three dimensions. If they are allowed to be any complex numbers we obtain the complex projective geometry of three dimensions.

From the algebraic point of view, there is no reason why the number of homogeneous co-ordinates should be restricted to four, and no such restriction is made by mathematicians. A point in a projective space of n dimensions is defined by $n+1$ homogeneous co-ordinates $(x_1,x_2, \ldots, x_{n+1})$ and projective transformations are defined by equations of the form

$$\bar{x}_1 = a_1^1x_1 + a_1^2x_2 + \cdots + a_1^{n+1}x_{n+1}$$
$$\bar{x}_2 = a_2^1x_1 + a_2^2x_2 + \cdots + a_2^{n+1}x_{n+1}$$
$$\cdot$$
$$\bar{x}_{n+1} = a^1_{n+1}x_1 + a^2_{n+1}x_2 + \cdots + a_{n+1}^{n+1}x_{n+1}.$$

If the co-ordinates and coefficients are real we arrive at the real projective geometry of n dimensions, if complex, at the complex projective geometry of n dimensions

As the number n increases the geometry becomes more complicated because the number of primary figures to consider becomes greater, but it does not become more difficult in principle. It is no longer possible to visualize our results as we do in the one-, two- and three-dimensional cases, but the logical processes by which they are proved remain the same. In order to explain the situation rapidly we have based the conception of an n-dimensional space on the notion of co-ordinates, but this is not necessary. It can alsa be developed without the use of co-ordinates from a purely descriptive set of axioms.

Projective, Affine and Metric Geometry. — The set of all projective collineations of a plane form a group (see the article GROUP). The properties of any figure which remain unaltered when this figure undergoes the transformations of this group are called *projective* properties For example, the property of a curve of having a second degree equation, *i e*, of being a conic section, is unaltered. Likewise the property of a point, line and conic section, that the point is the pole of the line with regard to the conic is a projective property. The theory of all projective properties of plane figures is the subject matter of the projective geometry of the plane.

The set of all projective collineations of a plane which leave a particular straight line invariant is a group which is called an *affine* group, and the theory of those properties of plane figures which are unaltered when the figures undergo the transformations of this group is called affine geometry (see AFFINE GEOMETRY). The invariant line is called the line at infinity of the affine geometry. An affine group has several subgroups, the most interesting being the ones determined by requiring that two points of the line at infinity shall be invariant. If the two points are real, the subgroup is one studied in the special theory of relativity (*q* v) and includes the Lorentz transformations. If they are conjugate imaginaries, the group is the group of similarity transformations of Euclidean geometry.

The Euclidean geometry can be characterized as the group of theorems which state those properties of figures which are left unaltered by tiie group of similarity transformations. Thus it makes no essential distinction between a large triangle and a small one which is similar to it, though it does deal with the ratio of the two triangles But the latter is an attribute of the figure composed of the pair of triangles, not of either triangle separateiy. The theorems of affine and projective geometry are all included in Euclidean geometry, because any property which is left invariant by the projective group is of course left invariant by all its subgroups. Thus affine geometry is a subclass of very general the. orems of Euclidean geometry which it seems desirable to isolate from the rest and study together. Projective geometry is a strll smaller class of still more general theorems. We seem by leaving out some of the details which distract our attention in the more elementary way of looking at geometry to get a deeper insight and a better grasp of the subject as a whole. Afterwards we are able to return to these details and grasp them rapidiy by studying the particular subgroup which determines the Euclidean metric. A study of the latter group with special reference to the two invariant points gives a rapid and comprehensive survey of Euclidean geometry. For example, the circles are the conic sections which pass through these two points—and the points are therefore called the *circular points at infinity.* Perpendicular lines are pairs of lines which meet the line at infinity in pairs of points which harmonically separate the circular points. The four tangents to a real conic from the circular points meet, in general, in four other points. Two of these are real and are the foci of the conic, and so on.

Non-Euclidean Geometry.— Another sub-group of the projective group which is of great interest is the group leaving a conic invariant. In the real geometry there are two cases to consider according as the conic is real or is composed entirely of imaginary points. The theorems stating properties invariant under the first group constitute what is called the hyperbolic non-Euclidean geometry *(see* NON-EUCLIDEAN GEOMETRY), those stating properties invariant under the second group constitute what is called the elliptic non-Euclidean geometry. The metric geometry or system of measurement of geometric figures, which is developed in these geometries is quite different from, though analogous to, the system followed by Euclid. Historically they were developed in antithesis to the Euclidean system, but they have the same projective geometry.

Axioms.— In attempting to give an introductory sketch of projective geometry we have started from the point of view of elementary Euclidean geometry and freely made use of conceptions which do not belong in projective geometry as the subject is finally defined with the aid of the group idea. This is probably the course which will be generally regarded as advisable in first approaching the subject. But since projective geometry is a collection of very general and significant propositions from which it is possible to specialize in a variety of directions, it is an attractive idea to make projective geometry the starting point of the logical formulation of geometry as a whole and arrive at the various more special branches by a process of specialization. The still more general branches will of course continue to be reached by the process of generalization. The problem of stating the axioms in purely projective terms and deriving the theorems from this foundation by purely logical processes has engaged the attention of several mathematicians in recent years and is quite fully developed in the last two books cited in the bibliography below.

History.— The conception of points at infinity goes back to G. Desargues *(cf.* his *Brouillon-projet,* 1639, in *Oeuvres de Desargues,* 1864), and many of the individual conceptions of projective geometry can be traced back to remote antiquity; but it may be said to appear first as a definite branch of science in 1822 in the *Traité des propriétés projectives des figures* of J. V. Poncelet. The development of the science was participated in by nearly all the geometers of the nineteenth century, notably by Carnot, Brianchon, Gergonne, Chasles, Mobius, Monge, Steiner, Plucker, Clifford, Cremona, H. J. S. Smith and H. Wiener. The clear separation of projective from metric properties dates from the publication of the *Geometrie der Lage* of K. G. Ch. von Staudt (Nurnberg, 1847) and his *Beiträge zur Geometrie der Lage* (Nurnberg, 1857). The formulation of the group-theoretic classification of geometries is due to F. Klein. The study of the axioms and the logical organization of the science as a separate entity has been participated in by many mathematicians during the last forty years, notably by M. Pieri.

BIBLIOGRAPHY.—Elementary: P. Field, *Projective geometry* (1923); D. N. Lehmer, *An elementary course in synthetic projective geometry* (1917); G. B. Mathews, *Projective geometry* (1914). Advanced: H. F. Baker, *Principles of geometry* (1922); L. Cremona, *Elements of projective geometry* (1885); F. Enriques, *Vorlesungen über Projektive Geometrie* (Leipzig, 1913); J. L. S. Hatton, *The principles of projective geometry* (1913); M. Pieri, *Geometria projettiva* (Turin, 1891); T. Reye, *Die Geometrie der Lage* (5th ed., Leipzig, 1909); F. Severi, *Geometria projettiva* (Padua, 1921); O. Veblen and J. W. Young, *Projective geometry* (1910); A. N. Whitehead, The *axioms* of *projective geometry* (1906). (O. V.)

PROKOPIEV, SERGEI (1891–), Russian composer, was born at St. Petersburg (Leningrad) in 1891. In 1910 the Rubinstein prize was awarded him for his first piano concerto. From the first his compositions attracted attention by their originality and audacity. In writing for the stage he chooses subjects which have elements of grotesqueness or harsh satire, such as *Chout* (*The Buffoon*), played by Diaghilev's ballet corps in Paris (1921) and *The Love for Three Oranges,* a fable, produced in Chicago in the same year. His *Scythian Suite* for orchestra has also an obvious programme. Other orchestral works are the *Symphonie classique* op. 25 *a Sinfonietta,* and the *Overture* on *Yiddish Themes.*

PROKOP, the name of two of the most prominent Hussite generals.

1. PROKOP, surnamed "Veliky" (the great) or "Holy" (the bald), was a married utraquist priest who belonged to an eminent family of Prague. Though a priest, he became the most prominent leader of the advanced Hussite or Taborite forces during the latter part of the Hussite wars, commanding them at their great victories at Usti nad Labam (Aussig) in 1426 and Domailice (Tauss) in 1431, during their frequent incursions into Hungary and Germany, particularly the Bohemian invasion of Saxony in 1429, after which Prokop concluded the treaty of Kulmbach (Feb. 6, 1430) with Frederick of Brandenburg, burgrave of Nuremberg. He was the most prominent member of the Bohemian embassy to the Council of Basel (1433). On the return of the embassy from this fruitless journey, when renewed fighting broke out, he besieged the Romans at Plzeň, but was forced by indiscipline in his own camp to raise the siege and return to Prague. The Bohemian nobility, both Romanist and utraquist, having leagued itself against the Taborites, a struggle began at Prague. Aided by the nobles, the citizens of the old town took the more democratic new town, which Prokop unsuccessfully attempted to defend. He now called to his aid Prokop "the Lesser." *(See* below.) They jointly retreated eastward from Prague, but their forces, known as the army of the towns, were defeated by the nobles at Lipan, between Kourim and Kolin, Prokop the Great perishing in this battle (May 30, 1434).

2. PROKOP "the Lesser," or PROKUPEK (the Bohemian diminutive of the word Prokop), was one of the greatest Hussite generals. Little is known of his early life. He took part in all the later campaigns of Prokop the Great in Germany, and succeeded him as commander of the Taborite army that besieged Plzeň. After the formation of the confederacy of the nobles he was recalled by Prokop the Great, with whom he shared the command of the army of the towns at the battle of Lipan, in which he also perished.

See Count Lutzow, *Bohemia: A Historical Sketch;* Palacky, *History of Bohemia;* Toman, *Husitske Valečnictvi* (Hussite Warfare).

PROKOPOVICH, THEOFAN (1681–1736), Russian archbishop and statesman, one of the ablest coadjutors of Peter the Great, was educated at the Orthodox academy of Kiev in Poland, and at Rome in the College of the Propaganda. On his return to Russia he became professor, and subsequently rector of, the academy of Kiev. He reformed the teaching, substituting the historical method of the German theologians for the antiquated Orthodox scholastic system. In 1709 Peter the Great, while passing through Kiev, was struck by the eloquence of Prokopovich in a sermon on "the most glorious victory," *i.e.,* Poltava, and in 1716 summoned him to St. Petersburg. Theofan was rapidly promoted, becoming, in 1718, bishop of Pskov, and finally, in 1724, archbishop of Novgorod. As the author of "the spiritual regulation" for the reform of the Russian Church, Theofan must, indeed, be regarded as the creator of "the spiritual department" superseding the patriarchate, and better known by its later name of "the holy synod," of which he was made the vice-president.

See I. Chistovitch, *Theofan Prokopovich and his Times* (Rus.; St. Petersburg, 1868); P. Morozov, *Theophan Prokopovich* as *a Writer* (Rus.; St. Petersburg, 1880).

PROLEGOMENON, a preface or introduction to a book, especially a preliminary introductory essay to a learned work, or a treatise which serves as a general survey or introduction to the study of some subject or as a special survey of the subject. The word is more often used in the plural.

PROLETARIAT or **PROLETARIATE,** a term borrowed from the French and used collectively of those classes of a political community who depend for their livelihood on their daily labour, the wage-earning, operative class as opposed to the capital-owning class. The Latin *proletarius*, from which the word was formed, was the name given to the body of citizens possessed of no property and who therefore served the state with their children (*proles,* offspring). This division of the members of the state was traditionally ascribed to Servius Tullius.

PROLOGUE, a prefatory piece of writing, usually composed to introduce a drama. The Greek πρόλογος, included the modern meaning, but was of wider significance, embracing any kind of preface. In Attic drama, a character, often a deity, stood forward or appeared from a machine before the action of the play began, and made from the empty stage such statements as it was necessary that the audience should hear. It was the custom to explain everything that had led up to the play, the latter being itself, as a rule, merely the catastrophe following on the facts related in the prologue. The importance, therefore, of the prologue in Greek drama was very great. With Euripides, as has been said, it takes the place of "an explanatory first act." On the Latin stage the prologue was often more elaborately written than in Athens, and in the careful composition of the poems which Plautus prefixes to his plays we see what importance he gave to it; sometimes, as in the preface to the Rudens, Plautus rises to the height of his genius. Molière revived the Plautine prologue in the introduction to his Amphitryon: Racine introduced Piety as the speaker of a prologue to Esther. The tradition of the ancients vividly affected our own early dramatists. Not only were the mystery plays and miracles of the middle ages begun by a homily, but when the modern drama was inaugurated, the prologue came with it, directly adapted from the ancient practice. Sackville prepared a sort of prologue in dumb show for his *Gorboduc* of 1562; and he also wrote a famous *Induction* (practically a prologue) to a miscellany of short romantic epics by diverse hands. In the Elizabethan drama the prologue was very far from being universally employed. In the plays of Shakespeare it is rare. After the Restoration, prologues became de rigueur. They were always written in rhymed verse, and were generally spoken by a principal actor or actress. See also EPILOGUE. (E. G.; E. E. K.)

PROLONGATION OF VIGOUR: see REJUVENATION.

PROME, a district in the Pegu division of Lower Burma, with an area of 2,938 sq.m. and a pop. (1931) of 410,651. It occupies the breadth of the valley of the Irrawaddy, between Thayetmyo district on the north and Henzada and Tharrawaddy districts on the south, and originally extended to the frontier of Independent Burma, but in 1870 Thayetmyo was formed into an independent jurisdiction. There are two mountain ranges forming respectively the eastern and western boundaries. The Arakan Yoma extends along the western side. The portion of the district on the right bank of the Irrawaddy is broken up by thickly wooded spurs running south-eastwards. Cultivation is confined to the parts adjacent to the river. On the eastern side lies the Pegu Yoma, and north and north-east of the district its forest-covered spurs form numerous valleys and ravines, the torrents from which unite in one large stream, the Na-weng. The principal river is the Irrawaddy, which intersects the district from north to south; next in importance are the Tha-ni and its tributaries and the Na-weng system of rivers. The district lies on the southern borders of the dry belt and the rainfall ranges from about 35 to 60 inches. The staple crop is rice, but cotton and tobacco are grown, while the custard apples are famous. The forests yield teak and cutch.

The early history of the once flourishing kingdom of Prome is veiled in obscurity. After the conquest of Pegu in 1758 by Alompra, the founder of the last dynasty of Ava kings, Prome remained a portion of the Burman kingdom till the close of the second Burmese war in 1853, when the province of Pegu was annexed to British territory.

Prome, the chief town, is on the Irrawaddy, 161 m. N. of Rangoon, pop. (1931) 28,295. It has a somewhat evil reputation for infectious diseases.

South and south-east the town is closed in by pagoda-topped hills, on one of which stands the conspicuous gilded Shwe Tsandaw. The town was taken by the British in 1825 and in 1852. In 1862 it was almost entirely destroyed by fire. It became a municipality in 1874. Other towns are Shwedaung (pop. 8,408) and Paungdé (pop. 13 479).

PROMETHEUS, son of the Titan Iapetus by the sea-nymph Clymene or by Themis (occasionally other parents are named). He was the friend and benefactor of mankind. He defended men against Zeus, who, according to a widely diffused mythical theory, desired either to destroy the human race and supplant it by a new and better species, or to avenge himself because men had got the better of him. The pedigree and early exploits of Prometheus are given by Hesiod (Theog., 510–616). At a meeting of gods and men at Mecone, it was the business of the assembly to decide what portions of slain animals the gods should receive in sacrifice.

On one side Prometheus arranged the best parts of the ox covered with offal, on the other the bones covered with fat, as the meat was covered in Homeric sacrifices. Zeus, invited to make his choice, chose the fat and found only bones beneath. A similar fable of an original choice, in which the chooser is beguiled by appearance, recurs in Africa and North America. See also Ada Thomsen in Archiv f. *Religionswissenschaft,* XII. 460 et seq. Zeus, enraged at this trick, according to Hesiod, or, according to other versions, desirous of exterminating the few people who had escaped the deluge of Deucalion, either never bestowed the gift of fire, or later withdrew it. Prometheus stole fire, concealed in a hollow fennel stalk (Hesiod, *Works* and *Days*); and a fennel stalk is still used in the Greek islands as a means of carrying a light (cf. Pliny, Nat. *Hist.*, XIII. 126). According to some legends, he gained the fire by holding a rod close to the sun. Probably the hollow fennel stalk in which fire was carried got its place in myth from the fact of its common use. We thus find Prometheus in the position of the fire-bringer, or fire-stealer, and so connected with a very wide cycle of similar mythical benefactors, divine, human, or bestial, among all sorts of peoples from the Murri of Gippsland[1] to Europeans and Vedic Indians[2].

In considering the whole question of fire mythology, one must beware of the hasty analogical method of reasoning too common among mythologists. For example, when a bird is spoken of as the fire-bringer, we need not necessarily conclude that, in each case, the bird means lightning. Again, because a hero is said to have stolen or brought fire, we need not regard that hero as the personification of fire, and explain all his myth as a fire-myth. The legend of Prometheus has too often been treated in this fashion, though he is really a culture hero, of whose exploits, such as making men of clay, fire-stealing is no more than a single example. This tendency to evoive the whole myth of Prometheus from a belief that he is personified fire, or the fire-god, has been intensified by Kuhn's ingenious and plausible etymology of the name Προμηθεύς, which he would connect with Skr. *prāmantha,* a fire-stick.

But there is no real reason to reject the classical interpretation, "fore-thinker" (cf. his brother Epimetheus, "after-thinker," "wise after the event"), for, as already shown, the myth of the stealing of fire and of the fire-stealer is current among races which are not Aryan, and never heard the word *prāmantha.*

Prometheus and Hephaestus (q.v.) are frequently brought into contact, generally as opponents; in some forms of the legend, Prometheus steals fire from Hephaestus's workshop, not from heaven. It is quite possible that Prometheus was an old and genuinely Greek deity, whose province included fire and its earlier industrial applications, but that he was later superseded by the popular oriental deity. If such were the case, it must have been very early, before either Homer or Hesiod wrote,

[1] *See* Brough Smith with Howitt, Native Tribes of South-east *Australia,* Aborigines of Victoria; Kuhn on bird fire-bringer in Isle of Man, Die Herabkunft des *Feuers* p. 109; Van Gennep, Mythes et *légendes d'Australie.*

[2] *Cf.* Bergaigne, La *Religion* vtdique, i. 52–56 and Kuhn's *Herabkunft;* and see the essays by Steinthal in appendix to English version of Goldziher's *Mythology* among *the* Hebrews.

probably not long after the first coming of the Achaeans to Greece. (A. L.; H. J R.)

See Preller-Robert *I.* 91 *et seq.; L. R.* Farnell, *Cults of the Greek States,* v. *378 et seq.*

PROMISSORY NOTE: see BILL OF EXCHANGE.

PROMOTER: *see* COMPANY.

PRONAOS, in architecture, the porch, portico or colonnade in front of the *naos, cella* or enclosed portion of a classic temple.

PRONGHORN or **PRONGBUCK,** the sole existing representative of a family (*Antilocapridae*), intermediate between deer and cattle; the forked horns resemble those of the latter group, but are annually shed and renewed. Standing about 3ft. high at the shoulder, the male prongbuck has the black horns rising vertically above the eyes. The colour is bright sandy fawn, with much white on the face, three white bars on the throat and white under parts and buttocks. The long white hair on the buttocks can be erected and expanded into bunches, these being guides to the herd when in flight. The tail is short. Female prongbuck produce one or two young at a birth, and are either hornless or furnished with more or less rudimentary horns.

Prongbuck, of which two races, the typical *Antilocapra americana* and A. *mexicana,* are recognized, inhabit the open plains of the temperate districts of western North America, where they were formerly abundant.

PRONUNCIATION. By means of his organs of speech man has at his disposal, for the purpose of speech, certain devices. He can make a great variety of sounds, and, subject to the limitations imposed upon him by the physical structure of his speech apparatus, he is able to modify these sounds in certain ways:—

(1) He can modify the length of time during which a sound persists.

(2) He can modify the degree of physical energy devoted to the production of a sound.

(3) He can, in the case of sounds that involve a periodic vibration of the vocal cords, regulate the periodicity of this vibration so as to produce varieties of pitch.

These modifications of Length, Stress and Pitch may serve different purposes, or may be used in various combinations.

1. Nature.—The spoken variety of a language consists of a certain number of sounds, influenced by the three modifications outlined above. These features, in the case of any given spoken language, constitute what we may term the acoustic matter of the language and the reproduction of these acoustic features by a speaker is what is known as a pronunciation of the language. The term "pronunciation" is used to denote the general acoustic features of a language; thus we speak of English Pronunciation, or the Pronunciation of Marathi. It is also used to denote the particular variety of acoustic phenomena used by an individual speaker, or by a particular section of a community; thus we may speak of disliking a man's pronunciation, or of liking the pronunciation of a certain district or social class.

2. Analysis of Pronunciation.—Detailed analysis of the pronunciation of individual speakers is the foundation of our knowledge of the pronunciation of languages and dialects, and those whose business it is to carry out such analysis should so train themselves that they can give reliable and accurate information upon all the aspects outlined above. Sounds must be described in detail, and the modifications, their function and distribution must be noted. Such detailed description of pronunciation is necessary for:—

(1) The study and teaching of the mother tongue, and of foreign languages.

(2) The devising of scientific systems of orthography for hitherto unrecorded languages.

(3) Comparative philological work.

(4) Pronouncing dictionaries.

3. Pronunciation and Language.—A spoken language persists as a "language" so long and only so long, as those who speak it pronounce it in such a way as to be readily intelligible amongst themselves throughout the area in which the language is spoken. Local variants, or fashions of pronouncing, arise in proportion to the extent of the territory over which the language is spread, but so long as those who use these local variants are conscious that they are in the main using the same language, and provided that they continue to use the written language common to the rest of their compatriots, their speech will be regarded as a variant, a dialect, of the main language.

If, for political or other reasons, any one group of dialect speakers desires a linguistic tradition of their own, and propose to make a new written form of their pronunciation, embodying a new and local vocabulary, then the seed of a new language is sown. In the past, whenever a language has, through the political expansion of a nation, spread over an area larger than that which gave it birth, disintegration has set in, beginning with divergence of pronunciation, ending with the establishment of new languages. Thus Sanskrit has given birth to the Aryan languages of India—Hindi, Bengali, Marathi, Gujarati, etc.; Latin has given us Italian, Spanish, French, Portuguese and Rumanian.

4. Pronunciation and Nationality.—Speech habits, amongst which we must include habits of pronunciation, differ from language to language; there is however a certain measure of similarity between the pronunciation of the various languages of a language family; and the language families of the world differ among themselves as considerably in the matter of pronunciation as in any other respect. The clicks of the Hottentot Bushman languages are found only in certain of the Bantu languages. The cerebral consonants of the Aryan and Dravidian languages of India are seldom found in other language families. When a language takes over words from another language, embodies what we call foreign words, the pronunciation of such words will be made to fit in with the general scheme of pronunciation of the borrowing language. French words taken into English will receive English sounds, English rhythm, English stress and English intonation. The very considerable Arabic element in Persian is pronounced in the Persian way, for the pronunciation system of Persian has nothing in common with that of Arabic. So European words are squeezed into Japanese moulds.

It very seldom happens that a language will adopt exotic sounds, or embody in its system sounds other than those which are its linguistic heritage. Instances of this, however, do happen; the cerebral consonants of the Indo-Aryan languages, which are uncommon in the rest of the world, are presumed to have been taken over from the Dravidians. The Arabic ق is preserved in educated Urdu, but in Southern Urdu colloquial is replaced by χ (the sound of "ch" in "loch"), and in Persian, except in the case of speakers who are influenced by a knowledge of Arabic, it is generally replaced by ǥ (the sound of Arabic غ).

5. Representation of Pronunciation.—Among a civilised community, language consists of two forms—a series of sounds, and a series of visual symbols, or letters, representing sounds. This method of making a visual language is known as a phonetic method of writing, and the system of symbols used is known as an alphabet.

On the other hand the visual language may be made without any apparent reference to the pronunciation of the oral language. Such a system is known as an ideographic system.

Most of the languages of the world have a phonetic visual form, the important exception being Chinese. The most widely used alphabets are the Roman, the Arabic, and the Indian, each with certain additions and modifications. The Arabic alphabet, for instance, is made to represent such widely diverse phonetic systems, as those of Arabic, Malay, Hausa, Persian, Urdu, and, until recently, Turkish.

So it has come about that alphabets, designed to represent the pronunciation of specific languages spoken many centuries ago, have spread over the modern world, and are used to express the pronunciation of many languages that have nothing in common with the pronunciation systems for which they were designed.

Since, as has been said, sight and sound are irreconcilable, it follows that any attempt to represent by means of visual symbols things that have no visual existence will be at best but partially successful, and will rest upon a variety of conventions. Each symbol will originally do duty for one "sound"; various devices may be employed to indicate the relative length of sounds, if it is felt desirable to denote this feature of the pronunciation; the position of what is known as the stress or accent may, or may not, be marked; it may be evident from other data. The intonation is not as a rule indicated, but there are certain devices, such as punctuation marks, interrogation and exclamation marks, the use of a form of type differing from the rest, which are conventionally associated with certain features of the intonation. The phonetic medium, although evidently the most expedient, is a clumsy one for the general purpose of representing language, but it is the only one for representing pronunciation. The world's great alphabets are, as we have seen, in reality obsolete, because each was designed to represent the pronunciation of one language many centuries ago. When extended to other languages they have proved either inadequate or redundant. The Roman alphabet, suitable for a language like Latin with its simple system of five vowel sounds, is completely inadequate for English with its twelve vowel sounds. The Arabic alphabet, designed for the peculiar word formation of Arabic, with its scanty vowels and abundant consonants, is inadequate for the Persian vowel system, and redundant for the Persian consonant system. Similarly the Devanagari alphabet proves inadequate to represent the pronunciation of the modern Indian vernaculars.

When, for various reasons, the visual language is a poor representation of the existing state of the pronunciation of a language, the language is commonly said to be unphonetic. This means that there is an absence of regularity in the conventional relationship between sound and symbol, which may be due to the unsuitability of the alphabet, or to the fact that the visual language, having become established in popular use at some distant period, has refused to register the phonetic changes that have taken place since. Attempts to readjust the relationship between spelling and pronunciation are usually vigorously resisted in all languages, there being a universal desire, apparently, to see in the historical form of the visual language something either sacred, as in the case of Arabic, or etymologically valuable, as in the case of English. In some parts of the English speaking world tentative attempts at this readjustment, which is known as Spelling Reform, are being made.

Where, as in the case of many African languages, no traditional visual languages exist, systems of writing, usually with the Roman alphabet, less frequently with the Arabic alphabet, have been designed, but here again the inadequacy of the alphabets has proved a serious obstacle. The sound systems of the great African language families have nothing in common with the sound systems of Europe, and little in common with one another. It is interesting to note that there is now being designed a special alphabet, based largely on the Roman, suitable for the representation of the pronunciation of the principal African languages, and that literature using the new script is beginning to appear.

To remedy the deficiency of traditional alphabets, many more detailed and adequate visual systems have been designed for the representation of pronunciation. These are of four classes:—

(1) Based on no existing visual forms, *e.g.*, The Bell-Sweet system.
(2) Based on a code, *e.g.*, Jespersen's Analphabetic system.
(3) Based on existing Roman letters with abundant diacritical marks, *e.g.*, The Lepsius Alphabet.
(4) Based on existing Roman signs, but using new letters instead of diacritical marks, *e.g.*, The International Phonetic Association Alphabet.

One or other of these systems must be used when it is desired to describe a pronunciation in detail, as in pronouncing dictionaries, descriptions of languages, and in comparative philological works.

Phonetically there is little to choose between these systems, but recent investigation into their comparative merits would appear, upon psychological, pedagogical and typographical evidence, to favour alphabets of the fourth class.

6. Influence of Spelling upon Pronunciation.— There is observed, in the case of highly civilized and educated communities, where the majority of the speakers are familiar with the visual language, a very marked influence exerted by the visual language upon the pronunciation. The visual language, which was originally designed to represent the pronunciation, and to be subservient to it, tends to become the criterion of accuracy, and to dominate the pronunciation.

As familiarity with the visual language increases so a new standard of accuracy in pronunciation arises, namely, the printed word. This is very evident from a consideration of the pronunciation of English place names. Historical pronunciations are being abandoned in favour of pronunciations more in keeping with the visual forms, which become familiar only with the advent of postal and railway communication. Daventry is now pronounced as written, though a local pronunciation, Daintry, has existed for centuries. It is interesting to record these old pronunciations, but it is doubtful whether they can now be restored to general use. If Daintry is to be admitted at the expense of Daventry, then "ain't" must be given preference to "haven't," for the principle that governs the disappearance of the medial "v" is the same in both cases. The influence of the visual upon the spoken language is likely to be a prominent feature in determining the future pronunciation of language.

7. Standards of Pronunciation.— The impression that one form of pronunciation is "better" than all others appears to be common in the languages of most civilized communities; it is found even in the case of those African languages that have never been written. The prestige of this form of pronunciation varies from language to language, and the degree of adverse criticism levelled at those who do not use it varies from country to country. It is by no means certain that there is now, or that there has ever been at any time, in any language, with the possible exception of Classical Arabic, what is popularly called a standard pronunciation; but it is quite evident that the desire for such a criterion is widespread.

The greater the territorial extent of the nation, the greater will be the number of metropolitan centres; the more organized and complex the social life, the greater will be the number of social classes, each with its own conventions of pronunciation. Where, as in the case of English, separate nationalities, at different ends of the earth, speak the same language, there will tend to grow up in each centre of national life, a different ideal as to what is considered the most desirable pronunciation. There is no more evident manifestation of national entity than a national language, and a new national language will begin when any one of the national groups of the English-speaking world desires to establish a national standard of pronunciation at variance with that in vogue in the geographical area where the language was born. History tends to teach that disintegration was inevitable in the conditions that prevailed in the past; it may be checked by increased oral communication, increased intermingling of population, but most of all by the definite teaching throughout the area, of one form of pronunciation. This teaching has preserved the entity of Classical Arabic; it has not prevented the disintegration of the Arabic into the various colloquial pronunciations that prevail in the different parts of the Arabic-speaking world.

In England there are local variants and class variants of pronunciation. The higher we ascend the social scale in all districts, the greater the uniformity in the pronunciation. The uniformity of the educational system—public school and university—of certain social classes leads to a uniformity in the pronunciation of those classes. This type, provided it is free from pedantry and affectation, is generally regarded as the nearest approach to a standard pronunciation of southern English. It is the style of pronunciation heard most often in public speech, in parliament, in the church, in the law courts, in the universities and the public schools, and in such of the State schools as recruit their teaching staff from the ranks of those who use this style of pronunciation. In detail it may differ slightly from county to county. from school to school, from speaker to speaker, but in the main it is recognizable as one pronunciation. Those who use it have approximately the same vowels; its rhythm is the same wherever we hear it; its intonation follows the same general principle; it uses the same means to achieve the effects of emphasis: and it is characterized among other things, by a peculiar treatment of the "r" sound. In most of these respects southern pronunciation differs from what is known as northern pronunciation, and in all of them it differs from American and Canadian pronunciation which have their own vowels, their own rhythm, their own intonations, their own distinctive treatment of the "r" sound, which reacts in no uncertain manner upon their vowel systems. America and Canada have their own pronunciation problems, for their enormous geographical extent is giving rise to local varieties, and localized standards. There is no standard pronunciation of English in these countries, any more than there is in Great Britain. The increased use of inter-continental oral communication, by means of telephone and wireless broadcasting, the interchange of teachers and actors, the use of the speaking film, may tend towards a certain degree of uniformity in the pronunciation of the English-speaking world, but these must be supported by definite action on the part of those responsible in all countries for the teaching of the mother tongue. It is agreed that a uniform pronunciation of English is desirable, but it is by no means certain how it is to be brought about. A group of English and American linguists met in London in 1927 to discuss the matter.

In 1926 the British Broadcasting Corporation set up an Advisory Committee to deal with doubtful questions of English pronunciation, and to settle, in the case of (1) unfamiliar words, (2) words having alternative pronunciation of equal currency and authority, (3) foreign words, upon one pronunciation to be used by the official speakers of the Corporation. The first list of this committee's recommendations was published in 1928.

8. Change of Pronunciation. — The study of language reveals an inability, on the part of pronunciation, to persist unchanged in any given place, or community, over a long period of time. The universal law is change; during their lifetime languages change slowly, imperceptibly, but nevertheless surely. It is not possible to assign any adequate reason for this universal and eternal change. It is possible that the change has its origin in man's physical and mental limitations. The link that holds the speech of one generation to that of the next is but a feeble one; speech persists as a series of recollected auditory images, associated with certain kinesthetic movements, which are however of secondary importance as far as the speaker is concerned. He is more concerned with the expression of his thought than with the physical adjustments by means of which his thought receives audible expression. This combined mental and physical process appears to produce upon the mind of the listener impressions of a fugitive character, which are less durable than the impressions created by the combined visual and physical processes involved in the visual language. Speech, as such, perishes instantaneously, having no permanent existence, being handed on by oral tradition, and suffering, during the centuries, like all else that lives only by word of mouth. So pronunciation changes from age to age, partly because it hangs on so fragile a thread as man's aural memory, and partly because the unconscious physical processes that give rise to the sounds, in themselves suffer modification owing to the lack of consciousness with which they are controlled. "Pottage" and "porridge" are now different "words" They are in reality but two pronunciations of the same word, and the curious story of their separate existence can still be learnt by listening to the bus conductor who announces Swiss Cottage as Swiss "Corridge." It is probable that wider study will tend to establish the fact that a given speech sound, under given conditions, will always change in a certain way. But it must not be forgotten that it has hitherto proved impossible to define what is meant by the term "speech sound," and we should do well to remember that the governing conditions are likely to prove more complicated than they appear upon examination of cases that have happened in the past. The principles governing the change in vowel sounds, the formation of which involves no tactile sensation in the mouth, appear to have nothing in common with the principles governing the change of consonant sounds, in the formation of which there is definite contact between two parts of the mouth, or enough constriction to give an impression of contact.

g. Teaching of Pronunciation. — The study of the mother tongue, and of foreign languages, must, if it is to be sound, rest upon a knowledge of pronunciation, which lies at the root of things so widely apart as sentence structure, syntax, rhythm and systems of versification.

The teaching of pronunciation requires, on the part of the teacher, training of a highly specialized order, and it should not be considered that a teacher is competent to teach the pronunciation of a language merely because that language happens to be his mother tongue. We are all, without special training, unaware of the various features that constitute the pronunciation of our language; we become conscious that there is a highly complicated system underlying our pronunciation only when we hear the system disturbed by foreigners who speak our language badly, *i.e.,* with the pronunciation system of their own.

The pronunciation of most European languages has been studied on modern phonetic lines, and there is an abundance of reliable literature on the subject. Research into the phonetic structure of American, Asiatic and African languages is proceeding, and reference libraries of gramophone records of languages and dialects are being established in many universities.

Pronunciation of the mother tongue is taught in the principal centres of education in the countries of Europe and America. It has already been stated that the traditional pronunciation of Arabic, reputed to have been that used by Mohammed, is still regularly taught throughout the Mohammedan world.

In Europe we find, in the case of French, a traditional stage pronunciation taught at the Conservatoire in Paris, and used in the State Theatres and Opera House. In Germany an attempt has been made to standardize a form of German pronunciation suitable for the theatre throughout German-speaking countries.

No such attempt at standardization has been made in England or America. As far as England is concerned, the pronunciation current upon the stage is that used by the educated people in the south-eastern part of the country.

This pronunciation, with, however, a certain degree of latitude, is taught in England for use on the stage, in public speaking, and in singing In the universities and public schools of England the pronunciation is left to look after itself, but there is, however, a strong tradition as to what is and what is not permissible.

In the State schools there appears to be an awakening to the importance of equipping children with a form of pronunciation that will not prove a handicap in social life; and endeavours are being made to provide instruction.

10. Conclusion. — It is difficult to forecast the future, for we are faced with a new set of conditions. Increased speed of transport has made the world smaller; the complication of modern life leads to an international vocabulary; increased travel and increased oral communication familiarize us with hitherto unfamiliar pronunciations; the increase of education familiarizes millions with visual language, while wireless broadcasting tends to make the inhabitants of a widely spread linguistic area acquainted with a selected form of pronunciation. It is possible that these combined forces may tend to prevent linguistic disintegration of the principal languages of the modem world.

(A. Ll. J.)

PROOF, that which establishes the truth of a fact or the belief in the truth (*see* Logic). In law "proof" is the establishment of the facts in issue in a particular case, by proper legal means, to the satisfaction of the court (*see* Evidence) ; specifically, documents so attested as to form legal evidence, written copies of what a witness is prepared to support on oath, and the evidence of any case in the court records are all termed "proofs." In Scots law the term is used of a trial before a judge alone as opposed to trial by jury. A trial impression, in printing, on which corrections and additions can be made (*see* Proof-reading) and, in engraving and etching, one of a limited number of impressions made before the ordinary issue is printed, are known as "proofs." In the earlier history of engraving a "proof" was an impression during the process of printing made for the artist's inspection. In the modern use of the term, where the impression has been taken before the inscription has been added to the plate, it is called a "proof before letter."

PROOF-READING, the process of correcting for the press the printed "proofs" of articles or books or other matter before publication. The signs most commonly used in proof-reading follow:

Sign	Meaning	Sign	Meaning
	Delete	em |	Em dash
	Delete and close up	en |	En dash
	Reverse	; |	Insert semicolon
	Close up	(:)	Insert colon and en quad
#	Insert space	(.)	Insert period and en quad
¶	Paragraph	? |	Insert interrogation point
□	Indent one em	(?)	Query to author
[	Move to left	⌒	Use ligature
]	Move to right	(sp)	Spell out
	Lower	tr	Transpose
	Elevate	wf	Wrong font
∧	Insert marginal addition	bf	Set in **bold face** type
V∧	Even space	rom	Set in roman type
×	Broken letter	ital	Set in *italic* type
	Push down space	caps	Set in CAPITALS
—	Straighten line	sc	Set in SMALL CAPITALS
‖	Align type	lc	Set in lower case
	Insert comma		Lower-case letter
	Insert apostrophe	stet	Let it stand
	Insert quotes	no ¶	Run in same paragraph
=|	Hyphen	ld >	Insert lead between lines

PROOF SPIRIT. The term applied to standard mixtures of alcohol and water which form the basis of charge of Customs and Excise duties in Britain and elsewhere.

The Spirits Act of 1816 (Great Britain) in legalising Sikes' hydrometer for revenue purposes gave for the first time a legal definition of proof spirit as follows:—"that which at the temperature of 51° F weighs exactly % of an equal measure of distilled water." The act did not state the temperature of the water and considerable discussion has taken place on this point. Documentary evidence has been discovered recently which places beyond all doubt that the temperature of the water was intended to be 51° F. The most recent investigation has established the fact that, at 60° F, proof spirit has a specific gravity of 0·91976, compared with water at the same temperature, and that it contains 49.28 per cent by weight or 57·10 per cent by volume of alcohol.

The British Proof system is based upon volume percentage at 50° F. Owing to the difference in the rate of expansion of alcohol and water the volume composition of any mixture of these two substances varies with the temperature. The British system ignores this change and allocates to a mixture the volume percentage and therefore the proof strength appropriate to it at 50° F. Although not strictly correct at other temperatures, the system has the merit of being highly convenient to both the revenue authorities and the spirit trade. Spirits, at strengths other than "proof," may be described as containing a percentage of proof spirit or as being "over proof" or "under proof." The percentage of proof spirit is that number of volumes of Proof Spirit which can be obtained from one hundred volumes of the mixture Thus at 50° F 100 volumes of absolute alcohol if diluted with water to proof strength give 175·35 volumes. It is therefore said to contain 175·35% proof spirit or to have a strength of 75.35 over-proof. In order to ascertain the number of gallons of proof spirit equivalent to the alcohol contained in a mixture of known strength and volume the number of gallons of the mixture is multiplied by the percentage of proof spirit and divided by 100.

American proof spirit contains 50% by volume of Tralles' alcohol at 15·6° C (60° F). This alcohol is not quite anhydrous having a specific gravity, at 15·6° C, of 0·7946, as compared with 0·79359 for absolute alcohol. In the Dutch system Proof Spirit contains 50% of anhydrous alcohol at 15° C (59° F.)

(F. G. H. T.)

PROPAGANDA. The purpose of propaganda is to influence opinion and conduct. Between the purpose itself and the methods employed to attain it a distinction should be made, and also between the original meaning of "propaganda" and the meaning which the word has gradually acquired. Since the World War, when all belligerent countries undertook it as an adjunct to their diplomatic and military operations, propaganda has come to be looked upon as mere advocacy of special interests or as an attempt to gain credence for statements partially or wholly untrue. Though this meaning was, and still is, justified, it is not exhaustive, nor are coloured or partial presentations of a particular point of view necessarily the most effective form of propaganda.

In one form or another, propaganda is probably as old as mankind. Rulers of States and political leaders, the founders of religions, of schools of philosophy and of new social systems have usually sought to persuade others of the goodness of their ideas and deeds. The most notable instance is the injunction of the Founder of Christianity to the disciples—"Go ye into all the world and preach the gospel to every creature" (Mark XVI. 15.). Obeyed by the early Christians, this injunction was presently reflected in the official style of the committee of cardinals of the Roman Church in charge of foreign missions—*Congregatio* de propaganda *fide.* It is likewise held to warrant the activities of non-Catholic Christian missionary societies.

Other religions, especially Islam, have frequently sought to propagate their faith by persuasion or force. The sword was for long the most effective agency of Islamic propaganda—widened later by moral persuasion also—though Islam was by no means the first or the only religious creed to spread its doctrines by physical violence. The Hebrew scriptures contain many references to "the sword of the Lord." The spread of Christianity itself was hastened by military means—witness the campaigns in which Charlemagne imposed it upon pagan tribes, and the forcible conversion of Mexico and other countries of central and southern America by the Spanish Conquistadores and their successors. The papacy itself sanctioned wars and persecutions as means of propaganda; and the annals of protestantism are not wholly free from violent deeds. To propagate or to defend beliefs supposedly salutary was the purpose. The use of force was the means.

Propaganda Before the War.—Official propaganda, organised by Governments, is mainly a post-war undertaking. Before 1914 Germany alone among the great countries of the world carried it on systematically. While other countries and other Governments engaged, from time to time, in special propagandist campaigns for definite objects, German propaganda was continuous and widespread. It was carried on chiefly by the Press Bureau of the German Foreign Office among the representatives of foreign newspapers resident in Berlin; by foreign press bureaux and telegraph agencies affiliated to the German press bureau and to the German official telegraph agency; by the staffs of German embassies and legations abroad, and by the head offices of foreign branches of German banks and shipping companies. Its object was to spread impressions favourable to Germany, to secure the publication of German views in the press and, as far as possible, to prevent or to neutralise unfavourable comment upon or criticism of German policy and German affairs. One drawback of this kind of propaganda is that those who engage in it are apt to be its victims. They end by mistaking the impressions which they have sought to convey for the convictions of those who receive them, and therefore to misjudge the effects produced.

War Propaganda.—For some months after the war broke out

German propaganda had the field to itself. The Allied Governments were unprepared to meet it. Directly, by wireless, and indirectly from centres established in neutral countries, German versions of the causes of the war and of the aims of the belligerents were circulated throughout the world. Undeniable military successes gave point to many of the German claims. Some Allied Governments were so fearful lest these versions and claims undermine the confidence of their peoples that they forbade even the publication of the German military bulletins. In Great Britain a wiser course was followed. The German bulletins were issued to the Press by the British press bureau and were regularly published, in whole or in part, by British newspapers since they, like the Government, were confident that the public would assess the German statements at their true value. This system was, in itself, a form of counter-propaganda since it used the exaggerations or the inaccuracies of enemy bulletins to neutralise their effect and to enhance the belief of the British public that it was being told substantially the truth about the progress of the war.

In France, on the other hand, the press was not allowed to publish the German bulletins. The French Government thought the French people might suspect it of hiding the truth if another than its own version of events were issued. Consequently a demand arose in France for the French-Swiss newspapers which contained the German bulletins. In this way their effect as propaganda was actually increased, and served to strengthen the direct influence of the subtle "defeatist" propaganda which the clandestine agents of Germany carried on among the French people.

Allied Propaganda. — When the Allied Governments, in their turn, decided to organise propaganda, they found themselves at a disadvantage. Their organisations had to be improvised, whereas the German organisation had been set up in peace time and perfected in the early months of the war. Moreover, German propagandists understood that, in propaganda as in actual warfare, the initiative is precious and that the offensive is better than the defensive. At first, Allied propaganda was everywhere on the defensive. Its purpose was conceived as the correction of the misstatements sent out by the enemy. However truthful the denial of a misstatement may be, "a lie has long legs." The inferiority of Allied propaganda in this respect became evident to the public in neutral countries; and the position was not improved when the Allied and British organisations began to issue large quantities of dull literature to explain the purity of Allied intentions and the formidable character of British military preparations. To be effective, propagandist literature needs to be interesting. Compilations of figures and declarations of lofty purpose can make little headway against news so attractively embellished as to kindle the imaginations of those who read it. In its early phases British war propaganda was not merely ineffective but inept. It failed to realise that appeals to enemy and neutral opinion must take account of enemy and neutral standpoints. It assumed that arguments convincing to British minds would equally convince foreign minds.

Before 1914, war had been commonly looked upon as a legitimate method of promoting national interests. Yet, in 1914, the chief belligerent countries felt, almost instinctively, the importance of proving that they were guiltless of having caused the struggle. Nobody claimed credit for having planned it or forced it on. The German imperial chancellor admitted from the outset in the Reichstag, on Aug. 4, 1914, that Germany was doing "wrong" by invading neutral Belgium. He claimed that "necessity knows no law" and promised to make good the wrong "as soon as our military goal has been reached." Other German spokesmen and agents attempted to throw the blame first on England and then on Russia; while the Allied countries unanimously blamed Germany and Austria-Hungary. By degrees, the conquest of neutral opinion was seen to be almost as important as victory in the field.

With the recognition of this aspect of the struggle came the search for means of waging it. Here, again, Germany outdistanced her enemies. Neutral war correspondents were invited to accompany the German armies and to supplement the German military bulletins by ostensibly independent accounts of their own. The Allied military authorities long hesitated to follow this example. Strong pressure was needed to make them realise that the war was a war of peoples, and therefore of opinion, not solely a war between armies; that even their own peoples' enthusiasm for a "war in the dark" might wane; and that it was expedient to counteract the effect upon neutral opinion of reports from the German front by equally graphic reports from the Allied fronts, attested by the names of writers whom neutral countries would trust. Thus, very tardily, regular war correspondents were attached to the Allied armies for the enlightenment of the Allied peoples, while neutral correspondents of recognised standing were invited to see things for themselves. In this way the influence of German journalistic propaganda was gradually offset, and the significance of the war as a war of opinion was recognised.

Propaganda and Policy. — Yet it was not until the beginning of 1918, in the middle of the fourth year of the war, that the need for a propagandist offensive, not only in neutral countries but among the enemy peoples themselves, began to be felt by Allied Governments. Confronted with a position of stalemate in the field, and perplexed by the protraction of the struggle, they realized at last that propaganda, in itself, no matter how skilful its methods, would be futile unless it were the expression of a definite policy. Until then, the only policy of the Allied Governments had been to secure military victory. They had not seriously attempted to express their eventual victory in terms of a lasting peace, so as to give enemy peoples something to hope for as well as something to fear. True, the President of the United States, Woodrow Wilson, had taken a step in this direction when, in Dec. 1916, he had invited all the belligerents to define their war aims. The necessity of answering this invitation had compelled Germany and Austria-Hungary, on the one hand, and the Western European Allies, on the other, to state broadly what they were fighting for, lest failure to respond to the American invitation should influence adversely the opinion of the — still neutral — American people. But it was not until more than a year later that the British prime minister, D. Lloyd George, spontaneously issued a statement of British war aims on January 5, 1918, in the form of an outline of peace conditions. This statement, which was clearly propagandist, was followed, three days later, by an important American pronouncement. On Jan. 8, President Wilson delivered to a Joint Session of the American Congress an address containing his famous "Fourteen Points," or principles, on which the United States would insist in the negotiation of peace. Whether or not he conceived this address primarily as propaganda, its propagandist effect was immediate. Nowhere was it greater than in Austria-Hungary and Germany.

Propaganda Against the Enemy. — Shortly afterwards, the British Government decided to establish a special department for propaganda against the enemy. The late Lord Northcliffe was persuaded to take charge of it; and, acting under expert advice, he made it a condition that the statements to be disseminated by his department should correspond strictly to the policy which the Government was determined to follow. The condition having been accepted, his department drew up an outline of policy which was submitted for official sanction. Then the first inter-Allied propaganda conference was summoned to coordinate means of action on the basis of this policy. Its main postulate was that the Allied Governments should promise freedom and independence to the subject races in the Austro-Hungarian Monarchy and to the Poles of Prussia and Russia. To this postulate the British Government at first demurred. Not until after the great German offensive of March 21, 1918, did it assent. Then, under stress of circumstances, the postulate was admitted; and, in proclamations sanctioned by the congress of the oppressed Austro-Hungarian peoples held in Rome at the beginning of April 1918, the non-German and non-Magyar troops of Austria-Hungary on the Italian front, and their peoples in the interior, were assured of the Allies' determination to liberate them.

The effect exceeded expectations. The Austro-Hungarian front quickly showed signs of disintegration, and the Habsburg Monarchy itself began to totter. Austro-Hungarian soldiers belonging to the subject races came over into the Allied lines in Italy bring

ing valuable information. The efficacy of propaganda as an instrument of sound policy was proved; for the policy itself corresponded to the underlying facts of a situation which the Allied Governments had been reluctant to recognise. The result was not achieved merely by the propagandist method of passing resolutions at the Rome Congress of the oppressed Habsburg peoples or by that of disseminating paper manifestos among the Austro-Hungarian troops on the Italian front. The adoption of the policy which those resolutions and manifestos proclaimed was itself a sequel to steady propagandist work which had been carried on in Western Europe and in the United States by representatives of the subject Habsburg peoples, notably by Czechoslovaks like Professor Masaryk and Dr. Beneš; by refugees from the Southern Slav provinces of Austria-Hungary like M. Supilo and Dr. Trumbitch; and by prominent Poles like MM. de Paderewski and Dmowski. They had gradually educated public opinion in Allied countries to an understanding of the conditions indispensable to a lasting peace in Central Europe. From the outset their propaganda had been conceived in terms of policy, and their policy framed in accordance with historical and contemporary fact. In order to make fact more convincing, Professor Masaryk had gone to Russia in May 1917 where he had succeeded in raising a force, or legion, of nearly 50,000 men from the Czech and Slovak soldiers of the Austro-Hungarian army who had surrendered to the Russians; and, after the Bolshevist Revolution in Russia, he had decided that his legion should march from the Black Sea through Siberia to Vladivostok on its way to join the Allied forces in Western Europe. In the United States and in Europe the propagandist effect of this march was overwhelming. It was "propaganda by deed" on the largest scale.

Allied policy in regard to one enemy country, Austria-Hungary, having been settled—if only as a basis for propaganda, in the first instance—it remained to work out and to apply a policy for propaganda against Germany and the German army. Obviously this policy was bound to reflect the military and political situations; and not until these situations began to turn in favour of the Allies could it be effectively framed or pursued. Once again, inaccurate or merely "propagandist" statements were eschewed. It was recognised that, in the long run, truth alone is persuasive, and that declarations of intention must swiftly be substantiated by events. Therefore the leaflets, which were distributed by millions over the German lines in France and Flanders in the summer of 1918, bore, on one side, an accurate map of the front, indicating gains and losses of ground in recent fighting; and, on the other side, comments upon the situation in Germany taken from German newspapers which were not allowed to reach the troops at the front. In a short time the German rank and file, which knew how much ground they had gained or lost, were convinced that these leaflets were truthful; while the extracts from the German press gave them, for the first time, an inkling of the state of affairs on their "home front." In conjunction with the successes of the Allied armies, these leaflets demoralised the German forces to such an extent as seriously to perturb the German commanders.

Propaganda at the Peace Conference.—The demonstration that successful propaganda must express a definite policy and that policy must be framed in accordance with actual or prospective fact, remains as the chief lesson of Allied propagandist activities during the war. Yet the lesson was soon forgotten. While preparations for the Paris Peace Conference were being made, some Allied Governments resumed propaganda of the older and less truthful type in the hope of promoting their interests during the negotiation of peace. This propaganda vitiated the whole atmosphere of the peace conference. In the presence of propagandist maps, drawn to substantiate the conflicting territorial claims of a dozen peoples, President Wilson exclaimed, indignantly: "Bring me maps that do not overlap." Drawn, written or spoken inaccuracies were accompanied by intrigue and pressure until the responsible statesmen of Europe found themselves so enmeshed that their expert advisers could not wholly disentangle them. Had not the framework of a peace settlement been created by the necessities of policy, as a basis for propaganda, during the war, the peace conference might have failed to reach even an approximately equitable settlement. As it was, the force of facts was too strong to be entirely overcome by interested misrepresentation.

Post-war Propaganda.—For some years after the peace conference, propaganda of the less laudable kind continued. It surrounded every meeting of the Supreme Allied Council for the adjustment of post-war difficulties. Alongside of it ran persistent German propaganda of which the object was to disprove the charge that the Government of pre-war Germany had been especially responsible for the war. Among the German people this propaganda was highly successful, and it made some impression in Allied countries. A monumental collection of German diplomatic documents, covering the period between 1870 and 1914 was issued in more than 50 volumes. The British Government, in its turn, presently authorised a similar publication of its documents, and at length, the French Government decided to follow the German and the British examples. Gradually the distinction between good propaganda and bad was again recognised, and a preference was shown for impressive presentations of truth. Realising that the public is entitled to information, and that declarations susceptible of being controverted on the morrow have little lasting value, many Governments established central offices to supply information, and attached special officials to their embassies, legations and consulates abroad in order to furnish it. Even if the line of demarcation between information and propaganda has not been everywhere scrupulously observed by these agencies, the general tendency has undoubtedly been towards greater truthfulness—except in the case of propaganda emanating from Governments which have suppressed freedom of opinion in their own countries.

Russian Communist propaganda, in particular, has been wholly unscrupulous in its efforts to promote a world revolution; and Western Governments have been obliged repeatedly to insist, as a condition of normal relations with Russia, that it should cease. But, as often as this condition has been accepted, it has been violated, for revolutionary propaganda abroad is looked upon as essential to the maintenance of a "dictatorship of the proletariat" in Russia. In point of fact, the world has become, since the war, the scene of a contest between incompatible views of social and political organisations just as it was during the war an arena for contending opinions upon the aims of the belligerents.

Propaganda for Peace.—In substance, the principle at issue is whether or not force shall be recognised as the final arbiter in human affairs. Against the advocates of force, propaganda is being vigorously pursued for the promotion of international peace and for the elimination of violence from international relations. In many countries influential peace societies have been formed to urge peoples and Governments to abandon the very idea of resorting to force in their dealings with other Governments and peoples. This propaganda derived strength from the establishment of the League of Nations by the Peace Treaties; and the United States of America, though not a member of the League of Nations, promoted in 1928 the conclusion of a world-wide treaty to renounce war as an instrument of national policy.

The Outlawry of War.—Peace propagandists are agreed upon their main object—the prevention of war and the enthronement of law as the supreme arbiter between nations—but they differ upon the means of attaining it. Some hold it incompatible with the pacifist ideal to apply "sanctions," that is to say, coercive measures, against the warlike. Others believe that "sanctions" are as necessary in upholding international law as pains and penalties are recognised to be in vindicating the laws of individual communities. The founders of the League of Nations were convinced that some provision should be made to coerce Governments guilty of making war without submitting their claims in advance to mediation, arbitration or conciliation. For this reason "sanctions," economic and military, were contemplated in the League of Nations Covenant. On the other hand, the partisans of the "outlawry of war" urge that it would suffice to forbid war by international agreement. Only thus, they claim, can peoples and governments be brought to conceive international relations in terms of peace instead of in terms of war as the *ultima ratio*.

Between these two schools of thought, controversy has been lively and protracted. Propaganda for the definition of an eventual 'aggressor," on the one hand, and for the simple "outlawry of war" on the other, has been vigorously carried on; but the practical efficacy of the arguments advanced on both sides may depend upon political and economic circumstances. The increasing rapidity of communication between nations, and the inter-twining of their financial and commercial interests appear to operate in favour of peace. However strongly individual peoples may cling to their several rights and sovereignties, the leading nations feel that a violent clash between their aims and the aims of others might expose them to disaster if not to destruction. Circumstances are thus propitious to propaganda for peace, inasmuch as they tend to make it representative of sound policy; and, in the light of experience, this condition should suffice to ensure its success.

(H. W. S.)

For "Propaganda by Deed" see ANARCHISM, BAKUNIN, INTERNATIONAL, THE, and COMMUNISM.

PROPELLER. For a description of the propeller as applied to aircraft see the article AIRSCREW. For marine propellers, see SHIPBUILDING.

PROPERTIUS, SEXTUS (*fl.* 30–15 B.C.), the greatest of the elegiac poets of Rome, was born of a well-to-do Umbrian family at or near Asisium (Assisi), the birthplace also of the famous St. Francis. We learn from Ovid, that Propertius was his senior, but also his friend and companion; and that he was third in the sequence of elegiac poets, following Callus, who was born in 69 B.C., and Tibullus, and immediately preceding Ovid himself, who was born in 43 B.C. We shall not then be far wrong in supposing that he was born about 50 B.C. His early life was full of misfortune. He lost his father prematurely; and after the battle of Philippi and the return of Octavian to Rome, Propertius, like Virgil and Horace, was deprived of his estate to provide land for the veterans, but, unlike them, he had no patrons at court, and he was reduced from opulence to comparative indigence. The widespread discontent which the confiscations caused provoked the insurrection generally known as the *bellum perusinum* from its only important incident, the fierce and fatal resistance of Perusia, which deprived the poet of another of his relations, who was killed by brigands while making his escape from the lines of Octavian. The loss of his patrimony, however, thanks no doubt to his mother's providence, did not prevent Propertius from receiving a superior education. After, or it may be, during its completion he and she left Umbria for Rome; and there, about the year 34 B.C., he assumed the garb of manly freedom. He was urged to take up a pleader's profession; but, like Ovid, he found in letters and gallantry a more congenial pursuit. Soon afterwards he made the acquaintance of Lycinna, about whom we know little beyond the fact that she subsequently excited the jealousy of Cynthia, and was subjected to all her powers of persecution (vexandi). This passing fancy was succeeded by a serious attachment, the object of which was the famous "Cynthia." Her real name was Hostia, and she was a native of Tibur (iv. 7, 85; iii. 20, 8). She was a courtesan of the superior class, somewhat older than Propertius (ii. 18, 20) but, as it seems, a woman of singular beauty and varied accomplishments. Her own predilections led her to literature; and in her society Propertius found the intellectual sympathy and encouragement which were essential for the development of his powers. Her character, as depicted in the poems, is not an attractive one; but she seems to have entertained a genuine affection for her lover. The intimacy began in 28 and lasted till 23 B C. These six years must not, however, be supposed to have been a period of unbroken felicity. Apart from minor disagreements an infidelity on Propertius's part excited the deepest resentment in Cynthia; and he was banished for a year. The quarrel was made up about the beginning of 25 B.C.; and soon after Propertius published his first book of poems and inscribed it with the name of his mistress. Its publication placed him in the first rank of contemporary poets, and amongst other things procured him admission to the literary circle of Maecenas. The intimacy was renewed; but the old enchantment was lost. Neither Cynthia nor Propertius was faithful to the other. The mutual ardour gradually cooled; motives of prudence and decorum urged the discontinuance of the connection; and disillusion changed insensibly to disgust. Although this separation might have been expected to be final, it is not certain that it was so. It is true that Cynthia, whose health appears to have been weak, does not seem to have survived the separation long. But a careful study of the seventh poem of the last book, in which Propertius gives an account of a dream of her which he had after her death, leads us to the belief that they were once more reconciled, and that in her last illness Cynthia left to her former lover the duty of carrying out her wishes with regard to the disposal of her effects and the arrangements of her funeral. Almost nothing is known of the subsequent history of the poet. He was alive in 16 B.C., as some allusions in the last book testify. And two passages in the letters of the younger Pliny mention a descendant of the poet, one Passennus Paullus. Now, in 18 B.C. Augustus carried the *leges Iuliae,* which offered inducements to marriage and imposed disabilities upon the celibate. Propertius then may have been one of the first to comply with the new enactments. He would thus have married and had at least one child, from whom the contemporary of Pliny was descended.

Propertius had a large number of friends and acquaintances, chiefly literary, belonging to the circle of Maecenas. Amongst these may be mentioned Virgil, the epic poet Ponticus, Bassus (probably the iambic poet of the name), and at a later period Ovid. We hear nothing of Tibullus, nor of Horace, who also never mentions Propertius. This reciprocal silence is probably significant. In person Propertius was pale and thin, as was to be expected in one of a delicate and even sickly constitution. He was very careful about his personal appearance, and paid an almost foppish attention to dress and gait. He was of a somewhat voluptuous and self-indulgent temperament, which shrank from danger and active exertion. He was anxiously sensitive about the opinion of others, eager for their sympathy and regard, and, in general, impressionable to their influence. His over-emotional nature passed rapidly from one phase of feeling to another; but the more melancholy moods predominated. A vein of sadness runs through his poems, sometimes breaking out into querulous exclamation, but more frequently venting itself in gloomy reflections and prognostications. He had fits of superstition, which in healthier moments he despised.

The poems of Propertius, as they have come down to us, consist of four books containing 4,046 lines of elegiac verse. The first book, or Cynthia, was published separately and early in the poet's literary life. It may be assigned to 25 B.C. The dates of the publication of the rest are uncertain, but none of them was published before 24 B.C., and the last not before 16 B.C. The unusual length of the second one (1,402 lines) has led Lachmann and other critics to suppose that it originally consisted of two books, and they have placed the beginning of the third book at ii. 10, a poem addressed to Augustus, thus making five books, and this arrangement has been accepted by several editors.

The subjects of the poems are threefold: (1) amatory and personal, mostly regarding Cynthia—72 (60 Cynthia elegies), of which the last book contains three; (2) political and social, on events of the day—13, including three in the last book; (3) historical and antiquarian—six, of which five are in the last book.

The writings of Propertius are noted for their difficulty and their disorder. The workmanship is unequal, curtness alternating with redundance, and carelessness with elaboration. A desultory sequence of ideas, an excessive vagueness and indirectness of expression, a peculiar and abnormal latinity, a constant tendency to exaggeration, and an immoderate indulgence in learned and literary allusions—all these are obstacles lying in the way of a study of Propertius. But those who have the will and the patience to surmount them will find their trouble well repaid. For power and range of imagination. for freshness and vividness of conception, for truth and originality of presentation, few Roman poets can compare with him when he is at his best. And this is when he is carried out of himself, when the discordant qualities of his genius are, so to say, fused together by the electric spark of an immediate inspiration. His vanity and egotism are undeniable, but they are redeemed by his fancy and his humour.

Two of his merits seem to have impressed the ancients themselves. The first is most obvious in the scenes of quiet description and emotion in whose presentation he particularly excels. Softness of outline, warmth of colouring, a fine and almost voluptuous feeling for beauty of every kind, and a pleading and melancholy tenderness—such were the elements of the spell which he threw round the sympathies of his reader, and which his compatriots expressed by the vague but expressive word *blanditia.* His poetic *facundia,* or command of striking and appropriate language, is more noticeable still. Not only is his vocabulary very extensive, but his employment of it extraordinarily bold and unconventional. New settings of use, idiom and construction continually surprise us, and, in spite of occasional harshness, secure for his style an unusual freshness and freedom. His handling of the elegiac couplet, and especially of its second line, deserves especial recognition. It is vigorous, varied and even picturesque. In the matter of the rhythms, caesuras and elisions which it allows, the metrical treatment is much more severe than that of Catullus, whose elegiacs are comparatively rude and barbarous; but it is not bound hand and foot, like the Ovidian distich, in a formal and conventional system. An elaborate symmetry is observable in the construction of many of his elegies, and this has tempted critics to divide a number of them into strophes.

Propertius's poems bear evident marks of the study of his predecessors, both Greek and Latin, and of the influence of his contemporaries. He tells us himself that Callimachus and Philetas were his masters (iii. 1, seq.), and that it was his ambition to be the Roman Callimachus (iv. 1, 64). But, as Teuffel has said, his debt to these writers is chiefly a formal one. Even into his mythological learning he breathes a life to which these dry scholars are strangers. We can trace obligations to Meleager, Theocritus, Apollonius, Rhodius and other Alexandrines, and amongst earlier writers to Homer, Pindar, Aeschylus and others. Propertius's influence upon his successors was considerable. There is hardly a page of Ovid which does not show obligations to his poems, while other writers made a more sparing use of him.

BIBLIOGRAPHY.—There is no existing ms. of Propertius older than the 12th century. Up till the publication of Bahrens's edition (1880), the oldest one, Neapolitanus (N., now at Wolfenbiittel), was universally regarded as the best, and even now critics are found to maintain its paramount claims. But the more judicious admit the value of the four mss. collated by Bahrens. Vossianus, *c.* 1300 (A); Laurentianus, end of the 14th century (F); Ottoboniano-Vaticanus, 15th century (V); Daventriensis, 15th century (D), to which has to be added the Holkhamicus, 1421 (L), collated by Postgate, *Cambridge Philological Transactions* (1894) vol. iv.

The *editio princeps* of Propertius is that of 1472 (Venice). Among later editions we may mention the following, those with explanatory or critical notes being marked with an asterisk: *Scaliger (1577, etc.), *Broukhusius (2nd ed., 1577), *Passeratius (1608, with *index verborum*), *Vulpius (1755, with *index verborum*), *P. Burmann (and Santen) (1780), *Lachmann (1816), *Hertzberg (1843–1845), L. Müller (1870), Haupt-Vahlen (last ed., 1904), *Bährens (1880), *A. Palmer (1880), *Postgate (1881), selections with introduction (text with critical notes in the *Corpus poetarum latinorum,* 1905, also issued separately), *Rothstein (1898), *H. E. Butler (1905) and with translation in Loeb library (1912) *index verborum* (to his own text), J. S. Phillimore (1911), Hosius (1911 and 1922). A. E. Housman (without publishing an edition) has done much to improve and explain the poems. For further information we may refer to F. Plessis, *Études critiques sur Properce et ses élégies* (1886), and to Teuffel's and Schanz's *Histories of Roman Literature.*

The following translations into English verse are known G. F. Nott (1782), bk. i.; C. A. Alton, selections in his *Specimens of the Classic Poets* (1814), ii. 21; *scq.;* C. R. Moore (1870); J. Cranstoun (1875); F. A. Paley (1866), verse translations from bk. v. with notes; also a few translations by the poet Gray, vol. i. (Gosse 1884); S. G. Tremenheere (1899), bk. 1. Prose translations: P. J. F. Gantillon (with Nott's and Elton's versions, Bohn, 1848); J. S. Phillimore (1906). (J. P. P.)

PROPERTY: *see* COMPENSATION, CONVEYANCING, PERSONAL PROPERTY, LAWS RELATING TO REAL PROPERTY AND CONVEYANCING.

PROPERTY, DEVOLUTION OF: *see* INTESTACY, LEGITIMACY AND LEGITIMATION; WILL.

PROPERTY, LAW OF: see LAWS RELATING TO REAL PROPERTY AND CONVEYANCING.

PROPERTY, PRIMITIVE. Property is bound up with every aspect of social life. It gives a stimulus to economic effort, enters into questions of marriage, family life, and inheritance, forms the subject of legal judgments, provides compensation for offences, and acts as a frequent incentive to war. It is held in goods such as food, clothing and weapons; and immaterial items (songs, personal names, mythological tales, magical spells, social offices) are in many communities a matter for precise ownership. The tie between man and property is often not one of mere economic interest; the basis of attachment is of the nature of a sentiment, a complex set of emotional considerations centring in the object. Thus to the Maori his tribal land is his greatest treasure, a fact which is illustrated by many proverbial sayings, *e.g.,* "The blood of man is the land" or "Man perishes but the land remains." This love of his ancestral soil is a factor which greatly complicates the economic aspect of alienation. The association of ownership with a tie of sentiment is common to other primitive communities, as with the Lango and their cattle.

The precise meaning of ownership is different in every culture, varying according to custom, tradition and the relative social status of those who enjoy its privileges. Failure to recognize the essential nature of the primitive conception of ownership has led to the formulation of many unreal hypotheses in anthropology—and, in the practical sphere, to misunderstanding and conflict between native and white man.

Primitive Communism.—From a partial study of the evidence, certain social theorists, as Friedrich Engels, were lured by their political ideals—for which this notion formed a useful precedent—to advance the thesis that the most primitive form of ownership was communism. This idea was championed on more scientific grounds by W. H. R. Rivers, who thought he had discovered in Melanesia evidence for the existence of a communistic type of economy marked by a lack of differentiation of personal interests. The institutions of every primitive people show a much closer relation between the individual and his group than that which animates European culture, and a greater readiness (inspired by custom) to yield to the corporate claims of the society. Thus among the Gilyak the catch after fishing is freely divided among the members of the community, even families which have taken no part in the work receiving a share. Yet at the same time private ownership is distinctly recognized in such articles as swords, shields, etc. Among the Mekeo people, again, a pig, an item of family property, is seldom killed except by command of a chief. At the same time the close grip retained by communal interests upon even a man's personal property does not indicate any sweeping suppression of his individuality. Communism, if this term be employed, signifies not a lack of recognition of individual interests, but a conscious subordination of them in major affairs—under the pressure of custom and public opinion—to the control of the group as a whole. That the process is one of integration of interests, not mere blind absence of any sense of individuality, is shown by the existence of complicated individual claims and privileges within the sphere of communal ownership. Thus in the case of the Melanesian canoe, the management of which was adduced by Rivers as a proof of communism, the deeper researches of Dr. Malinowski reveal a complex system of control with one man as master of the vessel and paramount owner, the others having lesser shares, each well defined, and all having specified duties and responsibilities to their fellow members. No irrational, undifferentiated absorption of the individual in the group can be discovered. This position is supported by the results of intensive research in material from Old Peru, Australia and New Zealand, while study of the problem of ownership in more general context suggests that this blend of "communism" with individualism is characteristic of all primitive society.

Land Tenure.—These conclusions apply also to the specific case of ownership in land, the precise system of which varies according to the economic conditions and social structure of the community concerned. Among hunting peoples the measure of tribal control of the territory over which they range appears to be fairly communal, though even here, as in the case of the north-eastern Algonkin tribes or the Vedda of Ceylon, the portion of land on which each family catches game may be very sharply demarcated and protected by heavy penalties from intrusion on the part of neighbours. With changes in the form of economy the partition of interests varies, until among people such as the Melanesians the delimitation of rights allows of ownership of the land by one man and of the fruit trees upon it by another. Again, a person's admitted status as an owner is often qualified by rights of other people, such as relatives, the chief or the village magician, to certain portions of the produce. The key to the understanding of a system of native land tenure lies in realizing the inadequacy of such simple labels as "communistic" or "individualistic" and in grasping the complex scheme of titles, claims, privileges and obligations on the part of individuals and the community with which the native himself invests the control of the soil.

Attempts have been made by Kohler, de Laveleye, Lafargue, Biicher, Lewinski and others to group the various types of ownership in a chronological sequence, to trace their origins, and on this basis to lay down theories of the evolutionary development of the idea of property. Such efforts, however, lack reality, and the undoubted contributions of these writers have come incidentally from their descriptive and analytical studies.

BIBLIOGRAPHY.—E. de Laveleye, *De la Propriété* (5th ed., 1901); W. H. R. Rivers, *History of Melanesian Society* (2 vols., 1914), *Psychology and Politics* (1923); J. H. Driberg, *The Lango* (1923); G. Pitt-Rivers, *The Clash of Culture* (1927); R. Firth, *Primitive Economics of the New Zealand Maori* (1928); More general: R. H. Lowie, *Primitive Society* (1920); B. Malinowski, *Argonauts of Western Pacific* (1922), *Crime and Custom in Savage Society* (1926); R. Thurnwald, articles "Eigentum" "Kommunismus," etc. in M. Ebert's *Reallexikon der Vorgeschichte* (1924–27); O. Leroy, *Essai critique à l'Etude de l'Economie primitive* (1925). (R. F.)

PROPHET (προφήτης), a Greek word used in the Greek Old Testament to translate the Hebrew *Nābī* נביא and consequently adopted into other European languages. In classical Greek it denoted one who, uttering or interpreting an oracle, was believed to speak not his own thoughts but a revelation "from without"; cf. the description of Cassandra (Agam.) and the Prophet of Apollo (*Eumen.*), by Aeschylus; of the blind seer, Teiresias, by Sophocles (Oed. *Tyr.*), and by Euripides (*Bacchae*); of the Cumaean Sibyl, by Virgil (Aen vi.); and note Plato, *Timaeus* 71 b., where he argues that persons who seek to give rational meaning to oracles "are not to be called prophets at all," but only those who speak in ecstasy. At the Delphic Oracle, however, not the frantic priestess, the Pythia, was designated "prophet," but the Guardians of the Shrine who ostensibly shaped her frenzied ejaculations into comprehensible replies. Etymologically προφήτης denoted "forth-telling," not "fore-telling"; but since προ could mean "before" in time, and since prophecies constantly dealt with future events and foreknowledge is not deemed to occur in conditions of normal consciousness, the notion that prediction and ecstasy are the essential elements in prophecy was an easy growth. Thus in the Hellenic period Philo of Alexandria looked on divination and oracular interpretation as imposture, but had high regard for the ecstatic who "speaks nothing of his own." Προφήτης was the best word available in Greek, for rendering the Hebrew Ndbi (it was preferable to μάντις), but the Hellenistic view of prophecy as ecstatic prediction obscured for centuries the wealth of religious interest in the Hebrew prophets. Why προφήτης was used to translate *hm-ntr,* the title of certain Egyptian priests, is unascertained.

HEBREW PROPHECY

The Hebrew noun Ndbi ("Prophet," *pl. Nebi'im*) is obscure in origin. Derivations implying intense excitement (נבע "to bubble up"; נבע Assyr., "to fall in transports") are etymologically improbable. The verbal form (an intensive) used in Hebrew often denotes frenzy or even lunscy, but this may reflect merely one aspect of prophetic development, and the fact that it is an intensive stem may imply simply that it is a loan-word in Hebrew. Conceivably it is not Semitic at all—there are Hittite possibilities. The likeliest Semitic connections are Arab. naba'a "to announce" (conjug. ii.); Bab.-Assyr. *nabû* "to name" (cf. the god, Nebo, Is. xlvi. 1). Ndbi, like προφήτης, may thus in origin be a colourless term: "One who utters a god-given message."

The **Fanatical** Prophets.—From a trustworthy narrative in I Sam. x. we learn that bands of prophets (Nebi'im), devotees of the national deity, Jehovah (Yahweh), existed c. 1000 B.C. at Hebrew localities (Gibeah, Ramah). Stimulated by rhythmic music, dancing and chanting, they wrought themselves into ecstasies when their frenzied behaviour and abnormal physical power exercised hypnotic effect over onlookers (I. Sam. x. 5–13), and, as it seemed to testify the might of the god whose spirit possessed them, encouraged popular trust in Jehovah and resistance to the Philistines. Since there is no earlier reference to collective prophesying in Hebrew history (Nu. xi. 25 *sqq.* cannot be regarded as of the Mosaic age), probably it was a feature of Palestinian-Syrian religion, first evoked in Israel in Samuel's time. There is no direct evidence for Wellhausen's assertion that "among the Canaanites such Nebi'im had long been familiar" but the indirect evidence is impressive. An Egyptian record (*c.* 1100 B.C.) relates how an envoy, Wenamon, secured a hearing when a youth in attendance on a Phoenician prince prophesied ecstatically in Wenamon's favour. Very instructive is the famous passage in I. Kings xviii. 19 sqq. concerning the 850 prophets of the (Phoenician?) Baal and of the Asherah, maintained by Queen Jezebel. At a much later period the orgiastic rites celebrated by devotees in honour of certain ostensibly Greek deities (Apollo, Dionysos) prove to have connections with the Baal worship of Syria and Phoenicia (so T. H. Robinson). When parallel phenomena are still exhibited by the dervish fraternities in Islam, it seems probable that this form of religious excitement was peculiarly congenial to the peoples of Western Asia Minor, and may well have been of immemorial antiquity in Palestine.

Certain it is that fanatical prophets became a feature of Israelitish society. They are mentioned in connection with many towns of special sanctity and importance, *e.g.,* Bethel, Jericho, Samaria. Possibly they had some organization (the phrase "schools of the prophets" has no warrant), and were supported by popular piety or by kings anxious to obtain inspired counsel in perilous moments. Along with the priests and the wise men, they were esteemed one of the three indispensable sources for the guidance of the State (Jer. xviii. 18). Even in the post-exilic period they lingered on, distinctive by their rough mantle and leathern girdle, mouthing out oracles for the superstitious (cf. the χρησμολόγος in Aristophanes, *Birds,* 959 *sqq.*)—so great a public nuisance that father and mother are exhorted to slay the son turned "prophet" (Zech. xiii. 3). The causes of degeneracy can be discerned. Thanks to Eastern respect for the psychologically abnormal, the calling afforded a livelihood and might attract impostors, for it was easy to share in, or simulate, ecstasy, and declare "Thus saith Jehovah." The violent emotions were dangerous to the moral stability of even the honest Nebi'im, and if simpler means of inducing ecstasy failed, the temptation to use noxious drugs was great.

The fanatical prophets, it may be concluded, manifested a real patriotism that helped to establish the State during the Philistine and the Syrian conflicts, but contributed nothing to the discernment of those dynamic religious beliefs which, as the power of Assyria and Babylon rose and engulfed the petty monarchies of Israel and Judah, alone made possible the astounding survival of the Jewish nation.

The Seer.—But the word Ndbi acquired a wider connotation. Later than the age of Samuel it came to be applied to persons who in earlier times would have been called Seers (*Rō'eh,* "Visionary"; or *Hōzeh,* "Gazer": I Sam. ix. 9). The Seer, ubiquitous in antiquity and ranging in dignity from the itinerant soothsayer to the guardian of some famous sanctuary, was credited with power, through interpretation of omens or (more impressively) through trance-visions, to gain knowledge from a spiritual being inaccessible to ordinary men: he was, as others were not, a "man of God." Balaam (Nu. xxii.–xxiv.) is typical: "essentially an Arab *Kāhin* or seer of that early type which combined the priest's offices of ritual and sacrifice, the diviner's reliance on omens and lots, and the prophet's experience of ecstasy and dreams" (G. A. Smith). The possibilities in the calling for good and evil are obvious. Affinities with the baser forms of divination—wizardry, necromancy, etc.—were close, and degenerate seers became only too numerous in Israel (Is. ii. 6, Mic. iii. 7), notwithstanding a strong tradition that such arts were peculiarly abhorrent to the God of Israel (I Sam. xxviii. 3, sqq. Ex. xxii. 18, Is. viii. 19). But the famous seers created the expectation of individuals in mysterious contact with God, "standing in his counsel," "knowing his secret," whose words should therefore have absolute authority in hours of crisis. Much more than the Nebi'im with their collective "inspiration," the seer is of the lineage of the great prophets. Yet a distinction may be drawn. The ordinary seer made his powers his profession and livelihood (Am. vii. 12), and his functioning was habitually passive: he waited to be consulted. The great prophets were men of diverse callings, driven by an irresistible constraint actively to declare to Israel the word of its God. Thus to his contemporaries Samuel was not one of the Nebi'im but the Priest-Seer of Ramah, whom a Saul could consult about strayed animals. Later generations rightly accounted him a prophet of the great type because of his initiative in rousing the people against the Philistines, in creating a monarchy, and later in rejecting Saul for David.

The Higher Prophecy.— But all the seers and prophets of antiquity would have but infinitesimal interest, were it not for the appearance in Israel of certain individuals of amazing spiritual insight, whom we, like their contemporaries, for lack of a better word must call "prophets." Their work and words endow Prophecy with almost inexhaustible importance for religion and for social organization. The diversity of the occupations and circles to which these higher prophets belonged is significant. A few, especially in the earlier period, pertained to the professional prophetic class: Samuel was a famous seer, Gad and Nathan official prophets of David's court, Micaiah one of the recognized Nebi'im (I Kings xxii.—a passage which should be studied). But Elisha was a prosperous farmer, Amos a shepherd of Judaea, Isaiah a citizen of Jerusalem, Micah a Judaean villager, Jeremiah a youth of ancient priestly family, Ezekiel a priest of the Temple. The unifying characteristic is that to each came an overmastering conviction that, temporarily or permanently, he must forsake his way of life and declare what God would say to His people. Their prophesying was the constraint of a vocation, not the pursuit of a profession. When their teaching is coordinated certain principles they held in common can be analysed (see articles on the several prophetical Books, HEBREW RELIGION, etc.) with results sufficiently impressive. But such surveys are meagre and mechanical: what counts is the stress of circumstance from which the great ideas were won, and the heroic application of beliefs to events. Knowledge of Hebrew prophecy is knowledge of the lives of glorious personalities; only when name after name of the prophets calls up the memory of lonely insight into truth, of unbreakable loyalty to duty, maintained through scorn and hatred and despite despair, can its splendour be realized.

Historical Development. — Complex as are the Pentateuchal narratives concerning Moses, it seems certain that an influential section of the mixed population under the Hebrew monarchies held a tradition that a great leader of prophetic character (yet not an ordinary seer, Nu. xii. 6–8; but such as Samuel had been, a man whom a Hosea or Jeremiah could call a Prophet, Ho. xii. 13, Jer. xv. 1) had led their ancestors out of Egypt to the independence of the desert, and had fired them with such confidence in the God Jehovah as had given them the unity necessary for a successful assault on Canaan. However dimly recalled, and by however few, the tradition of Moses, it may be held, preserved potent ideas: that Jehovah required a standard of morality that differentiated Him from other gods, and that in Moses himself — remembered as a life of splendid patience and mercy, of unswerving integrity and awe-inspiring intimacy with the invisible God — there had been seen a true servant of Jehovah. Subsequently in Canaan the leadership of Samuel not only established the national existence, but created in the popular consciousness the sense that their kingdom was truly, and not nominally, a theocracy, where kings must heed the word spoken by God's prophets to an extent startling in the ancient East (I. Kings xxi. $). The vigilance of prophetic censorship over the dynasty was notably displayed against David (by Gad and Nathan), against Solomon (by Ahijah), against Rehoboam (by Shemaiah); and momentously in Flijah's adamantine opposition to Ahab and Jezebel, whereby the alliance with Phoenicia was broken and Israel left to face unsupported the impending attack by Damascus.

The deep motives in the higher prophecy now became apparent. Not by political wisdom was Elijah actuated, but solely by an imperious religious instinct which swept aside all other considerations in the assertion that Jehovah demands an absolutely exclusive worship, and that He champions the rights of the humblest against even the king. This principle holds good throughout. Attempts (cf. Winckler) to explain the actions and attitude (*e.g.*) of Isaiah or Jeremiah primarily by political foresight or predilections can be shown in detail to be misconceived. Prophecy had created the nation, and wished to sustain it; not, however, in the interests of the nation, but in the interests of its God. The important account of Elijah's flight to Horeb, I. Kings xix. (taken in conjunction with the sequel: Elijah's sense of a commission to anoint Jehu king over Israel, and Hazael over Syria, followed by the achievement of those ends by Elisha, his disciple, and by high-minded prophets) shows that the parable read by Elijah in the quiet of the enduring mountain, following the storm, was not that the ways of God are gentleness alone, but on the contrary that the prophet's resolve to overthrow the house of Ahab must be pursued to its bitter end through revolution in Israel and war with Syria. The nation must pass through the tumult: thereafter the unalterable good purpose of its God would be apparent. In face of the grim realities of evil true religion must send first not peace but a sword.

The Golden Age.—A century later (c. 750 B.C.) the Golden Age of Hebrew prophecy, wherein the universal aspects of religious truth were perceived as the real significance of Israel's national faith in Jehovah, began with the oracles of Amos and Hosea in Northern Israel, to be continued in Judah, especially by Isaiah, Micah and Jeremiah. For Amos there is but one God of the whole earth, controller of other nations as well as Israel, whose favour everywhere is determined solely by such concern for moral conduct that not even the wrongs of a slave go unheeded by Him. Amos is styled the "Prophet of the Justice of God," but the phrase is wholly inadequate. Positive goodness, forbearance, mercy, kindness are the inexorable divine demand. Between Jehovah and Israel a special relation exists; but the implication is not (as the people imagine) favouritism, but responsibility: "to whom much is given, of them shall much be required" (Am. iii. 2). Faced by the iniquities of their times, earlier prophets had assailed the dynasty at whatever risk to the national fortunes; but Amos, appalled by corruptions that rotted society from top to bottom, uttered logically a judgment almost incomprehensible to the ancient mind — God will bring overwhelming ruin upon the nation itself (Am. vi.–ix. passim). Lastly, Amos marks a new era for religion by his special declaration that the immemorial forms of worship — sacrifices, fasts and feasts — are sheer futility: God is to be sought not through material offerings, but spiritually in upright and generous conduct (Am. v. 5, 14, 21–24). Here is the enunciation practically, if not also theoretically, of ethical monotheism. The profundity of these beliefs, which thenceforth became the gospel of the higher prophets, needs no emphasising. Not unjustly Amos has been called the forerunner of Kant.

To Hosea love seemed fundamental in the attitude of God to Israel. Deeper than the necessity for moral retribution lay the divine love. It has been observed that Amos and Hosea significantly complement one another; they "form a pair — law and love" (S. A. Cook).

Taught, it would seem, by some poignant personal experience, Hosea agonized with the dilemma: God must shatter the sinful nation, yet to do so would seem to end his gracious purpose in defeat (Ho. xi. 8, 9). What if the disaster, which is sure, be after all a means to an end—πάθει μάθος? Out of the ashes of Retribution, Hope must rise (Ho. ii. 15). Far more deeply than Amos, Hosea probed the problem of sin. The cultus was not merely futile; it was a prime source of iniquity, and must be abolished. He pities the masses; they sin indeed, but it is for lack of knowledge (Ho. ii. 8) Thus was prophecy released from pessimism. However near and overwhelming the "day of the Lord" in judgment, the prophet must exhort men to penitence and belief in an ultimate divine salvation.

The view (Gressmann, Gunkel) that Amos and his successors inherited a cut-and-dry eschatological expectation of woe followed by bliss—whether derived from native Israelite sources (Sellin) or influenced by Egyptian (Ed. Meyer) or Babylonian literature—rests on inadequate or misinterpreted evidence. The message of doom announced by Amos was startling to his hearers, and it would seem that the higher prophets' anticipation of some impending judgment catastrophic yet congruous with an undefeated divine purpose was radically the unaided product of their own reflection on the righteousness, power and goodness of God. In Hosea and Isaiah the element of hope beyond catastrophe is prominent. Whether it was conceived very vaguely, or more definitely (Messianic) depends on the dubious authenticity of certain passages (see APOCALYPSE, MESSIAH). For the achievement of an order of perfect righteousness apocalyptic cataclysm is, in reality, irrelevant; since love cannot be compelled. In their passionate pleading for reform the prophets were feeling their way to a deeper comprehension, which at last was attained when Jeremiah based his hope of a divine consummation simply on faith in God's effecting the moral regeneration of the human heart (Jer. xxxi. 31–34).

Isaiah *and Jeremiah.*—The task which lay before the great prophets of Judah (c. 740–586 B.C.)—who, in contrast to the facile optimism of the ordinary prophets "healing lightly the hurt of the daughter of Zion," continued convinced that the ruin of the State was at hand—was to discover how faith in Jehovah could survive the political destruction. In effecting this infinitely difficult task it was their sublime achievement "to liberate the eternal truths of religion from their temporary national embodiment, and disclose their true foundation in the immutable character of God and the essential nature of Man" (Skinner).

To Isaiah is due the conception of an Israel within Israel, a believing nucleus; a "Church of God." Convinced that he knew the mind and power of the living God ("Mine eyes have seen the King, the Lord of Hosts," Is. vi. 5), he reasserted on a higher level the earlier prophetic claim to control the national policy. Thorough social reform must accompany quiet trust in God, and in Him alone, for the fate of the nation (cf. Is. xxx. 15). Assyria is resistless, not in virtue of its vaunted might but because it is the weapon in Yahweh's hand against his sinful people (Is. x.). Whatever sufferings it inflicts in invading Judah will be the discipline of divine wisdom, and will leave behind a purified remnant of the faithful in Zion, through whom God's purpose shall be fulfilled (cf. Is. x. 2—23, xxviii. 16). Rejected by king and people, apparently he gave substance to his hopes by seeking disciples who accepted his principles (Is. viii. 16). At the crisis of the Assyrian invasion (701 B.c.?), he foretold the inviolability of Zion and this momentary form of his teaching was preserved in popular memory superstitiously apart from its spirit and the moral conditions on which his doctrine of Faith (Trust) rested (cf. Jer. vii. 1–15).

"Prophecy had already taught its truths, its last effort was to reveal itself in a life"—the life of Jeremiah. Living through the dreadful years which saw the two successful sieges of Jerusalem by the Babylonian armies, ending in the destruction of the city and temple and the deportation of its chief inhabitants, Jeremiah found himself forced either to utter unrelieved predictions of ruin to a people distracted alternately with panic and delusive relief, or, being silent, to deny the conviction of inspired knowledge that burned like a fire in his bones. The task entailed for him desperate loneliness, hatred and persecution—sufficient torment to a man of shrinking and sensitive temperament. But further he was tortured at times by doubt of his inspiration. Was he but self-deceived or even deceived of God? Were the confident prophets of peace right? And if the nation perished, how could the worship of Jehovah survive? "Hitherto there had been nations with their religions, but there never had been in the world a religion without a nation to act as its embodiment" (A. C. Welch). Out of the agony of his perplexity, preserved in some infinitely moving passages (Jer. xv. 10–18, xviii. 9, 10, 14–18, xx. 7–18) came the solution: recognition of how wonderful was the fact of the relation between his conscious self and the Divine Being he longed to serve. In his ultimate peace in God and victory over "fears without and fightings within," we mark the beginning of the modern view of religious faith. Whatever the function of the nations in God's sight, no conception of a moral God is credible unless the unit of divine interest be the human personality. Jeremiah had discovered that, wheresoever men live, they may find God, if in humility they do justice and love mercy. So he wrote (xxix. 4–14) to the exiles in Babylonia to live there that life of goodness which the prophets had seen to be the worship God desires: a momentous letter, for in the acceptance of his belief lay the continuance of the Jewish race, and the future of religion. "The spirit of Jeremiah, which breathed out on his people after his death, bore fruit in an experience of fellowship with God which satisfied the deepest aspirations of the human soul" (Skinner).

It was now conceivable that religion might survive the State. The last act of the higher prophecy was to give effect to the possibility. Through the constructive idealism of Ezekiel, and the magnificent, monotheistic, oracles preserved in Is. xl.–lv., and no less through the courage and insight of Haggai and Zechariah, whose exhortations effected the rebuilding of the temple in Jerusalem (520 B.c.) and thus set religion in the forefront of the renascent community's life, the Jews—sole link between the ancient Semitic empires and the new era of Persian and Greek domination—began both to preserve their identity in exilic settlements, and in Palestine to revive as a people increasingly conscious that it existed through, and for, its distinctive faith.

The Achievement of Prophecy.—The prophets were thus the saviours of their people. But their achievement should be realized in a wider setting. In their declaration of monotheistic belief and social idealism the world received an interpretation of human life applicable to every people and every age.

Ethical *Monotheism.* For intelligent men they shattered for ever the mental and moral dangers of polydaemonism and polytheism, proclaiming instead the reality of one only God, to be conceived as the infinitude of moral perfection. If modern terminology is permissible, they held both the transcendence and the immanence of God, and whatever the philosophical obscurities, this doctrine of God, as not less than "personal" in His relation to us, has been the succour of the human spirit, and the source of high and generous virtue for Western civilization. The precise stage at which monolatry (God as the only Being his people must worship, but one among other gods) rose into the pure monotheism patent in II. Isaiah—whether it goes back to Amos, to Elijah, to Moses—cannot be determined; for who shall measure genius? Perhaps the question is wrongly put. In antiquity no one ceased to believe in the existence of many spiritual beings (cf. Eph, vi. 12), and practical monotheism was achieved whenever it was felt that there is but one creative Spirit, alone meriting worship, other "gods" being wrong conceptions of God as He truly is, or lesser Spirits who beguile men's worship, and their images assuredly "non-entities," the works of men's hands.

The Worth of *the Individual.* The prophets discovered the immeasureable worth of human personality. It may be that not until Jeremiah did the significance of the individual's aspiration towards God become vividly apparent; but his experience was creative, and thereafter, aided by Ezekiel's teaching concerning individual responsibility, the instincts of personal piety were liberated to reach out, even through the problem of death, into deeper confidence in Man's worth to God. But this religion of the individual, the product of Prophecy's fundamental thinking and genius for ultimate values, was in no wise individualistic. The heart of prophetic doctrine had been insistence that the will of God is to create a world-order of perfect justice, and that, so long as the moral obligations of each and all go unhonoured, and the lowliest is denied mercy and kindness. there shall be no peace for Man. To the prophets therefore we owe that inestimable incentive for good, the idea of the "Kingdom of God" as the goal of social order.

Worship. "In primitive life," wrote Robertson Smith, "all spiritual and ethical ideas are still wrapped in the husk of a material embodiment. To free the spiritual truth from the husk was the great task that lay before the ancient religions . . . but none of the ritual systems of antiquity was able by natural development to shake itself free from the congenital defect inherent in every attempt to embody spiritual truth in material forms. A ritual system must always remain materialistic, even if its materialism is disguised under the cloak of mysticism." (Religion of the Semites, ed. S. A. Cook, whose note, p. 676, should be studied.) The prophets' criticism of worship was revolutionary, but fundamental and constructive, because they saw with absolute lucidity that true worship is a relation of personality, therefore spiritually, and not materially, determined. The human spirit can so use, or regard, material objects that (with vigilance) they may be symbolically or aesthetically helpful to the communion of God and man; but the material must never under any circumstances be treated as in itself an indispensable aid, or barrier, to the reception of divine influence by man. To suppose so is fatally to misapprehend the essential nature of a personal relationship. The prophets were clear: "God's favour is to be found by man's becoming, like Himself, just and merciful . . . Not gifts but fellowship, and the way to fellowship lay not through the sacrificial system re-interpreted, but through conduct; not gifts but justice, not sacrifice but mercy" (G. Buchanan Gray, Sacrifice, p. 44).

Privilege. The prophets did not abandon the old idea of Israel as a nation privileged of God; but they transfigured it by the contention that privilege is responsibility, election a call to service. And prophecy itself culminated in the vocation of Jeremiah to a life of sorrow and suffering, heroically accepted for a nation that hated him; and secondly, in the Servant-Songs of II. Isaiah (see ISAIAH) where the function of Israel is conceived as a self-sacrificial consecration, through unparalleled trials, for the redemption of mankind.

Knowledge of God. There were very many prophets in Israel. How came it that the few advanced towards a rational faith, and the many—equally convinced that their "Word" was from the Lord—failed? To whom, and why, is revelation given? Here again Jeremiah is illuminating. No outward criteria, he felt, avail to discern the true from the false prophets. Ultimately he saw that they were not sensitive, as he was, to the moral obliquity around them, or alive to the evil in their own heart; and he rested at last on the faith that if he surrendered himself absolutely to God's service, accepting whatever loneliness, pains or even death it might entail, God would speak truly through him (Jer. xv. 19). But this attitude had been the basic fact regarding all the great prophets; diverse in many ways, they were men of absolute sincerity and self-surrender. The example of their character is the last and greatest gift of the prophets to mankind, for it is the clue to sound religious experience everywhere: "the pure in heart shall see God."

The Prophetic Consciousness.—Until as late as the 17th century A.D., interest in the prophetic writings was almost exclusively concentrated on the predictive element.

As to this aspect, it should be noted that there are indeed instances of fulfilled presentiments (*e.g.*, Ez. xxxiii. 21, 22), and close correspondences of events with prophetic anticipations; but the prophets are wronged when, as is still sometimes maintained, the validity of their inspiration is felt to depend crucially on fulfilment of predictions, instead of broadly on the rightness of their interpretation of Life as ethical duty, dependent on the reality of the living God. The Suffering Servant anticipates Jesus Christ because the prophet was inspired by the vision of a life of absolute self-sacrifice, and Jesus accepted the conditions of that life and endured its issues. After the Reformation recognition of the poetical form of the prophetic literature led to the necessary analysis of the Books bearing the prophets' names. Criticism in the 19th century was marked by enthusiasm for the prophets as preachers of social righteousness; but present research, psychological and historical, reveals them primarily as men of religious genius, who must be studied in intimate connection with their Eastern environment. Recently it is urged (especially Hölscher) that the inner experiences, and outward behaviour, of the great prophets were closely akin to the ecstasies of the early Nebi'im. Certainly the subconscious is a highly important consideration in studying Hebrew prophecy, but the theory has been pushed to extremes and is sometimes maintained by grotesque forcing of the evidence. There ought to be more careful discrimination of terms, and "ecstasy" reserved for conditions in which the subject has lost all control of mind and body. Stress, inducing at times trance, with audition and vision, is exemplified in the great prophets (especially the "Call" experiences, cf. Is. vi.); but to argue that these men virtually never felt conviction break on them at any less intense level of the infinite gradations of emotion, never saw an illuminating parable in nature, never employed a symbolic action, unless in a state of uncontrolled ecstasy, is to go too far. There are indications that they distrusted increasingly the fervours of their opponents (so A. B. Davidson). Whatever resemblances they had to the ordinary prophets, it is the profound differences that will repay study. The extreme forms of the theory are ruled out by the grand consistency of the great prophets: the coherence of their teaching is the supreme psychological fact; and either the oracles we possess are the record of passionate but conscious reflection, or in these men conditions existed which caused the subconscious to produce the rational and the relevant to an unpsralleled extent. In any event, an Amos or an Isaiah is infinitely better understood by the analogy of Paul, with his vision on the Damascus road and his enthusiastic yet controlled temperament, than of the ecstatic seer or frenzied Nebi'im. It is true that the Hebrew prophet says, never "I saw," "I know," but "The Lord shewed me," "Thus saith Jehovah." Explanation is found in the psychological ideas which he shared with his contemporaries. H. Wheeler Robinson rightly emphasizes that Man was regarded as intimately dependent on God in his psychical as well as his physical properties; his "breath-soul" open to the invasion of spirits divine and demonic. Hence not only in the trance-experience, but under any intense emotional stress the Hebrew felt that he had "become another man," the "spirit of the Lord had laid hold upon him"; so that it is easy to realize sympathetically why the prophet was convinced that he spake never of himself but as "the messenger of Him that sent me."

The Prophetic Succession.—Hebrew prophecy possesses the unity of a single movement, having origin, development and climax. It ended not in exhaustion, but in the liberation of energy, manifested in personal piety, in efforts to systematize the great ideas (Judaism), and in inextinguishable Hope of a divine purpose in the world (Apocalypse). Hebrew Prophecy recurs not, but "true" prophets—called by many names, Saint, Preacher, Reformer, Scholar—have not ceased to be; for it was part of the work of prophecy to reveal that "all the Lord's people should be prophets," and that the prophet is he for whom God is the living God. Whenever discernment of truth in new aspects is imperative, the interpreting prophetic personality is prominent, and is ever the vitalizing element in religion Amidst the turmoil at the close of the last century B.C. and the first A.D., it is easy to see why individuals appeared who were manifestly prophetic in type—John the Baptist, Jesus Christ (though the term be inadequate for Him), Paul, Johanan ben Zakkai.

PROPHETS IN THE CHRISTIAN CHURCH

In the nascent organization of the Christian communities (Acts xi. 27, Eph. iv. 11, 1. Cor. xii. 28) prophets are mentioned, ranking next to the Apostles. Sometimes itinerant, sometimes settled in one locality, they were the evangelists of the early Church, credited with a direct spiritual inspiration (χάρισμα) for enlightenment and edification. Men can be appointed to an office; they cannot be appointed to prophecy. The conviction that in Christ all things were made new evoked minds sensitive to spiritual issues.

Therein the Christian prophets were in the true succession; but in all else how different from the lonely Hebrew seers. The Christian prophets were expected to provide intelligible utterances (1. Cor. xiv. 32), and were thus differentiated from the ecstatic "speaker in tongues," whilst they were also distinct from the permanent local officials—catechists, deacons, presbyters, bishops. From the valuable information in the *Didache* it appears that the high regard felt for them lasted fully a century; yet their position was always precarious. Sane enthusiasm might lapse into futile ecstasy (1. Cor. xiv. 29–33). Hypocrites might simulate the gift—the *Didache* insists that the prophet is worthy of maintenance and respect only if his piety is indubitable, and his conduct "worthy of the Lord." The prestige of the permanent officials increased in comparison with the occasional prophet, whose sole virtue seemed to be his edifying speech. But that gift might also be found among the regular ministers: and if so, how preferable! Lastly the zeal of the prophets might claim an authority, or make ascetic demands, on the Church which roused antagonism. At the end of the 2nd century the wild prophesying in the Montanist party (significantly of Phrygian origin) hastened the end. Armed with the now-accepted Canon of Holy Scripture ("the law and the prophets until John"), the authorities ruled that "Ecstasy was of the devil not of God" and that "Prophets must not accept gifts," and ere long they ceased as a distinctive class in the Church's organization.

BIBLIOGRAPHY.—The literature on this subject is so extensive that only a selection of important, or recent, works can here be cited. In addition to commentaries on the several prophets, and discussions in volumes dealing generally with the Religion of Israel, *see* W. R. Smith's *Prophets of Israel* (2nd ed., with notes by Cheyne, 1895); A. B. Davidson, art. "Prophecy" in Hasting's *Dict. Bib.* (1902); C. F. Kent, *Israel's Prophets* (Students O. T., 1910); *G. A.* Smith, *Early Poetry of Israel* (1910); Sellin, *A.* T. *Prophetismus* (Leipzig, 1912); G. Holscher, *Die Propheten* (Leipzig, 1914); M. Buttenwieser, *Prophets of Israel (N.Y., 1914)*; A. R. Gordon, *Prophets of the O.T.* (1916); E. König, art. "Prophecy, Hebrew," in E.R.E. (1918); Welch, *Visions of the End* (1922); Duhm, *Israel's Profeten* (2nd ed., Tubingen, 1922); Skinner, *Prophecy and Religion* (1922); *T.* H. Robinson, *Prophecy and the Prophets* (with bibliography by Peake) 1923; Peake, *Roots of Hebrew Prophecy* (1923); Wiener, *Prophets of Israel* (1923); S. A. Cook, in *Cambridge Ancient History,* vol. iii. (with bibliography, p. 736) 1925; J. M. P. Smith, *Prophets of Israel* (1925); Micklem, *Prophecy and Eschatology* (1926); and Fascher, Προφήτης (1927). On Hebrew psychology in relation to the prophets, H. Wheeler Robinson, *Christian Doctrine of Man* (1913), and arts. in *The People and the Book* (1925) and *O.T. Essays* (1927). On prophets in the Christian Church, *see* Selwyn, *The Christian Prophets* (1900); Mitchell, art. "Prophecy, Christian," in *E.R.E.* (1918).

(W. A. L. E.)

PROPIOLIC ACID, colourless crystals melting at 6° C and boiling at 144° C, soluble in water, with an odour like that of acetic acid. It has the constitution of acetylenemonocarboxylicacid, $HC{:}C{\cdot}CO_2H$, and is of interest as being the prototype of *ortho*-nitrophenylpropiolic acid, a substance prepared by the action of alcoholic potash on *ortho*-nitrocinnamic acid dibromide (A. v. Baeyer, 1880). This *ortho*-nitrophenylpropiolic acid, which crystallises in needles decomposing at 153–156° C, is readily converted into indigo (*q.v.*). Propiolic acid itself is obtained by the following reactions: Succinic acid is brominated, and dibromosuccinic acid by the action of alcoholic potash yields acetylenedicarboxylic acid, $CO_2H{\cdot}C{:}C{\cdot}CO_2H$. This acid or its monopotassium salt on boiling with water loses carbon dioxide, and propiolic acid is produced. On exposure to light it polymerises into trimesic acid (benzene-I:3:5-tricarboxylic acid).

PROPORTIONAL REPRESENTATION, an electoral arrangement designed to secure that the representative assembly shall be an exact reflection, a "snapshot," of the voting strength of parties among the electorate. The case for the system is fundamentally the case for representative government. Every trace of opinion, be it ever so small, ought to be represented in the legislature as near as possible to its proportional mathematical claim. That, and nothing else, is true democracy. The system first obtained principal support through the advocacy of John Stuart Mill who, about the middle of the 19th century, recommended the Hare system, on the ground that democracy must be especially careful that minorities get their appropriate representation. The appeal of this argument has been widespread and there are few democratic countries to-day which are without some such system.

The *Second* Ballet *system,* as practised in France, provides that, if there is not an absolute majority for any one candidate in the first poll, the bottom candidates shall be struck out and the two top candidates shall proceed to a second contest. This system raises political difficulties since the period between the first and second ballot is employed in unsavoury intrigues. To obviate these difficulties the Australian States use the system known as the Alternative Vote, which requires an absolute majority and where there is only one ballot, in which the voter instead of marking his choice with an X, marks the candidates in the order of his preference (whence Preferential Vote system), 1, 2, 3, etc.; and then the returning officer eliminates the bottom candidates in turn, distributing among the top candidates the preferences marked on the eliminated ballots.

These two systems attempt to correct the main defects of a single-member constituency: proportional representation proper seeks a more radical and creative end. It desires the creation of large constituencies with a number of seats. In the English Proportional Representation society's suggested programme, called the "Single Transferable Vote," a constituency of at least 300,000 inhabitants is suggested and at least five seats. In the German system prevailing since 1919, the constituencies average nearly one million electors, and 15 or 16 representatives. The severalty of representatives makes it possible for any well-knit minority with a quota of votes, *i.e.,* the lowest number required, in the circumstances, to get representation. Votes cast for a member shall not be lost to the party if he personally should fail, for they are transferred or accredited to other members of the party who hold them to make up the quota. This can be done in a number of ways. The system advocated in England is that the voter shall be free to indicate his preference by numbers against the long list of candidates, the returning officer then distributing the surplus preferences of successful candidates and those with no chance among those who are designated by the preferences, until all the seats are filled by those with quotas. This system leaves the voter free of party dictation. The Belgian system has a party list which the voter may either adopt as it stands or vary the order of the candidates—but he cannot vote outside the party which he has chosen. The parties (and the members) get the mathematical share of the seats to which their aggregate vote entitles them, measured by the d'Hondt system. In Germany the variation of the party list as determined by the party machine is not allowed, and each party gets one representative for each 60,000 votes it secures, while fractions of 60,000 are added together for each party (within certain limits) and again for each such 60,000 the party is permitted to nominate an extra member.

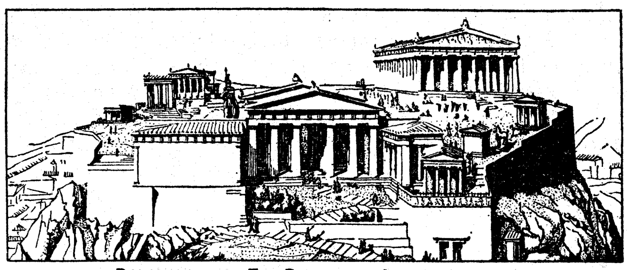
The merits, regarded from the standpoint of equity, are obvious. The demerits of the systems as they operate in Europe are these: (1) The personal contact between member and constituency is reduced; in its place the party machine rules by deciding the order of candidates on the list, and by requiring teamwork among candidates which results in the "star" man helping in the mediocrities. (2) A premium is placed upon the use of mechanical devices to make electors go to the poll—this is a direct result of a large constituency. (3) Small parties are kept in existence, which seriously disturbs the process of parliamentary government where a compact and single party majority in office faced by an opposition similarly constituted is thought to give the best results.

BIBLIOGRAPHY.—J. H. Humphreys, *Proportional Representation* (1911) and *Practical Aspects of Electoral Reform* (1922); *H.* Finer, *The Case against Proportional Representation,* Fabian Soc. Tract (1924); *A.* Headlam-Morley, *The New Democratic Constitutions of Europe* (1928). *See* also: *Representation,* the journal of the Proportional Representation Society (1908, etc.). (H. Fi.)

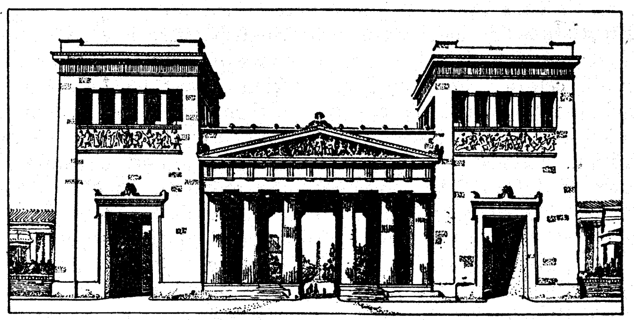
PROPOSITION, in logic, means usually the verbal expression of a judgment (*q.v.*). Propositions like judgments, are classified in various ways. See CATEGORY, JUDGMENT, LOGIC.

PROPYLAEA, the name given to a porch or gate-house, at the entrance of a sacred or other enclosure in Greece; these usually consisted, in their simplest form, of a porch supported by columns both without and within the actual gate. The name is especially given to the great entrance hall of the Acropolis at Athens, which was begun in 437 B.C. by Pericles, to take the place of an earlier gateway. Owing probably to political difficulties and to the outbreak of the Peloponnesian War, the building was never completed according to the original plans; but the portion that was built was among the chief glories of Athens, and afforded a model to many subsequent imitators. The architect was Mnesicles; the material Pentelic marble, with Eleusinian blackstone for dados and other details.

The plan of the Propylaea consists of a large square hall, from which five steps lead up to a wall pierced by five gateways of



(MNESICLES, ARCH.) RESTORATION OF THE PROPYLAEA, ATHENS (437 B.C.)



(LEO VON KLENZE, ARCH.) THE PROPYLAEA AT MUNICH, GERMANY, 1862

graduated sizes, the central one giving passage to a road suitable for beasts or vehicles. On the inner side towards the Acropolis, this wall is faced with a portico of six Doric columns. At the other end of the great hall is a similar portico facing outwards; and between this and the doors the hall is divided into three aisles by rows of Ionic columns. The western or outer front is flanked on each side by a projecting wing, with a row of three smaller Doric columns between Antae at right angles to the main portico. The north wing is completed by a square chamber which served as a picture gallery; but the south wing contains no corresponding chamber, and its plan has evidently been curtailed; its front projected beyond its covered area, and it is finished in what was evidently a provisional way on the side of the bastion before the little temple of Victory (Nike).

From this and other indications Prof. Dorpfeld has inferred that the original plan of Mnesicles was to complete the south wing on a plan symmetrical with that of the north wing, but opening by a portico on to the bastion to the west; and to add on the inner side of the Propylaea two great halls, faced by porticoes almost in a line with the main portico, but with smaller columns. This is questionable as it would have interfered with sacred objects such as the precinct of Artemis Brauronia and the altar of Nike. Nevertheless, the unfinished surface of the walls and the rough bosses left on many of the blocks show that the building was never completed. The Propylaea were approached in Greek times by a zig-zag path, terraced along the rock; this was superseded in Roman times by a broad flight of steps. In mediaeval times the Propylaea served as the palace of the dukes of Athens; they were much damaged by the explosion of a powder magazine in 1656. The tower, of Frankish or Turkish date, that stood on the south wing, was pulled down in 1874.

The term is also applied to various monumental gateways of modern times, especially in Germany. Outstanding examples are: the propylaea at Munich, by von Klenze (finished 1862), with sculpture by Schefzky; and that in Berlin, also known as the Brandenburger Tor, by Langhaus (1784), which was directly inspired by the propylaea at Athens.

See R. Bohn, *Die Propylaeen der Akropolis zu Athen* (1882); W. Dorpfeld, articles in *Mittheilungen d. d. Inst. Athen.* (1885) vol. x.
(E. GR.)

PROPYL ALCOHOLS, two compounds of this name, with the same formula C_3H_7OH exist, and both come into prominence in connection with modern developments of industrial organic chemistry.

Normal *propyl* alcohol, $CH_3{\cdot}CH_2{\cdot}CH_2{\cdot}OH$, is now obtainable as a by-product in the synthesis of methyl alcohol (*q.v.*) by condensing carbon monoxide and hydrogen in presence of a zinc-chromite or zinc-cobalt-chromite catalyst at 400° C under 200 atmospheres pressure. (See PRESSURE CHEMISTRY.) It is a colourless fragrant liquid boiling at 97·4° C and miscible with water in all proportions. It cannot be separated from water by distillation since the two compounds form an azeotropic mixture. (See DISTILLATION.) n-Propyl alcohol occurs in fusel oil and may be prepared by any of the synthetic methods applicable to primary alcohols. (See ALCOHOL.)

Iso-propyl alcohol, $(CH_3)_2CH{\cdot}OH$, is now manufactured on an extensive scale from propylene, $CH_3{:}CH{:}CH_2$, obtained by the cracking of petroleum. (See OLEFINES.) This olefine is absorbed in sulphuric acid, the liquid diluted with water and distilled, when isopropyl alcohol is obtained. It is a colourless, fragrant liquid boiling at 82·7° C. It is used industrially in the extraction of alkaloids and other compounds of therapeutic interest.

PROPYLON, in architecture, a small pylon, or monumental gateway, in front of a larger gateway or pylon (*q.v.*), especially in Egyptian architecture, in which the propylon is frequently a single truncated pyramidal form with the gateway in its centre.

PROROGATION, a postponement, specifically, in Great Britain, the termination without dissolution of a session of parliament by discontinuing the meetings until the next session. A prorogation of parliament affects both houses, and thus differs from an "adjournment," which does not terminate the session and is effected by each house separately by resolution.

PROSCENIUM, originally, in the Greek theatre, the entire area of the stage between the back wall or *σκηνή* (Latin scena), and the orchestra. In the modern theatre the word proscenium is used particularly in connection with the arch (proscenium arch) framing the stage.

PROSE, the plain speech of mankind, when written or composed without reference to the rules of verse. It has been usual to distinguish prose very definitely from poetry (*q.v.*). Ronsard said that to him prose and poetry were "mortal enemies." But "poetry" is a more or less metaphysical term, which cannot be used without danger. For instance, an ill-inspired work in rhyme cannot be said to be poetry, and yet most certainly is not prose. On the other hand, a work of highly wrought non-metrical writing is often called a prose-poem. This shows that the antithesis between prose and poetry is not complete. Prose, therefore, is best defined as comprising all forms of careful literary expression which are not metrically versified, and hence the definition from *prorsus* (direct or straight), the notion being that it is straight and plain, and is used for stating precisely that which is true in reason or fact.

Prose, however, is not everything that is loosely said. True, it is the result of conversation, but that conversation is not necessarily, nor often, prose. Prose is not the negation of all laws of speech; it rejects merely those which depend upon metre. What its laws are is not easy to say. But this is plain; as prose depends on the linking of successive sentences, the first requirement is that these sentences should be lucidly arranged. In prose, that the meaning should be given is the primal necessity. But as it is found that a dull, clumsy, monotonous arrangement of sentences is fatal to the attention of the listener or reader, it is needful that to plainness should be added various attractions and ornaments. The sentences must be built up in a manner which displays variety and flexibility. There should be a harmony, and even a rhythm, in the progress of style, care being taken that this rhythm and this harmony are not recognizably metrical. Again, the colour and form of adjectives, and their sufficient yet not excessive recurrence, is an important factor in the construction of prose. The omission of certain faults, too, is essential. In every language grammatical correctness is obligatory. Here we see a distinction between mere conversation, which is loose, fragmentary and often even ungrammatical; and prose, which is bound to weed away whatever is slovenly, and to watch closely lest merely colloquial expressions should slip in. What is required is a moderate and reasonable elevation without bombast or bathos. Not everything that is loosely said is prose, and the celebrated phrase of M. Jourdain is not exactly true, for all the loose phrases which M. Jourdain had used in his life, though they were certainly not verse, were not prose either. We must be content to say that prose is literary expression not subjected to any species of metrical law.

Greek.—The beginnings of Greek prose are very obscure. It is probable that they took the form of inscriptions, and gradually developed into historical and topographical records. We come down to something definite when we reach Hecataeus and Herodorus; and, although their writings have disappeared, we know enough to see that by the 5th century B.C. the use of prose in its modern sense had been established. We even know the character of the style of Hecataeus, and we hear of its clearness, its grammatical purity, its individuality—qualities which have been valued ever since. These writers were succeeded by Hellanicus, who wrote many historical books now lost, and by Herodotus, whose noble storehouse of chronicle and legend is our earliest monument of European prose. When once non-metrical language could be used as by Herodotus, it was plain that all departments of human knowledge were open to it. But it is in Ionia and the Asiatic islands that we find it cultivated by philosophers and critics. The earliest of these masters of prose survive only in much later records of their opinions; in philosophy the actual writings of Thales, Anaximander, Pythagoras and Empedocles are lost, and it is likely that their cosmological rhapsodies were at least partly metrical. We come into clearer air when we cross to Attica: Thucydides' priceless work has most fortunately come down to us; and Xenophon continued it in the spirit of Thucydides, and carried Greek prose to a great height of easy distinction. But it is in philosophy that prose in Greece gains flexibility and-variety, proving itself an unsurpassed vehicle for the finest human thought. The philosopher Plato is the greatest prose writer of Greece, and, in the view of many well qualified to judge, of the world. In his dialogues we see what splendour, what elasticity, what exactitude, this means of expression had in so short a time developed; how little there was for later prose-writers to add. The rhetoricians were even more highly admired by antiquity than the philosophers, and ancient, unlike modern, opinion would perhaps have set Demosthenes higher than Plato. In Aristotle we see the conscious art of prose-writing subordinated to the preservation and explanation of facts, and after Aristotle's day there is little to record in a hasty outline.

Latin.—The Romans obeyed the universal law by cultivating verse long before they essayed the writing of prose. The earliest historians of whom we have definite knowledge, Fabius Pictor and Cincius Alimentus, wrote in Greek. The earliest annalist who wrote in Latin was Hemina; the works of all these historians are lost. A great deal of primitive Roman prose was occupied with jurisprudence and political oratory. By universal consent the first master of Latin prose was Cato, the loss of whose chief works is to be deplored; we possess from his pen only a treatise on agriculture. In the next generation we are told that oratory was carried to the highest point by Marcus Antonius and Licinius Crassus—"by a happy chance their styles were exactly complementary to one another." Unfortunately none but inconsiderable fragments survive to display their qualities. Happily, however, those qualities were combined in a man of genius, whose writings have come down to us; this is Cicero, whose prose exhibits the Latin language to no less advantage than Plato's does the Greek. From 70 to 60 B.C. Cicero's literary work lay mainly in the field of rhetoric; after his exile he was chiefly occupied with theoretical treatises. The beautiful essays of his old age comprise two little masterpieces, *De amicitia* and *De senectute* (45 B.C.). It is to the collection of the private letters of Cicero, published after his death by Atticus and Tiro, that we owe our intimate knowledge of the age in which he lived, and these have ever since been held models of epistolary prose. Of Cicero's greatest contemporary, Julius Caesar, much less has been preserved, and this is unfortunate because Roman critical opinion placed him among the very chief of prose-writers; but we retain his *Commentaries.* The prose of Sallust, who followed Caesar, is hard, brief and sententious. The writers who succeeded him neglected these qualities, and Latin prose became more diffuse and rhetorical. But it was wielded by one writer of the highest genius, Titus Livius, who enriched the tissue of Latin prose with ornament which hitherto had been confined to poetry; this enables him "to advance without flagging through the long and intricate narrative where a simpler diction must necessarily have grown monotonous" (Mackail). The periodic structure of Latin prose, which had been developed by Cicero, was carried even further by Livy. The style of Pollio, who wrote a *History of the Civil Laws,* was much admired, and the loss of this work must be deplored. A different species of prose, the *plebeius sermo,* or colloquial speech of the poor, is partly preserved in the fragments of a Neronian writer, Petronius Arbiter. Of the Latin prose-writers of the silver age, Seneca, Quintilian and Tacitus, nothing need here be said.

English.—The independence of English prose is a fact which rests on a firm basis. "The Code of Laws of King Ine" dates from the 8th century, and there are various other legal documents which may be hardly literature in themselves, but which are worded in a way that seems to denote the existence of a literary tradition. After the Danish invasion, Latin almost ceased to be known, and translations began to be required. In 887, Alfred wrote in English, with the help of scholars, his *Hand-Book;* this, probably the earliest specimen of finished English prose, is unhappily lost. His English version of the *Cura pastoralis* was probably completed in 890. Later still Alfred produced translations from Bede, Orosius, Boethius and other Latin authors, and, in 900, closing a translation from St. Augustine, we read "Here end the sayings of King Alfred." The prose of Alfred is simple and clear without pretension. After him the first name of eminence which we encounter is that of Aelfric, who, about 997, began to translate, or rather to paraphrase, certain portions of the Bible into a very finished English. A little later vigorous prose was put forth by Wulfstan, archbishop of York (d. 1023). At the Conquest, the progress of English prose was violently checked, and, as has been said, it "was just kept alive, but only like a man in catalepsy." The *Annals* of Winchester, Worcester and Peterborough were carried on in English until 1154. Except in a few remote monasteries, English ceased to be used, even for religious purposes, and the literature became exclusively Latin or French. We may perhaps say that modern English prose begins with the *Testament of Love* of Thomas Usk (*c.* 1388). To the same period belong *The Tale of Melibee* and *The Parson's Sermon* by Chaucer; the treatises of John of Trevisa, whose style in the *Polychronicon* has a good deal of vigour; and the three versions of the *Travels* of Jean à Barbe, formerly attributed to "Sir John Mandeville." The composite text of these last-mentioned versions really forms the earliest specimen of purely secular prose which can be said to possess genuine literary value, but again the fact, which has only lately been ascertained, that "Sir John Mandeville" was not an original English writer robs it of much of its interest.

The anonymous compiler-translator can no longer be styled "the father of English prose." That name appears to belong to John Wyclif, who, in the course of his career as a controversialist, more and more completely abandoned Latin for English. The translation of the English Bible was begun by Nicholas Hereford. The completion of this work is usually attributed, but on insufficient grounds, to Wyclif himself. A new version was almost immediately started by John Purvey, another Wyclifite, who completed it in 1388. We are still among translators, but towards the middle of the 15th century Englishmen began, somewhat timidly, to write original prose. Capgrave, an Augustinian friar, wrote a chronicle of English history down to 1417; Sir John

Fortescue produced about 1475 a book on *The Governance of England;* and Reginald Pecock attacked the Lollards in his *Repressor of Over Much Blaming of the Clergy* (*c.* 1450). The prose of Pecock is sometimes strangely modern, and to know the ordinary English prose of the 15th century it is more useful to turn to *The Paston Letters.* The introduction of printing into England is coeval with a sudden development of English prose, a marvellous example of which is to be seen in Caxton's edition of Malory's *Morte d'Arthur,* in which the capacities of the English language for melody and sweetness were for the first time displayed. Caxton himself, Lord Berners and Lord Rivers, added an element of literary merit to their useful translations.

With the Renaissance, *Richard III.,* whether by Sir Thomas More or by Cardinal Morton, was a work of considerable importance; *Utopia* (1516) was unfortunately composed in Latin, which still held its own as a dangerous rival to the vernacular. In his *Governor* (1531) Sir Thomas Elyot added moral philosophy to the range of subjects thought proper for English prose. In the same year Tyndale began his version of the Bible, the story of which forms one of the most romantic episodes in the chronicles of literature; at Tyndale's death in 1536 the work was taken up by Coverdale. The *Sermons* of Latimer (1549) introduced new elements of humour and vigour. The earliest true biography was the *Life of Cardinal Wolsey,* by George Cavendish, written about 1557, but not printed until 1641. In the closing scenes of this memorable book, which describe what Cavendish had personally experienced, the perfection of easy English style is reached for the first time. The prose of the middle of the 16th century—as exemplified in Sir Thomas Wilson, Roger Ascham, and Sir John Cheke—is clear, unadorned and firm, these Englishmen holding themselves bound to resist the influences coming to them from Italy and Spain. Equal simplicity marked such writers as Foxe, Stow and Holinshed, who desired a straightforward prose in which to present their information. But Hoby and North introduced not a few exotic graces, and prepared the way for the innovations of Lyly in *Euphues* (1579). The extravagances of Lyly outdid those of his continental prototypes, and euphuism became a disturbing influence which, it may be, English prose has not, even yet, entirely thrown off. In spite of its popularity, it was opposed in its own day, not merely by the stately sobriety of Hooker, but by the sweetness of Sir Philip Sidney. Raleigh wrote an English prose perhaps more majestic than any which preceded it, but he revelled in length of sentence and ponderosity of phrase, so that the prestige of *The History of the World* on the whole delayed the emancipation of English prose. The direct influence of euphuism was seen for some time in the work of poets like Lodge and Greene, and divines like Andrewes; its indirect influence in the floweriness and violence of most prose down to the Restoration.

Donne had a sonorous majesty of style; and Burton could use English with humour and vivacity when he gave himself the chance. In spite of the skill with which, during the civil wars and the Commonwealth, authors like Jeremy Taylor, Fuller and Milton manipulated prose, and in spite of the magnificence of Sir Thomas Browne, it was not until shortly before the Revolution that English prose reached its perfection. According to Dr. Johnson, Sir William Temple (1628–99) was the first writer who gave cadence to English prose. The new tendency was all in favour of brevity and crispness of shorter sentences and easier constructions. Not a little of the majesty of the earlier age was lost; but for practical purposes prose became a far more businesslike implement than it had hitherto been. The treatises of Halifax, or the sermons of South, mark the change. The power of English speech was first comprehended perhaps by Dryden, who combined dignity and even pomp of movement with an ease and laxity on occasion which gave variety to prose, and approximated it to ordinary speech. This then may be called the foundation of modern English prose, which has extended into no departments not recognized, at least in essence, by Bunyan, Dryden and Temple. The ensuing varieties have been mainly matters of style. In the 18th century, for instance, there was a constant alternation between a quiet, rather cold elegance and precision, which was called the Addisonian manner, and a swelling, latinized style, of which Johnson is the most famous exemplar. But as far as arrangement and syntax are concerned, it cannot be said that English prose has altered essentially since about 1680. It is, however, to be noted that in the course of the 19th century attempts were made to restore the beauty and variety of early 17th-century diction.

Icelandic.—The independent invention of prose by the Icelanders is one of the most singular phenomena in history. It resulted from the fact that story-telling was a recognized form of amusement in the isolated life of an Icelandic household. Something of the same kind had existed in Norway before the exodus, but it was in Iceland that it was reduced to an art. It is remarkable how suddenly the saga, as a composition, became a finished work. The deliberate composition of sagas began about the year 1030, and it is recorded that Ari Fródi (1067–1148) was the first man in Iceland who wrote down stories. Many of Ari's books are lost, but enough survive to show what Icelandic prose was in his hands, and the impress of his rich and simple style is felt in all the succeeding masterpieces. Snorri, and the anonymous authors of *Njala, Laxdaela,* and the rest, exhibit simple prose style at its highest. The great historian, Sturla (1214–84), is the latest of these classic writers of Iceland, and after his death there was a rapid decline. The splendid prose of these two centuries stands unrelated, an unparalleled portent in European literature.

Spanish.—In Castilian, as elsewhere, verse is far advanced before we meet with any distinct traces of prose. A religious treatise is attributed to a monk of Navarre, writing in the 13th century. Between 1220 and 1250 a chronicle of Toledo was indited. But the earliest prose-writer of whom Spain can really boast is King Alphonso the Learned (1226–84), in whose encyclopaedic treatises "Castilian makes its first great stride in the direction of exactitude and clearness" (Fitzmaurice-Kelly). Almost all the creditable prose of the end of the 13th century is attributed to Alphonso, who was helped by a sort of committee of authors. The king's nephew, Juan Manuel (1282–1347), author of *Conde Lucanor,* carried prose to a further point in delicacy and precision. The poet Ayala (1332–1407) was another gifted artificer of Spanish prose, which suffered a setback in the hands of his successors, Santillana and Mena. It rose once more in *The Sea of Histories* of Pérez de Guzmán (1378–1460), in whom the lucid purity of Castilian prose is for the first time seen. In the 15th century the shapeless novel of chivalry was predominant, while in the age of Ferdinand prose decayed. The next great writer whom we meet with is Guevara (d. 1545), whose *Dial of Princes* exercised an influence which even extended to English prose (in North's well-known version). The historians of this period were of less value. The earliest picaroon novel, *Lazarillo de Tormes* (1554), introduced a new form and exhibited Castilian prose style in a much lighter aspect. Still greater elegance is met with in the writings of Juan de Valdés and of Luis de León. Of the latter Fitzmaurice-Kelly says that "his concise eloquence and his classical purity of expression rank him among the best masters." The instrument, accordingly, was ready to the hand of the supreme magician Cervantes, whose *Don Quixote* was begun a few years (about 1591) after *Los Nombres de Cristo* of Luis de León. The prose of Lope de Vega is stately and clear, but admittedly has little importance in comparison with his verse. Quevedo's style had the faults of antithesis and obscure ingenuity; but his *Visions* (1627) are of course famous. The latest struggles of a decadent critical conscience, battling against affectation, are seen in Gracián (1601–58) and Molinos (c. 1640–97). When Spanish prose revived in the 19th century, in the person of Larra (1809–37), the influence of French models was found to have deprived it of distinctly national character, while giving it a fresh fluidity and grace.

French.—There had long been a flourishing versified literature in the vernacular of France, before anyone thought of writing French prose. It was the desire to be exact in giving information which led to a partial divergence from metre. The translator of the *Chronicle of Turpin* mentions that he writes in prose "because rhyme entails the addition of words not in the Latin." Thus about 1200 verse began to be abandoned by chroniclers who had some definite statements to impart. They ceased to sing;

they wrote as those around them spoke. The earliest French prose was translated from the Latin, but Baldwin VI. (d. 1205) is said to have commissioned several scribes to compile in the vulgar tongue a history of the world. If this was ever written it is lost, but we possess a *Book of Stories* written about 1225 by a clerk at Lille, which may fairly be said to be the beginning of French prose history. When once, however, a taste for prose was admitted, the superiority of that medium over verse as material for exact history could not but be perceived. The earliest French prose-writer of genius was Villehardouin, who put down memoirs of his life between 1198 and 1207; he left his book, *The Conquest of Constantinople,* incomplete. In the history of prose, Villehardouin takes an eminent place. In his style are seen many of the most precious elements of French prose, its lucidity, its force, its sobriety and its charm. He had been trained as an orator, and was content to write as he had learned to speak. He was followed by other admirable writers of memoirs, Robert of Clari, Henri of Valenciennes, the anonymous chronicler of Béthune, to whom we owe the famous description of Bouvines, and the Minstrel of Reims. The last-named finished his *Récits* in 1260. These works in the new easy manner of writing were found to be as elegant and as vivacious as any in verse. They led the way directly to the earliest historian of modern Europe, Joinville, who finished his *Histoire de St. Louis* in 1309. A century later Froissart left his famous *Chroniques* unfinished in 1404, and again 100 years passed before Philippe de Commines dropped the thread of his *Mémoires* in 1511. These three are simply the most eminent figures in a great cloud of prose-writers, who helped to facilitate the use of the national language. In the 15th century, moreover, Antoine de la Salle deserves mention as practically the earliest of French novelists. But with the Renaissance came the infusion into France of the spirit of antiquity, and in Rabelais there was revealed an author of the very highest genius. The year 1532, in which the first brief sketch of *Gargantua* appeared, was critical in French literature. In 1549 appeared the *Défense et illustration de la langue française* of Joachim du Bellay, in which the foundations of French literary criticism were firmly laid. The liberation of the language proceeded simultaneously in all directions. In 1539 it was officially decreed that all judicial acts were thenceforward to be written "en langage maternal français." Calvin led the theologians, and his precise and transparent prose gave the model to a long line of sober rhetoricians. It is in Calvin that we meet for the first time with a simple French prose style, which is easily intelligible to-day. There is some pedantry in St. François de Sales, some return to the spirit of mediaeval French in Montaigne; so that the prose of these great writers seems to us more antiquated than that of Calvin. Yet the *Institution* belongs at latest to 1560, and the immortal *Essais* at earliest to 1580. We are approaching the moment when there should be nothing left for French prose to learn. But we pause at Brantôme, in whom the broad practice of French as Froissart and the mediaeval chroniclers had used it was combined with the modern passion for minute and picturesque detail. With the beginning of the 17th century there sprang up almost an infatuation for making prose uniformly dignified, for avoiding all turns of speech which could remind the reader of the "barbarous" origins of the language; the earliest examples of this subjection of eloquence to purely aristocratic forms have been traced back to the *Servitude volontaire* of La Boétie (1530–63). In the pursuit of this dignity the prose writers of the 16th century ventured to borrow not words merely but peculiarities of syntax from Greece and Rome. The necessity of remaining intelligible, however, checked excess, and after a few wild experiments the general result was discovered to be the widening of the capacities of the language. In the 17th century a great stimulus was given to easy prose by the writers of romances, led by d'Urfé, and by the writers of letters, led by Balzac, with whom French prose lost its heaviness and its solemnity; it became an instrument fit to record the sentiments of social life; here was discovered what Voltaire calls the *nombre et harmonie de la prose.* French style became capable of still more when it was used by Descartes and by Pascal to interpret their majestic thoughts. At this moment, in 1637, the French Academy was founded, for the distinct purpose of purifying and enlarging the French language; and in time, out of the midst of the academy, arose the important *Remarques* (1647) of Vaugelas, a work of grave authority, which was the earliest elaborate treatise on the science of prose in any language. Antiquated as Vaugelas now seems, and little regarded by modern writers his work is still the basis of authority on the subject. In common with his colleagues he laid down laws by which harmony of structure, a graceful sobriety and exactitude of expression, could be secured to every practised French writer. He was not accepted as infallible, even in his own age; he was immediately exposed to the criticism of La Mothe le Vayer, who, however, was radically at one with him regarding the basis of his definition. The great demerit of the early academicians was that they knew little about mediaeval French. They thrust everything aside which they regarded as barbarous, and the work of the 19th century was to recover from a past behind Rabelais elements of great value which the 17th had arbitrarily rejected. In the succeeding centuries there has been a vast extension of the practice of French prose, but in spite of all neologisms, and of the waves of preciosity which have periodically swept over the French language, the treatise of Vaugelas remains the final code in which the laws that govern French prose are preserved.

Italian. — The case of prose in Italian has this unique feature that, instead of gathering form obscurely and slowly, it came into sudden existence at the will of one of the greatest of writers. Latin had almost universally been used in Italy until the close of the 13th century, when Dante created a vernacular prose in the non-metrical part of his *Vita Nuova* (*c.* 1293). For a long time the prose of Dante stood practically alone, and Petrarch affected to despise the works which his great predecessor had written in the vulgar tongue. But about 1348 Boccaccio started his *Decameron,* which gave classic form to the prose romance of Italy. It should have been greatly to the advantage of Italy that in the hands of Dante and Boccaccio prose was born full-grown, and had not to pass through the periods of uncertain development which awaited it elsewhere. After this brilliant beginning, however, there was a decline, the writers of the next age lacking the courage to be independent of antiquity. There was a return to Latin phraseology which made many works almost macaronic in character; the famous *Hypnerotomachia* of Colonna is an instance. Something of the purity of Boccaccio was recovered by Sannazaro in his *Arcadia* (1489); even Sannazaro, however, did not see how needful it was to cast off Latin constructions. At length Machiavelli and Guicciardini succeeded in releasing prose from the yoke of Rome, and in writing undiluted Tuscan. In the 16th century the prose writers of Italy became extremely prolific, with Pietro Bembo at their head. The novelists were now prominent, but, although they take a foremost place in the history of Italian literature, there was little art in their employment of language. Many of them were born out of Tuscany, and, like Bandello, never learned the rules of pure Italian prose. Since the 16th century Italian would seem to have undergone no radical changes, and its prose has been stationary in form. At the close of the 19th century a new school of writers, with Gabriele d'Annunzio at its head, created a demand for a new prose, but the remedy suggested by these innovators was neither more nor less than a return to Boccaccio and Machiavelli.

German. — The earliest attempts in German prose belong to the age of Charlemagne, and the first example usually quoted is the *Strassburger Eidschwüre* of 842. For all literary purposes, however, metrical language was used exclusively during the *mittelhochdeutsch* period, which lasted until the end of the 13th century. What little prose there was, was limited to jurisprudence and theology. David of Augsburg (d. 1272) is named as the earliest vernacular preacher, but only one of his sermons has reached us. More important was Berthold "the Sweet" (1220–72), whose sermons were published in 1824. Historical prose began with the Saxon Chronicle of 1248. There was little to record in the next two centuries, until prose was revived by Geiler von Kaisersburg (1445–1510) in his sermons. About the same time translations were made of the *Decameron* and other Italian novelle. The development of prose in Germany is, however, negligible until we reach Luther's Bible (N.T., 1522), on which all classic German prose is based. Johann Fischart composed important secular books in the vernacular, in particular the *Bienenkorb* (1579) and an imitation of *Gargantua* (1575), the earliest German novel. Nearly a century passes before we reach the curious picaresque romance of *Simplicissimus* (1669) of Grimmelshausen. But the neglect of prose by the German nation was still general. Even men of the stamp of Leibnitz wrote in Latin or French. What Luther had done was, however, completed and confirmed in the middle of the 18th century by Lessing, the creator of modern German prose. The critical period in this revival was 1764 to 1768, which saw the production of *Laocoon* and the *Hamburgische Dramaturgie*. We pass presently to Jean Paul Richter, and so to Goethe, in whose hands German prose became the organ of thought and eloquence which it has been ever since.

BIBLIOGRAPHY.—J. Earle, *English Prose* (1890); C. Favre de Vaugelas, *Remarques sur la langue française* (1647), *Nouvelles remarques* (1690); T. Mundt, *Kunst der deutschen Prosa* (1837); J. W. Mackail, *Latin Literature* (1895); J. Fitzmaurice-Kelly, *History of Spanish Literature* (1898); G. Vigfusson, *Sturlungasaga* (1878); G. Saintsbury, *History of English Prose Rhythm* (1912). (E. G.; E. E. K.)

PROSECUTION, the procedure by which the law is put in motion to bring to trial a person accused of crime (*see* CRIMINAL LAW; INDICTMENT). In theory in Great Britain the king is in all criminal offences the prosecutor, because such offences are said to be against his peace, his crown and dignity, but in practice such prosecutions are ordinarily undertaken by the individuals who have suffered from the crime. This is a different procedure from that prevailing in Scotland and European continental countries, in all of which a public department or officer undertakes the prosecution of offences.

In the United States, crimes against the Federal Government are prosecuted by the different United States attorneys and their assistants under the general supervision of the United States attorney-general. In the States, prosecution is by district, State's or county attorneys, or their assistants, somewhat under the supervision of the State attorney-general. Sometimes a special prosecutor is named. So it has come about that those who comprise the prosecuting force are termed collectively the prosecution.

PROSERPINE, generally accounted the Latin form (*Proserpina*) of Persephone, a Greek goddess, daughter of Zeus and the earth-goddess Demeter (*q.v.*). Some, however, regard *Proserpina* as a native Latin form, not borrowed from the Greek, and connected with *proserpere,* meaning the goddess who aided the germination of the seed. (*See* PERSEPHONE.)

PROSODY, properly the study of accent, breathing and quantity. In modern use, the theory of versification. (*See* VERSE.)

PROSPECTING, whether it be the search for minerals by a lone prospector, or by two or more prospectors, or by an organized party of trained men in a more or less unknown region, or by an operating company in its producing property at depth, is how our mineral deposits are discovered and developed. Geophysical prospecting has helped, particularly with petroleum. In prospecting, time, patience, optimism, and money are essentials. (*See* GEOPHYSICS; PETROLEUM.)

The mineral industry of any advanced country is second in importance to its welfare, agriculture being first; therefore, prospecting for and the mining, metallurgy, and manufacturing of metals are basic to civilization.

Generally, when prospecting is mentioned, gold comes to the mind of the layman, but there are many other minerals of considerable marketable value and industrial use—antimony, asbestos, bauxite, beryllium, chromite, graphite, manganese, mercury, mica, molybdenum, nickel, platinum group, tantalum, tin, titanium, tungsten, uranium, vanadium, zinc, and zirconium, for example.

Seepages of oil and structures favourable thereto, and oil-bearing shale should be examined.

Even deposits of building stones, cement-making rock, and sand and gravel should not be overlooked.

In recent years, to list a few important deposits found throughout the world. the following minerals may be mentioned: Aluminium ores (bauxite) in Europe; chrome ore in Turkey and the Philippines; copper ores in Rhodesia and Nevada (Rio Tinto); gold in California (Golden Queen), Nevada (Jumbo), Fiji, New Guinea, and the Philippines; manganese in South Africa; nickel in British Columbia and Brazil; potash in New Mexico; and radium and silver in north-west Canada. These particular discoveries were made in regions ranging in climate and topography from the Arctic Circle to the tropics and from plains to mountains and jungle. No conditions are too severe for the determined and experienced prospector; but it can be said that the natives or mountain people of some countries, as in South America and Asia, do some searching and occasionally bring worthwhile deposits to the attention of engineers or scouts for exploration companies.

Minerals of similar appearance frequently mislead prospectors and others: Mica, iron pyrite, pyrrhotite, and chalcopyrite are mistaken for gold; graphite, for molybdenite; dolomite, for colemanite; stibnite, for bismuthinite; marcasite, for tellurides; zincite, and erythite, for cinnabar; stannite, for tetrahedrite; barite, for scheelite; garnierite, for malachite; and obsidian, for pitchblende.

Surface rocks stained by copper, iron, manganese, and mercury are misleading because frequently there is no persistence of ore at depth.

The black sands of certain beaches and river bars, and such sands caught in the sluices of hydraulicking and dredging operations, have misled many a man into believing that they are high in gold and platinum. In a few places these sands, which are mostly iron minerals, have paid to work. They have also on some dredging operations in which they are a highly concentrated product.

Gold does not exist in colloidal condition in ores and waters or in any other form such that assays cannot detect it; assays get all the gold and silver, and custom plants pay on assays only.

Because not more than one property in two hundred submitted for examination to exploration companies becomes a mine, a prospector should make sure by development and by assays of representative samples that a claim is really worth attention. An outcrop or a small pit does not mean an "enormous tonnage," nor will companies that are looking for deposits consider such a showing.

Prospecting is permitted on public lands in certain countries under regulations which require that a certain amount of work be done each year. If work is not continued each year, claims become forfeitable to anyone who re-stakes or re-pegs them. No prospecting is permitted on private property unless an arrangement is made with the owner. There are regulations for placers and for lodes.

At one time, and now in some regions, prospectors set out afoot or with a burro, mule, horse, camel, or canoe for some area they had in mind; nowadays, for those who can afford it, transport is made easier by motor-cycle, motor-car, motor-truck, and aeroplane. The aeroplane leaves men and departs, but a motor-car or truck is locally useful in getting supplies and for haulage, and often is a source of power for any small equipment.

Many veins reveal themselves by their outcrops; and by stripping away the country rock and trenching across them, any ore-shoots may be discovered and developed. If the outcrop of a vein has been eroded and only pieces of "float" ore are to be seen on a hillside, these should be traced to what appears to be their source. Then some trenching may uncover the vein.

A prospector should have a pick, shovel, hammer, short drills, dynamite, pan, and something for crushing samples, say a mortar and pestle. The pan is used for washing gravel or crushed ore for gold, cinnabar, tin, and heavy sulphide minerals. A good hand lens is a more useful device for magnifying minerals than is generally recognized. A man should have ample food and clothes suitable to the district he is prospecting.

When a prospect shows enough ore for a small mill or for shipment to a custom mill or smelter, the owner should try to arrange for this. An ore may be suitable for sorting out the waste rock and then shipping the remainder to a custom plant, or it may be sorted and treated locally.

Several firms in the United States, Canada, Australia, New Zealand, and Africa make milling and treatment plants for prospects.

The question arises: Where to search for minerals? Semi-desert, rivers, foothills, and mountains have produced much wealth. Mountain chains are or may be, as they have been, great future sources of minerals — the Rocky mountains; the Cascades; the Sierra Nevada and Coast Range; the chains of Idaho, Nevada, and Arizona; the Sierra Madre of Mexico and the Andes of South America, have been productive. Some mountains have not revealed much. Volcanic areas or those made up of flow rocks are generally favourable. Faulting, folding, and intrusions of igneous rocks are part of the formation. Every outcrop, especially of quartz, should be closely examined, sampled, and panned. If a formation is "likely" in appearance, prospect it thoroughly before moving camp. Placers may occur at high elevation: the drift gravels of the Sierras and gravels of the Rockies, or along and at the mouths of rivers. They may contain gold, precious stones, tin, tungsten, and zircon.

Prospectors and miners with ambition and money enough can attend the special, free summer courses given by certain schools of mines, some of which send lecturers into the field. In such manner, prospectors can enlarge their knowledge of minerals and the occurrence and identification of them. Booklets and sets of minerals are available at a low price.

Makers and dealers in mine machinery and equipment are always glad to send information to those who would like to install some type of plant. Several books on general prospecting or on gold alone are procurable at reasonable charge from firms in New York city; Gardendale, Quebec; London; and Sydney, Australia. By such means the prospector becomes better informed regarding rock formations and the minerals likely to be in them, as well as in methods of testing what the minerals are.

To some extent, governments encourage and aid prospectors and engineers through their State or Provincial and Federal Bureau of Mines, Departments of Mines, and Geological Surveys. Various investigations are made and the results are published and are available free or at a low charge. This statement refers particularly to the United States, Canada, and the British Empire. Some governments appropriate money for certain field investigations and some allot cash loans to prospectors, miners, and small companies. Sometimes free assays and tests on ores are run, and free identification of minerals is made. In some countries the government operates mills for small producers. (M. W. v. B.)

PROSPECTUS: *see* COMPANY.

PROSPER OF AQUITAINE or PROSPER TIRO (*c.* 390–*c.* 465), Christian writer and disciple of St. Augustine, was a native of Aquitaine, and seems to have been educated at Marseilles. In 431 he appeared in Rome to interview Pope Celestine regarding the teachings of St. Augustine and then all traces of him are lost until 440, the first year of the pontificate of Leo I., who had been in Gaul and thus probably had met Prosper. In any case Prosper was soon in Rome, attached to the pope in some secretarial or notarial capacity. Gennadius (*De script. eccl.* 85) mentions a rumour that Prosper dictated the famous letters of Leo I. against Eutyches. The date of his death is not known, but his chronicle goes as far as 455, and the fact that Ammianus Marcellinus mentions him under the year 463 seems to indicate that his death was shortly after that date. Prosper attacked the Pelagians in a polemical poem of about 1,000 lines, *Adversus ingratos,* written about 430. After Augustine's death he wrote three series of Augustinian defences, especially against Vincent of Lerins (*Pro Augustino responsiones*). His chief work was against Cassian's *Collatio,* his *De gratia dei ut libero arbitrio* (432). He also induced Pope Celestine to publish an *Epistola* ad *episcopos Gallorum* against Cassian. He corresponded with Augustine and made an abridgment of his commentary on the Psalms, a collection of sentences from his works. He also put into elegiac metre, in 106 epigrams, some of Augustine's theological dicta.

Prosper's *Epitoma chronicon* is a careless compilation from St. Jerome in the earlier part, and from other writers in the later, but the lack of other sources makes it very valuable for the period from 425 to 455 of which he had personal knowledge. There were five different editions, the last of them dating from 455, after the death of Valentinian. For a long time the *Chronicon imperiale* was also attributed to Prosper Tiro, but without the slightest justification, for it exhibits Pelagian tendencies.

The *Chronicon* has been edited by T. Mommsen in the *Chronica minora* of the *Monumenta Germaniae historica* (1892). The complete works are in Migne's *Patrologia latina.* Tome 51. *See* L. Valentine, *St. Prosper d'Aquitaine* (Paris, 1900) and A. Potthast *Bibliotheca historica* (1896).

PROSTEJOV or PROSSNITZ, an old town in Moravia, lies in the fertile valley of the Hanna, a tributary of the Morava. Pop. (1930) 33,487. Germany occupied the town in March 1939, at the time of Czechoslovakia's dismemberment.

PROSTITUTION, a word which may best be defined as promiscuous unchastity for gain. In German law it is described as *Gewerbsmassige Unzucht.* It has always been distinguished in law and custom from concubinage, which is an inferior state of marriage, and from adultery and other irregular sexual relations, in which the motive is passion. Prostitution has existed in all civilized countries from the earliest times, and has always been subject to regulation by law or by custom. The more important of the external reasons which induce women to turn to prostitution for a livelihood in modern times are: (1) difficulty of finding employment; (2) excessively laborious and ill-paid work; (3) harsh treatment of girls at home; (4) promiscuous and indecent mode of living among the over-crowded poor; (5) the aggregation of people together in large communities and factories, whereby the young are brought into constant contact with demoralized companions; (6) the example of luxury, self-indulgence and loose manners set by the wealthier classes; (7) demoralizing literature and amusements; (8) the arts of profligate men and their agents. Alcohol is often an aid to prostitution, but it can hardly be called a cause, for the practice flourishes even more in the most abstemious than in the most drunken countries. These observations apply to the West. In Oriental countries girls are commonly born into or brought up to the trade, and in that case have no choice.

In Eastern Religions. — Among the ancient nations of the East, with the exception of the Jews, prostitution appears to have been connected with religious worship, and to have been not merely tolerated but encouraged. The code of sexual morality laid down in the Book of Leviticus is prefaced by the injunction not to do after the doings of the land of Egypt, nor after the doings of the land of Canaan, where all the abominations forbidden to the Jews were practised; and whenever the Israelites lapsed from their faith and "went a-whoring after strange gods," the transgression was always associated with licentious conduct. In Egypt, Phoenicia, Assyria, Chaldea, Canaan and Persia, the worship of Isis, Moloch, Baal, Astarte, Mylitta and other deities consisted of the most extravagant sensual orgies, and the temples were merely centres of vice. In Babylon some degree of prostitution appears to have been even compulsory and imposed upon all women in honour of the goddess Mylitta. In India the ancient connection between religion and prostitution still survives; but that is not the case in China, a most licentious country, and, considering the antiquity of its civilization, and its conservatism, we may perhaps conclude that it formed an exception in this respect among the ancient nations.

Among the Jews, who stood apart from the surrounding peoples, the object of the Mosaic law was clearly to preserve the purity of the race and the religion. Prostitution in itself was not forbidden, but it was to be confined to foreign women. Jewish fathers were forbidden to turn their daughters into prostitutes (Lev. xix. 29), and the daughters of Israel were forbidden to become prostitutes (Deut. xxiii. 17), but no penalty was attached to disobedience, except in the case of a priest's daughter, who was to be burnt (Lev. xxi. 9). This distinction is significant of the attitude of Moses, because the heathen "priestesses" wrre nothing but prostitutes Similarly, he forbade groves, a common adjunct of heathen temples and a convenient cover for debauchery Again, his purpose is shown by the severe penalties imposed on adultery (death) and on unchastity in a betrothed damsel (death by stoning), as contrasted with the mild prohibition of prostitution. So long as it did not touch the race or the religion, he tolerated it; and even this degree of disapproval was not maintained, for Jephthah was the son of a harlot (Judges xi. 1).

There is abundant evidence in the Old Testament that prostitution prevailed extensively in Palestine, even in the earlier and more puritan days. The women were forbidden Jerusalem and places of worship; they infested the waysides, and there is some evidence of a distinctive dress or bearing, which was a marked feature of the trade among the Greeks and Romans. In the later period of aggrandizement that increase of licentious indulgence which Moses had foreseen took place, associated with infidelity. The remarkable series of ordinances laid down by Moses in the interest of public health contains unmistakable recognition of venereal disease and its contagious character (Lev. xv.).

In Ancient Greece.—Passing on to the ancient Greeks, we find prostitution treated at Athens on a new principle. The regulations of Solon were designed to preserve public order and decency. He established houses of prostitution (dicteria), which were a state monopoly and confined to certain quarters. The dicteriades were forbidden the superior parts of the town, and were placed under various disabilities. They were compelled to wear a distinctive dress, and so far from being connected with religion, they were not allowed to take part in religious services. These laws do not seem to have been carried out at all effectually, and were presently relaxed. After the Persian wars more stringent regulations were again introduced. The *dicteriades* were placed under police control, and were liable to prosecution for various offences, such as ruining youths, committing sacrilege and treason against the state. It is clear, however, that as time went on the Athenian authorities experienced the difficulties encountered by modern administrations in carrying out state regulation. There were grades of prostitution, socially though not legally recognized, and women of a superior order were too powerful for the law, which failed to maintain the ban against them. The Greek *hetaerae,* who were prostitutes, not "mistresses," and the most gifted and brilliant members of their class known to history, wielded great and open influence. The test case of Phryne, in which the stern attitude previously maintained by the Areopagus broke down, established their triumph over the law, deprived virtuous women of their sole advantage, and opened the door to general laxity. In later times any one could set up a dicterion on payment of the tax. In other Greek cities extreme license prevailed. At Corinth, which was famous for sensual practices, a temple, with a huge staff of common prostitutes for attendants, was established in honour of Aphrodite and for the accommodation of the sailors frequenting the port. The worship of this goddess became generally debased into an excuse for sexual excesses.

Ancient Rome.—The Romans united the Jewish pride of race with the Greek regard for public decency, and in addition upheld a standard of austerity all their own. In early days female virtue was highly honoured and strenuously maintained among them, of which the institution of the vestal virgins was a visible sign. Their attitude towards prostitution differed, accordingly, from that of other ancient nations. Among them, alone, it was considered disgraceful to a man to frequent the company of prostitutes; and this traditional standard of social conduct, which markedly distinguished them from the Greeks, retained sufficient force down to the later days of the Republic to furnish Cicero with a weapon of rhetorical attack against his political opponents, whom he denounced as scortatores. Prostitution was more severely regulated by them than by any other ancient race. They introduced the system of police registration, which is the leading feature of administration in most European countries to-day. From the earliest days of the Republic prostitutes were required to register at the aediles' office, where licenses were issued to them on payment of a tax. They were placed under stringent control, had to wear a distinctive dress, dye their hair or wear yellow wigs, and were subject to various civil disabilities; but the severest feature of the system was that, once registered, their names were never erased, and consequently remained for ever under an indelible stain. As in our times, registration became ineffective, and neither law nor tradition could check the demoralizing influence of ease and luxury when once external conquest left the Romans free to devote their energies to the pursuit of pleasure. An attempt was made, by the enactment of severer laws against prostitution, to stem the rising tide of immorality, which threatened to taint the best blood in Rome with the basest elements in the later days of the Republic. Citizens were prohibited from marrying the descendants or relatives of prostitutes, daughters of equestrians were forbidden to become prostitutes, and married women who did so were liable to penalties. More stringent regulations were also imposed on prostitutes themselves, in addition to the old disabilities and police system, which remained in force. If these laws had any effect at all, it was to promote the general prevalence of immorality; they certainly did not diminish prostitution. The profligacy of imperial Rome has never been surpassed for gross and obscene sensuality.

Under Christianity.—The greatest change introduced by Christianity with regard to prostitution was the adoption of a more charitable attitude towards these social and legal outcasts. The Roman state tax, which had descended to the emperors and had been further regulated under Caligula, was partly given up in the 4th century by Theodosius, on the representations of Florentius, a wealthy patrician, who offered to make good the ioss of revenue out of his own pocket. It was fully and finally abolished by Anastasius I. in the next century, and the old registers were destroyed. Then some of the civil disabilities of prostitutes were removed by Justinian in the 6th century. Gibbon, who never gave credit for a good motive when a base one could be found, attributes Justinian's action solely to his desire to marry Theodora, whose life had been notorious; and no doubt she influenced him in the matter, but it is permissible to assume a good motive. Even Gibbon is constrained to admit her virtue after marriage, and to give her credit for "the most benevolent institution" of Justinian's reign, the rescue home for fallen women in Constantinople, which was at any rate disinterested. Though it did not succeed, it marks a turning-point in the treatment of a class which had never met with public sympathy before. At the same time procuration and connivance were severely punished, which is in keeping with the Christian attitude. The early Christian Church laid great stress on chastity, which probably suggested to its Roman persecutors the horrible punishment of forcibly prostituting Christian maidens. Such malignity enhanced the glory of martyrdom without shaking the constancy of its victims; and the triumph of purity in an age of unbounded licence was conspicuously recognized by Alaric, the Gothic conqueror, who gave strict orders in the sack of Rome that the virtue of Christian women was to be respected. The Church, however, was not severe upon prostitutes, to whom the altar was open upon repentance, and some of the fathers explicitly recognized their trade as a necessary evil. Among them was St. Augustine, a man of the world, who saw that its suppression would stimulate more destructive forms of immorality. Gradually charity degenerated into patronage. Rome, conquered spiritually by Christianity and materially by the northern barbarians, sapped the virtue of both.

Charlemagne made an effort to suppress the prevailing disorder, but his private life was licentious, and his capitularies, which ordained the scourging of prostitutes and panders, were not inspired by any regard for morality. A period of reform followed. The rise of chivalry, with its lofty idealization of women, and the wave of Christian fervour connected with the crusades, inspired a vigorous and high-minded campaign against an all-prevalent evil. The Church became exceedingly active in prevention and rescue work, and was assisted by a devout and zealous laity. Rescue missions were organized, convents were founded everywhere for the reception of penitents, and dowries were subscribed to procure them husbands. Fulke de Neuilly was a conspicuous figure in this work. He held missions, preached, and collected large sums for marriage 'dowries. Pope Innocent III. (1198–1216) pronounced it a praiseworthy act to marry a prostitute; and Gregory IX., a few years later, wrote to Germany that brothel-keepers were not to prevent prostitutes from attending missions, and that clergy and laity who drew profit from prostitution were banned. "Urge bachelors," he wrote. "to marry repentant girls, or induce the latter to enter the cloister."

Regulated by Law.—In spite of such eiforts, and of occasional spasms of severity by individual rulers, prostitution flourished everywhere throughout the middle ages. It was not merely tolerated, but licensed and regulated by law. In London there was a row of "bordells" (brothels) or "stews" in the Borough near London Bridge. They were originally licensed by the bishops of Winchester, according to John Noorthouck, and subsequently sanctioned by parliament. Stowe quotes the regulations enacted in the year 1161, during the reign of Henry II. These were rather protective than repressive, as they settled the rent which women had to pay for the rooms, and forbade their compulsory detention. The act was afterwards confirmed in the reigns of Edward III. and Richard II. In 1383 the bordells belonged to William Walworth, lord mayor of London, who farmed them out, probably on behalf of the Corporation, according to analogy in other parts of Europe. They were closed in 1506, but reopened until 1546, when they were abolished by Henry VIII. In London we get the earliest known regulations directed against the spread of venereal disease. The act of 1161 forbade the bordell-keepers to have women suffering from the "perilous infirmity of burning"; and by an order of 1430 they were forbidden to admit men suffering from an *infirmitas nefanda.* Probably it was by virtue of this order that in 1439 two keepers were condemned to eleven days' imprisonment and banishment from the city. In 1473, again, it is recorded that bawds and strumpets were severely handled by Lord Mayor Hampton.

Elsewhere in Europe much the same state of things prevailed during the same period. Prostitution was both protected and regulated, and in many places it constituted a source of public revenue. In France prostitutes were distinguished by a badge, and forbidden to wear jewels and fine stuffs and to frequent certain parts of the town. Public brothels on a large scale were established at Toulouse, Avignon and Montpellier. At Toulouse the profits were shared between the city and the university; at Montpellier and Avignon the trade was a municipal monopoly, and farmed out to individuals; at Avignon, where the establishment was kept up during the whole period of the popes' residence, the inmates were subjected to a weekly examination. In 1254 Louis IX. issued an edict exiling prostitutes and brothel-keepers; but it was repealed two years later, though in this and the succeeding century procuration was punished with extreme severity. In some parts of France prostitutes paid a tax to the seigneur. In Germany, according to Fiducin, the public protection of Lust-Dirnen was a regular thing in all the large towns during the middle ages. "Frauenhäuser," similar to those in London and in France, existed in many places. They are mentioned in Hamburg in 1292; and from later records it appears that they were built by the corporation, which farmed them. So also in Ulm, where special regulations were issued in 1430. We find them existing at Regensburg in 1306, at Zürich in 1314, at Basel in 1356 and Vienna in 1384. According to Henne-am-Rhyn, admission to these houses was forbidden to married men, clergy and Jews, and on Sundays and saints' days they were closed.

The laws of the emperor Frederick II. in the 13th century contain some curious provisions. Any one convicted of a criminal assault on a prostitute against her will was liable to be beheaded; if she made a false accusation she was subject to the same penalty. Any one not going to the assistance of a woman calling for help was liable to a heavy fine. In these ordinances the influence of chivalry may be detected. At the same time prostitutes were forbidden to live among respectable women or go to the baths with them. Hospitality to important guests included placing the public Frauenhauser at their disposal. So King (afterwards Emperor) Sigismund was treated at Bern in 1414 and at Ulm in 1434, so much to his satisfaction that he publicly complimented his hosts on it. Besides the municipal Frauenhauser, there were "Winkelhäuser," which were regarded as irregular competitors. In 1492 the licensed women of Nuremberg complained to the mayor of this unfair competition, and in 1508 they received his permission to storm the obnoxious Winkelhaus, which they actually did. In Italy and Spain the system appears to have been very much the same. At Bologna prostitutes had to wear a distinctive dress, in Venice they were forbidden to frequent the wine-shop, and in Ravenna they were compelled to leave a neighbourhood on the complaint of other residents. At Naples a court of prostitutes was established, having jurisdiction over everything connected with prostitution. It led to great abuses, was reformed in 1589, and abolished about a century later.

The Reformation.—In the 15th and 16th centuries a great change took place. It was due to two very different causes: (1) fear of disease; (2) the Reformation. With regard to the first, there can be little doubt that both the slighter and graver forms of venereal disease existed in very remote times, but until the 15th century they attracted comparatively little attention. The constitutional character of syphilis was certainly not understood—which is by no means surprising, since its patholdgy has only recently been elucidated (see VENEREAL DISEASES)—but one would still have expected to find more notice taken of it by historical, moral and medical writers in classical and mediaeval times. Nor is it possible to explain their reticence by prudery, in view of the unbounded literary licence permitted in those ages. One can orily conclude that the evil was less widely spread or less virulent than it afterwards became. At the end of the 15th century it attracted so much notice that it was supposed to have originated then *de* novo, or to have been brought from the West Indies by Columbus—both untenable hypotheses; and, as usual, each country accused some other of bringing the contagion within its borders. To speculate on the cause of this increased prevalence would be idle; it is enough to note the fact and its consequences. It was immediately followed by the Reformation, and the two together led to a general campaign against the system of licensed prostitution. The last Frauenhaus was closed in Ulm in 1531, in Basel in 1534 and in Nuremberg in 1562. In London, as already noted, the bordells were abolished in 1546. In Paris an ordinance was issued in 1560 prohibiting these establishments, and later all prostitutes were required to leave the city within twenty-four hours.

It is observed by Henne-am-Rhyn—no friend of toleration—that their suppression was followed by the appearance of the crime of infanticide, by the establishment of hospitals for foundlings and for syphilis. This suggests an indictment against humanity which is hardly justified by the facts. Infanticide was no new thing, and foundling hospitals date from the beginning of the 13th century. Their marked increase and the establishment of syphilitic hospitals came a century later than the Reformation campaign against the Frauenhauser. The suppression of the latter did not affect the prevalence of prostitution. In the 17th century another spasm of severity occurred. In 1635 an edict was issued in Paris condemning men concerned in the traffic to the galleys for life; women and girls to be whipped, shaved and banished for life, without formal trial. These ordinances were modified by Louis XIV. in 1684. The Puritan enactments in England were equally savage. Fornication was punishable by three months' imprisonment, followed by bail for good behaviour. Bawds were condemned to be whipped, pilloried, branded and imprisoned for three years; the punishment for a second offence was death. In Hamburg all brothels were pulled down and the women expelled from the town. If these measures had any effect, it was speedily lost in a greater reaction; but they have some historical interest, as the present system was gradually evolved from them.

The Protection of Health.—It would be tedious and unprofitable to follow all the steps, the shifts and turns of policy, adopted in different countries during the 18th century for the suppression or control of an incurable evil. They involve no new principle, and merely represent phases in the evolution of the more settled and more systematic procedure in force at the present time. Its chief feature, as compared with the past, is the establishment of an organized police force, to which the control of prostitution is entrusted, coupled with a general determination to put the subject out of sight and ignore it as far as possible. The procedure on the continent of Europe is virtually a return to the old Roman system of registration and supervision, except that there is no State tax, and names can be removed from the register. The objects are the same, namely, public order and decency, with one important addition, which has given rise to much controversy. This is the protection of health.

From what has gone before, the reader will have gathered that it is not, as frequently supposed, a new thing. Already in the middle ages the question occupied the attention of parliament in England, and a weekly examination of public women by the barber (the surgeon of that time) was instituted at Avignon. The practice was adopted in Spain from about 1500, and later in many other places. But the abolition of licensed brothels, and the consequent growth of private prostitution, rendered it a dead letter. To meet the difficulty, registration was devised. It was first suggested in France in 1765, but was not adopted until 1778. The present regulations in France are based on the ordinances of that year and of 1780 which in their turn were borrowed from those of the 16th and 17th centuries, previously mentioned. The *theory* of the modern attitude towards prostitution is clearly laid down by successive ordinances issued in Berlin. Those of 1700 stated that "this traffic is not permitted, but merely tolerated"; the more precise ones of 1792 pronounced the toleration of prostitution a necessary evil, "to avoid greater disorders which are not to be restrained by any law or authority, and which take their rise from an inextinguishable natural appetite"; and the regulations of 1850 and 1876 are headed: "Polizeiliche Vorschriften zur Sicherung der Gesundheit, der offentlichen Ordnung und des offentlichen Anstandes." This embraces the whole theory of present administration, and if Gesundheit be omitted, is not less applicable to the United Kingdom than to the continent. The last attempt to suppress prostitution in Germany is worth noting, as it occurred so late as 1845. Registration was stopped and the tolerated houses were closed in Berlin, Halle and Cologne. The attempt was a complete failure, and it was abandoned in 1851 in favour of the previous system.

White Slave Traffic.—In recent years the question of prostitution has become international through the movement to suppress the "white slave traffic." A congress was held in London in 1899, and in 1902 the French Government summoned an official conference, which resulted in the Convention of 1904, signed by the 12 principal European nations, with the exception of Austria. By this Convention the States bound themselves to coordinate information relative to the procuring of women from abroad, to keep a watch at places of entry and to repatriate women who wished it. In 1910 the United States passed the White Slave Traffic Act, which imposed severe penalties on the transport of women for immoral purposes. In the same year an international Convention for the suppression of the White Slave Traffic was signed in Paris by 13 nations, including Austria. This convention went much farther than the previous one. It bound the parties to punish anyone who had "procured, enticed or led away, even with her consent, a girl under age for immoral purposes" and also anyone who had "by fraud or by means of violence, threats, abuse of authority or any other method of compulsion, procured a girl or woman over age for immoral purposes, notwithstanding that the various acts constituting the offence may have been committed in different countries." This involved altering the internal law relating to prostitution in certain countries. Voluntary committees were formed in the principal countries to collect information and push the matter.

After the World War of 1914–18, the League of Nations took up the problem in accordance with Article 23, which entrusted the League with "the general supervision over the execution of agreements with regard to the traffic." In 1921 the League summoned an international conference at Geneva, attended by delegates from 34 nations. It proposed that the words "white slave traffic" should be altered to "traffic in women and children," that a new convention should be drafted, that an advisory committee be set up and that Governments should be invited to make annual reports on the traffic and on the measures taken for checking it. All these proposals were carried out. In 1923 the advisory committee recommended that "pending the abolition of the system of State regulation, no foreign woman should be employed in or carry on her profession as a prostitute in any licensed house"; that a questionnaire be issued to the Governments; and that a study of conditions on the spot should be undertaken by experts. In 1927 the committee of experts appointed in pursuance of the foregoing recommendation published a report in two parts containing information obtained by visits to 28 countries and the replies of Governments to the questionnaire sent out. This report has been used in the following observations on the principal countries.

Great Britain.—In Great Britain there is no system of licensed houses or registration of prostitutes. The law is mainly governed by the Criminal Law Amendment Act of 1885, as amended in 1912 and 1922, which makes procuration or attempted procuration a misdemeanour. The law further makes it a felony to have carnal knowledge of a girl under 13, and a misdemeanour in the case of a girl between 13 and 16. The same applies to the occupiers of premises who knowingly permit these offences, to persons taking a girl under 18 out of the possession of her parents or guardians for the purpose, and to the detention of any woman or girl in a brothel. The maintenance of brothels is prohibited, and by the Vagrancy Act of 1898 males are prohibited from living on the earnings of prostitutes. The traffic in women and children is dealt with by the Children (Employment Abroad) Act of 1913, which prescribes the conditions for a magistrate's license to take girls under 16 out of the country for "singing, playing, performing or being exhibited for profit"; and by the Aliens Order of 1920. The Licensing Act of 1872 contains a provision, adopted from 1847, which makes it an offence for publicans to allow "common prostitutes to assemble and continue" in licensed premises. Otherwise they are not interfered with by the police except for disorder or annoying persons by solicitation: in regard to the latter, which also applies to males, the police exercise their own discretion and exhibit much variation of practice.

There is some evidence that street-walking by prostitutes, which used to be the great feature of London as compared with other capitals, has diminished; but the diminution may be partly explained by the practice, which has greatly increased, of motorcars waiting about and picking up girls. There is no reason to believe that prostitution has diminished; but on the other hand it is clear that the foreign traffic in girls is of very small account. Englishwomen are too independent to make good subjects, and the Criminal Law Amendment Acts have been successful in preventing such exploitation as there was. Great Britain is a party to all the international conventions.

The Question of Compulsory Examination.—NOaccount of Great Britain mould be complete without a reference to the partial adoption in certain garrison centres of the system employed elsewhere. In 1864 a Contagious Diseases Prevention Act was passed providing for the coinpulsory medical examination of prostitutes and the detention in hospital of those found affected. It applied to 11 garrison towns, was amended in 1866 and in 1869 was applied to 18 towns. This gave rise to a campaign in the opposite direction, with which Mrs. Josephine Butler's name was prominently associated. A royal commission investigated the question in 1871 and a select committee did the same in 1879. The majority reported in favour of the acts, being impressed by the evidence, which was strongly for them, and much of which was quite unbiased. Nevertheless in 1883 the House of Commons passed a resolution condemning the medical examination of women, and as this would have entailed refusal to vote the money required to carry on the system it was immediately dropped. In 1886 the acts were formally repealed.

In India the system was introduced for military cantonments in 1865, partially suspended in 1884 and stopped in 1888 on account of the action of the House of Commons. A new Cantonment Act was passed in 1889 and an amending act in 1893, which prohibited the compulsory and periodical examination of women. In consequence of the enormous increase of syphilis—from 75.5 to 174·1 per 1,000 for primary and from 29·4 to 84.9 for secondary cases—which followed, a new order was made in 1897, which gave power (1) to call on persons suffering from a contagious disorder to attend a dispensary, (2) to remove brothels,

(3) to prevent the residence or loitering of prostitutes near cantonments. Troops in India or in other stations abroad are in a different position from those at home and show a much larger proportion of men affected. If the army statistics of the different countries are examined over a number of years, two things appear:— (1) wide variations between the several countries, (2) a sort of epidemic rise and fall. The variations may be explained by the degree of care exercised in the regulated countries, Prussia having consistently the best record; the English figure is higher than for any regulated country. Flexner, arguing against regulation, suggests that the important factor is the size of the town, but that takes effect through the difficulty of carrying out the measures, which increases with the size.

United States.—The system is the same as in England; that is to say, there are no licensed houses or registration and periodical examination of prostitutes. The Federal Government has adhered to the convention of 1904, but not to those of 1910 and 1921, owing to the fact that the several States have their own laws in relation to prostitution. The Attorney-General of the United States is charged under the law of 1910 with the prosecution of cases of international and inter-State traffic in women and girls. The severe immigration law of 1917, which prohibits the importation of aliens for prostitution makes it difficult to pass; but there is no interference with emigrants on this account.

France.—French law has been considerably affected by the conventions of 1904, 1910 and 1921, France having signed and ratified the first two and adhered to the last. The criminal law takes no cognizance of prostitution, but the police have power to regulate it, in Paris under the prefect of police, elsewhere under that of the mayor. Brothels are licensed in two categories—(I) *maisons* de *tolérance* (residential), (2) *maisons* de passe or de rendez-vous (houses of call); the keeper of the former must be a woman who is the owner of the premises or has a registered lease. Only women of 21 and of French nationality are allowed to reside; the inmates are medically inspected every week, while other registered prostitutes are examined fortnightly. Registration is either voluntary or compulsory after repeated arrests. There are in Paris about 235 licensed houses, of which 30 are *maisons de tolérance;* the number of inmates is about 2,100 and it remains pretty constant. Girls under 18 are not registered, but are dealt with under Articles 270 and 271 of the penal code, as amended by the law of 1921, under which they are brought before the juvenile court and subjected to reforming measures. The registered prostitutes form only a small proportion of the total number. Procuration is an offence recognized by the penal code, which has been strengthened by a law passed in 1922. France appears to be the headquarters of the outgoing traffic in women and girls, especially to Cuba, Mexico, Panama and the South American republics. The incoming traffic is comparatively small. In 1924 the official returns of the registered prostitutes showed a total of 583, of whom 223 were Italians and 146 Belgians.

Germany.—Prostitution is not forbidden, but under article 361 of the penal code women are liable to arrest for practising prostitution without being under police control or for contravening regulations after being placed under control. The regulations include weekly or fortnightly medical examination, together with strict rules in regard to public demeanour and conditions of life. There are in Berlin about 6,000 registered prostitutes, and 2,200 in Hamburg; and these are reckoned at one-third of the total number. Procuration is prohibited, under the name of Kuppelei, by article 180 of the penal code, which was strengthened in 1927 by a provision of the law for combating venereal disease, which explicitly names the conducting of a brothel or of a business akin to that of a brothel as included in procuration. Nevertheless most large towns, except Berlin, still have them. There is (1) ordinary *Kuppelei,* which is simply assisting procuration for gain and (2) aggravated *Kuppelei,* which includes false pretences and procuration by parents, guardians, teachers, etc., and entails a much more severe penalty. With regard to the international traffic the German Government states that Germany is not at present a country of destination, but only one of transit. Foreign women, when arrested for prostitution, are expelled; eight such women were deported from Berlin in 1924 and 21 procurers. The outgoing traffic is much the same as before the war, but attempts are being made to prevent it in accordance with the international conventions, to all of which Germany is a party. A law passed in 1923 requires that all agencies providing employment abroad must be licensed and supervised. and another, passed in 1924, provides further protection for girls under 18 by requiring the consent of the juvenile court.

Italy.—After a fluctuating policy Italy has adopted the French system. Under the law of 1926 prostitution is regulated, and all inscribed women must submit to medical examination. In 10 cities there were 324 licensed houses in 1924. Strict conditions are laid down in the law of 1926. Procuration is an offence under the penal code, which was strengthened in 1923. With regard to the traffic, the law governing the outgoing traffic was made more stringent in 1919, but there appears to be considerable evasion of the passport regulations. The incoming traffic shows an increase. Out of 11,924 prostitutes interrogated in 15 months of 1923–24, 782 were found to be of foreign nationality. During 1925 that number had risen to 865, most of whom were Austrians and French.

Other European Countries.—A similar system prevails in Belgium, Portugal, Spain, Rumania, Greece, Hungary and Austria, excepting Vienna, where licensed houses have been abolished. The German or the English plan is followed, more or less, in Holland, Poland, Czechoslovakia, Switzerland and the Scandinavian countries. Colonies, dominions and dependencies usually follow the example of the mother-country.

Cuba.—The licensed areas were abolished in 1913, but conditions still remained very bad, particularly in Havana, until 1925, when a vigorous movement was initiated by the Government, under the inspiration of the League of Nations Committee, which visited Cuba in 1924. The police became very active, and the houses where prostitution was carried on were reduced from 477 to 224. The incoming traffic, which had greatly increased since the war, was largely stopped in 1925 by a decree making it an offence to assist immigration for the purpose of prostitution and providing for the deportation of foreign women and keepers of prostitutes. The number of women so engaged in Havana was stated to be 700, chiefly French, Spanish and Italian. Except for the deportations the outgoing traffic was small. Cuba is a party to all the conventions.

The Argentine Republic.—South America has become the main objective of the traffic from Europe. The Argentine is a party to none of the conventions. Prostitution is there regulated by the municipalities. Houses are licensed and prostitutes are registered and medically examined. In Buenos Aires there were 585 licensed houses in 1923, showing a considerable increase. The women are chiefly French, Poles, Italians and Spaniards, but "there is a constant flow of foreign prostitutes from every corner of Europe to the Argentine around all barriers devised to check it. . . . It is clear that the traffickers manage to evade every restriction, and the evidence discloses an elaborate system for running the business of prostitution and securing girls therefor to the great profit of third parties." (Report of committee.)

Brazil.—Brazil is a party to the conventions of 1904 and 1910 and has signed the convention of 1921. There are no laws regulating prostitution and no licensed houses. The penal code, as modified in 1915, makes procuration and brothel-keeping an offence; but brothels, and ostentatious ones, abound in Rio de Janeiro. With regard to the traffic Brazil is a country of demand and prostitutes come there from everywhere. A memorandum prepared by the medical officer of health of Rio de Janeiro gave the nationality of 1,683 prostitutes; of these 987 were Brazilians, 158 Russian, 148 French, 144 Poles and 69 Portuguese.

It is hoped that the foregoing notes will sufficiently indicate the general position in the Western world There are two main differences between the treatment of prostitution in the several countries. The first difference is the licensed house, which generally exists on the Continent but not in Great Britain and her dominions or in the United States. There is, however, a tendency to follow the example of Germany or, at least, of Berlin and abolish them. This has been done in Switzerland, Holland, Czechoslovakia and the Scandinavian States. It is largely a geographical and racial question, but the tendency is in that direction. The second difference lies in the registration and examination of prostitutes. There is none in Great Britain, Holland, Switzerland and the United States; the institution of venereal clinics does something to protect the public health in its place, and does it better. The great object of the police in regard to prostitution is the maintenance of public order, which is undoubtedly assisted by licensing. But to-day prostitution is essentially an urban problem, and the vast size of modern cities makes clandestine prostitution so easy that the licensed houses hold only a small proportion of the total number. What proportion it is impossible to say; the estimates freely made are mere guesses.

Another modern problem is the international traffic, maintained by *souteneurs* and capitalist principals. The fact that this question has been taken up by the League of Nations is highly significant. No nation can wish to retain the traffic, with its abominable accessories, and the new immigration laws and, to a lesser extent, the greater protection afforded to girls going abroad, show that the action of the League is having a marked effect. But more than that, it has stirred the Governments to look into an unsavoury subject and has affected the whole anti-prostitution movement, which began in Great Britain with the campaign against the Contagious Diseases Acts.

BIBLIOGRAPHY.—W. F. Amos, *State Regulation of Vice;* Committee of Fifteen (New York), *The Social Evil* (1902); Conference Internationale (Brussels, 1899), *Comptes rendus;* Flexner, *Prostitution in Europe;* Gibbon, *Decline and Fall of the Roman Empire;* Henne-am-Rhyn, *Die Gebrechen der Sittenpolizei;* Parent-Duchatelet, *De la prostitution dans la ville de Paris;* Reuss, *La Prostitution;* Von Raumer, *Geschichte der Hohenstaufen;* Sanger, *History of Prostitution;* Schlegel, *Histoire de la prostitution en Chine;* Schrank, *Die Prostitution in Wien;* Sturmer, *Die Prostitution in Russland;* Tarnowsky, *La Prostitution;* Zehnder, *Die Gefahren der Prostitution; Reports of the International Conference on Trafic in Women and Children* (Geneva, 1921); *Reports of the League of Nations Advisory Committee on Trafic in Women and Children* (6 sessions, 1922, 1923, 1924, 1925, 1926, 1927); J. Butler, *Personal Reminiscences of a Great Crusade; Reports of the International Bureau for the Suppression of Trafic in Women; Report of Experts on Trafic in Women and Children* (Geneva, 1927). (*A.* SL.)

PROSTYLE, in architecture, a portico projecting in front of a building, or a building with such a portico.

PROTAGORAS (*c.* 481–411 *B.C.*), Greek philosopher, was born at Abdera. He is known as the first of the Sophists (*q.v.*), *i.e.,* he was the first to teach for payment. It is said that he received nearly £400 from a single pupil. He learned philosophy in the Ionian school, and was perhaps a pupil of Democritus, though this is doubtful on chronological grounds. He was an older contemporary of Socrates. Pericles entrusted him with the task of framing laws for the new colony of Thurii (Plut. *Pericles,* 36). At the age of 70, having been accused by Pythodorus, and convicted of atheism, Protagoras fled from Athens, and on his way to Sicily was lost at sea. Besides *Truth,* and the book Of *the* Gods which caused his condemnation at Athens, Diogenes Laertius attributes to him treatises on political, ethical, educational and rhetorical subjects. Protagoras was the first to systematize grammar, distinguishing the parts of speech, the tenses and the moods.

BIBLIOGRAPHY.—See Diogenes Laertius, *Lives of the Philosophers* (ed. C. G. Cobet, Paris, 1850), the representations in Plato's *Protagoras* and *Theaetetus;* the fragments in Johannes Frei, *Quaestiones Protagorae* (Bonn, 1845) and A. J. Vitringa, *Disquisitio de Protagorae irta et Philosophia* (Groningen, 1852); for the Thurian legislation, *see* A. Menzel, *Protagoras als Gesetzgeber von Thurii* (1910). *On* Protagoras' philosophy *see* Th. Gomperz, *Greek Thinkers* (Eng. trans. L. Maynus and S. S. Berry, 4 vols., 1901–12); and works quoted under SOPHISTS.

PROTEACEAE, a family of dicotyledonous plants comprising about 50 genera and some 960 species, of which about 600 are Australian, including the silky oak (*Grevillea* robusta) introduced into Ceylon for shade and timber, the Queensland nut (*Macadamia ternifolia*), cultivated in Hawaii, California, and Florida, and the Australian honeysuckles (Banksia); there are about 260 species in southwestern Cape of Good Hope, including the silver tree (Leucadendron *argenteum*); the remaining species have a wide but irregular distribution in Asia, Africa, America and Australasia. Most of the species are trees or shrubs, and the majority are xerophytic (*i.e.,* inhabit arid country).

PROTECTION. By protection in the restricted sense is meant the use by the Government of special forms of regulation or restraint, particularly import duties and analogous fiscal expedients, in order to encourage or to maintain essential industries which are endangered by foreign competition. What industries are essential must be determined by the requirements of public policy. Protection is one phase of national policy, and its ultimate object is national security. The free trade theory assumed that every man knew his own interest better than anyone else did; that everyone would follow his own interest rather than the interest of anybody else, and thirdly that the interest of the individual coincided with the interest of the community. On these assumptions rested the whole doctrine of *laisser faire* (*q.v.*), that economic movements should be left to follow what was called their natural course under free competition. Society was an aggregate of individuals assumed to be equal to one another in the competitive struggle, and all individuals consciously or unconsciously pursued their own interests. Protection on the other hand involved a different conception. There was the interest of the individual, the interest of trade, and the interest of the commonwealth. The last was the most important. On the free trade theory the government should not interfere by tariff or other regulations in order to foster trades which did not make their own way in the competitive struggle, or to direct existing trades into channels in which they did not flow under purely individualist conditions. In so far as such attempts were successful they involved loss to the whole body.

The country practising free trade was realising "natural" conditions; tariffs or other regulations which interfered with such conditions, were artificial, imposing obstacles in the way of free movement associated with the "natural" state. Protection was therefore prejudicial to the realization of the greatest prosperity. A reversion to protection as a policy involves not merely the sporadic use of tariffs in order to safeguard particular industries, but a conception of the State, its constitution, its functions and its ultimate aims, different from the underlying conceptions of the free traders. To the free trader wealth is the end in view; to the protectionist wealth is the means. The real end governing the policy of protection may not be economic at all in the narrow sense, but may be national or imperial solidarity and power, though undoubtedly a protectionist holds that while the free trade policy may lead to the greater wealth of individuals, the protectionist policy properly administered, will bring about a balance of economic activities, involving a higher maximum of efficiency to the community as a whole and a more equitable distribution between the economic groups.

If agricultural enterprise under free competition and free trade cannot be made to pay, the free trader would abandon it and concentrate on those industrial lines of activity which under such conditions are at the time more profitable. The protectionist on the other hand would argue that this is a shortsighted view. In the first place agriculture is necessary to the State for its security, the maintenance of a healthy population and many other purposes not directly and immediately economic. But more than that, the protectionist would say that it is absurd from the economic point of view for a country to sacrifice its agriculture, for agriculture is the guarantee of a large home market for the country's manufactures, and the large and expanding home market is the best security for the successful exportation of manufactures. Given the home market, continuous running of the manufactories and the proportionate reduction of the burden of standing charges, cheapens cost of production and makes possible easier entry into markets abroad and a higher remuneration for the workers at home. The free trader would say that if an industry does not pay its way under a policy of free importation, it is better that the capital employed in that industry should be invested in some other branch of economic activity which is remunerative; that the artificial maintenance of such an industry by the imposition of protective tariffs is an economic loss to the community. The protectionist would point out that the capital of such a depressed industry cannot be transferred to another industry, that capital is in the concrete form of factories and workshops and machines and many other forms which cannot be realised if the industry has fallen. It may indeed be desirable in certain circumstances to abandon it, but such a question cannot be decided without weighing carefully the number of persons employed, the possibility of their finding employment in other industries, the place of the industry in the national life, its relation to other industries in the scale of production, the possibility of obtaining its products in a suitable manner from other sources, its bearing on national security, and many other considerations of the highest importance. The free trader would not use tariffs or other artificial means for establishing in a country a new industry not hitherto practised. If such an industry were not likely to develop as the result of the unaided efforts of individuals, the free trader would not use government aid to promote it. The protectionist would consider the resources available in the form of raw materials, the possibility of acquiring the necessary skilled labour, the available organising ability, the demand for the products of such an industry at home and the accessibility of markets, and if the prospects were favourable would not hesitate to impose a definitely protective tariff with the intention to encourage the industry in view, even though for a few years it might involve higher prices to consumers at home, and he would do that all the more readily if there was plenty of capital for investment in the country for which he was responsible. Doctrinaire views on the question of protection have greatly declined in recent years, especially as a result of the Wòrld War. There are very few people who have influence in public affairs at the present time who would not be prepared to admit important exceptions to the free trade view and be willing to adopt a protectionist policy in particular cases, especially in regard to industries which are essential for the national security.

The justification of protection is to be found not in its conformity or its departure from an abstract theory, but in the conditions which govern the development of actual states and the laws of their development. It does not really belong to the domain of abstract economics, but to statecrait and practical organisation. The range of philosophical and other assumptions underlying the pure theory of economics is neither wide nor accurate enough to cover the varied motives and activities of an organic community, and men may at the same time accept and make use of the theory of economics so far as it goes, and yet be strong protectionists in action. In the article on ECONOMICS it has been shown how to use economic theory in investigation in opening up the relations between different series of economic facts and in suggesting approximations for the solution of practical problems. But the world we live in is a world of realities and of varying policies. We are dealing with nations, communities, human beings and concrete things, and it can never be assumed that the world does or ought to conform to the requirements of a purely theoretical system. The objections to protection in a hypothetical world where there is complete mobility of labour and capital, and time is an abstraction, are not relevant when we have to consider the great industries and the lines of commerce of the actual world, the tangled relations of the groups of human beings, their different histories and environment, and the divergent interests with which statesmen have to deal. If we keep in view the wide gulf between the world of pure theory and the conditions of actual life, we shall not hastily come to the conclusion that the states which have practised a protective policy have achieved success in spite of the measures they have adopted to secure it.

The Fall of the Old Policy.—In the middle ages the source of England's wealth was the exportation of raw materials, with which she purchased the manufactures and the luxuries of other countries. In those ages many of the regulations adopted were not, as they have been regarded by free trade writers, restraints upon liberty, but the conditions of its exercise. Freedom is only possible where there is security. Before the close of the middle ages manufactures were greatly extended as a result of encouragement, by the native aptitude of the people, and by the immigration of skilled artisans. Movements analogous to those of modern times took place on a small scale, and there were signs of a growing nationalism long before the close of the middle ages. Action taken by the trading companies, especially the great Merchant Adventurers Company, encouraged foreign trade, and we can trace in numerous statutes the foundations of what was subsequently called the mercantilist system. Then took place a development not dissimilar to that in continental countries in modern times. Internal barriers were removed. England and Scotland were united. Great Britain and Ireland became one economic area. By that time the United Kingdom, under the policy which was so widely condemned later on by economists, achieved economic supremacy. With apparently illimitable supplies of coal and other requisites of production, her industries growing by leaps and bounds from the use of new inventions, the whole organisation and structure of great industries rapidly changing, the old laws and methods of regulation became obsolete, and the tariffs worked out to suit the more primitive stages of industrial development were simply embarrassing or irrelevant in the new conditions. Attempts to adapt them failed and the old duties were swept away, not so much in obedience to a theory but because the necessary adaptations could not be made. It might have been more statesmanlike and prudent to keep at least the framework of the old system, but with wealth as the supreme end in life and with the opportunities which the new industrialism gave, this was the accepted course of contemporary statesmen. By 1860 free importation was the established policy of the country and the methods by which English statesmen had built up the economic power of the country were remembered simply as the economic fallacies of a former generation.

The Mercantile System in England.—In order to bring out the character of protection in its modern form we must make some further historical contrasts in British policy. The older policy was not protection in the narrow sense in which the word has been used in modern controversy. The idea of building up a great industrial commercial state by that policy ran through most of the economic measures which were adopted, affecting agriculture, trade and commerce, commercial treaties, finance, labour legislation, the poor laws, and colonial policy for several generations, and discriminating duties were imposed not from logical necessity or through loyalty to some theoretical system, but as practical expedients like any other form of regulation to deal with problems as they were at the time understood. Whole trades and branches of trades were left free. The mercantilism of England was always different in important respects from the Colbertism of France, and the tariff systems, generally, of continental states. Adam Smith comments on the "liberality" of English policy as contrasted with that of other states. It was a "free trade" system in (1) its extension of the powers of the central government over the trade and industry of the country at the expense of local and sectional bodies, close corporations, etc.: (2) the consequent equalising of opportunities and development of free enterprise, (3) the "nationalising" of great trades such as the East India trade, the trade of the Levant, etc., (4) the removal of internal restrictions, such, for example, as those on the corn trade. (5) the introduction of free trade first between England and Scotland and then between Great Britain and Ireland.

The term "free trade" was used in many different senses in contemporary literature and practice, but scarcely at all in its modern sense. It was applied to the freedom of intercourse between states as secured by treaty, to privileges granted to alien traders by which they were put on equal terms with the denizens of the country. It sometimes suggested illegality, piracy and unfair avoidance of established regulations; it was applied to the "interlopers" who carried on free trade with no regard to the regulations of the chartered companies, and to the smugglers who escaped the payment of duties levied by the state. In modern times free trade does not necessarily involve the meaning applied to it in England, but the policy of free exchange, and the levelling up of conditions by means of a tariff or other regulations to secure equality of competition between the countries concerned. Free importation in the modern English sense is peculiar to England, just as in England the term protection has come to be restricted in its application to the imposition of duties. It is also to be noted that the rôle played by the colonies under the mercantile system was roughly that which Cobden and his followers expected both colonies and foreign countries to play when the United Kingdom adopted free importation, and if the mercantilists sometimes imposed special regulations to direct colonial trade into channels considered favourable for the development of the mother country, the adherents of the Manchester school not infrequently used the power and influence of England to keep the economic activities of neutral and eastern countries in a stage considered favourable to the interests of British industry and to prevent the due expansion of those countries on lines more in accordance with the wishes of the people and the national resources of those countries.

There is a further distinction between the older system and Cobdenism. Both were forms of "national" as distinct from "imperial" policy, but under the former the colonies had a great part to play. They were in a position entirely different from that of foreign countries, in relation to the United Kingdom; and the system of preferences which then existed would have lent itself to the building up of the empire. Under the Cobdenite system the colonies had no part to play at all different from that of foreign countries, and the "interests of the consumer" took the place of the "interests of the commonwealth" as the basis of public policy. The older system looked forward, as it were, to the establishment of a great empire. Cobdenism was not really internationalism viewed from the point of view of British policy, but nationalism in a narrow, insular sense and the policy of England under its influence was based upon the economic monopoly secured by the rapid progress of invention. The influence of the new industrialism broke the cautious continuity of British policy. Walpole and Pitt revised the fiscal system by removing duties on raw material and reducing other duties with the view of increasing revenue. Huskisson revised the fiscal system in much the same spirit. The measures throughout this period were more in accordance with the cautious and statesmanlike line of Adam Smith's *Wealth of Nations* rather than with the later economists. If this movement had not been interrupted England would probably have retained the means of conducting international negotiations for consolidating the empire and providing a wide basis for revenue without any violent changes, but under later influences the policy of free importation was carried to extremes. People pursued the logical consequences of free trade rather than the practical interests of the country. The free traders on the one hand and the protectionists on the other were in violent and direct opposition on grounds of abstract theory rather than practical policy. But there is no important economist of the free trade school who does not admit important exceptions to the doctrine of free importation. The idea that all economists of that school were Cobdenites is without foundation. Reference has been made above to Adam Smith and his cautious attitude, but the great classical economists fairly generally admitted cases in which duties on imported manufactures might be desirable. Allowing therefore for the very different philosophical conceptions which were the basis of economics at that time as compared with our own, and the very different economic conditions which prevailed, there is not so much to distinguish the attitude of the writers of the early part of the nineteenth century from those of our own day in regard to practical policy as may be thought from manifestations of feeling during the fiscal controversy. The views of economists must be distinguished from the use made of them by political and social controversialists. The Ricardian theory of rent, the high prices and the practical difficulties of the times gave such people magnificent opportunity for working up a crusade against landlords, and the free trade movement which at first had been a most reasonable and proper effort to get rid of tiresome obsolete restrictions, became in the hands of extremists an instrument of social and political revolution. It is in England especially that the free trade movement was directed mainly against the landlord class and later on the capitalists, and it has grown by natural stages into the socialistic movement of modern times, while protectionism in all its branches has been more identified with methods of creating an industrial and commercial state of the modern type.

The qualifications of the free trade doctrine admitted by John Stuart Mill went far to undermine the whole basis of the doctrine. His famous admission in regard to infant industries of a new country could be made to cover a very large proportion of the protectionist expedients adopted in modern countries. The economic conditions and the rapid growth of the United States in the 19th century naturally made an immense impression. It was necessary to work out an explanation for such progress under an economic policy so different from that of England. But historically speaking, analogies to the development of the United States policy could be found all the world over. The word "new" in regard to industry cannot be confined in its application to the historic position of a country or an industry. It must apply to the stage of organisation of particular industries and if it is once admitted that a high tariff is justified from that point of view, the tariff policy of Europe during the nineteenth century finds much justification from the writings of the economists. But the admission could easily be extended to cover many other important steps of policy. The case may be taken of the country whose industries have been actually devastated by war or destroyed in the sense that the existing organisation for production had broken up, markets lost by the diversion of great works into activities for which they were not built and where vast works of reconstruction are required to bring them back to the peace efficiency which they once had. On Mills' admission it is difficult to deny the claim for protection while reorganisation is being carried out. The question becomes a matter of practical expediency, when we have to consider whether in given circumstances duties should or should not be imposed as an instrument of organisation. Obviously the policy to be pursued cannot be decided on purely abstract grounds.

The German Zollverein.—The most remarkable instance in modern times of the constructive use of a protective tariff in the building up of a great empire is to be found in the history of Germany. At the beginning of the 19th century Germany consisted of a number of small states each enjoying fiscal autonomy, separated from one another by customs frontiers, and after the era of the Napoleonic wars, German statesmen and economists saw that if national industries were to be established on a modern scale, these numerous areas would have to be unified. Standing alone and more or less isolated economically from their neighbours, they could not get the full advantages they could obtain in production by the development of their materials from their numerous population and from their mutual commercial relations. Germany had to choose between a large-state and a small-state policy, and Prussia began the work of organisation by the adoption of the tariff of 1818. Internal tariffs in the provinces of Prussia were swept away. Prussia as a whole was given protection against all external competitors, and other German States were invited to enter into union with her. The result of this movement was the formation of the Prusso-Hessian Zollverein. This was followed by the Zollverein between Wurtemberg and Bavaria and other combinations. These combinations were then brought into union and the first treaty of the Zollverein was adopted in 1834. The larger part of Germany thus became more or less a homogeneous economic area, except for a survival of a number of internal duties which it took many years to get rid of. The treaties were in the first instance for 12 years. By the end of the first period other states had acceded and so the process went on until the German Zollverein was completed. The Zollverein was not co-terminous with the German Empire, but it was the condition and the means by which the German Empire was created.

This movement was not understood in England, where it was regarded as protectionist in the narrow sense in which the word was used in English controversy. There were gloomy prophecies as to what would happen to Germany and what would happen to the trade of England with Germany. In fact the German movement was not dissimilar from that extending over a long period of time during which the economic union of England, Scotland and Ireland was effected, and many internal barriers were swept away.

The formation of the Zollverein brought about freedom of trade over a vast area, and its trade was protected against foreign competition by a carefully devised tariff round its external frontier. It is obvious that the internal union could not have been secured without the external protection. The German tariff and the internal organisation were necessary parts of the same movement, and the tariff organisation was supplemented by great schemes of reconstruction affecting every aspect of German life. The progress which followed the movement is without parallel; and the German empire became the most powerful competitor in the world with other countries. This feat of statesmanship was all the more remarkable as it was carried out in the teeth of British competition. When Great Britain entered upon her era of rapid commercial progress, she was first in the field with the inventions which revolutionised industrial processes, and she had the manufacturing monopoly of the world. Germany at the beginning was technically behind Great Britain, but she had one great help to her progress. Just when she was applying on a vast scale the principles of policy which had made Great Britain mistress of the world, that country turned her back on her o n traditions and made a free present of her market to any country which could exploit it. The rapid industrial progress of Germany was undoubtedly partly due to the fact that German exporters had free entry into the English market for their goods. Before the World War, it was quite common for great German factories to be planned, erected and organised on the basis that they could always dispose of their surplus productions in the English markets to an advantage at any price they could fetch.

This illustration from Germany is given in order to show how misleading was and is the practice of abstract English free traders of grouping the commercial policies of the world under two categories, of free trade and protection. Actual policies as they have been carried out can never be described in that simple manner. It is not enough to say that the actual policies are a combination of both theories. They are not. The actual policies of countries are the expression of the living activities of great societies as they have been determined by their long history and the powers and functions which they have developed, and they never follow the lines of an abstract theory divorced from the facts of that development. All countries have followed or are following much the same general course of development as Great Britain up to the modern era, but no country in any part of the world has ever deliberately adopted the practice of free importation in modern times. Many German students for years before the mar studied very carefully the course of events in England in order to avoid the mistakes which had been made.

We can see how the growth of the Zollverein brings into clear relief the mutual relations of the measures adopted in carrying out a great policy of economic nationalism, and the conditions under which such a policy can be achieved. Internal fiscaldifferences have to be swept away as far as possible, and that requires the provision of some alternative means for furnishing the revenue which in the first instance has to be sacrificed. So we get the organisation of a tariff against external countries and the development of means of direct taxation. The process further involved a policy for application to the means of communication, especially the railway system and transport by sea. In all these processes there was necessary some political reorganisation. The small States had to sacrifice their autonomous fiscal powers when they entered into the new union. The Zollverein on the German model could not be achieved without such sacrifice, a condition which could not be realised in the British empire where the dominions would certainly not give up their fiscal autonomy.

The German measures could not be carried through without social reorganisation and mainly under the influence of the German Centre Party and their arrangement with Bismarck a whole code of new social laws was evolved. To enlarge still further the economic borders and to bring fresh markets on the continent within their ambit, the Germany treaty system was developed. Later on in order to meet the economic pressure which followed from their rapid development, Germany pushed into a colonial policy and the exigencies of diplomacy, quite apart from the necessities of defence, forced Germany into a naval policy, and the German navy was established. Thus the German empire was gradually forced to adopt in a modern form all the leading characteristics of the old English national system, and the instrument by which these changes were brought about was the German tariff. This immense constructive movement, the greatest example we have of modern economic nationalism, obviously cannot be described as simple protection. It was a great scheme of organisation in which for one purpose or another the German tariff had to be used as an instrument.

Modern Attitude to Protection.—A certain practical attitude to the question of protection characterises the policy of all countries in modern times. It is recognised that every case has to be examined on its merits. No two tariff systems are the same, nor can it be decided which is more protectionist than another without the most careful examination not only for the actual rates of duty, but of all surrounding circumstances. (See TARIFFS.) French and German policies have been in their main features singularly permanent during the nineteenth century. The broad lines of policy have remained and are likely to remain as long as these countries subsist. There are no signs of any considerable modification. French policy, it may be said, is certain, since the acquisition of Alsace and Lorraine, to become more nationalist in character and the features which have marked successive tariffsfor many years are more likely to be emphasised than abandoned. Italy is showing all the signs of a nationalist régime, and she will proceed along much the same path as Germany and France. The new states which have been formed since the World War all show the marks of strong nationalism and this has found expression in the high tariffs they have one and all imposed. Under the pressure of modern economic conditions which are unfavourable to the existence of small States, many of them, while they may retain their political independence, will be forced by circumstances into economic combination, and the course of development followed by the German empire will be repeated in the economic sphere.

In the Far East the same movement is making rapid progress. It is many years since Japan embarked upon her own national policy. The development there is not in the least likely to be checked, still less will there be any return to the stage from which it was the departure. The old economic régime in China is at an end. Whether politically that huge country settles down to internal peace or not, it is certain that there will be an effective tariff in China organised for the purpose of Chinese industrial development and not as it has been, a revenue tariff while the Chinese market provided the means of disposing of the produce of European states. India is pursuing the same course, a fact of the utmost significance to Great Britain, because the Indian market as the Lancashire exporter has known it, is diminishing in importance; and the effect of this development upon the cotton trade and all the other 40 industries bound up in the cotton trade is of the greatest political and economic importance to Great Britain and the whole of the British empire. Egypt is following the same course. Within three years the conventions come to an end. Egypt will then have ready a new tariif. Every one of the British dominions is following the same course of development on national lines, and there is no sign that any other course, preference within the empire excepted, will be seriously considered. Great Britain, no longer the economic mistress of the world, one amongst many great nations at least as well equipped as she is, all pursuing with conviction the policy which they believe made the British empire, has abandoned her free trade attitude. There are now thousands of import duties in the British tariff. There is nothing between the present piecemeal application of protection and the working out of a tariff on a sczle suited to domestic and imperial needs except transitory influences and questions of immediate expediency.

It seems therefore that both protection and free trade in the academic sense of loyalty to a particular theory in which these words were used, have ceased to cover in any way the developments of policy in the world as we know it. There is a reversion all the world over to a conception of policy similar to that which inspired the earlier national policy of England under which protective tariffs are used or not used on the grounds of pure expediency to assist the aims of modern nationalism or imperialism, and this modern nationalism or imperialism is not a policy based upon the exploitation of any country or race, but the due adjustment of the economic relations of countries in such a manner as to secure their autonomous development and the efficiency of production. (W. A. S. H.)

UNITED STATES

The Civil War divides the protection policy of the United States into two distinct periods of approximately equal length. During the first 70 years there was a quarter-century (1789–1816) during which tariff making was governed primarily by revenue considerations; this was followed by a period of vigorous protection to rising young manufactures (1816–32), a period which was succeeded in turn by a quarter-century of declining protective duties (1833–60). With the Civil War, new forces came into operation, and since 1862 the United States has followed a rigid and consistent protective policy, interrupted thus far only by the relatively moderate Wilson and Underwood tariffs of 1894 and 1913.

When Congress met under the Constitution, the first bill introduced in the House of Representatives was a measure to provide revenue by means of a customs tariff. Various States had protective duties before the Constitution was adopted, and the debates on the revenue bill show clearly a general willingness to use the tariff to encourage domestic industries. Yet the rates enacted were low (in general but 5%), with specific duties on certain articles selected for special encouragement. During the 20 years following, the European wars created a great foreign market for American raw products, and made ship-building and shipping highly profitable, notably in New England; so there was little growth of American manufactures, and no appreciable increase of protectionist sentiment, despite the strong argument for protection put forth in Hamilton's *Report on Manufactures* (1792). As more revenue came to be needed, tariff rates were raised from time to time, but no special attention was given to their protective aspects, and down to 1816 the actual operation of the customs duties was only remotely protective.

From 1808, however, the industrial situation changed abruptly. The Embargo act (Dec. 1807), followed by the Non-Intercourse act (1809) and the war with England, cut off a large part of the export and import trade. Small manufactures sprang up in various parts of the country to meet pressing needs. Financially weak, and often ill-equipped, they were in no position to meet the sharp competition of the more advanced British manufactures with which they were faced on the return of peace. Their cries of distress, together with the need for more revenue, in 1816 brought new tariff legislation. Though designed to aid the manufacturers, this measure embodied only moderate duties, running as high as 25% on textiles for three years only, with a provision for minimum valuation. Though bad crops in Europe for a time kept the price of farm products high, the farmers too found themselves in difficulty after the crisis of 1818–19, and their thoughts turned toward the possibility of a home as opposed to a foreign market. As a result of these conditions there sprang up after 1819 an agitation for internal improvements and a vigorous protective movement, which aimed to insure national self-sufficiency by encouraging young manufactures and affording the farmer a home market. This so-called "American system," popularly identified with the name of Henry Clay, its foremost spokesman, had its early strength in the middle and Western States, New England at first holding aloof because of its predominant shipping and commercial interests. As industrialization proceeded, however, New England swung over, and from the latter part of the '20s that section became a foremost advocate of the protective system, which Pennsylvania had favoured from the first.

In response to the demand for protection, Congress passed the Tariff act of 1824, raising the duties on textiles, and also on iron, wool, hemp and other articles of particular interest to the middle and Western States and to the farmers Agitation was renewed after the crisis of 1825–26, culminating in the celebrated Harrisburg convention of 1827. In the following year, as a result of extraordinary political manoeuvres, a new law was enacted, the so-called "tariff of abominations," which brought further sharp increases of rates, particularly on wool and other goods whose protection was specially distasteful to the New England protectionists. Four years later this measure was superseded by another act, which put the tariff into a form satisfactory to its friends. Goods not produced in the United States paid low rates while textiles, iron and other articles which it was desired to protect, paid high ones. Woollens, for example, were taxed 50%, while the specific duty on rolled bar-iron at 1832 prices was equal to 95%.

The Southern States were unable, because of slavery, to develop manufactures, and they were interested chiefly in a good market for their raw cotton. Rightly judging that protection was bound to work directly to their disadvantage, they had from the beginning sharply opposed protection. The opposition became so fierce that South Carolina undertook to nullify the Act of 1832, but the firmness of President Jackson maintained the Federal authority. As a consequence of Southern opposition, however, the compromise tariff of 1833 was enacted, providing for a slow reduction of duties over a period of 10 years, until in 1842 no rate should exceed 20%. Manufactures had in fact by 1832 become settled on a firm basis, and interest in the tariff waned, while other questions, like internal improvements and slavery, came to occupy public attention. The final low rates of the act of 1833, it so happened, were in effect but two months, as the Whig Party in 1842, for political rather than economic reasons, passed a new high-tariff measure, which remained on the statute books for four years. The protective movement had largely lost force, however, so this measure was without much difficulty replaced in 1846 by the so-called Walker tariff, a moderate measure under which the most important protected articles paid 30% except cottons, which paid 25%. There was little interest in the tariff, and in 1857 a redundancy of revenue led to further reductions, the 30% rate going down to 24%. Often called a free-trade tariff, the act of 1857 in fact marked the lowest level of protective rates since the beginning of active protection. Under the circumstances then existing, the reduction of duties commanded general approval, even among the manufacturers. The protective movement of the '20s, the period in which manufactures were becoming firmly established, had gradually lost fervour after 1832, leaving the way clear for the fixed opposition of the Southern States to make itself effectively felt. The interest of farmers and manufacturers alike turned to other methods than tariff legislation as a means of insuring prosperity, and no real or supposed national interest was successfully invoked to stay the growing movement toward greater freedom of international trade. A revenue shortage following the crisis of 1857 occasioned the enactment of the Morrill tariff of 1861, framed to attract protectionist votes to the Republican Party in the campaign of 1860. Undertaking only to restore the rates of 1846, its authors yet sought to give added protection to Pennsylvania and the Western States by changing *ad valorem* to higher specific duties and by raising rates on iron and wool. Even so, the measure belongs essentially to the period of tariff liberalization beginning in 1833.

The Civil War brought profound industrial changes, and gave a new direction to tariff policy. Hitherto, customs duties had been practically the sole source of government revenue, and tariff legislation had therefore been dictated to no small extent by the condition of the Treasury. The war, with its insatiable demands for revenue, called into existence an elaborate system of internal-revenue taxes, of which the imposts on liquor and tobacco remained as a permanent and highly important part of the revenue system, thus affording legislators somewhat more leeway to deal with customs duties without primary consideration of their effects on the revenue. The internal-revenue acts of 1862 and 1864 laid heavy taxes on the production of commodities of all sorts, taxes which were naturally accompanied by corresponding increases of duties on imports. As those who framed the laws were protectionists, they were eager to see that no domestic producer was injured; accordingly, almost any duty asked for was granted. A tariff structure, "in many ways crude and ill-considered," establishing "protective duties more extreme than had been ventured on in any previous tariff act," to quote the leading authority, was thus suddenly built up. Like the other hasty financial legislation of the period, it was originally designed to meet the war emergency. At the end of the war, however, the structure thus erected, instead of being rebuilt, was preserved practically intact, and with relatively minor modifications continued to serve as one of the two pillars of Federal finance down to 1913.

After the war, the internal-revenue taxes, except those on liquor and tobacco, were promptly swept away, but the protected interests successfully resisted the reduction of protective duties, thus retaining what had been granted during the war both as compensation for internal taxes and as protection. The demand for tax reduction and tariff reform was met in 1870 by a lowering of rates on revenue articles like tea, coffee, sugar and spices, but an actual raising of certain protective duties, including those on steel rails and nickel. Two years later it became necessary to do something more to reduce revenue. Fearing worse things, the protectionists consented to a horizontal 10% reduction of all duties, on condition of the entire repeal of the non-protective duties on tea and coffee. When more revenue was needed in 1875, the 10% was easily and quietly restored. On the other hand, the high war rates on wool and woollens had been in 1867 raised yet higher, at the instance of certain woollen manufacturers and sheep breeders represented in the Syracuse convention; and the elaborate scheme of classified duties on wool, together with compound specific and *ad valorem* compensating and protective duties on woollens, introduced in the Morrill act, had been further developed. Similarly, the Lake Superior copper producers succeeded in 1869 in getting Congress to raise the duties on copper ore and ingot copper. By this means a combination of copper producers for a decade obtained extra prices equal to a good part of the duty. In 1870 the 45% duty on steel rails was changed to a slightly higher specific duty of $28 a ton. Rail costs fell rapidly, and by 1877 this amounted to almost 100%. The small number of American companies owning the Bessemer patent made enormous profits and expanded their business rapidly. At the request of interested producers, though with less striking results, there was a similar raising of duties on marble and nickel.

No general revision of duties occurred until 1883, when a redundant revenue compelled a reconsideration of the entire situation. A tariff commission was appointed, made up of protectionists. Its recommendations looked, on the whole, towards reduction, but little attention was paid to them. The protectionist forces in control of Congress managed, by skilful parliamentary management, to get rates raised on goods which continued to be imported despite the existing protective duties—articles such as fine woollen cloths and dress goods, cotton hosiery, laces and embroideries, iron ore and various special manufactures of steel—while duties were lowered chiefly in cases where the new rates were no less prohibitory than the old, such as cheap cottons, steel rails and copper. The act made no fundamental change in the protective system. Tariff discussion continued, and President Cleveland's annual message to Congress in Dec. 1887, urging general tariff reduction, particularly on raw materials, made protection the outstanding issue of the presidential campaign of 1888. The Republicans were successful, and they proceeded accordingly to revise the tariff in order to make it more highly protective. By the McKinley act (1890) the duties on wool and woollens were raised, as were also those on such cottons as continued to be imported, particularly knit goods. Linens went up sharply, and velvets and plushes of all sorts, of which imports were heavy, were charged high rates in the effort to establish a new industry. With the same purpose, tin-plate, with which the United States had been supplied almost entirely by importation, was charged $2\frac{2}{10}$ cents a pound, but with the proviso that it should be admitted duty free after 1896 unless domestic production should equal $\frac{1}{3}$ of imports in some one year between 1890 and 1896. The existing duty of two cents a pound on sugar, which was practically a revenue duty, since only a tenth of the supply was produced at home, was repealed. and the domestic producer was given a two-cent bounty instead, the two measures together taking something like 60 millions a year out of the Treasury. The whole act was a bold attempt to extend the protective system distinctly farther.

In the two succeeding political campaigns the Republicans were overwhelmingly defeated, and the Democrats returned to power pledged to tariff reduction. Party quarrels over the silver question, however, together with the narrowness of the party majority in the Senate and the determination of certain Democratic senators to maintain protection for particular interests, resulted in the emasculation of the tariff measure passed by the House, and the Wilson act of 1894 was allowed to become law without the president's signature. Even so, it constituted a break in the series of increasingly protective measures enacted since the Civil War. First, and most important, wool was made free, and the complicated duties on woollens were replaced by simple *ad valorem* duties, which, however, afforded the manufacturers a protection equal to the full amount that they had nominally enjoyed under the McKinley act. Rates on the finer cottons were lowered somewhat. Iron and steel duties were lowered, though not in any significant manner, and the rate on tin-plate was cut in two. Coal and iron ore, as raw materials, were made free by the House, but the Senate restored both to the dutiable list, though at reduced rates. The great battle was waged over sugar; the outcome was a duty of 40% *ad valorem* on raw sugar, and of 40% plus one-eighth of a cent a pound, plus an extra tenth of a cent a pound on sugar coming from any country that gave an export bounty, on refined sugar. This result was commonly regarded as a victory for the "sugar trust" and a violation of party pledges. The measure as a whole was a great disappointment to the tariff reformers. It went into effect, moreover, in the early stages of a period of business depression.

The money question carried the Republicans back into power in 1897, but political conditions made monetary legislation impossible, and President McKinley called Congress in extra session for the sole purpose of tariff revision. A new bill was promptly reported, and the Dingley act was passed without delay, restoring essentially the system of 1890. The wool and woollens duties of that year were re-established, with some changes, mostly upward. Specific duties, even higher than the previous high *ad valorem* ones, were laid on silks, and linens were treated likewise. The farmer got a duty on flax, and the ranchman, for the first time in 25 years, a tax on hides. As the iron and steel industry was largely beyond reach of foreign competition, rates were left in good part where they had been put in 1894, but certain specialties, like razors and cutlery, which continued to be imported, were raised by changes in classification, while tin-plate, the manufacture of which in the United States had been greatly aided by the relative cheapening of American steel sheets in the years immediately preceding, was given rates little in advance of those of 1894. Rates on raw sugar mere pushed above those of the Wilson act, thus at once increasing revenue and giving added protection to the beet-growing industry, and the refiners kept the $\frac{1}{8}$ cent differential of 1894. The Dingley act, it will thus be seen, gave up no part of the protective structure of 1890, and at a number of points extended it beyond its previous limits.

The rapid growth after 1898 of industrial combinations, popularly supposed to be special beneficiaries of the tariff, and the rise in the cost of living, led in time to increasing criticism of the protective system, and aided, along with the restiveness of the Middle-West farmers and the growth of manufactured exports, in putting the protectionists more or less on the defensive. The Republican Party, accordingly, in the campaign of 1908 enunciated the so called "true principle" of protection, that duties should equal the difference between cost of production at home and abroad, plus a reasonable profit to American industries. Theoretically and practically impossible as the principle is, it yet indicated the line of defense to be adopted in the tariff revision promised by Taft as a presidential candidate. The Payne-Aldrich act of 1909 was in fact written along the same lines as its predecessors, with little more than lip-service to the "true principle." The House committee proposed to admit coal, lumber, iron ore and hides free. Hides were freed in fact, bringing some reductions in leather and shoes; the other materials continued to pay duties, though at reduced rates. As usual, practically important upward changes were made in the textile schedules, as in the rates on mercerized cotton, cheap hosiery and silks. The iron and steel duties, most of which had long since ceased to have practical significance, were generally reduced; but razors were given another upward turn, as were also pliers, cheap cotton gloves, asbestos fabrics, and other particular articles whose claims were effectively presented by their producers to the legislators. Figs, prunes and lemons were protected. The act brought no substantial modification of the protective system, but the whole tone of its supporters indicated inability or unwillingness to push much farther the aggressive protectionist policy of the '90s.

The back-handed reciprocity provisions of the acts of 1890 and 1897, authorizing the president by proclamation to impose duties on certain goods otherwise free, if coming from countries that discriminated against products of the United States, were omitted from the Act of 1909. Instead, the rates of 1909 were declared the minimum tariff and those rates plus 25% (of the value of the goods) the maximum. After March 31, 1910, the maximum rates were to go into effect automatically, except in the case of those countries where the president had satisfied himself that "no undue discrimination" was exercised against the United States. By strenuous exertions the administration managed to avoid the imposition of the maximum rates in any case, though tariff wars with France, Germany, and especially Canada, were narrowly averted. The president also construed a provision of the maximum and minimum clause as authorizing him to appoint a tariff board, which proceeded to make studies on the basis of the "true principle," the moderate protectionists believing that its findings might serve as a second line of defense against the reduction of genuinely protective duties. The same moderate group, under the leadership of President Taft, were eager to do something for the export manufacturers, whose eagerness for foreign markets had been recognized in the Act of 1909 only in the ill-judged maximum and minimum provisions. A measure was accordingly driven through Congress, against the bitter opposition of the extreme protectionists, approving a treaty for a moderate measure of reciprocity with Canada, and freeing wood-pulp irrespective of Canadian action. To the disappointment of the moderates, Canada rejected the treaty.

The year 1913 found the Democrats in control of the presidency and of both branches of Congress. President Wilson promptly called Congress in special session, and a new tariff measure was enacted which was widely hailed as marking the beginning of a new era in American tariff policy. Announcing the principle of a "competitive tariff," and declaring their intention to injure no "legitimate industry," the party in power yet proceeded to a downward revision looking to definitely moderate protection. Wool was admitted free; and woollens after Jan. 1, 1914, were to pay a straight ad valorenz rate of 35%. Sugar, the duty on which, with the growth of the beet industry, had become a protective one, was to be free after May 1, 1916, by which time it was thought that the newly enacted income tax would be in running order and would be yielding income effectively. Cottons were sharply reduced; though most of the reductions were nominal the ne rates meant the probability of increased imports of the finer goods. Silks were cut somewhat, though the general rate was still 45%. Coal and lumber were freed, and leather and boots and shoes followed hides to the free list. Iron ore and crude iron and steel products likewise were made free, and rates were cut to a maximum of 20% on the advanced products. To meet the farmers' wishes, agricultural implements, by a harmless gesture, were carried to the free list; but at the same time wheat, flour, cattle and meats were freed in response to the demand for a lowered cost of living, thus introducing the possibility of a less restricted border trade. The "jokers," special rates imposed at the behest of particular favoured producers, which had become so conspicuous and unpleasant a feature of protective acts, for the greater part disappeared. The act repealed the maximum and minimum provisions of 1909, and in 1916 a tariff commission was established. While many of the reductions of the Underwood act were politically rather than economically important, it represented a genuine though cautious attempt at a wider freedom of trade.

After the outbreak of the World War, for half a decade American industries, despite reduced duties, had no European competition whatever. Various of the so-called "war babies," notably the chemical industry, grew enormously to meet immediate needs. With the return of peace, some of them faced sharp foreign competition. The spectacular fall of prices in 1920 plunged agriculture into distress, and the farmers turned to protection as a supposed remedy. When the Republicans returned to power in 1921, they promptly laid high duties (quite incapable of raising prices under the circumstances) on various farm products that had been freed in 1913, notably wheat, corn and meat, as also wool and sugar. This "emergency" measure was followed by the Fordney-McCumber tariff of 1922, following the lines of the Act of 1909, but surpassing it in the application of protection. Agricultural rates were higher than in 1909. Generally without economic significance, they did in fact mean the probability of higher prices for such products as California fruits, wheat on occasion, and notably sugar. Wool was given increased protection, and the elaborate system of compensating and protective duties on woollen manufacture was restored. Textiles generally fared about as in 1897 and 1909. Iron alloys and specialties subject to foreign competition, like cutlery and firearms, were raised above the rates of 1909, as were china ware, jewellery, toys and laces, the last-named paying 90% ad *valorem.* Coal-tar products, dye-stuffs and chemicals, which had sought absolute prohibition, were granted extremely high rates.

The Act authorized the President, after investigation by the tariff commission, to raise or lower rates (within the limit of 50% of the prescribed duties) as might be necessary to equalize costs in the principal competing country. Under this provision the president raised rates in a number of cases, but lowered them in no important instance.

The farmers failed to share the prosperity of the twenties, and early in his administration President Hoover called Congress in extraordinary session to revise the tariff for their benefit. Congressional action promptly took the form of a general upward revision of duties, giving rise to a fierce legislative struggle. Export manufacturers urged moderation, financial experts pointed out the necessity of increasing imports in view of the creditor position of the United States, protests against threatened injuries came from forty foreign countries, and more than a thousand economists signed a memorial advocating the defeat or veto of the measure. Nevertheless it was enacted in 1930, after a notorious process of log-rolling. According to the calculations of the tariff commission, the Act raised the average rates in every schedule, the increase being greatest on agricultural products. Sugar, cattle, dairy products, grains, lemons and other California products, wool, woollen and silk goods, manganese and tungsten bearing ores, and pig iron all went up. Lumber, brick, cement, hides, sole leather, and boots and shoes, all of which had been free, were subjected to duties.

There were increases on many small manufactured products, like watch and clock movements, cheap toys and matches, unimportant to the United States, but highly important to certain foreign exporting countries.

The flexible tariff provision was retained. The raising of American duties at a time when international trade was already declining caused sharp resentment abroad, and was promptly followed by higher tariffs in many countries. From 1929 to 1933 the foreign trade of the world, according to League of Nations figures, fell by 25 per cent in quantity and 65 per cent in value.

In 1934 a reciprocity act was passed authorizing the President for three years to make trade agreements with other countries; this act was later extended to 1940. Under it 19 nations made reciprocal trade agreements with the United States up to Jan. 1, 1939.

BIBLIOGRAPHY.—E. Stanwood, *American Tariff Controversies in the Nineteenth Century* (Boston, 1902); F. W. Taussig, *Free Trade, the Tariff and Reciprocity* (New York, 1920); F. W. Taussig, *State Papers and Speeches on the Tariff* (Cambridge, 1892); *The Tariff*

History of the United States (7th ed., New York, 1923); A. Berglund and P. G. Wright, *The Tariff on Iron and Steel,* (Washington, 1929); L. R. Edminster, *The Cattle Industry and the Tariff,* (New York, 1926); T. W. Page, *Making the Tariff in the United States* (New York, 1924); M. A. Smith, *The Tariff on Wool* (New York, 1926); P. G. Wright, *Sugar in Relation to the Tariff* (New York, 1924); F. W. Bidwell, *Tariff Policy of the United States* (New York, 1933); J. L. Laughlin and H. P. Willis, *Reciprocity* (New York, 1903); F. B. Sayre, *The Way Forward: the American Trade Agreements Program* (New York, 1939). (H. R. M.; X.)

PROTECTIVE COLOURATION: *see* COLOURS OF ANIMALS, MIMICRY.

PROTECTORATE, in international law, now a common term to describe the relation between two States, one of which exercises control, great or small, direct or indirect, over the other. It is significant of the rare use of the term until recent times that the word does not occur in Sir G. C. Lewis's book on *The Government of Dependencies.* Yet the relation is very ancient. There have always been States which dominated their neighbours, but which did not think fit to annex them. Engelhardt *(Les Protectorats anciens et modernes)* and other writers on the subject have collected a large number of instances in antiquity in which a true protectorate existed, even though the name was not used. Thus the hegemony of Athens, as it existed about *467* B.C., was a form of protectorate; though the subject States were termed allies, the so-called "allies" in all important legal matters had to resort to Athens (Meyer, *Geschichte des Alterthums,* vol. iii. s. 274).

In dealing with dependent nations Rome used terms which veiled subjection (Gairal, *Les Protectorats internationaux,* p. 26). Thus the relationship of subject or dependent cities to the dominant power was described as that of *clientes* to the *patronus* (Marquardt, *Romische Staatsverwaltung,* 2nd ed., vol. i. p. 80). Such cities might also be described as *civitates foederatae* or *civitates liberae.* Another expression of the same fact was that certain communities had come under the power of the Roman people; *in deditionem* or *in fidem populi romani venire* (Marquardt, *Romische Staatsverwaltung,* i. *73,* 81). The kingdoms of Numidia, Macedonia, Syria and Pergamum were examples of protected States, their rulers being termed *inservientes.* The Romans drew a distinction between *foedera aequa* and *foedera iniqua.* The latter created a form of protectorate. But the protected State remained free.

In mediaeval times this relation existed, and the term "protection" was in use. But the relation of subordination of one State to another was generally expressed in terms of feudal law. One State was deemed the vassal of another; the ruler of one did homage to the ruler of another. In his book *De la République* Bodin treats of *ceux qui sont en protection* (I. *c. 7),* or, as the Latin text has it, *de patrocinio et clientela.* In Bodin's view such States retain their sovereignty (I. c. 8). Discussing the question whether a prince who becomes a *cliens* of another loses his *majestas,* he concludes that, unlike the true vassal, the *cliens* is not deprived of sovereignty. Elsewhere he remarks, "le mot de protection est special et n'emporte aucune subjection de celuy qui est en protection." He distinguishes the relation of *seigneur* and *vassal* from that of *protecteur* and *adherent* (p. 549, ed. 1580). At times letters of protection were granted by a prince to a weak State, as *e.g.,* by Louis XIII. in 1641 to the prince of Monaco (Gairal, p. 81).

Reverting to the distinction in Roman law, Grotius and Pufendorf, with many others, treat protection as an instance of unequal treaties; that is, "when either the promises are unequal, or when either of the parties is obliged to harder conditions" *(De jure belli et pacis, I.* c. 13. 21; *De jure naturae, 8.* c. 9).

Definitions.—"The one common element in protectorates is the prohibition of all foreign relations except those permitted by the protecting State. What the idea of a protectorate excludes, and the idea of annexation, on the other hand, would include, is that absolute ownership which was signified by the word *dominium* in Roman law, and which, though not quite satisfactorily, is sometimes described as 'territorial sovereignty.' The protected country remains, in regard to the protecting State, a foreign country; and this being so, the inhabitants of the protectorate, whether native-born or immigrant settlers, do not by virtue of the relationship between the protecting and the protected State become subjects of the protecting State" (Lord Justice Kennedy, *Rex* v. *Crewe,* 1910, 2 K.B. *576).*

The term is used very loosely. Often it designates a relation which is deemed politic to leave indefinite: a State desires to obtain the reality of conquest without the responsibilities attaching thereto. Protectorate may mean no more than what it says: "One State agrees to protect or guarantee the safety of another." The term is also employed to describe any relation of a political superior to an inferior State, It is also used as the equivalent of suzerainty. As appears from the article SUZERAINTY, the terms are distinguishable. But both imply a desire to carry out changes without friction and not to break up ancient forms; both proceed on the plan of securing to the stronger State the substance of power while allowing the weaker State a semblance of its old constitution.

Certain protectorates originate in treaties; others have been imposed by force. Some are accompanied by occupation, in which case it is difficult to distinguish them from annexation. Thus the treaty of May 1881, art. 2, between France and Tunis, provides for the occupation of strategical points by the protecting State (A. Devaulx, *Les Protectorats de la France,* p. 21).

Strictly speaking, a protectorate cannot exist over a domain uninhabited or ruled by no organized State; in such cases the elements of the true protectorates are wanting. But the distinction is not adhered to.

Indian Protectorates.—It has been the policy of the British Government in India to establish on the frontiers, as elsewhere, protectorates. The political advantages of the system are pointed out in Sir A. Lyall's *Rise and Expansion of the British Dominion in India.* It is a system "whereby the great conquering or commercial peoples masked, so to speak, their irresistible advance"; it was much practised by the Romans in Africa and Asia; it has been chiefly applied in modern times in India (p. 326). The Indian States are sometimes described as "Feudatory States," sometimes "Independent and Protected States" (Twiss), sometimes "Mediatized States" (Chesney), sometimes "Half-Sovereign," sometimes as in a position of "subordinate alliance" (Lord Salisbury, *Parliamentary Papers,* 1897 [c. 8700]. s. 27). The Interpretation Act 1889 refers to the Indian native princes as under the "suzerainty" of the British Crown These States are really *sui generis,* and their precise position can be understood only by a private examination of the treaties affecting them. *(See* Ilbert, *Government of India,* and the article INDIAN LAW.)

There are two principal classes of protectorates; the first being those exercised generally by treaty over civilized countries. Of the first, Andorra, protected by Spain and France as successors of the counts of Foix, is an example *(see* ANDORRA). The second class of protectorates consists of those exercised by one civilized State over an uncivilized people, sometimes called a "Colonial Protectorate" or "pseudo-protectorate," and usually the preparatory step to annexation. These have become common, especially in Africa, since 1878. The second class may be subdivided into two groups: *(a)* protectorates exercised over countries with organized Governments and under recognized sovereigns, such as the Malay States; and *(b)* those exercised over countries possessing no stable or definite Governments and rulers. The territories of chartered companies, when not within the dominion of the protecting State, may also for some purposes be regarded as protectorates. For details, the specific treaties must be consulted.

Protectorates and International Law.—The legal position of protectorates is still somewhat undetermined; there is an old view and also a new view of their nature. The relation may be one of international law, two States having entered into obligations by treaty. Or the relation may be one of public law; one of two States has become subordinate to, and incorporated with, the other. The general rule is that the protected State does not cease to be a sovereign State, if such was its previous status Its head is still entitled to the immunities and dignity of a sovereign ruler (see *Development Co* v *Kelantan [Government] and A. G.,* 1924, *A* C. *797)* Further, the establishment of a protectorate does not necessarily rescind treaties made between the protected State and other States, at all events when it is not in reality conquest or cession, or when any modification would be to the injury of third parties (*Parl. Papers,* "Madagascar," 1897 [c. 8700]; Trione, 187). Nor does the new relation make any change as to the nationality of the subjects of the two States, though in some countries facilities are afforded to the subjects of the *Unterstaat* to transfer their allegiance; and they owe a certain ill-defined degree of obedience to the protecting State. Nor, speaking generally, does the territory of the protected State become part of the territory of the *Oberstaat;* in this respect is it unlike a colony, which may be regarded as an extension or outlying province of the country. At the same time, the question whether a particular protectorate forms part of the "dominion" or "territory" of the Crown for any purposes or within the meaning of any statute cannot be regarded as wholly free from doubt; its terms and intention must be examined. *(See* Hall, *International Law,* 8th ed., 150; Heilborn, *Das völkerrechtliche Protectorat* [1891], 535; Tupper, *Indian Protectorates,* 336; Laband, *Das Staatsrecht des deutschen Reiches* [1876–82], 2, s. 70; *Sub Luza II.* v. *Miller and Swaziland Corporation,* 1926, D.C. 518).

The older view of the position of a protectorate according to international law is contained in the decision of Dr. Lushington in the case of the "Leucade" (8 S.T., N.S., 432), to the effect that, the declaration of war by Great Britain against Russia notwithstanding, the Ionian islands, which were then under the protectorate of Great Britain, remained neutral. The king of Great Britain had the right of declaring peace and war. "Such a right is inseparable from protection." But the Ionian States did not become necessarily enemies of the State with which Great Britain was at war. According to one view, the protected State is implicated in the wars to which the protecting State is a party only when the latter has acquired a right of military occupation over the territory of the former. "Cette solution a été reconnue par la France en 1870, à propos de la guerre contre l'Allemagne pour les iles Taiti alors soumises à notre protectorat; elle s'imposerait pour la Tunisie, l'Annam et Tonkin, et pour le Cambodge, oh les traités nous conférent le droit d'occupation militaire" (M. Despagnet). In the event of hostilities between the protecting and protected States, such hostilities would be regarded not as of the nature of an insurrection, but as a regular war (Trione, 149).

By the General Act of the Berlin Conference it was agreed that the acquisition of a protectorate should be notified to the signatories to the agreement (art. 34), and it has been the practice to give such notice.

Many writers adhere to the doctrine that there is no impairment of sovereignty of the weaker State by the establishment of a protectorate. They also allege that it is *res inter alios acta,* an arrangement which concerns only parties to it. But the trend of recent policy and purport of much recent legislation are against this view. The probability is that in such cases Governments and courts applying international law would probably be guided not by technical facts—such, to take the 'case of British possessions, as the fact that an order in council permitted appeals to the Judicial Committee—but would look to the facts of the case. "Any State which undertakes to protect another assumes towards the rest of the world responsibility for its good behaviour—the more complete protection the more extensive the responsibility—and this responsibility involves a duty to interfere if need be" (Coolidge, *United States as a World Power,* p. 167; and to the same effect Liszt, *Volkerrecht,* p. 31; and Zorn, *Volkerrecht,* p. 45). The tendency is for protecting States to assert jurisdiction over foreigners within the territories of the protected States (Westlake, 187; Jenkyns, p. 176; Ilbert, 3rd ed., ch. 6). Hall remarks (*International Law,* 8th ed., p. 150 n.) that "all the States represented at the Berlin Conference of 1884–85, with the exception of Great Britain, maintained that the normal jurisdiction of a protectorate includes the right of administering justice over the subjects of other civilized States." The General Act contemplated measures which are scarcely compatible with the exemption of European traders and adventurers from the local civilized jurisdiction. He points out that Great Britain—which until lately took the view that a protected State possesses only delegated powers, and that an Eastern State cannot grant jurisdiction over persons who are neither its own subjects nor subjects of the country to which the powers are delegated—had by the Pacific order in council of 1893 and the South African orders in council of 1891–94 asserted jurisdiction over natives and foreign subjects. "The Orders show a gradual increase of the assumption of internal sovereignty" (Jenkyns, 193). The fact is that in the case of protectorates over uncivilized or semi-civilized countries a development is inevitable: control quickly hardens into conquest, and international law more and more takes note of this fact. *(See* also MANDATE, SOVEREIGNTY, SPHERES OF INFLUENCE, STATE.)

BIBLIOGRAPHY.—Bodin, *Les Six Livres de la République* (Lyons, 1580); *De republica libri sex* (1586); Stengel, *Die Staats- und völkerrechtliche Stellung der deutschen Colonien* (1886), *Die deutsche Schutzgehiete* (1895) and *Die Rechtsverhältnisse der deutschen Schutzgebiete* (1901); Heimburger, *Der Erwerb der Gebietshoheit* (1888); Trione, *Gli stati civili nei loro rapporti giuridici coi popoli barbari e semibarbari* (1889); D'Orgeval, *Les Protectorats allemands; annales de l'École des Sciences Politiques* (1890); Wilhelm, *Théorie juridique des protectorats* (1890); Despagnet, *Essai sur les protectorats* (1896); Iéze, *Étude the'orique,* etc., *sur l'occupation,* etc. (1896); Laband, *Revue de droit international civilisés, et barbares,* xvii. 1, xviii. 188; "Protectorates" in the *Encyclopaedia of the Laws of England,* 2nd ed., vol. xi.; Raty, *International Law* (1909); Ullmann, *Volkerrecht,* s. 26 (1908); Von Stengel in *Zeitschrift fur Kolonialrecht* (1909), p. 258; Sir W. Lee-Warner, *Protected States of India* (1910); G. W. Rutherford, "Spheres of Influence," *American Journ. Inter. Law,* vol. 20 (1926), p. 300. (J. MAC.)

PROTEINS are highly complex substances found in all living cells, in blood and in materials elab'orated for the development of the young animal or plant, such as milk, eggs and seeds. The word is derived from the Greek πρῶτος, meaning first, because proteins are apparently of first importance in respect of the phenomena which we call life, which can only exist in association with a material called protoplasm, which consists very largely of proteins. The composition of proteins varies somewhat. They all contain carbon, hydrogen, oxygen and nitrogen; most of them contain sulphur, and some contain phosphorus. The average composition is, C 51%, O 25%, N 16%, H 7%, S 0·4%, P 0·4%. They are formed by the union of a certain number of substances called amino-acids, of which about 20 have been discovered.

Amino-acids.—The living cells of the plant are able to form the amino-acids from relatively simple compounds, such as nitrates or ammonium salts, obtained from the soil. These amino-acids are then built up into the characteristic proteins of the particular plant. Animal cells are unable to form amino-acids from simple inorganic substances; the amino-acids must consequently be supplied in the food, in the form of plant proteins in the case of herbivorous animals, and animal proteins in the case of the carnivora. By the processes of digestion these food proteins are broken down into their constituent amino-acids, which are absorbed into the blood and are then available for building up the proteins of the tissues. It is probable that certain of the amino-acids can be formed in the body from other amino-acids, but on the other hand some essential amino-acids cannot be formed thus, *i.e.,* they must pre-exist in the protein of the food. The essential amino-acids are tryptophane, lysine, histidine, cystine, and possibly tyrosine and arginine. It follows that the nature of the amino-acids of which a protein is composed determines, to a certain extent, its value as a foodstuff for animals. Protein is disintegrated into its constituent amino-acids by boiling with dilute mineral acid, which converts tryptophane into a black substance called humin. Some proteins can be broken down by the action of certain digestive ferments, notably trypsin.

The amino-acids isolated by breaking protein down into its constituents are substances which contain both an acid (carboxylic) group and a basic (amino-) group. They can be divided into classes depending on the number of these groups, as follows:—(a) neutral amino-acids, containing one acid and one amino-group, *e.g.,* glycine, alanine, leucine, tyrosine and cystine, (b) acid amino-acids, containing two acid and one amino-group, *e.g.,* aspartic and glutaminic acids; (c) basic amino-acids, containing one acid and two amino-groups, *e.g.,* arginine and lysine; (d) heterocyclic compounds, in which a ring compound of carbon and nitrogen is united to an amino-acid group, the two most important members being histidine and tryptophane. The amino-acids are united to one another by a condensation (or subtraction of the elements of water) between the carboxylic group of one compound and the amino-group of its neighbour:

$$\underset{\text{Alanine}}{H_2N{\cdot}CH(CH_3)\,COOH} + \underset{\text{Glycine}}{HHN\,CH_2{\cdot}COOH} \longrightarrow \underset{\text{Alanyl-glycine.}}{H_2N{\cdot}CH(CH_3){\cdot}CO{\cdot}NH{\cdot}CH_2\,COOH}$$

The compound formed by such an union (peptide linkage) is called a di-peptide.

Very long chains of amino-acids have been formed synthetically, and the resulting compounds, called polypeptides, closely resemble the proteins in many ways. These *peptides* are split up into their constituent amino-acids by prolonged boiling with dilute mineral acids, the elements of water being added. This splitting or hydrolysis is also effected by two of the digestive enzymes found in the body, viz., trypsin of the pancreatic juice and erepsin of the intestinal juice. It is almost certain that there is at least one other type of union between the amino-acids, for pepsin, the enzyme of the gastric juice which digests proteins, is unable to split the peptide linkage, yet can break the highly complex food proteins into relatively simple compounds.

Classification of Proteins.—The system of classification adopted by the American Society of Biochemists is in general use and is closely followed in Great Britain; where the British Physiological Society uses a different name this is indicated by (B). The three main groups are those of the simple, conjugated and derived proteins, as follows:—

I. Simple Proteins: naturally occurring proteins formed from amino-acids only.

Albumins. Coagulable by heat, soluble in water and dilute salt solutions; *e.g.,* serum albumin, egg albumin and lactalbumin.

Globulins. Coagulable by heat, soluble in dilute salt solutions and dilute solutions of acids and alkalis. Generally insoluble in water, but a few ("pseudo-globulins") are soluble in water; *e.g.,* serum globulin of the blood and myosin, the chief protein of meat.

Glutelins. Found in cereals. Heat coagulable, insoluble in neutral solvents, but soluble in dilute acids and alkalis.

Prolamines (Gliadins [B]). Also found in cereals, but distinguished from the glutelins by their solubility in 75% alcohol; *e.g.,* zein from Indian corn (*Zea mais*), and gliadin from wheat.

Albuminoids (Scleroproteins [B]). Found in the skeletal and connective tissues of animals. They are characterized by their insolubility in most reagents; *e.g.,* keratin of hoofs and hair, elastin of yellow elastic tissue, collagen (the anhydride of gelatin) from tendons and white connective tissue.

Protamines. Basic proteins which are formed from a few amino-acids only and these mainly the basic amino-acids. They are found in the heads of ripe spermatozoa and in ova.

Histones. Similar to the protamines, but less rich in the basic amino-acids. They are not so basic as the protamines. They are present in unripe spermatozoa, in the red blood corpuscles and in the lymphoid tissues of the body.

II. Conjugated Proteins: proteins joined to a non-protein or prosthetic group.

Chromo-proteins. The prosthetic group is coloured, *e.g.,* haemoglobins of vertebrate blood, and haemocyanin of invertebrate blood, both of which are connected with respiration.

Glycoproteins (Glucoproteins [B]). The prosthetic group contains a carbohydrate radical; *e.g.,* mucin and mucoids.

Nucleoproteins. The prosthetic group is nucleic acid, which contains phosphorus, purine bases, pyrimidine bases and a sugar group. They are widely distributed in animal and vegetable cells, especially in nuclei.

Phosphoproteins. The prosthetic group is phosphoric acid. They are distinguished from the nucleoproteins in that they do not contain purine or pyrimidine bases; *e.g.,* casein of milk and vitellin of egg-yolk.

III. Derived Proteins: these are the decomposition products of any of the above, produced by boiling in water or by hydrolysis with dilute acids, alkalis or by the action of enzymes; the artificially synthesized polypeptides are also included.

Metaproteins. Insoluble in water or dilute salt solutions. Soluble in dilute acids or alkalis. Coagulated by heat if they are in suspension.

Proteoses. Soluble in water, not coagulated by heat. Precipitated by saturation with ammonium sulphate.

Peptones. Similar to the proteoses, but not precipitated by saturation with ammonium sulphate. They are relatively simple proteins and are much more diffusible.

Peptides. Simple peptones, generally of known constitution.

Reactions and Properties.—In the foregoing scheme of classification physical properties are mainly used for the characterization of the proteins. Certain colour reactions can be obtained arising from the chemical structure of the protein molecule and due either to the presence of certain amino-groupings in the protein molecule or to the special linkages formed by their union with one another. The more important of these colour reactions are, (1) the xanthoproteic, indicating such aromatic groups as tyrosine and tryptophane; (2) the glyoxylic, due to the presence of tryptophane; (3) Millon's, due to tyrosine; (4) the sulphur test, due to cystine; and (5) Molisch's test for a carbohydrate complex. It follows that a protein like gelatin, which does not contain either tryptophane, tyrosine or cystine, fails to give the glyoxylic, Millon's or sulphur tests. Zein does not contain tryptophane, but does contain tyrosine; hence it gives Millon's test but not the glyoxylic reaction. The biuret colour reaction, however, is of a different character, in that it is not given by any amino-acid but is given by all proteins, owing to the particular way in which the amino-acids are linked together.

The proteins are precipitated by certain complex acids called the alkaloidal reagents because they were first used for the precipitation of alkaloids (*q.v.*). The more important of these acids are tannic, picric, phosphotungstic, phosphomolybdic, metaphosphoric, sulphosalicylic, tri-iodo-hydriodic and ferrocyanic. These reagents only precipitate in acid solutions, the precipitates being soluble in alkalis. The peptones and peptides are less readily precipitated than the more complex proteins. The proteins are also precipitated in neutral or slightly alkaline solution by the salts of certain metals, especially those of copper, lead, mercury, iron and gold.

Of considerable importance in connection with the general physical properties of the proteins is the fact that the solutions are usually in the colloidal state (see COLLOIDS). The feature of this condition is that the material is suspended in the solvent (water, salt solution, etc.) in particles of a certain size. If they are larger than 0·0001 mm. (0·1μ) they can be retained by filter paper or porcelain and are visible with an ordinary high-power microscope, and constitute a "coarse suspension" or precipitate; if they are smaller than 1×10^{-6} mm. (1$\mu\mu$) they form a "molecular solution," and the substance will diffuse through parchment or collodion membranes. Between these limits we have the colloids, in which the particles are too large to pass through parchment membranes and too small to be removed by filter paper, or be seen with an ordinary microscope, but are large enough to interfere with the passage of light rays, being thus rendered "visible" by the ultramicroscope. The proteins, and particularly the complex natural proteins, exist in the colloidal state owing to the great size of the molecules. The length of the molecule of egg-albumin has been found to be 4·17$\mu\mu$, that of the molecule of serum albumin 4·41$\mu\mu$, whilst the molecules of serum globulin or of gelatin may be as large as 50–100$\mu\mu$.

The particles in suspension may in some cases exist in the form of single molecules, but a slight change in the conditions may cause these to coalesce to form larger clumps, even to the extent of providing visible aggregates, or a precipitate. This can sometimes be effected by altering the acidity or alkalinity of the fluid, sometimes by the addition of a small amount of a particular neutral salt. When the aggregates formed cannot be dispersed by reverting to the original conditions, the phenomenon is known as coagulation. The best known example is that of the coagulation of the albumins and globulins of the egg by boiling, an alteration ("denaturation") taking place in the native proteins. The altered protein is precipitated at a certain reaction, which is generally on the acid side of strict neutrality. At the coagulating temperature the particles of protein in the precipitate adhere together to form an irreversible coagulum. To produce this coagulation, a given temperature and reaction and the presence of certain inorganic substances are necessary. The first two conditions vary somewhat with different proteins and have been used for the characterization of some of the albumins and globulins.

The use of strong solutions of neutral salts as a method for the precipitation of certain proteins is of considerable importance. The chief salts employed are magnesium sulphate, sodium sulphate and particularly ammonium sulphate. When a solution is fully saturated with the last substance all proteins with the exception of the peptones and peptides are completely precipitated. The addition of one part of a saturated aqueous solution of ammonium sulphate to one part of a fluid is called "half-saturation" and is used for the separation of globulins from albumins. The methods for the complete removal of proteins from a solution depend on the nature of the proteins present. In the case of the albumins and globulins, heat coagulation at the correct reaction may sufhce. The most important precipitants are tungstic acid, metaphosphoric acid and colloidal iron, though tannic and mercuric and lead salts are sometimes employed.

Uses of Proteins. — The most important use of protein is that of a food-stuff for man and the domestic animals, since protein is the only form in which they can obtain a supply of the amino-acids that are essential for the building-up and maintenance of the protoplasmic tissues of the body. Some of the amino-acids are used for the formation in the tissues of certain derivatives (generally known as "internal secretions") without which it is impossible for the body as a whole to function properly. It will be seen therefore that the nature and balance of the various amino-acids in a particular protein will have a marked effect on what is known as the "biological value" of the protein as a food. Thus the chief protein of Indian corn is zein, which does not contain any tryptophane — one of the essential amino-acids — and consequently persons whose sole protein is that of Indian corn are apt to suffer from the disease known as Pellagra, which may be due to the deficiency of tryptophane.

Another function of protein in the diet is that of supplying energy by combustion in the body. The proteins also are concerned in promoting the oxidation of the carbohydrates and particularly of the fats in the body. Thus the inhabitants of very cold climates can withstand the low temperatures on a diet very rich in protein and fat, the high protein content enabling the fats to be oxidized more readily in the body. This action is known as the "specific dynamic action" of the proteins. The inhabitants of the tropics, on the other hand, subsist on a diet that contains a relatively small amount of protein, the energy requirements for the maintenance of body temperature being very low. It was at one time thought that the muscular energy of the body was obtained from the proteins alone, but it has been found that this is erroneous. Carbohydrates normally function in this way, but the requisite carbohydrates can he supplied from certain of the amino-acids in animals fed on a pure protein diet. Any excess of protein in the diet over the immediate needs of the body is usually oxidized in a few hours, the body being unable to store protein as it can fats or carbohydrates. But within certain limits it seems that if abundant protein is taken with regular muscular exercise, as in the training diet of some athletes, a small percentage of this protein can be stored for increase in the size of the protoplasmic masses of the individual muscle fibre. The utilization of proteins as food-stuffs is primarily dependent on their digestibility. Proteins like the keratins of hair and horn are not broken down into amino-acids by the enzymes of the alimentary canal and cannot serve as foods. The average amount of protein in the adequate diets of adult inhabitants of the temperate climes is about 100 grams per diem.

The industrial uses of proteins are dealt with in other articles (*see* GELATIN, GLUE, CASEIN, HAIR, WOOL, SILK, LEATHER, etc.). Other uses are in the manufacture of water-resisting adhesives, distempers, small articles, such as buttons, and in the special transparent preparation known as "galalyte" which is used for artificial amber.

BIBLIOGRAPHY.—S. W. Cole, *Practical Physiological Chemistry* (1928); D. J. Lloyd, *Chemistry of the Proteins* (1926), contains useful bibliography; T. B. Osborne, *The Vegetable Proteins* (1924); R. H. A. Plimmer, *The Chemical Constitution of the Proteins* (1924).

(S. W. C.)

PROTESILAUS, a Thessalian hero, son of Iphiclus, and husband of Laodameia. He was the first to spring ashore on Trojan soil, although he knew it meant instant death. His wife prayed that he might be permitted to return to earth for three hours. Her prayer was granted, and on the expiration of the time allotted she returned with him to the nether world. Hyginus gives (*Fab.*, 104) what seems to be a rationalistic version of this. It is curious that no surviving Greek author tells the story. In another account (Conon, *Narrationes,* 13) Protesilaus survived the fall of Troy and built the city of Scione. His tomb and temple were near Eleus in the Thracian Chersonese.

Iliad, ii. 698; Ovid, *Heroides,* xiii.; Lucian, *Dial mort.* xxiii., 1; Philostratus, *Heroica,* iii.

PROTESTANT, the generic name for an adherent of those Churches which base their teaching on the principles of the Reformation. The name is derived from the formal *Protestatio* handed in by the evangelical states of the empire, including some of the more important princes and imperial cities, against the *recess* of the diet of Spires (1529), which decreed that the religious *status quo* was to be preserved, that no innovations were to be introduced in those states which had not hitherto made them, and that the mass was everywhere to be tolerated. The name Protestant seems to have been first applied to the protesting princes by their opponents, and it soon came to be used indiscriminately of all the adherents of the reformed religion. Its use appears to have spread more rapidly outside Germany than in Germany itself, one cause of its popularity being that it was negative and colourless, and could thus be applied by adherents of the "old religion" to those of the "new religion," without giving offence, on occasions when it was expedient to avoid abusive language.

As the designation of a Church, "Protestant" was unknown during the Reformation period and for a long while after. In Germany the Reformers called themselves usually *evangelici,* and avoided special designations for their communities, which they conceived only as part of the true Catholic Church. It was not until the period of the Thirty Years' War that the two main schools of the reformed or evangelical Churches marked their definitive separation: the Calvinists describing themselves as the "Reformed Church," the Lutherans as the "Lutheran Church." In France, in England, in Holland the evangelicals continued to describe their churches as *ecclesiae reformatae,* without the *arrière pensée* which in Germany had confined the designation "Reformed" to the followers of a particular church order and doctrine. As to the word "Protestant," it was never applied to the Church of England or to any other, save unofficially and in the wide sense above indicated, until the style "Protestant Episcopal Church" was assumed by the Anglican communion in the United States.

PROTESTANTENVEREIN is the name of a society in Germany the general object of which was to promote the union (*Verein*) and progress of the various established Protestant Churches of the country in harmony with the advance of culture and on the basis of Christianity. It was founded at Frankfort-on-the-Main in 1863 by a number of distinguished clergymen and laymen of liberal tendencies, representing the freer parties of the Lutheran and Reformed Churches of the various German states, amongst whom were the statesmen Bluntschli and Von Bennigsen and the professors R. Rothe, H. Ewald, D. Schenkel, A. Hilgenfeld and F. Hitzig. The more special objects of the association were, beside the promotion of mutual toleration and respect among adherents of different creeds and of all Christian works necessary for the moral strength and prosperity of the nation, the assertion of the right of the clergy, laity and both lay and clerical professors to search for and proclaim freely the truth in independence of the creeds and the letter of Scripture.

BIBLIOGRAPHY.—*See* D. Schenkel, *Der deutsche Protestantenverein*

und seine Bedeutung fur die Gegenwart (Wiesbaden, 1868, 2nd ed., 1871); *Der deutsche Protestantenverein in seinen Statuten und den Thesen seiner Hauptversammlungen 1865–1882* (Berlin, 1883); P. Wehlhorn in Herzog-Hauck's *Realencyklopädie;* H. Weinel, "Religious Life and Thought in Germany To-day," *Hibbert Journal* (July 1909).

PROTESTANT EPISCOPAL CHURCH, in the United States of America is spiritually the direct descendant of the Church of England, and is a part of the Anglican Communion. From the Church of England the Protestant Episcopal Church inherits its faith, its liturgy and its spiritual traditions, though it is entirely independent in its own life and government. The preface of the American Prayer Book, officially set forth in 1789, affirms the substantial identity and continuity of the two Churches in the following words "This Church is far from intending to depart from the Church of England in any essential point of doctrine, discipline or worship; or further than local circumstances require.': The Protestant Episcopal Church is therefore in full fellowship with the Anglican Communion, while at the same time it is wholly free and independent in the ordering of its life and the fulfilment of its mission in the United States. It is significant that in the year 1642 members of the English Church meeting in the Colony of Maryland, and frequently other groups in that early period, described themselves as Protestant Catholics, and this designation, if rightly interpreted in the light of history, describes well the doctrinal position of the Protestant Episcopal Church, catholic and also free, apostolic and evangelical, orthodox and also modern in its spirit.

The first permanent establishment of the Church was at Jamestown, Va., in 1607, although services were held earlier in various parts of the country by the clergy who as chaplains accompanied groups and parties engaged in exploration. On the Pacific coast services were held by Francis Fletcher, chaplain of Drake's ship the "Pelican." Before the end of the 17th century the English Church had become the established church of Virginia and Maryland. In New York, Trinity parish received its charter from the British Crown in 1697, with the bishop of London, Henry Compton, as its first rector. A few years earlier, in 1686, the Church obtained a precarious foothold in Massachusetts; it was planted in Connecticut in 1706. The growth of the English Church in the colonial period was due in large part to the help of the Society for the Propagation of the Gospel in Foreign Parts, founded through the efforts of the Rev. Thomas Bray, a missionary in Maryland. From the foundation of the Venerable Society in 1701, until the Revolution, its missionaries were primarily responsible for the vitality of the English Church in America. Through all this period however, the Church had no bishop in the American colonies. It was under the jurisdiction of the bishop of London, who naturally could do little for this far distant field. Without bishops, the Episcopal Church was in an anomalous position. Those desiring to be ordained to the ministry were compelled to make the long and perilous voyage to England. The people could not be brought to confirmation. Efforts to secure the consecration of bishops by the mother church in England were strongly opposed by the Nonconformist churches in the colonies, especially in New England.

Revolutionary Period.—The Revolution was a time of severe trial for the Church of England in the colonies. Many of the clergy felt called upon to give up their parishes and return to England, though others, especially in the South, remained at their posts and gave their support to the American cause. Of the laity a large majority were on the side of the Revolution, and many of them were among its most active leaders. Two thirds of those whose names are signed to the Declaration of Independence were members of the Episcopal Church. William White, afterwards the first bishop of Pennsylvania, was chaplain of the Continental Congress. George Washington, himself a member of the Church, went, accompanied by both Houses of Congress, to St. Paul's chapel, still standing on Broadway and Vesey street, New York, for the religious service which completed the ceremonies of his inauguration as first president of the United States, and this service was conducted by Samuel Provoost, the first bishop of New York and rector of Trinity church.

At the close of the war the Church was so disrupted that to many its survival seemed doubtful. Steps were taken for its reorganization, but the process proved to be a protracted one, and continued far into the next century. It was recognized that the episcopate must now be secured without delay. The clergy of Connecticut met and elected Samuel Seabury to the office of bishop and requested him to proceed to England and seek episcopal consecration. Meeting with discouragement in England, Seabury turned to the Scottish Episcopal Church and was consecrated by the Scotch non-juror bishops, in Aberdeen, on Nov. 14, 1784, thus becoming the first bishop of the Church in America. The consecration of Bishop Seabury established a close bond between the Episcopal Churches in America and Scotland. This was further strengthened by a Concordat in accordance with Art. V. of which the Eucharistic Canon of the American Prayer Book is framed on the Scottish rather than the English model. More than two years later on Feb. 4, 1787, William White, of Pennsylvania, and Samuel Provoost, of New York, were consecrated bishops in Lambeth chapel, by the archbishops of Canterbury and York and two other English bishops. On Sept. 19, 1790, the Rev. James Madison, of Virginia, was also consecrated bishop in England.

At a Convention held in 1789, after much previous discussion, the Book of Common Prayer was set forth and the constitution and canons were adopted. The Church was organized for her work, but the conditions which she faced were full of difficulties. As a result of the revolutionary war there was much popular prejudice against any institution claiming connection with England, in the communities influenced by Puritanism there was strong opposition to the principles and teachings of the Episcopal Church, and there were divisions within her own household. At the Convention of 1811 only one of the six bishops attended, and there were few more clergy and laymen present than in 1789.

Period of New Vigour.—But at this time a new spirit was stirred in the Church largely by the devotion, zeal and spiritual power of three men, John Henry Hobart, Alexander Viets Griswold and Richard Channing Moore, consecrated bishops respectively of New York, the eastern diocese and Virginia. In Virginia, Bishop Moore's powerful preaching and strong personality roused the Church to new life. Bishop Griswold's diocese included an immense region comprising the collapsed diocese of Massachusetts (which had already had two bishops, Bass in 1797 and Parker in 1804), Maine, Rhode Island, New Hampshire and Vermont. His achievements were truly amazing; with only 16 clergy in all at the outset of his episcopate he had the satisfaction of ending it with a fivefold increase in the number both of parishes and communicants, and with the redivision of his cumbersome territory into five separate dioceses. Bishop Hobart's episcopate was even more far-reaching in its effects. His labours were prodigious and his power as a teacher was felt by all. He anticipated the main positions of the Oxford Movement in the Church of England and left his spiritual impress not only on the diocese of New York but on the whole Church, taking his place as one of the greatest bishops the Church in America has had. The interest of Hobart and Moore in theological education, and in the training of candidates for the ministry, resulted in the foundation of the General Theological seminary in New York in 1819 and of the Theological seminary in Virginia, in 1824.

The Church was now aroused to meet the new conditions and opportunities of its reconstituted life. The Domestic and Foreign Missionary Society, founded in 1821, gave fresh impetus to the work of Church extension. Philander Chase, the pioneer bishop of the West did his great work in Ohio and founded Kenyon college, obtaining from churchmen in England funds for this undertaking; Jackson Kemper went further into the North-west where his arduous labours prepared the way for future dioceses; James Harvey Otey did noble missionary work in Tennessee and the South-west. James Lloyd Breck, priest and missionary, started schools in Minnesota, at Faribault, and pushed on across the country, establishing new foundations as he went, until he reached the Pacific coast. During this period the Episcopal Church grew steadily from a proportion of one communicant to 400 of the population in 1830 to one communicant to 107 at the end of the century. With the growth and development of the country new dioceses and missionary districts were established. In 1853 Bishop Kip began his labours as first bishop of California; in 1854 bishops were consecrated for Oregon and Iowa; in 1859 Bishop Whipple was sent to Minnesota to take up his work among white people and Indians. Another outpost of this period was the Theological seminary at Nashotah, Wis., established by alumni of the General seminary in 1842, and to this day styled The Mission.

The spirit of the Church at this time was strikingly illustrated in the "Muhlenberg Memorial" of 1853. Its impassioned and moving appeal to the Church to weigh more earnestly its unique opportunity, to slough off sectarianism and realize the implications of a Catholic but non-papal Episcopacy, to view without disquiet the possibility of modifications in method and technique which might lead to a more adequate effectiveness, displays in rare degree both practical wisdom and prophetic vision. While this appeal led to some changes in current practice the essential challenge which it offered has not yet been fully faced. It was a challenge which might have brought forth new and great things, had not the struggle which was to issue in the Civil War precluded this.

Separate Administrations. — The breaking out of this great conflict compelled the separation in administration of the Northern and Southern dioceses, but it produced no permanent division in the Church. The dioceses in the South met together as "The Protestant Episcopal Church in the Confederate States," but when the general convention met in New York, in 1862, the Southern dioceses, although absent, were included as usual in the calling of the roll, and immediately upon the conclusion of the war, the two groups of dioceses came together without friction.

Since the period of the Civil War, the Church has made progress, its growth more than keeping pace with the increase in population. Its organization covers every part of the United States and its dependencies, and it carries on missionary work in other lands. It has bishops and organized missionary work in Alaska, Porto Rico, the Panama Canal Zone, the Hawaiian Islands, the Philippine Islands, Cuba, Mexico, Brazil, China, Japan, Liberia, Haiti and the Dominican Republic.

Among the educational institutions of the Church are Trinity college at Hartford, Conn.; the University of the South at Sewanee, Tenn.; Hobart college at Geneva, N.Y.; Kenyon college at Gambier, O.; St. Stephen's college at Annandale, N.Y.; and the American Church institute for negroes. The Theological schools, in addition to the General Theological seminary in New York, which is the official institution of the whole Church, and the Virginia seminary previously mentioned, are the Berkeley Divinity school at New Haven, Conn.; the Divinity school in Philadelphia; the Episcopal Theological school in Cambridge, Mass.; Nashotah house at Nashotah, Wis.; Seabury Divinity school at Faribault, Minn.; the Theological school at Sewanee, Tenn.; the Seabury–Western Theological seminary at Evanston, Ill.; the Church Divinity school of the Pacific, San Francisco, Calif.; the College of St. John the Evangelist, Greeley, Colo.; the Bishop Payne Divinity school at Petersburg, Va.; Bexley hall, Gambier, O.; the Du Bose Memorial Church Training school, Monteagle, Tenn.; and the De Lancey Divinity school at Buffalo, N.Y. The Church has also, especially in the East, many important schools for boys and girls.

Church Development. — The life of the Church finds expression in a great number of societies and organizations, such as the Women's Auxiliary to the National Council; the Brotherhood of St. Andrew; the Girls' Friendly Society; the Seamen's Church Institute of America; the Social Service Commissions; the Church clubs of the various dioceses; the Church Mission of Help, and the Church Congress in the United States. Among the religious orders are the Society of Mission Priests of St. John the Evangelist; the Order of the Holy Cross; St. Barnabas Brotherhood; the Community of St. Mary; the Sisterhood of St. John the Baptist; the Sisterhood of St Margaret; the All Saints Sisters of the Poor; the Sisterhood of the Holy Nativity; and others. The institutions for the training of deaconesses include the New York Training School for Deaconesses; the Church Training and Deaconess House of the Diocese of Pennsylvania; the Chicago Church Training school; and the School for Christian Service and Deaconess Training School of the Pacific at Berkeley, Calif.

The governing body of the Protestant Episcopal Church is the General Convention which meets every three years, and which consists of the House of Bishops and the House of Deputies, the two Houses sitting and deliberating separately. The House of Bishops has as its members all the bishops of the Church. The House of Deputies is composed of not more than four presbyters and four laymen elected by each diocese and not more than one presbyter and one layman elected by each missionary district. Either house may originate and propose legislation, and all acts of the Convention must be adopted and authenticated by both houses. In the House of Deputies the vote on any question may be taken by orders, the clerical and lay deputies voting separately and a concurrent vote of the two orders being required for the adoption of the resolution. The laity thus have their full share and responsibility in the legislative action of the Church. No alteration in the Book of Common Prayer may be made unless this is proposed at one meeting of the General Convention and adopted at the next succeeding triennial meeting. Each diocese holds its own annual Convention, presided over by the bishop, in which both clergy and laity have their part. The diocese adopts its own constitution and canons for the regulation of its internal affairs, with the provision that these must not conflict with the constitution and canons of the General Convention. A bishop is elected by the diocese, but the election must be confirmed by a majority of the bishops exercising jurisdiction within the United States, and by a majority of the standing committees of all the dioceses. Missionary bishops are elected by the House of Bishops, the choice being subject to confirmation by the House of Deputies if the General Convention is in session, and at other times by a majority of the standing committees of the several dioceses. As regards the ministry, the Episcopal Church, in common with the Anglican Communion, holds to the historic threefold order of bishops, priests and deacons. The official pronouncements on this subject are contained in the Preface to the Ordinal. The constitution of the Church (Art. viii.) provides that no person shall be consecrated bishop, or ordained priest or deacon, until he shall have made in writing, in presence of the ordaining bishop or bishops, the following declaration: "I do believe the Holy Scriptures of the Old and New Testaments to be the Word of God and to contain all things necessary to salvation; and I do solemnly engage to conform to the Doctrine, Discipline, and Worship of the Protestant Episcopal Church in the United States of America." And every person before being baptised and received into membership in the church is required to answer affirmatively the question "Dost thou believe all the articles of the Christian Faith as contained in the Apostles' Creed?" Neither the clergy nor the laity are required to subscribe to the Thirty Nine Articles.

Church Activities. — An important change in the organization of the Church was made in 1919 by the establishment of a national council, with the presiding bishop at its head, to act as the executive body of the General Convention between its sessions, and to have charge of the general missionary, social and educational work of the Church; with the provision that, for the future, the presiding bishop should be elected instead of succeeding to this office by seniority of consecration. The national council has given new impetus and effectiveness to the work of the Church and strengthened her corporate life. The revision and enrichment of the Book of Common Prayer, undertaken in 1913, has been given much consideration at each meeting of the General Convention since that time. The statistics reported at the last meeting of the Convention in 1925 included the following: dioceses and missionary districts, 104; communicants 1,193,321; clergy, 6,140; candidates for Holy Orders, 454; lay readers, 3,740; enrolled in Sunday Schools 498,814; total contributions for the year 1925, $41,746,055. It is the earnest and increasing desire both of clergy and people that the Protestant Episcopal Church in the United States should make the utmost of her opportunity to serve the cause of Christian reunion; and at the General Convention in 1910 a movement was initiated to bring about a world conference on faith and order. After 17 years of preparation and effort, the conference was held in 1927 at Lausanne, and was attended by representatives of all the major Churches of Christendom with the exception of the Roman Catholic Church.

BIBLIOGRAPHY.—See W. S. Perry, *Historical Collections Relating to the Episcopal Colonial Church* (1870), and *History of the American Episcopal Church* (1885); Bishop White, *Memoirs of the Protestant Episcopal Church* (1880); S. D. McConnell, *History of the American Episcopal Church* (1890); C. C. Tiffany, *History of the Protestant Episcopal Church* (1905); see also ref. under art. ENGLAND, CHURCH OF. (W. T. M.)

PROTEUS or **OLM,** a blind, water-breathing, tailed amphibian, inhabiting the limestone caves to the east of the Adriatic. It is a small eel-like animal, with minute limbs, the anterior pair having three toes on each, the posterior two, a narrow head, with flat truncate snout, minute rudimentary eyes hidden under the skin which is pale flesh-coloured, with the short, plume-like external gills blood-red *(Proteus anguinus)*. *Proteus* forms with *Necturus* the family Proteidae. The second genus, which is widely distributed in eastern North America, is more generalized in structure, having better developed limbs, with four digits, and is adapted to live in the light. Its thyroid gland is very much reduced, but, unlike the axolotl (*q.v.*), it cannot be transformed into a terrestrial form by feeding with thyroid. Exposure to white light causes the skin to become black, even over the eyes; however, in red light, no blackening occurs, and the eyes grow large and functional.

In 1896 a Proteus-like Amphibian *(Typhlomolge rathbzini)* was unexpectedly discovered in Texas during the boring of an artesian well 188 ft. deep, when it was shot out with a number of remarkable and unknown crustaceans. This form agrees with *Proteus* in the absence of functional eyes, the presence of external gills, and the unpigmented skin. It differs in the short body and the long slender limbs with four to five digits. It is remarkable in having no thyroid gland at all. While *Proteus* has lungs in addition to gills, *Typhlomolge* lacks the lungs, and with them the trachea and larynx. Both the *Proteus* and *Typhlomolge* are permanent larval forms.

Another blind Urodele, *Typhlotriton spelaeus,* is known from caves in the Mississippi valley. It has neither gills nor lungs in the adult, and is found under rocks in or out of the water. It is not allied to *Proteus* but to *Amblystoma (see* AXOLOTL). The eyes are normal in the larva, but in the adult have undergone degeneration. It is not a persistent larva.

See H. Gadow, *Amphibia* (*Cambridge Natural History*).

PROTEUS, a Greek sea-daimon, shepherd of the flocks of the sea (seals, etc.) and a great prophet. According to Homer, his dwelling place was the island of Pharos, near the mouth of the Nile; in Virgil his home is the island of Carpathus, between Crete and Rhodes. He knew all things, past, present and future, but disliked telling what he knew. Those who wished to consult him had first to surprise and bind him during his noonday slumber in a cave by the sea, where he spent his time during the heat of the day surrounded by his seals. Even when caught he would try to escape by assuming all sorts of shapes, that of a lion, a serpent, a leopard, a boar, a tree, fire, water. But if his captor held him fast the god at last returned to his proper shape, gave the wished-for answer and plunged into the sea. He was subject to Poseidon.

In post-Homeric times the story (invented by Stesichorus?) ran that Proteus was the son of Poseidon and a king of Egypt, to whose court Helen was taken by Hermes after she had been carried off, Paris being accompanied to Troy by a phantom substituted for her. This is the story followed by Herodotus, who got it from Egyptian priests, and by Euripides in the *Helena*. From his power of assuming whatever shape he pleased, Proteus came to be regarded, especially by the Orphic mystics, as a symbol of the original matter from which the world was created.

See Homer, *Od.* iv; Virgil, *Georg.* iv; Stesichorus, p. 26 (44) ed. Bergk, with his notes; Euripides, *Helena;* Herodotus, ii, 112, 118.

PROTHERO, SIR GEORGE WALTER (1848–1922), British historian, was born in Wiltshire Oct. 14, 1848, being the eldest son of the Rev. G. Prothero. Canon of Westminster Abbey. Educated at Eton, he went from there to King's college, Cambridge, where he became a fellow. For a time a master at Eton, he soon returned to Cambridge as lecturer and tutor at King's college, where he was senior tutor from 1881. In 1884 he was appointed university lecturer in history; in 1894 he went to Edinburgh as professor of history; and in 1899 he succeeded his brother Rowland, afterwards Lord Ernle (*q.v.*) as editor of *The Qziarterly Review*. During World War I he was director of the historical section of the Foreign Office and in that capacity he attended the Peace conference in Paris. He was created K.B.E. in 1920 and died in London July 10, 1922.

Prothero's chief historical works are *The Life and Times of Simon de Montfort* and the collection of authorities entitled *Select Statutes and other Constitutional Documents Bearing on the Reigns of Elizabeth and James I.* He also wrote a *Memoir of Henry Bradshaw*, a *School History of Great Britain and Ireland* (to 1910) and *German Policy Before the War*. He edited Voltaire's *Louis Quatorze* and J. R. Seeley's *Growth of British Policy* as nell as the Cambridge "historical series," and he was one of the editors of *The Cambridge Modern History*.

PROTHESIS, in the liturgy of the Orthodox Eastern Church, the name given to the act of "setting forth" the oblation, *i.e.* the arranging of the bread on the paten, the signing of the cross (σφραγίζειν) on the bread with the sacred spear, the mixing of the chalice, and the veiling of the paten and chalice *(see* F. E. Brightman, *Liturgies Eastern and Western, 1896)*. (Gr. **πρόθεσις** a setting forth). The term is also used, architecturally, for the place in which this ceremony is enacted, a chamber on the north side of the central apse in a Greek church, with a small table. During the reign of Justin II (565–574) this chamber was located in an apse and another apse was added on the south side for the diaconicon (*q.v.*), so that from his time the Greek church was triapsal. In the churches in central Syria both prothesis and diaconia are generally rectangular, and the former, according to de Vogué, constitutes a chamber for the deposit of offerings by the faithful. Consequently it was sometimes placed on the south side, if when so placed it was more accessible to the pilgrims. There is always a much wider doorway to the prothesis than to the diaconicon, and there are cases where a side doorway from the central apse leads direct to the diaconicon, but never to the prothesis.

PROTIĆ, STOJAN (1857–1923), Yugoslav statesman, was born at Krusšvak Jan. 29, 1857, and at first entered the government service. He soon came into conflict with the repressive régime of King Milan and in 1882 became editor of *Samouprava* and a leader of the new Radical party. He was imprisoned for a press offence in 1883 and again in 1885. He held subordinate posts in the Radical cabinet of 1887. In 1899 an attempt on King Milan's life was used by the government to rid itself of its Radical rivals. Protić was sentenced to 20 years' hard labour, although, in fact, he had no connection with the crime. Pardoned nine months later, he became director of the National library. After the revolution of 1903 he represented the Radicals in the first provisional cabinet under King Peter and remained minister of the interior in most of the succeeding cabinets down to 1907. He was finance minister during the Bosnian crisis and again became minister of the interior during the period of the Balkan Wars and the European crisis of 1914. In 1914, when leaders of the secret "Black Hand" organization were implicated in the murder of Serajevo, this organization was actually at daggers drawn with the Serbian government owing to a quarrel with Protić.

Protić remained out of office during the period of coalition government from Dec. 1914 to June 1917, but continued to exercise great influence in the background. He was returned to office in 1917 and played an active part in the negotiations leading to the Corfu agreement between the Serbian government and the Yugoslav committee.

He showed more comprehension for the Croat and Slovene standpoint than his colleague Pašić, and when the conflict between Pašić and Trumbić in 1918 delayed the recognition of Yugoslavia by the Allies and created an awkward situation with Italy, Protić was appointed the first premier of the new Yugoslav state. He was keenly interested in the constitutional problem, and after his resignation in Aug. 1919 published his own draft project. Disagreeing with the exaggerated centralism of Pašić, he declined office in 1921 and drifted steadily away from his old colleague. Protić died in Belgrade in Nov. 1923.

His publications include *The Aspirations of Bulgaria* (1916) and *Le problème Albanais,* etc. (1913), issued under the pseudonym of "Balkanicus."

PROTISTA: *see* PROTOZOA.

PROTOACTINIUM, a radioactive element of atomic number 91 and estimated atomic weight 232. It is the "parent" of actinium, which it forms by loss of an a-particle. *(See* RADIOACTIVITY.)

PROTOCOL, in diplomacy, the name given to a variety of written instruments. The French word *protocole* is derived from the late Latin *protocollum,* from the Greek *πρῶτος* first, and *κολλᾶν* to glue, *i.e.,* originally the first sheet of a papyrus roll. The *protocollum* under the late Roman empire was a volume of leaves, bound together with glue, in which public acts were recorded, so as to guard against fraud or error on the part of those responsible for preparing them; and in later usage it came to be applied tu the original drafts of such acts. Thus, too. the work *prothocollare* was devised for the process of drawing up public acts in authentic form.

In diplomacy the name of "protocol" is given to the minutes (*procès-verbaux*) of the several sittings of a conference or congress; these, though signed by the plenipotentiaries present, have only the force of verbal engagements *(see* CONGRESS). It is also given to certain diplomatic instruments in which, without the form of a treaty or convention being adopted, are recorded the principles or the matters of detail on which an agreement has been reached, *e.g.,* making special arrangements for carrying out the objects of previous treaties, defining these objects more clearly, interpreting the exact sense of a doubtful clause in a treaty (*protocoles interpretatifs*) and the like. Occasionally also an agreement between two or more powers takes the form of a protocol, rather than a treaty, when the intention is to proclaim a community of views or aims without binding them to eventual common action in support of those views or aims.

Finally, "the protocol" *(pvotocole diplomatique, protocole de chancellerie*) is the body of ceremonial rules to be observed in all written or personal official intercourse between the heads of different states or their ministers. It lays down the styles and titles of states, their heads and public ministers, and indicates the forms and customary courtesies to be observed in all international acts. "It is," says M. Pradier-Fodéré, "the code of international politeness."

See P. Pradier-Fodéré, *Cours de droit diplomatique* (1899), ii, *499;* E. Satow, *Diplomatic Practice.*

PROTOGENES, a Greek painter, born in Caunus, on the coast of Caria, but resident in Rhodes during the latter half of the 4th century B.C. He was celebrated for the minute and laborious finish which he bestowed on his pictures, both in drawing and in colour. Apelles, his great rival, standing amazed in the presence of one of these works, could only console himself by saying that it was wanting in charm. On one picture, the "Ialysus," he spent seven years; on another, the "Satyr," he worked continuously during the siege of Rhodes by Demetrius Poliorcetes (305–304 B.C.) notwithstanding that the garden in which he painted was in the middle of the enemy's camp. Demetrius, unsolicited, took measures for his safety; more than that, when told that the "Ialysus" just mentioned was in a part of the town exposed to assault. Demetrius changed his plan of operations. Ialysus was a local hero, the founder of the town of the same name in the island of Rhodes, and probably he was represented as a huntsman. This picture was still in Rhodes in the time of Cicero, but was afterwards removed to Rome, where it perished in the burning of the Temple of Peace.

The picture painted during the siege of Rhodes consisted of a satyr leaning idly against a pillar on which was a figure of a partridge, so life-like that ordinary spectators saw nothing but it. Enraged on this account, the painter wiped out the partridge. The "Satyr" must have been one of his last works. We would then be about 70 years of age, and had enjoyed for about 20 years a reputation next only to that of Apelles, his friend and benefactor. Both were finished colourists so far as the fresco painting of their day permitted, and both were laborious in the practice of drawing, doubtless with the view to obtaining bold effects of perspective as well as fineness of outline. It was an illustration of this practice when Apellrs, finding in the house of Protogenes a large panel ready prepared for a picture, drew upon it with a brush a very fine line which he said would tell sufficiently who had called. Protogenes on his return home took a brush with a different colour and drew a still finer line along that of Apelles, dividing it in two. Apelles called again, and thus challenged, drew with a third colour another line within that of Protogenes, who then admitted himself surpassed. This panel was seen by Pliny (*N.H.* xxxv, 83) in Rome, where it was much admired, and where it was destroyed by fire.

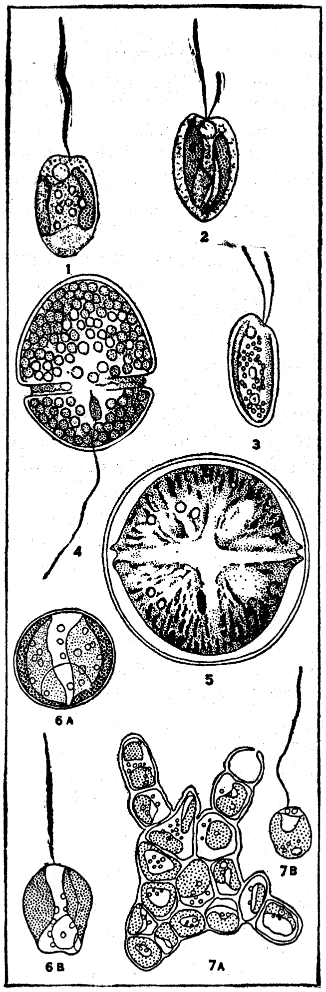
In the Propylaea at Athens was a painting by Protogenes representing personifications of the coast of Attica, Paralus and Hammonias. For the council chamber at Athens he painted figures of the Thesmothetae, but in what form or character is not known. Probably these works were executed in Athens, and it may have been then that he met Aristotle, who recommended him to take for subjects the deeds of Alexander the Great. In his "Alexander and Pan" he may have followed that advice in the idealizing spirit to which he was accustomed. To this spirit must be traced also his "Cydippe" and "Tlepolemus," legendary personages of Rhodes. Among his portraits are mentioned those of the mother of Aristotle, Philiscus, the tragic poet, and King Antigonus. But Protogenes was also a sculptor to some extent, and made several bronze statues of athletes, armed figures, huntsmen and persons in the act of offering sacrifices.

PROTOGUEROFF, ALEXANDER NICHOLOFF (1867–1928), Macedonian revolutionary leader, was born at Ochrida, Macedonia, in 1867. He went to the military school of Sofia, and, after some military service in Bulgaria, joined the Macedonian movement in 1895 and commanded a band of insurgents. He was a moderate member of the Superior Macedonian committee in Sofia, a rival of the Secret committee which was responsible for the rising of 1903. From 1908 to 1911 Protogueroff served in the army, and after a period in retirement, was elected in 1912 president of the Executive committee of the Macedonian societies.

When World War I broke out he organized the 11th Macedonian division, and commanded the 3rd brigade, later becoming assistant to the Bulgarian governor of Macedonia. In Sept. 1918 he was made commandant of Sofia, and maintained order when the Bulgarians were driven back. Later he left the army and entered politics, being arrested on Nov. 4, 1919, with Radoslavoff's cabinet. He escaped, and after two years in hiding, reached Macedonia in Oct. 1921, where he joined Todor Alexandrov, the Macedonian leader, and his chief lieutenant Peter Chaiileff.

On Aug. 31, 1924, Alexandrov was assassinated by Chaiileff's friends, as a result, it is supposed, of an agreement between Chaiileff and the Communists. Protogueroff in his turn arranged for the assassination of four of the persons responsible for Alexandrov's death. Chaiileff himself was assassinated on Dec 23, 1924, and two more of his followers in the following year. During the later years of his life Gen. Protogueroff retired from active participation in the revolutionary movement, and became interested in spiritualism.

PROTOPHYTA. The designation Protophyta ("first plants") is applied to all simple one- and several-celled organisms that obtain their nourishment after the manner of a plant. Such forms probably afford a fairly accurate picture of what the early stages in the evolution of the vegetable kingdom were like. The simpler Algae (*q.v.*) are of course embraced in the Protophyta. Together with Protozoa (*q.v.*) the latter constitute the Protista, which comprise all the most elementary forms of life. There are many classes of Protista. some definitely holophytic (*i.e.,* feeding like a plant), others definitely holozoic (*i.e.,* taking in solid food like an animal), while still others exhibit a mingling of plant and animal characteristics, so that it depends to some extent on personal bias whether they be referred to Protozoa or Protophyta. A rigid definition is impossible and undesirable. The Protophyta may, however, justifiably be taken to include all simple organisms carrying on photosynthesis. In this process organic compounds are built up from carbon dioxide and water with the help of solar energy absorbed by pigments which are held within the cells in special protoplasmic bodies, the chromatophores. The latter always contain green chlorophyll which predominates in the green Algae (Chlorophyta), but in many classes is associated with other pigments (yellow, brown, red, etc.) which give a distinctive colouration to their respective members. Moreover, the carbon-compounds, that accumulate in the cells after active photosynthesis, vary in the different classes (starch, fat, leucosin, etc.), an indication that distinct metabolic processes are associated with the diverse types of pigmentation. The various classes can thus be distinguished on a physiological basis by their special mechanisms for nutrition.



FROM "SUSSWASSERFLORA," AND HARTMAN & PASCHER, "ARCHIVES FÜR PROTISTENKUNDE". (GUSTAV FISCHER)

TYPES OF PROTOPHYTA

1. Chromulina, motile cell (Chrysophyceae). **2.** Ochromonas, motile cell. **3.** Cryptomonas, motile cell. **4.** Glenodinium, motile cell (Dinophyceae) **5.** Hypnodinium, motionless cell (same). **6a.** Chrysosphaera, motionless cell (Chrysophyceae). **6b.** Chrysosphaera, Zoospore (same). **7a.** Thallochrysis, branched filament (same). **7b.** Thallochrysis, Zoospore (same)

Motile and Stationary Forms.—Many of the simplest unicellular Protophyta are actively motile with the help of delicate protoplasmic threads, the cilia or flagella, whose number and arrangement is usually distinctive for each class (figs. 1–4). Every class, however, also includes motionless organisms of varied type, partly unicellular (figs. 5, 6a) and partly multicellular (fig. 7a). Many of these reproduce themselves by means of naked swarmers (zoospores), which are essentially similar to the motile unicellular individuals of their class and which, after a period of movement, lose their cilia and give rise to the stationary organism. This fact has led to the assumption—now generally accepted—that such sedentary forms have evolved from motile unicells in much the same way as they arise from their zoospores during their individual life-history. It is, however, probable that in some series of Protophyta (*e.g.*, Myxophyceae) no motile organisms were ever evolved, even the unicellular individuals being motionless from the first.

In certain classes of Protophyta (Chlorophyceae, Xanthophyceae, Myxophyceae) the majority of the known genera are stationary, *i.e.*, they exhibit the essentially plant-like characteristic of immobility. These are usually grouped under the name of Algae (*q.v.*) which also comprise some series that have evolved beyond the level of the Protophyta and in which no simple forms are known. In other classes of Protophyta, however, the majority of the species are motile and, for this reason, and also because the simpler individuals are ordinarily not clothed by a cell-wall, they have been regarded as something apart from the Algae more nearly related to Protozoa and grouped as Flagellata. But in several of these classes (Dinophyceae, Chrysophyceae) motionless unicellular and filamentous types corresponding to those found in Chlorophyceae, Xanthophyceae, etc. (see ALGAE) have been discovered in recent times, and there is thus no valid reason for separating them from those Protophyta that are grouped as Algae.

A number of colourless Protista resemble plants, since they feed mainly by absorbing (organic) solutions and not by ingesting solid particles, *i.e.,* they are saprophytes or parasites. Such forms are probably in part descended from holophytic types which have lost their chromatophores, while others may have been devoid of them from the first. From such primitively colourless Protophyta various series of fungi may have originated, although some fungi may have been derived from pigmented types by loss of chromatophores.

(For classification see ALGAE.)

Range of Form.—Most classes exhibit a more or less extensive range from simple unicells to branched multicellular filaments. One can distinguish motile and motionless unicells, colonies of motile and motionless individuals, palmelloid forms with numerous cells embedded in mucilage, simple and branched filaments, etc. Analogous forms, often almost identical in shape though with the differences in pigmentation, etc., characteristic of the relevant groups are met with in most classes of holophytic Flagellata. Thus, Chrysosphaera (fig. 6) is a spherical unicell, similar to Chlorococcum (Chlorophyceae) or Halosphaera (Xanthophyceae), but it possesses the orange chromatophores and leucosin of Chrysophyceae and reproduces by zoospores closely resembling a Chromulina, one of the motile unicells of that class; similarly *Hypnodinium* (fig. 5) is such a motionless member of Dinophyceae, whose protoplasmic body before dividing during reproduction acquires temporarily the typical transverse and longitudinal furrows. Palmelloid forms, analogous to *Tetraspora* (Chlorophyceae), are seen in *Phaeosphaera* (Chrysophyceae) and *Phaeococcus* (Cryptophyceae), while filamentous types are represented by Phaeothamnion or *Thallochrysis* (fig. 7) (Chrysophyceae) and *Dinothrix* (Dinophyceae), all reproducing by zoospores resembling closely the motile unicells of their particular classes. Further details cannot be given in the confines of a short article, but it will be clear that there is a far-going parallelism in the evolution of the different classes of Protophyta.

Reproduction.—The reproductive processes are of the simplest kind, most commonly consisting in a mere division of the individual into two parts, which in the motile forms may even take place during movement. Reproduction by zoospores, as already mentioned, is frequent in the more advanced stationary forms (figs. 6, 7). Sexuality, altogether lacking in the Myxophyceae, is rare and restricted to the higher forms in most classes. Oogamy (see ALGAE) is encountered alone in the Chlorophyceae, where altogether the reproductive methods show a greater elaboration than among other Protophyta.

Relation to Other Groups.—The definite range from simple to complex implies an upgrade evolution which is recognizable also in the reproductive processes. As far as present knowledge goes, however, the multicellular filamentous types are of the simplest kind in most Protophyta. Even when branching occurs, there is no differentiation among the cells and the formation of reproductive units takes place in the simplest possible way. In other words these classes have ended blindly without developing far in the direction of the multicellular plant and it is only in Chlorophyceae (as well as in Phaeophyta and Rhodophyta which, as explained above, must have had a Protophyte ancestry) that a considerably greater specialization is found; and this is accompanied by more complex reproductive methods and the development of an oogamous sexual process. While in the two classes of seaweeds massive and complex bodies have been evolved, this is not the case in the green Algae, although in other respects their advanced forms are almost as highly specialized as those of seaweeds. The absence of more elaborate types in Chlorophyceae is probably due to their further evolution into land-plants in the far past, just as the simpler (extinct) Phaeophyta and Rhodophyta evolved into the seaweeds of the present day. In the same way other classes of Protophyta must have given rise to the various groups of fungi. There is little evidence of relationship between the known classes of Protophyta; most, if not all.

seem to represent separate attempts at the evolution of a holophytic organism. The occasional resemblances to classes of Protozoa are no doubt due to the fact that plant and animal tendencies were not clearly segregated in all the different evolutionary series.

BIBLIOGRAPHY.—For a general account of Protophyta, *see* F. E. Fritsch, *Presidential Address* to *Section K, British Associztion* (1927).
(F. E. F.; X.)

PROTOPLASM, defined by Huxley as "the physical basis of life," is the essential material of which living creatures are composed. A typical multicellular organism can be analysed into component organs, which are built up of diverse tissues, in turn consisting of cells. In pursuing the analysis the biologist reaches, within the cell, the essential living matter or protoplasm. But a cell often includes material which cannot be thought of as alive, or as playing an essential rôle in the characteristic chemical routine or metabolism. Such non-living material is conveniently called metaplasm, and may be illustrated by waste pigments or by crystals. If the whole of this metaplasm could be subtracted from the entire cell-substance or cytoplasm, and from the whole nuclear substance or nucleoplasm, the remainder would be protoplasm.

Soon after the vague recognition of the cellular structure of plants and animals in the later 17th century by Hooke, Malpighi and Grew, there began to be some appreciation of the fact that the cells had contents. Yet it required another century before Corti and Treviranus saw the streaming movements inside the cells of some plants. Even then the open secret was missed, for the objective envisaging of life as involving an intricate series of physical and chemical changes within the cells was still far distant.

The term "protoplasm" was first used by Purkinje in 1840 in reference to the formative material of animal embryos. It was taken over by von Mohl (1846) and applied to the "slimy, granular, semifluid" constituents of plant-cells, as distinguished from cell-wall, cell-sap and nucleus. Some time before that, however, Dujardin had discerned the living material in Foraminifera. He called this "sarcode" (1835), and defined it as a "living jelly, glutinous and transparent, insoluble in water, and capable of contracting into globular masses and of adhering to dissecting needles so that it can be drawn out like mucus." Soon there came an identification of Dujardin's animal "sarcode" and von Mohl's plant "protoplasm," and yet the acceptance of this unifying idea was slow. This was partly because the statement of the cell-theory by Schwann and Schleiden (1838) gave undue prominence to the importance of the cell-wall. Indeed it was not till 1861 that Max Schultze won conviction for the fundamental idea that throughout the whole world of life there is one general kind of living material, protean, yet nevertheless always essentially similar. (J. A. TH.)

The various methods of studying living matter may be grouped under three general headings: (1) microscopic observations of the structure and behaviour of the great variety of cells which constitute living organisms, both plant and animal; (2) a chemical analysis of the materials composing protoplasm and (3) the application of experimental methods on living cells to ascertain the extent to which protoplasmic phenomena can be explained in physico-chemical terms and to study chemical reactions within the living cell. All of these methods have been used since protoplasm was first recognized as the physical basis of life. However, the results obtained were largely empirical or purely speculative until the newer developments in the fields of physics and chemistry could give some significance to the physical configuration and chemical constitution of protoplasm.

The technical difficulties of making observational studies on cellular structures in the living state have resulted in the elaboration of methods for the fixation of tissues and cells with killing agents. As for chemical analyses of cellular tissues the usual procedure entails complete destruction of the cell. The results obtained by such methods can be accepted only with the qualification that the passage from life to death undoubtedly occasions structural and chemical changes in the form of recombinations and decompositions so that the structures and compounds found in dead matter can offer at best a very incomplete idea of the composition of living protoplasm.

Protoplasm exists only in discrete units almost always of microscopic dimensions. The living cell contains the protoplasmic unit which exhibits all the properties characteristic of living beings. In many kinds of cells the protoplasm becomes highly specialized by the predominance of one or a few of the life functions, as explained in the article HISTOLOGY. In multicellular organisms there are well-established cases which indicate a continuity between the protoplasm of neighbouring cells. The extent to which this phenomenon occurs and its significance are still in question. There is no doubt, however, that the cells composing an organism exert mutual interactions which are of the greatest functional importance in the general economy of the whole.

The protoplasmic unit within each cell always is bounded by a sharply outlined surface and contains at least one differentiated structure, the nucleus, the removal of which ultimately leads to the death of the protoplasm. From what is known regarding the chemical constituents, especially the proteins and fatty substances, and from the optical behaviour of protoplasm, it has been concluded that the components of protoplasm exist largely in the colloidal state. Beyond the visible structure of protoplasm as revealed by the microscope we must therefore look for the existence of an ultra-microscopic, colloidal structure. Whatever this structure may be there is no doubt that the extraordinary properties of surfaces especially characteristic of colloids play a large part in protoplasmic phenomena. (See COLLOIDS.)

One of the many difficult problems in a consideration of the constitution of protoplasm is the significance of the many and varied visible structures within the protoplasm. (See CYTOLOGY.) In addition there is reason to believe that the nucleus of the cell contains a large number of discrete, self-propagative particles of colloidal dimensions—the genes. (See HEREDITY.) So far as the rest of the protoplasm is concerned investigations have pointed in a different direction. Nevertheless, experimental studies in embryology have indicated that the cytoplasm of the unsegmented egg, for example, contains specifically different, but not necessarily visibly formed, materials which play an important part in development. We must conclude that the concept of regional differentiation within the cell must be taken into serious account in any attempt to interpret protoplasm in terms of physics and chemistry.

Chemical Analysis. (a) Inorganic Components.—Water is the most abundant single component of protoplasm. It is important in promoting chemical activity by dissociation of electrolytes. It also takes an intimate part in the building up and breaking down of such chemical compounds as proteins and carbohydrates, a procedure which must be occurring constantly in the metabolism of a living cell.

The common salts in protoplasm are the chlorides, carbonates, and phosphates of sodium, potassium, ammonium, calcium, magnesium and iron. These substances are present in certain relative concentrations so that the specific properties of one balance those of others in the normal chemical equilibrium of the cell. Gases are also present in solution, viz., oxygen and carbon dioxide which play an important rôle in the oxidation processes.

(b) Organic Components.—The organic compounds obtained from protoplasm are the carbohydrates, lipins and proteins. The most stable of the carbohydrates probably serve as structural materials, others supply energy by undergoing oxidation. The lipins, or fatty substances, serve similar purposes. They have a much higher energy content. Their insolubility in water together with their ability to combine with electrolytes to form soaps with varying water-soluble properties are of considerable significance in the constitution of protoplasm.

The proteins are the most complex of the organic compounds. In common with the fats and carbohydrates they are composed chiefly of carbon and hydrogen, but they also possess certain radicals (NH_2 and COOH) which give them the peculiar property of behaving both as acids and as bases. The proteins readily combine with inorganic ions to form salts; this is one of the factors which enables protoplasm to retain a high concentration of certain inorganic elements relatively independent of that of the environing medium. Because of their varying acid and basic groups the proteins can likewise maintain the protoplasm at its own peculiar degree of acidity and basicity. Proteins are mostly all colloidal, their solutions are often viscous and exhibit reversible states of solidity and fluidity. These remarkable properties of the proteins probably serve as a basis for the complex system of structure and chemical interactions in protoplasm.

Many of the chemical changes which involve either the breakdown or the synthesis of the compounds discussed in the preceding paragraphs can be made to occur in vitro extremely slowly or under conditions (*e.g.*, high temperature) which cannot possibly obtain in living protoplasm. It is known, however, that certain substances, called enzymes, have been extracted from animal and plant tissues, which enable reactions to occur at a relatively high velocity and under conditions probably existing in living protoplasm. Many inorganic substances, called catalysts, are known whose effects are analogous to those of enzymes.

The Physico-Chemical Structure of Protoplasm. (a) The Protoplasmic Surface.—Protoplasm is always surrounded by an aqueous environment. This, obviously true for all organisms which live in water, is equally true for land-living forms whose outer coating of dead and dying cells is so constituted as to form a waterproof layer to maintain the proper conditions of moisture for the living cells within.

In order to account for the fact that the protoplasm maintains its integrity we must assume either that the entire mass of protoplasm is practically insoluble in its surrounding medium or that its immiscibility is due to an enveloping layer or membrane. There is considerable proof that the second assumption is the correct one. For example, when the protoplasmic surface of a variety of living cells is torn with microneedles (see MICROMANIPULATION) the interior protoplasm tends to flow out and dissipate in the surrounding aqueous medium. The material, as it flows out, especially when the surrounding medium has the proper salt content, frequently forms a new surface membrane which encloses it and keeps it intact. Another experiment which indicates the existence of a differentiated membrane is the microinjection of coloured solutions which normally do not penetrate the protoplasm from without. The colour quickly spreads through the protoplasm but remains within its boundary.

Differences in the penetrating powers of various chemical substances have given us some idea as to ,the nature of this membrane. Water passes in freely especially when it contains certain salts in solution, viz., NaCl and KCl, to pure solutions of which the plasma membrane, in many instances, appears to be relatively permeable. Other salts, *e.g.*, $CaCl_2$ and possible $MgCl_2$ in pure solutions have no appreciable powers of penetration. The rate of penetration of acids and bases appears to be a function of their degrees of ionization, viz., those which are the most highly ionized appear to be least able to penetrate. The most universally penetrating substances seem to be those which are lipoid or organosoluble. These facts have convinced many investigators that the surface membrane of protoplasm is at least largely lipoid or fatty in nature, an assumption which is supported by the immiscibility of protoplasm with water.

In all probability we must consider the physiologically active part of the membrane as a shifting, dynamic structure resulting from interactions of protoplasmic components with the environment and undergoing reversible reactions with the various chemical substances dissolved in the surrounding medium. Non-living membranes which exhibit rapidly reversible reactions of this type are well known.

Some substances to which the protoplasmic membrane appears to be freely permeable are known to be unequally distributed between the interior of the protoplasm and its environment. This is accounted for in part by the chemical combinations of the freely penetrating substance with nonpenetrating substances present on one or the other side of the membrane.

Mention must also be made of a different type of penetration, viz., that by which particulate matter may enter protoplasm. Insoluble particles may adhere to, or be wetted by, and consequently sink into the protoplasmic surface layer after which they may gain access into the interior by the reactive changes occurring between the interior and the surface membrane. Space permits only the recital of a list of the possible factors which play a part in the passage of substances through membranes, viz., simple diffusion, osmosis, electro-endosmose, surface tension and solubility in the material of the membrane.

(b) The *Internal* Protoplasm.—The necessity of the nucleus for the life of the protoplasm of a cell has been so well recognized that the term "protoplasm" is generally applied to an organized system consisting of a differentiated nucleus contained within a mass of so-called cytoplasm.

The nucleus is a differentiated part of the protoplasm of the cell. Usually it readily coagulates when the cell is injured or killed and then appears as a network of granular fibrils enclosed within a membrane. The importance of the nucleus is most evident during the reproductive activity of the cell which is heralded by the transformation of the nuclear materials into peculiarly constant bodies, the chromosomes. (See CYTOLOGY.)

Interchanges between the nucleus and cytoplasm undoubtedly occur, possibly during the entire life cycle of the cell. However, not enough is known at present regarding the nature of this relation to permit any certain interpretation. What is known is that a relation does exist which is essential for the continued life of the cell.

Under the microscope the substance of the cytoplasm appears to be a translucent, optically structureless fluid, the hyaloplasm in which lie various sized granules, globules and fibrillae in varying amounts. In many instances these visible bodies are grouped in definite patterns, some of which constitute specialized structures. (See CYTOLOGY.) The significance of these structures must be left to the future.

The presence of visible granules, fibrils and vacuoles in the hyaline matrix is such a universal feature that many of the older conceptions of protoplasm were based on the assumption that these inclusions form an essential part of protoplasmic structure. However, in view of the fact that these structures vary in the protoplasm of different cells, not only in form but also in number, and may be entirely absent in some cells or appear only at some stages in the life of a cell, we must regard them rather as specialized differentiations in each case.

A feature which strikes the eye of the observer is the constant movement of the visible granules in the hyaline matrix of the protoplasmic substance. This continual, translational movement, as distinguished from the vibratory Brownian movement, is very noticeable and rapid in some cells and barely perceptible in others. True Brownian movement is also seen in protoplasm, sometimes in restricted areas and at other times throughout the entire protoplasm of a cell. The protoplasm of some cells is very fluid, in others it is quite viscous. The viscosity may change at different periods in the life history of a cell.

A factor which has been found to be important in the maintenance of protoplasm is the antagonistic action of certain salts in the protoplasm and in the fluids which bathe it. As an example we may discuss the action of two of the most common salts: sodium chloride and calcium chloride. The fluids contained in all living organisms, plant or animal, contain these (or very similar) salts in definite, relative concentrations which approximate those of the same salts in the ocean. Protoplasm will not survive beyond very narrow limits of those relative concentrations, the proportions being about fifty parts of sodium to one of calcium. The actual concentrations of these elements do not appear to be as important as are the proportions in which the two exist. The significance of these salts probably lies in the fact that the salts of sodium have a dispersive action while those of calcium have an aggregative action on two of the most important constituents of protoplasm, viz., proteins and fats.

The chemical state of the proteins and fats probably also accounts for the fact that protoplasm can survive only within narrow limits of an acid-base equilibrium. This is maintained by the buffer action of the acid and basic combinations of certain salts, *e.g.*, the carbonates. In this way any excess acid or base liberated during metabolic activity is neutralized before the protoplasm is affected injuriously. Temperature and oxygen tension in the environment also play important rôles in controlling chemical interactions in protoplasm.

Conclusion. — Protoplasm is the material basis of life and maintains its peculiar properties only as it exists in the form of organized, structural units of microscopic dimensions and under limited environmental conditions. Each unit possesses all the life properties of motility, responsiveness, nutrition, growth and reproduction. Its complicated chemical and physical state is essentially unstable and can be maintained only by chemical interactions involving a continuous expenditure of energy. Moreover, the chemical reactions are controlled by definite structural conditions. It continually and intermittently receives energy (*e.g.,* potectial chemical energy of foodstuffs) and releases energy in kinetic form (mechanical energy, heat, light, electricity). The instability of protoplasm is shown by the ease with which a slight change in the constitution of its chemical environment or even mere mechanical disturbances destroy it and convert it into a nonreversible and unorganized mixture of substances.

BIBLIOGRAPHY.—J. Alexander, *Colloid Chemistry,* vol. ii. (New York, 1929); W. M. Bayliss, *Principles of General Physiology* (1927); *E.* V. Cowdry, *General Cytology* (Chicago, 1925); Max Hartmann, *Allgemeine Biologie* (1927); *L.* V. Heilbrunn, *The Colloid Clzemistry of Protoplasm,* vol. i. of Protoplasm Monographs (Berlin, 1928); Rudolf Höber, *Physikalische Chemie der Zelle und der Gewebe* (1926); W. Lepeschkin, *Lehrbuch der Pflanzenphysiologie auf physikalisch-chemischer Grundlage* (1925); R. S. Lillie, *Protoplasmic Action and Nervous Action* (Chicago, 1923); Jacques Loeb, *The Organism as a Whole* (1916); Otto Meyerhof, *Chemical Dynamics of Life Phenomena* (1924); W. J. V. Osterhout, *Injury, Recovery and Death in Relation to Conductivity and Permeability* (1922); Walter Stiles, *Permeability* (1924); *A.* von Tschermak, *Grundlagen der Allgemeinen Physiologie* (1924). (R. CH.)

PROTOPOPOV, ALEXANDER DMITRIEVICH (1864–1918), Russian statesman, was born in 1864 and educated in a military school. He served for some time in the army before going into business. As a big landowner of the Simbirsk province, he took an active part in the Zemstvo life, and was elected member of the Executive board of the Simbirsk Zemstvo and marshal of the nobility of the Simbirsk province. He was elected member of the third (1907) and of the fourth State Duma, where he joined the left wing of the Octobrist (Moderate Liberal) party. Later he became vice-president of the State Duma. In March 1916 he visited the capitals of western Europe as one of the leaders of the Russian parliamentary delegation. At the beginning of Oct. 1916 he was appointed minister of the interior in the Stiirmer cabinet, proving to be now the strongest upholder of reaction. He enforced the censorship, and interfered dangerously with the food-supply work of the Zemstvos and Towns Union. At a stormy meeting held at the Duma he was asked to resign his post, and when he refused his name was struck off the list of members of the party. Hated by the Liberal circles and by the Duma, Protopopov not only supported the reactionary policy of Stiirmer and Prince Galitzin, but he is said also to have been one of the secret organizers of the disturbances of Feb. 1917, which he proposed to suppress by military force, and which, unexpectedly for him, resulted in the overthrow of the empire and of himself. He was arrested by the Provisional Government and committed for trial. He remained for many months in the Peter and Paul fortress and was executed by order of the Extraordinary Commission in Sept. 1918.

PROTOZOA. The forms of life included under the name Protozoa are enormously varied. The separation of the group from the Metazoa (higher animals), plants and bacteria, is based to some extent on convenience in classification, but it does rest on certain definite characters which distinguish the Protozoa from the three main groups.

Single protozoans are as a rule extremely small, so small that they can only be seen with the heip of the microscope, and the unaided and inexperienced eye will only pick them out where by chance a great mass of one kind or another have collected together: heaped together in this way they will scarcely look like living creatures. When we see the surface of a small stagnant pond covered with a sheet of green, we really have in front of us a great host of the flagellate organism *Euglena* (fig. 16). When, on board ship, we see phosphorescence at night so strong that every drop of water seems to sparkle we are really watching the antics of countless millions of the luminous protozoan *Noctiluca miliaris* (fig. 18). Chalk is in reality the mud of an ancient sea purified by various chemical processes but consisting ultimately of the calcareous shells of Foraminifera and little else.

But much oftener people come into contact with Protozoa without knowing it; in water of every kind there are Protozoa without number; nearly every human being harbours protozoans of various innocuous species, living as parasites; not rarely other parasitic species will make their presence felt most disagreeably, although they do not play as important a part in this connection as Bacteria do. The exciting agent concerned in blackwater fever, malaria, sleeping sickness, amoebic disentery, Nagana cattle plague in East Africa, coastal fever of cattle in South Africa, to mention a few examples, is in each case a protozoan. Apart from these practical considerations, interest centres on the Protozoa on account of the picture they show us of the infinite diversity of living organisms.

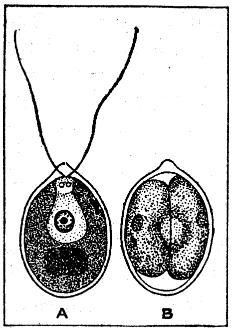
In common usage the Protozoa are said to be "unicellular animals" in contrast to the higher animals and plants which are built up of many cells. The protozoan corresponds to a single such element; it is an isolated cell (*q.v.*). What do we mean by this? A comparison between a protozoan and a multicellular animal of comparable size may make this clear. When we look at a small nematode (an organism related to the thread worm) under the microscope we find that its body is made up of separate organs—gut, nervous system, sexual organs and so forth; these organs appear to consist of more or less clearly defined and separated parts which we call cells. These cells are not all alike; the cells of the gut look quite different from those of the nervous system or of other organs; these small, fundamental elements of the animal body only resemble one another in the ground plan of their structure: In each of them we can distinguish a cell-body and a cell-nucleus. Now let us consider the protozoan chosen as a type (fig 1); it has organs: its body has an opening through which it takes in its food; a skeletal structure provides the body with a distinctive form and ensures its rigidity; fine hair-like processes serve for locomotion, but the body of the animal as a whole, instead of being made up of individual elements, consists of one single cohering mass of protoplasm. And if we look for cell nuclei, we find only one. The protozoan thus agrees with the individual cell of a higher animal or plant in this essential character of the organization of the cell—its division into cell-body (cytoplasm) and cell-nucleus; but only in this, for if we look carefully at the individual cells of the worm we have just taken as an example we find none that equal in complexity the single cell of the protozoan.

It is not hard to see why this should be so. The protozoan is a cell by itself; it swims about freely, finding its own food; it leads a life of its own. The muscle-cells of the worm on the other hand are incapable of independent existence; they rely for nourishment on the cells of the intestine, while these cells in their turn, absorbing nutriment, have no power of contraction. In other words, the protozoan is constitutionally versatile, the cells of the worm specialize; they stand in relation to one another on the principle of division of labour; they are viable only when brought together into a many-celled individual.

Furthermore, if we compare the protozoan as *an individual,* as a creature capable of living an independent life, with a many-celled worm or insect then without question the protozoan is much more easily regarded as the simpler, the less complex. But there is another way of approaching the question. We can as well compare the protozoan with the particular cells of the multicellular organism, and then we find that the protozoan leaves the cells of the higher animals far behind: the most complex known cells are found in the Protozoa.

For these and for various other reasons C. Dobell has pronounced this comparison of the protozoan with a single cell of a many-celled organism to be essentially inadmissible, for by it we compare *whole* independent individuals (Protozoa) with dependent parts (cells) of an individual. According to Dobell, the Protozoa are not unzcellular but *non*-cellular organisms This idea is not difficult to understand: if we compare the protozoan with the nany-celled animal as a whole, we may say that the latter is divided into cells, the former not; therefore the protozoan is not organized in a cellular manner. Nothing can be said against this conception in so far as it is limited to the physiological aspect, that is, to the functions of the individual; and yet it can easily be shown that the Protozoa are unicellular.

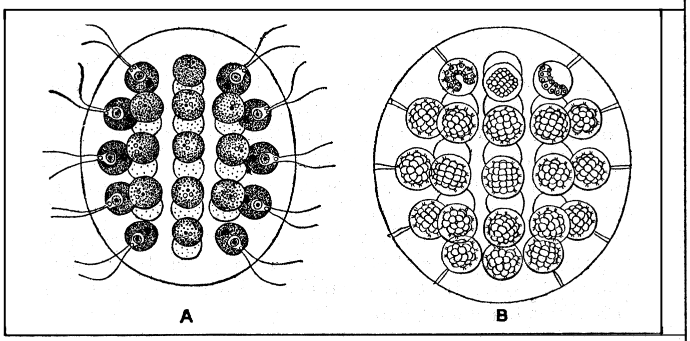
It has been mentioned above that in many protozoans we only find a single nucleus Moreover this nucleus not only looks like the nucleus of any animal or plant cell, but also behaves in precisely the same way when the protozoan reproduces itself This process generally takes the form of division; one individual splits into two (or more) new individuals. The nucleus of the mother-cell also divides at the same time; this division of the nucleus proceeds like the nuclear division of a cell in animal tissue. It is therefore clear that, while from the physiological point of view we may compare the protozoan individual as a complete organism with a worm or a butterfly, from the structural and physiological point of view (i e., with reference to its organization) we must compare it with a single cell of the worm, etc ; for the protozoan does not multiply like a worm, but like a single cell of a worm.



FROM KUHN, "MORPHOLOGIE DER TIERE IN BILDERN" (BORNTRAEGER)

FIG. 1—CHLAMYDOMONAS ANGULOSA, (A) ADULT INDIVIDUAL, (B) CELL SPLITTING INTO TWO INDIVIDUALS

The unicellular condition of many, but not all, protozoans may be demqnstrated in yet another way. There are groups of Protozoa, such as the Volvocineae, which include unicellular and multicellular species. The obvious close relationship between these single-celled and many-celled forms makes it quite clear that these latter are nothing but cell-colonies functioning as individuals. Let us compare Chlantydomonns (fig 1) with *Eudorina* (fig. 2): the *Chlamydomonas* individual has a nucleus, a chromatophore and two flagella; when it reproduces it splits into two new independent individuals. The individual of Eudorina is made up of 32 cells, which have a perfectly regular arrangement inside an egg-shaped mucilage-sheath. When Eudorina reproduces, each of the 32 separate cells has to divide first into two; each of these two divides again; their products divide, and so on until after a series of five divisions each original cell of Eudorina has given rise to 32 cells which are



FROM HARTMANN, "ALLGEMEINE BIOLOGIE" (GUSTAV FISCHER)

FIG. 2.— EUDORINA ELEGANS (GREEN MULTICELLULAR PROTOZOAN. ALLIED TO CHLAMYDOMONAS): (A) ADULT INDIVIDUAL. (B) LAST STAGE OF VEGETATIVE DIVISION (MAGNIFIED 100 TIMES)

held together iri a common wall of mucilage (fig. 2b). At this point the gelatinous wall of the "mother colony" dissolves and each of the 32 new cell-groups slips out of the "skin" of its mother-cell, and begins an independent existence as a new *Eudorina* individual. Now if we look more closely at a single cell of a Eudorina individual we find that it is exactly like an individual of *Chlamydomonas* (fig. 1a). But the *Eudorina* colony has already reached a true multicellular condition; its single cells, although like one another, are not capable of independent life. Yet we need not hesitate to compare them with the independent individuals of *Chlamydomonas.*

This example enables us to enlarge our original definitian of Protozoa. We have said above that Protozoa are unicellular organisms, but to be more accurate we had better say "most Protozoa," because there are also these multicellular protozoans like Eudorina which are connected by transitional forms with single-celled species. There are also Protozoa that we cannot call unicellular (although they do not form cell colonies) because they contain numerous nuclei (fig. 24). But nearly all these polyenergid forms, as these multicellular and multinuclear protozoans are called, in contrast to the truly uninuclear and unicellular, monoenergid forms, differ essentially from multicellular animals: there is no difference amongst the single cells, or nuclei, as the case may be, of such a polyenergid protozoan; they are all approximately equal in regard to structure, as well as function. This difference between protozoans and higher multicellular organisms has been expressed by the terms homoplastic and heteroplastic. The multicellular or multinucleate protozoans, composed of similar cells, are designated as homoplastic; multicellular higher animals and plants, on the contrary, composed of unlike cells, are heteroplastic.

What we have just said still does not apply to all Protozoa; it is, indeed, almost characteristic of living organisms that they do not admit of neat classification. There are a few Protozoa that are heteroplastic (Volvox, the Myxosporidia, etc.). The colonies of Volvox (fig. 19), a protozoan closely allied to *Eudorina,* are made up of 12,000 to 22,000 cells, but only a small number of these are capable of developing into new colonies; most of the cells are incapable of this and degenerate and die when the old colony gives rise to new ones; these cells are only capable of vegetative functions of movement and nutrition, whereas the reproductive cells are non-motile. Thus in Volvox we have already arrived at a division of labour between vegetative body- and reproductive germ-cell.

If in spite of this we number these forms amongst the Protozoa it is either because, like Volvox, they are linked by a series of transitional forms to typical unicellular species, or because, like the Myxosporidia, they are separated by their lack of proper organs from the lowest multicellular animals, the sponges. On the other hand the division between the Protozoa and the lower plants (Algae and Fungi) can only be arbitrary and therefore difficult to determine.[1] We may give as an illustration of this the fact that there is a long-standing dispute between botanists and zoologists as to whether certain forms, such as the Volvocineae, should belong to the Protozoa or to the Algae; for this group has undoubted affinities with true multicellular plants (the green algae). But we will not concern ourselves with these difficulties here. We need only emphasize the fact that we know of no single protozoan type that could be looked upon as the ancestral form of any known multicellular organism.

We can divide the Protozoa into numerous groups (orders or classes) which we may call natural, *i.e.,* protozoans belonging to one of these groups appear to be related as the dog is to the bear and the cat. But it is only rarely that we can trace between the various groups of Protozoa a relationship like that which exists between the mammals and the birds. Many protozoans are as little related to one another as the mammals are to the insects. On this account it is naturally difficult to make generalizations about anatomical and other similar characters which will hold for all Protozoa. A cursory glance at the text figures will show that the form can be extremely diverse. Some are completely shapeless, others rigidly constructed; some are asvmmetric, and others completely symmetrical. A comparison of the magnifications given in the figures shows further that the absolute size can be immensely variable. There are protozoans that only measure about $\frac{1}{10,000}$ in. and others some thousand times this diameter; indeed there are some giants, like *Nummulites* (a foraminiferan) which are as big as a shilling piece, and the plasmodia of many niyxomycetes are many times larger

[1]All protozoans are marked off from the Bacteria by the possession of a typical cell-nucleus.

BODY STRUCTURE

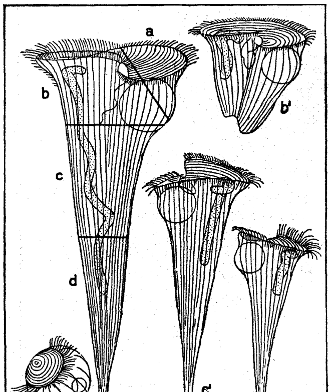
In considering the anatomical form of the Protozoa we have already mentioned that the protozoan always consists of a cell-body (cytoplasm) and cell-nucleus (or "nucleus" for short). Cell-body and nucleus are composed of that mysterious substance we call protoplasm (*q.v.*), which is the very material of life.

We can often study the structure of protozoans thoroughly enough in the living animal. As a rule, however, for the purpose of making more complete observations we make use of two technical processes that are indispensable in work on the microscopic anatomy of the higher animals and plants. First we clot, or coagulate, the protoplasm with various chemical reagents, just as we coagulate the albumen of an egg by boiling it; we then soak it with various dyes; the individual constituents of the cell-body have now, in their coagulated condition, the property of absorbing these dyes and they have moreover particular preferences for certain colouring materials (see CYTOLOGY); making use of this we can stain different parts of the cell different colours, and so make them more clearly visible.

Cytoplasm.—There seems to be no essential difference between the protoplasm of the Protozoa and that of other forms of life. We therefore content ourselves with saying here that it is more or less colourless, translucent or even transparent, and slimy or more toughly gelatinous; it chiefly consists of substances allied to white of egg, the so-called proteins. It is not infrequently differentiated into distinct zones and is capable of producing all kinds of structures—bubbles of liquid (vacuoles), delicate threads (fibrillae), granules, membranes, crystals and—to a certain extent—of changing into various substances—starch, oil and so forth.

Nucleus.—The nucleus of Protozoa is a clearly defined protoplasmic body, usually of rounded shape although there are other forms; as a rule only the so-called nucleolus, a small spherical body of albuminous substance whose structure and function are not as yet exactly understood, stains differently from the rest of the nucleus and can be distinguished from the main body of the nucleus proper, the karyoplasm. Nucleoli which are very big in comparison with the rest of the nucleus and are only present singly are called karyosomes. The surrounding karyoplasm may show various kinds of structure, granular, spongy, thread-like, or it may appear homogeneous.

It is with regard to the function of the nucleus that the Protozoa have provided some interesting facts; it is easy enough to cut in two a large uninucleate protozoan such as Amoeba, and if we watch the later behaviour of the two pieces, one of which is of course without a nucleus, we find that only the part with the nucleus can develop again into a complete individual; the part without a nucleus, on the other hand, although it can remain alive for a little while and even move about, is quite unable to take in and digest food; above all it is incapable of developing into a complete individual and sooner or later it consequently degenerates and dies (fig. 3). A nucleus can only come from a nucleus; it cannot arise *de novo* from the cytoplasm. The nucleus is therefore an organ essential for the life of the cell; we cannot yet define its functions in the Protozoa more exactly. Investigations of inheritance in the higher plants and animals have shown that it is the seat of the hereditary material and this is no doubt also the case with the Protozoa (see HEREDITY).



FROM HARTMANN, "ALLGEMEINE BIOLOGIE" (GUSTAV FISCHER)

FIG. 3.—STENTOR ROESELI REGENERATION: ANIMAL ON LEFT CUT, AS INDICATED BY LINES, INTO FOUR PIECES: (B, C, D) WITH NUCLEUS, (A) WITHOUT; (A', B', C', D') THE SAME PIECES A DAY LATER (ALL BUT A' HAVE DEVELOPED INTO SMALL STENTORS)

We have already shown that many protozoans are multinucleate, and in these forms the nuclei are usually all alike. Yet there are Protozoa with dissimilar nuclei. These are the Ciliata, possessing in the simplest case two nuclei (fig. 4), the so-called macronucleus and the much smaller micronucleus. We shall discuss the importance of this "nuclear dimorphism" later.

Organoids.—Cytoplasm and nucleus are the only body-parts that all Protozoa have in common[1]; of all other organs we can only be sure that they occur in certain species. We shall therefore deal with these structures quite briefly. A distinction can be made between organoids and non-protoplasmic inclusions. The organoid,

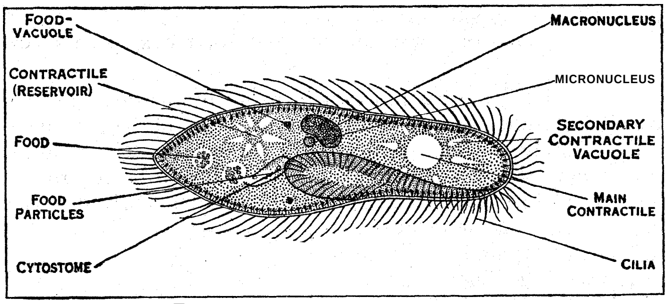
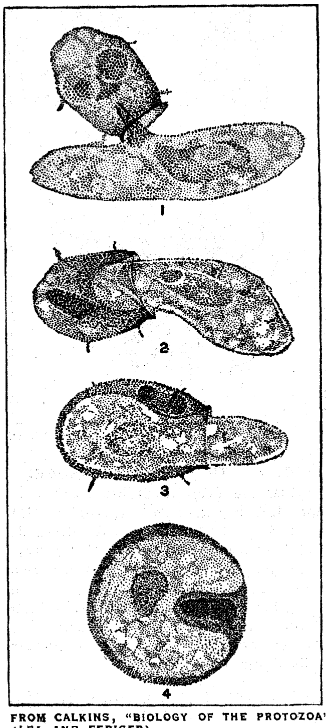


FIG. 4.—PARAMAECIUM CAUDATUM

e.g., a chromatophore, cilium or myoneme contractile element, is composed of living protoplasm which is more or less clearly delimited from the cytoplasm and performs a particular function, and comparable in one way therefore with an ordinary organ of a multicellular animal such as stomach, eye or muscle. Non-protoplasmic inclusions, on the other hand, such as a membrane or a siliceous skeleton, are non-living, like a snail's shell.



FROM CALKINS, "BIOLOGY OF THE PROTOZOA" (LEA AND FEBIGER)

FIG. 5.—DIDINIUM NASUTUM (CILIATE) DEVOURING A PARAMAECIUM: (1) DIDINIUM HAS SEIZED THE PARAMAECIUM WITH A KIND OF SUCKER: (2 & 3) SWALLOWING PREY; (4) PARAMAECIUM COMPLETELY SWALLOWED

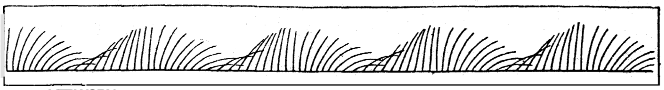
One of the most important organoids—indeed we may say in a certain sense the most important organoid—is the chloroplast or *chromatophore,* which we only meet with in those protozoans which feed like green plants. The chromatophore is sharply marked off from the cytoplasm and consists of protoplasm saturated with chlorophyll, the green colouring matter of leaves (fig. 1); like the nucleus it can only arise from division of another chromatophore.

There are several kinds of such cell-constituents capable of division. Amongst these are to be included the centrosomes which play such an important part in nuclear division; these are spherical and for the most part they are rather small structures. Closely related organically to the centrosome is the basal granule, a nodular thickening at the base of a flagellum or cilium (figs. 1, 16, 17; for further discussion, *see* below).

Most of the organellae developed in the protozoan cell are however incapable of division; that is, they arise usually out of the undifferentiated cytoplasm and can disappear again into it. To this group belong the static fibrillae, more or less stiff threads or little bristles which serve as an internal skeleton for many protozoa. They thus ensure the maintenance of the typical body-form of the organism much as the metal framework keeps an

[1]Whether also the so-called mitochondria and Golgi-bodies (see CYTOLOGY: *Cell inclusions*) are present in all protozoans is not yet known; they have only so far been found in a few species.

umbrella in shape (fig. 1). In all probability such static fibrillae take part in the formation of flagella and cilia. We speak of flagella when these are long, as compared with the body itself, and few in number (figs. 7, 16). Cilia are relatively short and numerous (figs. 4, 8). Cirri are nail-shaped structures which consist of several cilia stuck together. These hair- or string-like appendages of the



FROM VERWORN, "ALLGEMEINE PHYSIOLOGIE" (GUSTAV FISCHER)

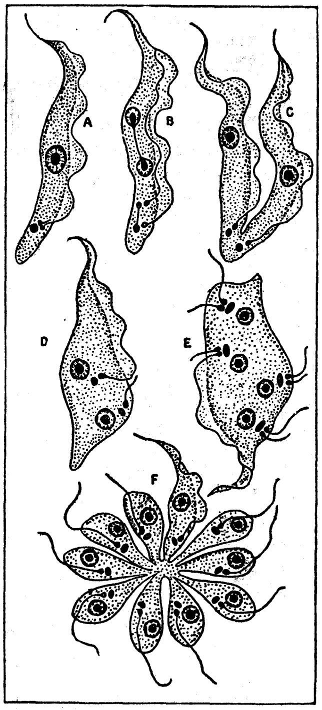
FIG. 6.— DIAGRAM OF A WAVE OF MOVEMENT THAT RUNS OVER A ROW OF CILIA

body have a locomotive function in many protozoans and in all probability always consist of a rigid axis (static fibril) surrounded by a relatively less viscous mantle of protoplasm. The rigid axis arises from a basal granule which is probably to be regarded as its centre of formation; many protozoans can be deprived of their cilia—shaved, as it were—and then the basal granule can be seen to grow a fresh cilium (fig. 8).

A third kind of fibrillar organoid is the myoneme, a contractile fibre or band which is the muscle of the protozoan; very little is known of the structure of this element except that, in most cases at least, it corresponds to the non-striated rather than to the striated muscle of the higher animals (see MUSCULAR SYSTEM).

We do not know definitely whether there are in some Protozoa, as many investigators have claimed, apart from the fibrillar organoids just mentioned, fibres which serve, like the nerves of the higher animal, for the conveyance of sensory impulses.

No more can we be certain of true sense-organs in the Protozoa, although the red granule, or stigma, found at the fore-end of all green protozoans is very frequently considered as analogous to an eye. Its sensitiveness to light has not yet, however, been critically demonstrated, although it is quite possible that it represents a sense-organ (for a more detailed discussion *see* below).



FROM KUHN. "GRUNDRISS DER ALLGEMEINEN ZOOLOGIE FUR STUDIERENDE" (THIEME)

FIG. 7.— TRYPANOSOMA BRUCEI (A) Basale granule divided, one portion forming a new flagellum; (B) nucleus and blepharoplast divided; (C) division of cellbody; (D–F) Trypanosoma lewisi; (D) nucleus and blepharoplast divided; (E) each daughter nuclei and blepharoplasts divided again; (F) dissolution of mother animal into eight daughter individuals (X 2000)

Another organoid, found in protozoans living in fresh water, but not as a rule amongst those living in the sea or as parasites. is the contractile *vacuole.* This 'may be called the kidnev of the protozoan. In the simplest cases it is merely a bubble or-bladder which pours out its contents at intervals through a very minute opening. The lining of this bubble is marked out by special properties which we need not go into more deeply here. The contractile vacuoles of many protozoans are much more complicated and consist usually of a chief vacuole, emptying itself directly into the exterior, and a system of subordinate or accessory vacuoles emptying themselves into the central vacuole. The accessory vncuoles therefore work in alternation with the central vacuole: when the accessories empty the central one swells and when it empties the accessories fill up again (fig. 4).

Up to now we have only been dealing with relatively simple organoids; we meet a more complicated type in the cytostome, the mouth of some protozoans. Many protozoans have no mouth at all and yet are able to take in food *(see* below, Nutrition) but others have a proper mouth. In the simplest cases it is nothing but a trough or slit-like deepening of the body surface (fig. 1). In more complex forms the cytostome is a cavity held open by supporting fibrillae (fig. 8); it is moreover carpeted with cilia which drive the food in a current into the blind end of the cytostome (fig. 4). Uniike the mouth of a higher animal, the cytostome is not continued in a stomach but comes to a blind end. The food is driven against the blind end of the cytostome, which then swells out until a so-called food-vacuole is cut off from it; this is pushed into the inside of the cell-body and the food there digested (fig. 4).

Many protozoans have also a cell anus or cytoproct which usually consists of a mere hole held open by supporting fibrillae.

Non-protoplasmic Bodies.—Amongst the by-products of the protoplasm, which we shall call alloplastic bodies, are the skin and the various kinds of protective covering or armour. Some Protozoa are completely naked, *i.e.,* their surface consists of ordinary protoplasm. With other forms, the surface, though still living protoplasm, is hardened into a more rigid skin (pellicula). With still others the protoplasm differentiates on its surface a non-

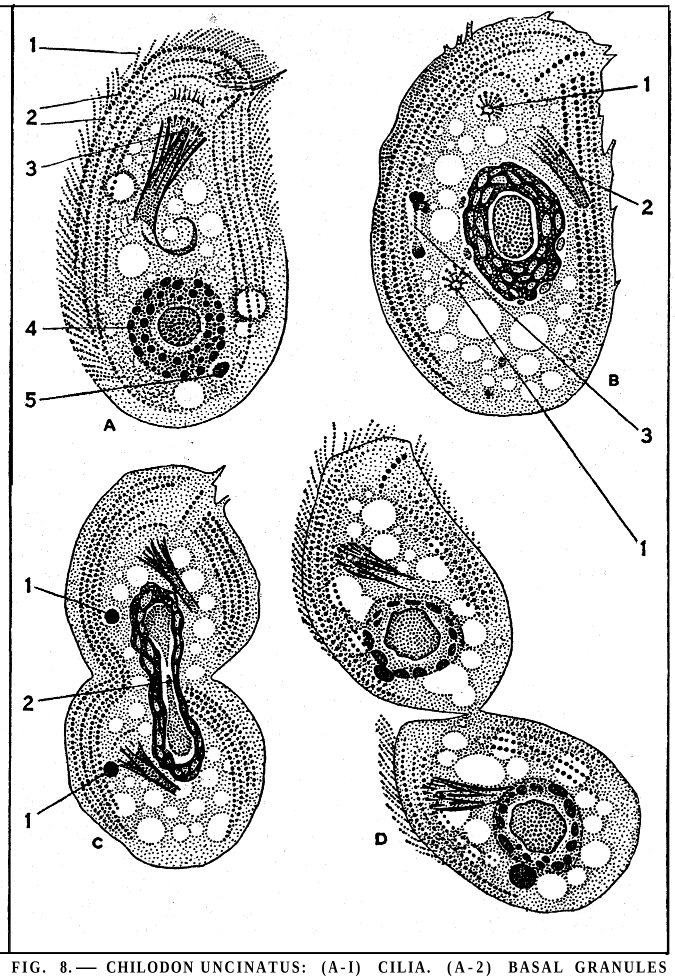


FIG. 8.— CHILODON UNCINATUS: (A-1) CILIA. (A-2) BASAL GRANULES OF CILIA. (A-3) CYTOSTOME. (A-4 & 5) MACRONUCLEUS (B-1) NEW CYTOSTOME, (B-2) OLD CYTOSTOME, (B-3) DIVIDING MICRONUCLEUS. (C-1) DAUGHTER MICRONUCLEUS. (C-2) DIVIDING MACRONUCLEUS. (D) TWO INDIVIDUALS NEARLY SEPARATED

living, more or less rigid coat, and this coat is often separated by a space from the body of the cell. Nothing exact is known of the chemical composition of these skins; possibly they are often of a material related to the chitin of an insect's skin; in many green protozoans the skin consists of cellulose, as in plants, but frequently it is not rigid at all but merely a slime-coat (fig. 2). Finally by the deposition of mineral matter such as chalk or silica some protozoans change their skins into a protective shell or armour, in the same way that a lobster's shell is constructed by deposition of chalk in a ground mass of chitin. Some protozoans, for example the *Euglypha,* also secrete mineral substances inside their bodies for later use in building up a hard skeleton.

We need not discuss here all the other non-living substances that we meet with in the bodies of Protozoa (starch, fat, etc.); as far as we understand their rôle they seem to act as reserve materials or exist as superfluous products of the organism's economy. We must just mention the fact that some protozoans have pigments (blue, red, etc.) that are distributed in the form of granules in various parts of the body; colourless forms are however in the majority.

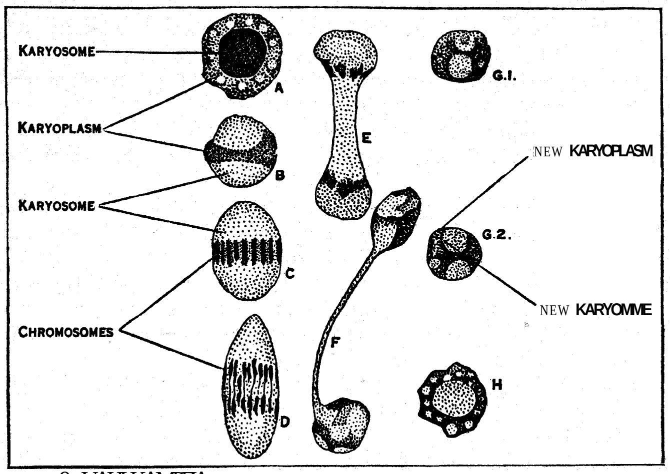


FIG. 9.—VAHLKAMPFIA BISTADALIS. (A–H) SUCCESSIVE STAGES IN CELL DIVISION

Colony Formation.—All protozoans, as we have already shown, are not unicellular and uninucleate; actually there are all intergrades between the unicellular and uninucleate forms and the multicellular and multinucleate. A protozoan that almost always has four nuclei we can still call unicellular; a plasmodium of a myxomycete (slime mould), whose thousands of nuclei are embedded in a single mass of protoplasm, scarcely has a title to this name; yet we can hardly call it multicellular, so the name "polyenergid" has been invented for this kind of creature. The gap between one-celled and many-celled Protozoa is filled by Protozoa that form colonies; when the progeny to which a protozoan has given rise by division stay together, the aggregate is called a colony. Polyenergid Protozoa arise from uninucleate germ-cells in a similar way, but only the nucleus divides while the cytoplasm remains undivided. When the individual cells of a colony are arranged in a particular order and especially when they are no longer capable of independent existence we have arrived at the stage at which we can call the colony a multicellular individual.

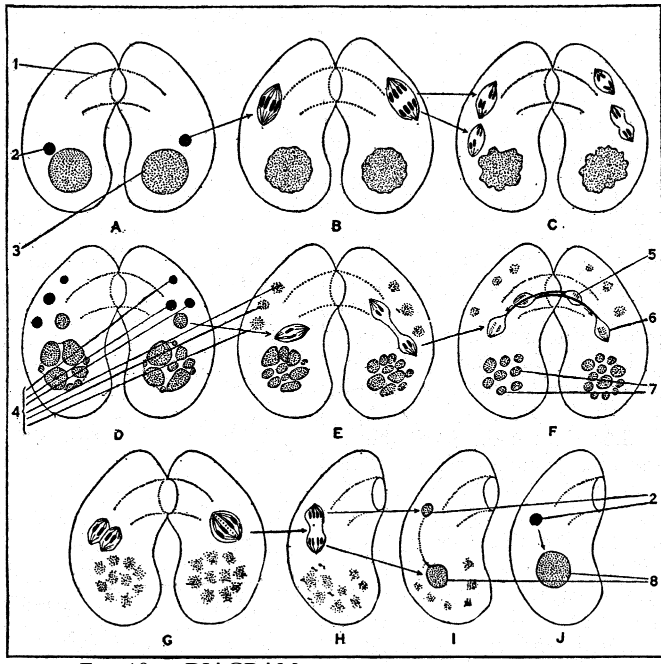


FIG. 10.—DIAGRAM OF CONJUGATION IN THE INFUSORIA

(A) Conjugants united by their cytostomes; (B, C) first and second divisions of micronucleus; (D, E) third division of the micronucleus; (F) exchange of nuclei; (G) nuclei unite; (H) young exconjugant; (I) exconjugant. One of the daughter-nuclei of the fusion nucleus is becoming the micronucleus, the other the macronucleus; (J) almost completely reorganised exconjugant; (1) cytostome; (2) micronucleus; (3) macronucleus; (4) degenerating daughter nuclei of the first two divisions of micronucleus; (5) male nucleus; (6) female nucleus; (7) fragments of old macronucleus; (8) new macronucleus

PHYSIOLOGY

Nutrition.—We can divide the Protozoa according to their method of nutrition into four groups. The first consists of organisms provided with chromatophores (figures 1, 2, 16, 17, 19). These organisms create their own food just like plants, by producing starch out of carbonic acid gas (CO_2), their chlorophyll enabling them to use the energy of sunlight for this purpose; then, absorbing various salts from the water, they build up with the starch those albuminous substances of which their bodies are composed. These organisms are therefore self-supporting in the fullest sense of the word, for they can exist without the help of any other living creatures: they are "autotrophic." There are, we ought to say, some amongst them that are also capable of feeding on other organisms. All other Protozoa are "heterotrophic," *i.e.,* they use for their nutrition either other organisms directly or, more rarely, substances produced by other organisms. Protozoans forming this second group of nutrition types (the saprophytes) live on the products of putrefaction; that is, on substances formed when bacteria decompose organic materials.

A third group, including most heterotrophic Protozoa, live like so many animals by eating more or less solid food. They will attack almost anything; living organisms from the most minute bacteria to small multicellular animals—water-fleas, small worms and so forth. As parasites they prey upon the tissue-cells of the animals in which they live. Still others live on dead bodies, or parts of bodies of other protozoans or multicellular animals, or particles of nutritive material yielded by other organisms—starch, wood, and so on.

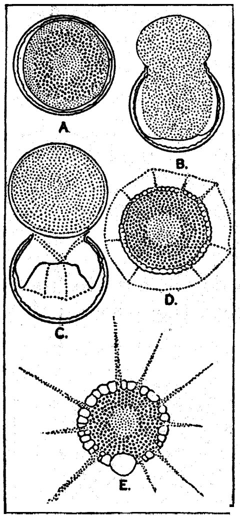


FIG. 11.—ACTINOPHRYS SOL

(A) Mature cyst; (B) bursting of cellwall; (C) young individual free: (D) young begins to form pseudopodia; (E) young individual nearly complete (X 350)

The last group of nutrition types comprises the majority of the parasitic Protozoa. They live on the dissolved food they imbibe through their body-surface from the blood, stomach-content and lymph of their host.

A word is necessary with regard to the ingestion of the food. The autotrophous species, those living on putrefying material, and also most of those living as parasites, feed osmotically; the food they need is dissolved in water; it permeates and is absorbed through the protoplasm surface. The solid food of the other heterotrophic protozoans must be swallowed whole before it can be absorbed. This can be done in various ways; those protozoans that have no cytostome are often capable of taking in food at any point of their surface and eat merely by flowing round and engulfing their prey, a process which is called "amoeboid ingestion." A variation of this habit is the engulfing of the food material not by the body of the protozoan itself but only by special outgrowths of the body called "pseudopodia" and its absorption into the body proper only later or not at all. The delicate, hair-like or netted pseudopodia of some protozoans, *e.g.,* heliozoans, are sticky and are used as traps; the victim comes up against the pseudopodium, sticks to it and is engulfed.

Protozoa having a cytostome naturally absorb their food through it; whether they are of the kind that wafts its food with cilia into the cytostome, or whether the prey is seized by the cytostome, the process of absorption is completed by the protozoan pushing itself over the prey in such a way that the latter is gradually covered up by the body (fig. 5). In the first case a sort of fore-mouth is often developed; this is called a peristome, and is lined with cilia which drive the prey towards the cytostome, as in fig. 4.

The so-called Suctoria actually do not devour their prey at all but suck it with the aid of stiff suckers or tentacles (fig. 12). Although most Protozoa swallow their prey alive, there are certain kinds that first kill their victims with poisons.

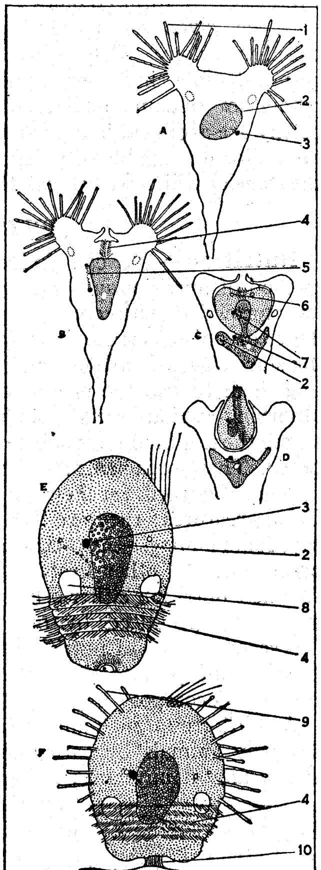


FIG. 12.—TOKOPHRYA QUADRIPARTITA
(1) Tentacles, (2) Macronuoleus, (3) Micronucleus, (4) Belt of cilia, (5) Dividing Micronuclei, (6) Bud, (7) Daughter Micronuclei, (8) Contractile vacuole, (9) Sucking Tentacles, (10) Stalk

The food particles are absorbed into the inside of the cell-body in both eating and sucking protozoans; the space in which they lie engulfed is spoken of as the "food vacuole." Its walls are of living protoplasm, but we can regard it as a primitive gut. Substances are secreted into it to kill and dissolve the engulfed substances; the food-materials extracted from these latter are absorbed by the protoplasm. We do not yet know very much of the details of digestion, although certain digestive ferments have been identified in some protozoans. In many species the food vacuole follows a definite course round the body, while digestion is in progress. When an indigestible remnant is left at the end, the vacuole is brought to the surface and its contents expelled, often through the so-called cytopyge or cell anus.

Like all other forms of life the Protozoa do not need to use at once, for building up their bodies, all the food they absorb; they

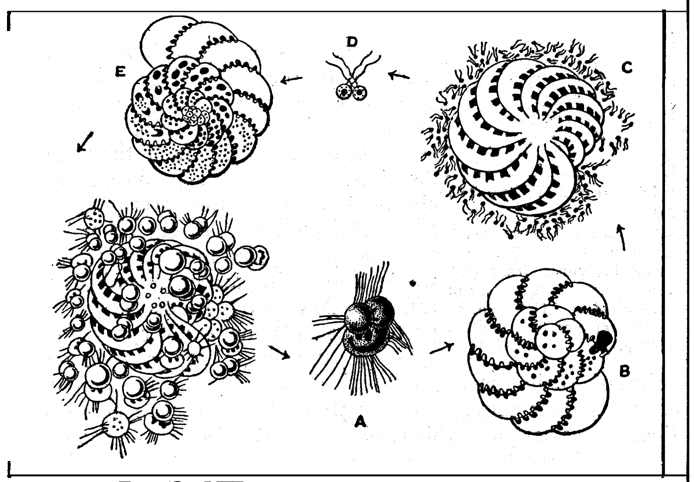


FIG. 13.—LIFE CYCLE OF POLYSTOMELIA CRISPA
(A) Young megalospheric individual; (B) adult decalcified; (C) adult resolving into two flagellate gametes; (D) conjugation; (E) microspheric individual produced from zygote; (F) same, resolved into pseudopodiospores

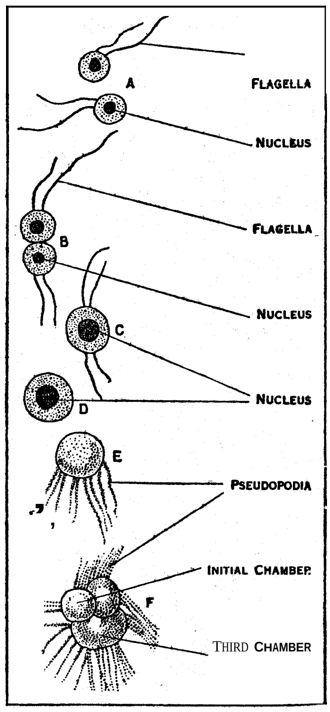
put a proportion of it by as reserve material to be used in case of necessity. Various kinds of materials—such as starch and the so-called paramylon, a starch-like body—are stored in this way both by the autotrophic species and by those living on decomposing organic matter; the other heterotrophous Protozoa store fat, glycogen and volutin.

Respiration.—All protozoans need oxygen for production of energy; most free-living (or non-parasitic) protozoans, and the blood parasites, absorb oxygen directly from the medium they live in. They require no special arrangements such as the lungs or gills of other animals; oxygen can diffuse to where it is wanted. Intestinal parasites and some living free in very putrid water not only do not require free oxygen but are incapable of living in a medium containing any appreciable amount of it; they are "anaerobic"

Excretion.—We know very little of the expulsion of the products of the decomposition of the body substance and reserve materials. In the bodies of many protozoans are to be found crystals partly consisting of salts of uric acid; these are probably to be considered as excretions. In all probability most excreta escape through the surface of the body or are expelled from the contractile vacuole.

Movement.—In many Protozoa the constituents of the protoplasm can be displaced inside the body, actually by means of currents in the cytoplasm (*see* CELL; PROTOPLASM) and some Protozoa can contract their whole bodies, some even particular parts of the body, by means of their myonemes

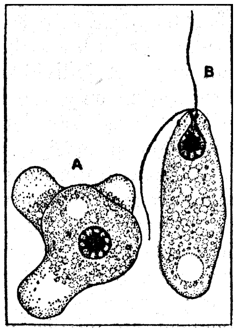
Active locomotion on the other hand is achieved in some form by nearly all Protozoa; there are certainly a few almost incapable of movement, either because they have settled and grown on a fixed body (fig. 12) or because they do not possess true motile organs. The movement of protozoans can be effected either by proper organs for the purpose or in various other ways. The simplest organs of motion are the so-called pseudopodia, which are outgrowths from the body, of the most varied form; these can be extended or withdrawn at will. They serve for a kind of creeping movement; the pseudopodium is formed and sticks to the material underfoot; then a new pseudopodium is stretched out on the side of the old one in the direction in which movement is to take place, and protoplasm now flows on to this In this simple way the whole protoplasmic mass is rearranged bit by bit and the protozoan moves forward. Protozoans whose pseudopodia are relatively small in proportion to the whole body form their pseudopodia just like Amoeba, but use them much more like real feet, putting them out in the direction of movement and then drawing them in again These pseudopodia may be quite thin and delicate, branched or netted, and are then called rhizopodia The mechanism of amoeboid movement is not yet fully explained.



FROM DOFLEIN, "LEHRBUCH DER PROTOZOENKUNDE" (FISCHER)
FIG. 14 —POLYSTOMELLA CRISPA
Copulation of the gametes (A–C) flagella being thrown off; (D) young microsphaerical individual which has arisen from zygote; (E–F) formation of the chambers. Magnified 2,000 times

Quite another kind of movement is that by means of cilia and flagella. The whip-like flagella (fig 16) either rotate, as in a circle described by an index-finger with the hand at rest, or strike like the lash of a whip; the rotation has a sucking effect like that of an aeroplane propeller and this drives the protozoan forward. The whipping action of the flagellum is not so well understood.

The cilia are usually arranged in thick complex bands (fig. 6) and beat, *i.e.,* they move like an index-finger that bends to strike a keyboard and then straightens again. Usually the cilia work together, every cilium in the row beating a little later than the next before it, so that a wave appears to pass completely over the row. This phenomenon has often been compared to the effect of a gust of wind passing over a cornfield. The blows of the cilia have a rowing action very like that of a duck's foot. The cilia of sessile protozoans produce currents in the water which carry the particles of food into the neighbourhood of the cytostome. The lightning quickness with which the forward movement may be modified is due to an alteration in direction of the beats of the particular cilia or through co-ordinated work of individual rows of cilia. "Cirri" strike just like cilia but being so much stiffer function more like legs.



FROM KUHN, "MORPHOLOGIE DER TIERE IN BILDERN" (BORNTRAEGER)

FIG. 15.—VAHLKAMPFIA BISTADIALIS

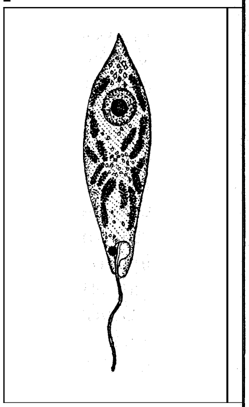
(A) Ameboid stage in semi-damp surroundings; (B) flagellate stage in water. (Magnified 800 times)

The myonemes of protozoans serve in the main only for alteration of the form of the individual's body. Some protozoans can pull themselves together like a hedgehog or as a snail draws itself into safety within its shell. They do not do this slowly, however, but suck together with lightning rapidity; the best known example is the pulling together of the stalk-muscle of the vorticellids. Some protozoans can creep along with the help of their myonemes in a way probably not very different from snails.

The rapidity of all these kinds of movement is very variable. The most efficient are ciliar and flagellar movement, although even these are in no way comparable in their effect with the rapid movements of the higher animals. The movements of flagella and myonemes are often amazingly quick yet the greatest speed they could induce in the protozoan would be usually not more than $\frac{1}{10}$ or even $\frac{1}{20}$ in. a second. Creeping by muscles or pseudopodia is naturally much slower, at the most $\frac{1}{1000}$ in. a second.

Physiology of Sensation.—Protozoa are sensitive to the following stimuli: (1) light; (2) mechanical disturbance, such as a blow; (3) change of temperature; (4) chemical stimuli; (5) electrical stimuli. Not all protozoans react to all of these stimuli; there are, for example, many protozoans that seem to have no sense of light.

Proper sense organs are as yet scarcely known amongst the Protozoa. Only a peridinean (Erythropsis) has a stigma constructed in a complex fashion which may be thought to function like an eye, although this has not been proved. Probably, however, all stigmata serve for light perception and some cilia may sometimes function as feelers.



FROM KUHN, "MORPHOLOGIE DER TIERE IN BILDERN (BORNTRAEGER)

FIG 16.— EUGLENA VIRIDIS VEGETATIVE INDIVIDUAL (MAGNIFIED 850 TIMES)

The mode of transmission of sensations, like the presence of sense-organs, is as yet unknown. When the fore-end of certain protozoa is disturbed, and as a result the whole animal contracts, we can only conclude that the point touched has given an impulse to the myoneme.

Practically the only reactions we can recognize at sight in protozoans are those consisting in movement. Light-sensitive protozoans swim towards the light. Touch-sensitive protozoans contract when they are touched, alter their direction of movement or try to swallow the offending object. Some chemical stimuli, e g , weak acids, have the effect of frightening protozoans away from the region, whereas others such as oxygen or a food-particle have the opposite effect.

REPRODUCTION

Most higher animals reproduce sexually, *i e.,* they produce eggs and sperm and bring them together so that the egg is fertilized by a sperm and then develops into a new individual. Only a few Protozoa can be shown to multiply in this way, and most can reproduce without this process; indeed in many protozoans reproduction does not depend on fertilization and there is no connection between them (see below).

The method of reproduction which is found most frequently is simple division into two. An individual splits into two pieces of which each soon appears just like the animal before splitting (fig. 7, 8). This seemingly simple division is in reality a very complex process. First the nucleus divides and if several are present they all divide about the same time; then the cell body usually splits by stretching out and being constricted; a ring-shaped furrow gradually cleaves the cell in two as if a loop of string had been put round the middle and were being pulled tight. This division furrow has usually a defined position on the axis of the protozoan; some divide longitudinally (fig. 7), others transversely (fig. 8).

In many cases the "new-born" daughter-animals, as mentioned above, are soon indistinguishable from their parents; this means that they have reconstituted the set of cell-organoids, which is done for some of the latter, such as the chromatophores, by division as in the nucleus; other organoids are merely distributed and each daughter-cell makes good those it lacks; in this way the flagella and cilia are divided. When the basal granule splits one piece of it takes the flagellum with it and the other forms a new flagellum (fig. 7). Finally there are organoids in no way taken over from the old individual, having been pushed out during the division or even dissolved in the protoplasm. Such organoids are formed anew in each daughter animal (fig. 8). Protozoa that are enclosed in a hard shell often divide in such a way that although the protoplasm has divided quite equally only one of the two parts takes over the shell while the other slips out and builds a new shell.

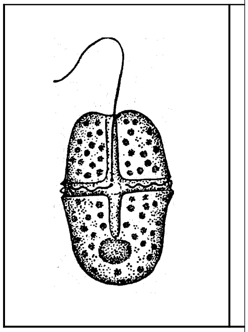
Nuclear Division.—Before considering the other kinds of division, something must be said of the division of the nucleus in the Protozoa. In multicellular plants and animals division is a highly developed process whose most important feature is the appearance of thread-like or rod-shaped bodies called chromosomes. At the same time—often under the influence of the centrosomes, ball-shaped organoids present in the cell at first singly but at division splitting into two separate halves—a fibrous, often spindle-shaped body is constituted; this is the spindle, and to it the chromosomes attach themselves in such a way that they come to lie in a plate across the spindle, at either end of which the centrosomes are found.

At this stage the nuclear membrane dissolves. And now each chromosome splits along its whole length into two exactly equal halves, which pass to opposite poles of the spindle. As all the halves do this at the same time, two groups of daughter chromosomes are constituted, each with a number of chromosomes exactly equal to that which the mother-nucleus had at the beginning of the division. Finally each group of chromosome halves gradually takes the form of a nucleus and the spindle disappears.

Nowadays we know fairly well what this complicated process called *mitosis* (see CYTOLOGY) really means. The chromosomes are protoplasmic bodies having an individual character, that is, they can only arise by division of other chromosomes exactly like themselves. Moreover in the so-called resting nucleus, *i.e.,* the non-dividing nucleus, they carry on their individual existence. We know further, that they are the bearers of the hereditary properties of the animal. It is for this reason that they are so carefully divided and distributed to the daughter-nuclei at division. The spindle is the apparatus that organizes the exact separation.

Besides mitosis there is another kind of division called direct nuclear division or amitosis. It consists of a simple cleavage of the nucleus into two pieces and only appears in cells that are more or less abnormal or at any rate are incapable of giving rise to offspring with any chance of prolonged survival.

Earlier it was thought that amitosis was very widespread as the normal method of division in the Protozoa; it was even thought that in contrast to mitosis it was the primitive, the original, **type** of nuclear division and that in some of the Protozoa the transitional forms between mitosis and amitosis were preserved. Such is not the case; in all groups of Protozoa we recognize to-day the occurrence of true mitosis, as complicated in every way and indeed often much more complicated than in multicellular animals. As a matter of fact those processes which were thought to be transitional are nothing but mitoses whose true nature has been concealed by a variety of peculiar circumstances (fig. g). In no case can we say that the method of nuclear division in the Protozoa is simpler or more primitive than in the higher animals and plants; the chromosomes of the Protozoa are no fewer than, and show in most cases the same peculiarities as, those of multicellular organisms, so that we may be permitted to regard them also as the bearers of the hereditary characters.



FROM KUHN, "MORPHOLOGIE DER TIERE IN BILDERN" (BORNTRAEGER)

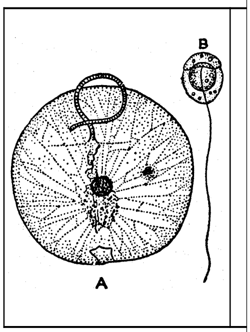
FIG. 17.—GYMNODINIUM AERUGINOSUM, A NAKED DINOFLAGELLATE (MAGNIFIED

Most cases of true amitosis in the Protozoa are more or less pathological; only the so-called macronuclei of the Infusoria divide regularly by amitosis (fig. 8), and we shall see later with what exceptional condition this is associated.

Apart from these types of division there is one more, multiple nuclear division, where the nucleus breaks up at the same time into numerous nuclei; this phenomenon is still very inadequately known. The so-called free nuclear formation has already been referred to.

Other Kinds of Division.—Some Protozoa do not divide into two daughter cells of equal size but into one large and one small. In these cases we call the division budding or gemmation and the smaller animal we call a gemma or bud (fig. 12). Yet another method of multiplication is a "multiple division" in which the noth her-animal divides at once into more than two—often several hundred—daughter-individuals (figs. 7, 13); sometimes the "mother" disappears entirely but sometimes a portion is left over, the so-called residual body, which finally degenerates. This process is preceded by a series of nuclear divisions (fig. 7).

The daughter-individuals arising by this process are rarely like the mother-individual. They are called, when provided with flagella, swarm-spores (fig. 12, 18b), and when surrounded by a stiff membrane and non-motile, spores; as a type these two forms are known as agametes. This unlikeness is also generally the case with gemmation and may occasionally arise from ordinary simple division. In all these cases, of course, the newly arisen smaller individual has to pass through some process of development.



FROM KUHN, "MORPHOLOGIE DER TIERE IN BILDERN" TRAEGER)

FIG. 18.—NOCTILUCA MILARIS

(A) Adult animal, (B) One of the swarm spores

Requirements of Reproduction.—A protozoan reproduces itself only once, for the mother protozoan divides itself into its daughter products. Further the protozoan, like the higher animals and plants, only reproduces when it is grown up and mature, having its special organization fully developed, and having reached its full specific size. When it arrives at this stage, division occurs automatically. The rate of multiplication, *i.e.*, the time that must elapse before a protozoan just arisen from division can divide again, is very different in different species and depends, apart from many other things, on the food-supply and normal size of the species. Relatively small protozoans that are well nourished are often mature in a few hours.

FERTILIZATION

We understand by fertilization (*q.v.*) the fusion of two cells and nuclei which are unequal, being differentiated sexually into male and female. The two cells that fuse together are called gametes, the product of their fusion the zygote. In the higher animals the gametes are called eggs and sperm and the zygote the fertilized egg. The latter rapidly divides to form a many-celled embryo, which later becomes a new individual of the species to which it belongs (see EMBRYOLOGY).

Amongst the Protozoa, most can multiply by simple division and many are only to be driven to the act of fertilization by exceptional external influences, such as lack of food, overcrowding, accumulation of the products of metabolism and so on. And even then fertilization is sometimes not associated with multiplication but rather with a reduction of numbers, for the gametes are here not parts of individuals but often whole individuals so that at fertilization only one individual is produced by two. The zygote produced develops into an ordinary individual which only then can begin to multiply.

With such protozoans fertilization seems merely an intermezzo, virtually superfluous, which, as we shall see later, can be left out entirely under favourable conditions of life; it may be mentioned here that there are many protozoans in which we know no sexual process and in which there very possibly is none, *e.g.,* euglenoids and trypanosomes. There are protozoans on the other hand as dependent on fertilization for their reproduction as most of the higher animals. A gregarine for example cannot multiply by plain division; once mature it shuts itself up, together with another individual, in a capsule and each breaks up by multiple division into a large number of small gametes, leaving over the so-called residuary body. After this the gametes of the one fuse with those of the other; each of the numerous zygotes formed in this way surrounds itself with a thick membrane: it is now called a spore; inside this membrane the zygote divides into eight elongated cells, the sporozoites. These sporozoites are embryonic gregarines which, as soon as the spores get into the gut of the animal in which the particular gregarine grows—its "host"—slip out and grow into mature animals. Here then sexual reproduction is apparently indispensable to the continuance of the species.

It has been supposed, almost down to the present day, that fertilization is necessary to all protozoans, if not actually as a means of reproduction then for some other reason; it was thought to have been proved that Protozoa that had for some time multiplied only asexually, gradually aged; that they became weaker, showed all kinds of symptoms of degeneration and finally petered out altogether as a strain if they failed to find an opportunity of fertilization. After fertilization, on the other hand, the organism's vitality appeared to be restored. Hence it was concluded that for the maintenance of the race mere asexual division was not enough; that after a certain period of this kind of multiplication a process of senescence necessarily supervened and that this danger could only be escaped by sexual reproduction or some other kind of reorganization such as parthenogenesis (*q.v.*). Hence fertilization was called a process of rejuvenation. The observations on which this assumption was based are undoubtedly correct, yet the conclusions that have been drawn from them are only applicable to a limited group of Protozoa—the infusorians—and not even applicable to all species of these.

Other protozoans of various kinds (*Eudorina, Actinophrys*) have been kept for years under the most careful observation and it has been determined that so long as they are kept under favourable conditions of life they will reproduce asexually year in and year out, probably indefinitely, without degeneration.

This fact is referred to as the "potential immortality" of the protozoan; a multicellular animal must die because it can only reproduce by discharging from its system cells which develop into new individuals while its body cells are incapable of indefinite reproduction or existence. A protozoan, on the other hand, which divides into two and passes into its offspring entire, does not need to die. Such death as it undergoes is not the result of senility but of an accident. It is indeed potentially immortal.

Let us now turn to the different kinds of fertilization that occur amongst the Protozoa; we find here a much greater diversity than amongst the higher animals and plants. The gametes of the Protozoa are not always so different from one another as the sperm and egg-cells of the higher animals. It is true that some types exist in which the female gametes look just like animal egg-cells;

i.e., they are relatively large, stationary cells, rich in reserve materials. The male gametes in these species are constructed on the same plan as animal spermatozoa; they are relatively small, deficient in protoplasm and are exceedingly mobile. We call the protozoans whose gametes differ in this way "oogamic," the female gametes "macrogametes," the male "microgametes." But there are protozoans in which the pairs of gametes are absolutely indistinguishable; in these cases we speak of "isogamy" (fig. 10). All imaginable transitional stages are to be found between isogamy and oogamy.

The point must be made clear that in the so-called vegetative phase individuals of most protozoans do not show whether they are male or female. Sex-determination itself, that "something" that makes the difference between a male and a female, is not really understood in most cases. In some species it has been shown that the distinction is the result of the "reduction-division" that follows fertilization. This reduction-division consists in the separation of the two chromosomes, determining respectively maleness and femaleness, and their distribution to opposite cells which take the sex determined by these chromosomes. In those sexually differentiated Protozoa in which the reduction-division takes place immediately before fertilization, sex-determination is probably of the same kind as in the higher animals (see SEX).

Two remarkable variations of merogamy are specially worth noticing. One is called autogamy. While as a rule only gametes from different individuals are capable of fusing, in some Protozoa it happens that gametes that are the progeny of one individual will fuse. When this occurs, as in Actinophrys, a heliozoan, where the vegetative individual first splits up into two gametes, one male, the other female, which then fuse, we call the process "paedogamy." When however the cell-division that follows the so-called pregametic nuclear division is suppressed, and the whole sexual process really consists in a nucleus dividing and the two halves fusing straight away we speak of "autogamy."

Of quite another kind from those just considered is the process called conjugation, found only in the infusorians and suctorians. Two individuals meet, unite at one point and exchange gamete nuclei. It must be remembered that the infusorians have nuclei of two kinds, large macronuclei and small micronuclei (fig. 4). In the simplest case an infusorian has one nucleus of each kind. The two conjugating individuals (conjugants) unite first at their cytostomes (fig. 10). Then, as the next step, the micronucleus of each conjugant divides; the products of its division divide again and now three of the four new nuclei degenerate. The remaining nucleus divides itself again so that each conjugant has now two nuclei, offspring of its micronucleus. The macronucleus of each conjugant has meanwhile broken up and later disappears altogether. And now out of each individual one nucleus, the "migrating nucleus," wanders into the other cell and fuses with the stationary nucleus there left behind. The two infusorians, now called "ex-conjugants" separate at this point and from the fusion-product of the stationary and the migrating nuclei arise new micro- and macro-nuclei; in the simplest form of the process the fusion nucleus simply divides and the two halves develop into micro- and macronucleus respectively.

In conjugation therefore it is not two cells that fuse to make one, but two hermaphrodite cells each of which forms a male, migrating, and a female, stationary, gamete-nucleus; the cells then exchange their male nuclei just as pairing snails or earthworms exchange their sperm. It is not hard to see why conjugation should rejuvenate these Protozoa, because the macro-nucleus degenerates and is re-formed from the fused gamete-nucleus; in doing this the organism dispenses with an old cell-constituent, the new one being supplied from the "potentially immortal" micronucleus.

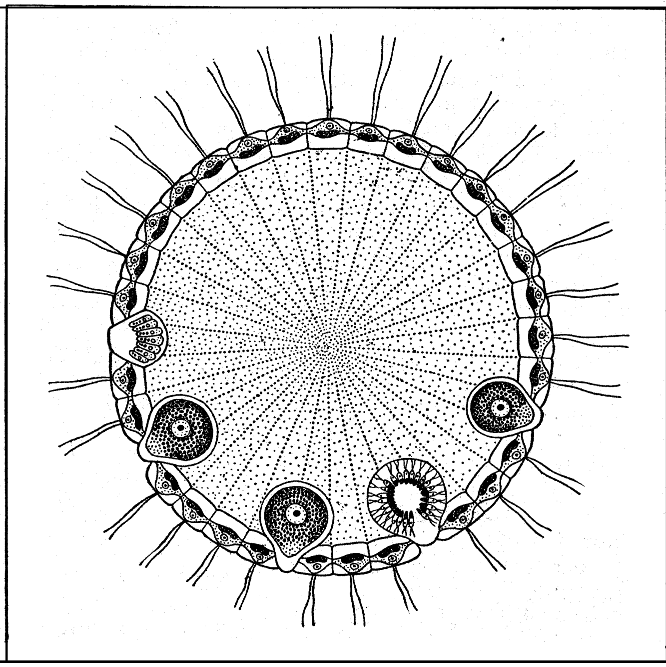
We have so far only concerned ourselves with the gametes of the Pratozoa; nothing more need be said about the process of their fusion, but what happens afterwards? The question is not at all easy to answer. The fate of the zygote amongst different species of Protozoa is very various. Only very seldom does the zygote turn directly into an ordinary vegetative individual, as is the case with the infusorians. Foraminifera (fig. 14) and myxomycetes. Usually at least a short resting-stage is intercalated; the cell surrounds itself with a stiff membrane and only later escapes from it to become again a vegetative individual; such is the case with the heliozoan, *Actinophrys,* and the Volvocineae. Very often however the zygote begins soon after fertilization to multiply in some special way. It breaks up by multiple division into a number of uninuclear cells which may surround themselves with membranes and inside these divide further. Only from the germs formed in this way can new vegetative individuals arise.

Amongst Protozoa, as in the higher animals and plants, reduction divisions of chromosomes have also been shown to occur; in some the division takes place just before gamete-formation; in others (Volvocineae, Coccidia), shortly after fertilization. In view of what we already know of nuclear division in the Protozoa it is not at all surprising that the course of reduction division turns out to be in some cases (*e.g.,* in *Actinophrys*) quite as complex as in the higher animals. (See CYTOLOGY.)

Parthenogenesis.—The egg cells of some animals and plants are known to be capable of developing without fertilization into new individuals; this kind of development we call parthenogenesis (*q.v.*), and it is not unknown among the Protozoa. In Actinophrys for example both gametes instead of fusing can encyst separately, shutting themselves up in a capsule, and later reappear as vegetative individuals.

ENCYSTMENT

We have already had occasion to show that zygotes may become enclosed in a rigid membrane. But the vegetative individuals of many Protozoa are also capable of doing so. This process, called encystment, is only met with as a rule when a shortage of food sets in or when the water in which the creatures live begins to dry up. This kind of cyst we call, in contradistinction to the "fertilization cyst" referred to earlier, a "protective cyst." Apart from these we



FROM KUHN, "GRUNDRISS DER ALLGEMEINEN ZOOLOGIE FUR STUDIERENDE" (THIEME)

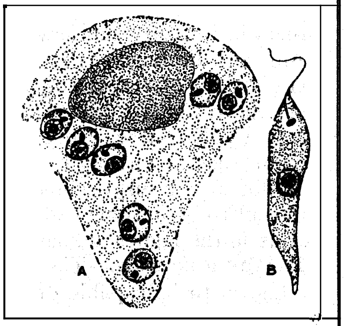
FIG. 19.—VOLVOX GLOBATOR: DIAGRAMMATIC SECTION THROUGH A GAMETE-FORMING COLONY

ought to mention the "reproductive cyst"; some protozoans do not divide in the free motile state, but first encyst, the products slipping out again after division.

When about to encyst the protozoan rounds itself off, secretes a membrane—which can afterwards be strengthened—and throws off or absorbs most of its organoids, such as flagella, static fibrillae, etc. (those of course remain which can only be reproduced by division, such as the centrosome and chromatophores). Finally it exudes a portion of the sap present in the protoplasm. Encystment consists then not only in the formation of a capsule but of a process of dedifferentiation of the individual, a reversion to a quasi-embryonic condition. The membranes are to ensure that the cyst shall be able to withstand complete drying out and the action of chemical compounds such as weak acids that would kill the vegetative individual. The thickening (dehydration) of the protoplasm ensures the resistance of some protozoans to temperatures as high as 60° C (180° *F*) which certainly could not be borne by the same species in the vegetative condition.

The encysted protozoan is in a condition of dormancy; it has no metabolic activity that can be proved, and it can in consequence survive in this "latent" condition for a very long time.

Germination (encystment) calls for little comment. The cysts sf many protozoans have weak places left in the coat at which they open as at a hinge or suture or even pores filled with plugs of silica; but in most cases the cyst-envelope bursts open like the shell of a lizard's egg (fig. 11). This explosion is often due to the absorption of water by the protoplasm and its consequent swelling in the early stages of growth, but sometimes it is due to the swelling of the inner layers of the cyst membrane.



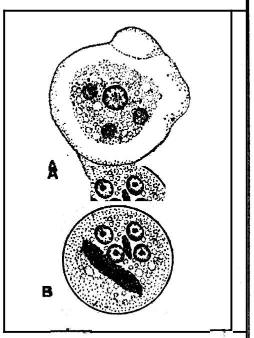
FROM KUHN, "MORPHOLOGIE DER TIERE IN BILDERN (BORNTRAEGER)

FIG. 20 — LEISHMANIA **DONOVANI** (A) White blood-corpuscles, in which the non-flagellate individuals lie (magnified 3,000 times): (B) individual provided with a flagellum (magnified 1,800 times)

The protozoan shortly before it emerges usually reconstitutes many of its typical organoids; on swimming out it completes this process and resumes its vegetative life.

DEVELOPMENT AND REGENERATION

A process equivalent to the development we find in the higher animals and plants from embryo to adult is found to some extent in nearly all Protozoa with the exception of those in which the dividing mother-animal splits every one of its organoids and distributes them to its daughter-cells. But this process of development, being limited in many Protozoa to the regeneration of the organoids after encystment or division (fig 8) takes very little time and does not give any impression of complexity. Complications that strike us as being like the early steps of embryonic development in multicellular organisms are found in the Volvocineae, at whose reproduction one cell gives rise to a colony (fig. 2, 19). The development of other protozoans such as the foraminiferans is a lengthy process (fig. *13*, 14), and in some we even find that peculiar roundabout way of developing, by repetition of ancestral forms, that is so often found in the higher animals. These processes are comparable to the formation of the gill-arches in early life by mammals (*see* EMBRYOLOGY and VERTEBRATE EMBRYOLOGY).



FROM KUHN, "MORPHOLOGIE DER TIERE IN BILDERN" (BORNTRAEGER)

FIG. 2.—ENTOMOEBA HISTOLYTICA (A) Vegetative individual, (B) four-nucleated cyst type of this organism

A process physiologically related to development is regeneration (*q.v.*), the replacement of lost body parts. Some protozoans are not capable of this; the capacity of the others varies in degree Some can only reconstitute their flagella, which they may have been caused by certain stimuli to cast off. Others may be cut into small pieces, and every one of these will grow up into a new individual—provided of course that it has at least part of a nucleus (fig. 3).

LIFE-CYCLES: ALTERNATION OF GENERATIONS

The successive stages of development of a higher animal such as a bird can be looked upon as a cycle; if we begin with the fertilized egg the embryo follows, then the young animal, then the mature animal that again produces eggs; the cycle is complete. In some animals, such as the green-flies or aphids (*q.v.*), several generations have to be gone through before this cycle is closed. In each of these instances, in birds and in aphids, we can speak of a life-cycle; in the aphids we can also recognize an "alternation of generations."

Naturally every organism has a life-cycle, even a protozoan that multiplies by division, for here also young animals are produced by division that only later come to resemble the creature that produced them. But it has become usual to speak of a life-cycle only when some other special process is introduced into the life history. An infusorian can for example multiply by division, but it can also encyst or it can conjugate. Now we speak of an obligatory or of a facultative life-cycle according to whether the succession of events in the life-history is strictly determined, on the one hand, or capable of a certain amount of adjustment, on the other. The obligatory life-cycle is governed solely by the intrinsic properties of the individual, running its course, provided only that the ordinary requirements of life are met; the other, the facultative life-cycle, is profoundly influenced by such external conditions as temperature, nutrition and the condition of the medium in which the organism lives.

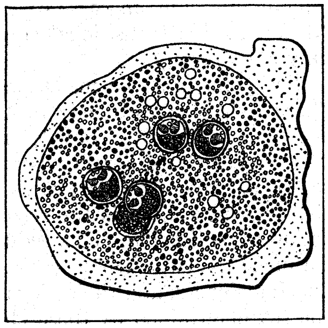
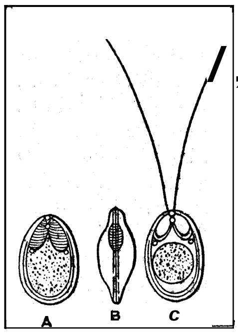

FROM THEOLAN, "LES MYOSPORIDIES" (LES PRESSES UNIVERSITAIRES)

FIG. 22.—SPHAEROSPORA DIVERGENS A small adult individual containing 5 spores (magnified 540 times)

There are Protozoa on the other hand that have a clearly facultative career, as they can reproduce by simple fission for an indefinite number of generations; whilst under certain conditions they are forced to copulate or encyst (*e.g., Antinophrys*).

There is also an obligatory life-cycle in those protozoans that show an alternation of generations. By this alternation we understand a succession of generations that are distinct from one another both in their form and in their method of reproduction. The classical example of protozoans with an alternation of generations is the Foraminifera (fig. *13*, 14). In most of these two distinct types can be recognized, the so-called micro- and macro-spherical individuals. The microspherical individuals are the asexual generation; as soon as they are mature the protoplasm breaks up into numerous germs, "agametes," which creep out of the shell of the mother-individual and gradually develop into new individuals—but individuals of the other, the macro-spherical, type. Then the protoplasm of these breaks up, this time into gametes, and after fusion we have the microspherical generation again (fig. 14).



FROM BALBIANI, "LEÇONS SUR LES SPOROSOAIRES" (OCTAVE DOIN)

FIG. 23.—MYXOBOLUS ELLIPSOIDES (A) Frontal view with capsules not yet exploded, (B) side view of same, (C) frontal view with capsules exploded

VARIABILITY, POLYMORPHISM, HEREDITY

Like all other organisms the Protozoa can be profoundly modified by various external conditions such as temperature, nutrition and state of the environment. Scarcity of food supply often leads to dwarfing, a rich supply to relatively giant growth. Some protozoans are so dependent on eternal factors, so malleable, that they may be altered beyond recognition. For example some *Amoebae* that live in half-moist surroundings by transference to water come to develop flagella and turn into flagellates (fig. 1j). In view of this mutability it was earlier hoped—when the protozoans were regarded just as primitive organisms—that changes from one species to another might be observed directly. This hope has not been fulfilled.

In other words, the inheritance of acquired characters is as little proved in the Protozoa as in the higher animals and plants. Certainly characters "acquired" by a protozoan under the influence of special external conditions reappear in the offspring. But this reappearance does not last very long.

Modifications of this kind are called "enduring modifications," in contrast to genuine hereditary variations (so-called mutations) which have been observed in some forms and remain constant through any number of divisions and fertilizations.

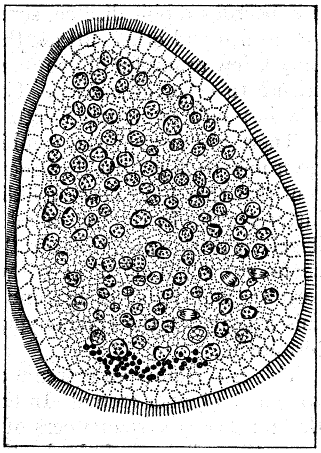
PHYLOGENY

We have already pointed out in the introduction that the different classes and orders of the Protozoa are not related to one another as those of the vertebrates are; that on the contrary a vast number of groups have been united under the "phylum" Protozoa for the sake of convenience. On this account it is useless to speak of the "phylogeny" of the Protozoa as a whole. In a few groups only is it possible to distinguish more primitive from more highly developed forms and make a kind of genealogical tree. An example of such a developmental series has already been touched upon. In the Volvocineae it can be clearly seen how cell-colonies have arisen from single-celled types and how a division of labour has followed.

HABITS OF LIFE

The protoplasm of all living creatures contains water and it can only survive dry conditions so long as it is in some way protected from drought. The vegetative stages of nearly all Protozoa being unprotected they can only live in a moist medium; their cysts on the other hand can remain dried up for a long time. We find Protozoa therefore in all kinds of fresh waters, as well as in the sea. They are also found free in moist earth and moss, and as parasites they occur in the body-fluids (blood, intestines, etc.) and tissues of animals, occasionally even of plants. Their cysts can be found wherever they are carried by wind and by other organisms,

Not only is the distribution of the Protozoa strictly limited by water-content but it is further limited by temperature and salt-content. Most free-living, *i.e.*, non-parasitic, Protozoa will scarcely stand temperatures of more than 30° C (86° F) and temperatures of above 45° C (113° F) or below zero C (32° F) are fatal to most species in the vegetative condition. In hot springs, however, infusorians have been found at temperatures of 64° C (148° F) and freezing has been resisted by some species. In the same way too strong solutions of salts such as those in the Algerian salt lakes render protozoan life impossible.



FROM METCALF, "OPALINID CILIATE INFUSORIANS"

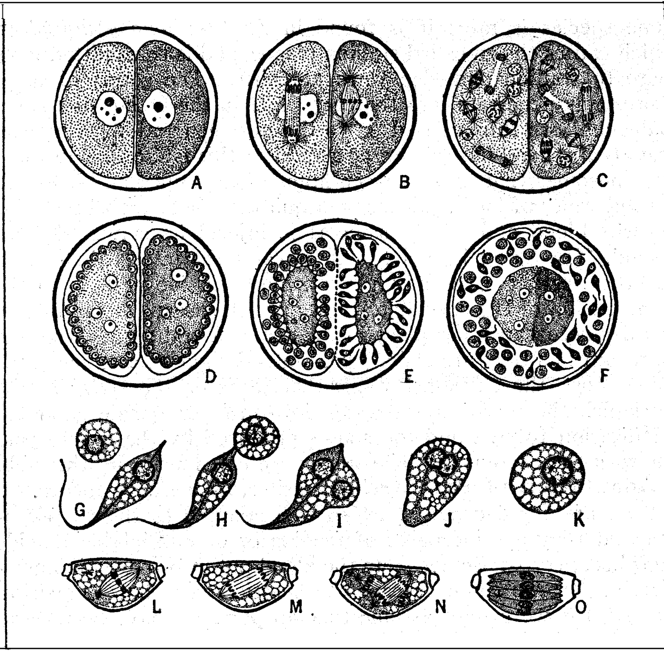
FIG. 24.—OPALINA RANARUM: (VEGETATIVE INDIVIDUAL) WHOLE ENDOPLASM FILLED WITH DARK-COLOURED BODIES, AS INDICATED IN THE LOWER HALF OF THE FIGURE. [MAGNIFIED 230 TIMES)

Naturally one of the essentials of life is the possibility of getting food; this requirement is met in each of the habitats that we have mentioned for one species or another. It is the most important factor, apart from temperature, that exercises a decisive influence in determining the life-cycles of protozoans which go into a period of winter rest in the encysted condition.

Every protozoan is more or less strictly adapted to its natural environmental conditions. Thus it may find life altogether impossible in conditions varying a little from the normal, although these may be the natural ones for another species. For example, a freshwater protozoan cannot exist in the sea, nor a blood-parasite in fresh water. Yet there are Protozoa that are very adaptable in these respects; some species normally living in fresh water can live for a considerable time in the intestines of animals or in the dissolving fluids secreted by carnivorous plants; intestinal protozoans of some animals can live on in the intestines of others that have eaten their first host.

Free-living Protozoans.—We can divide the Protozoa into ecological groups according to their modes of existence, remembering however that these groups are joined by every intergrade. The one all-important distinction is of course that between free-living and parasitic Protozoa.

The free-living Protozoa are composed of plankton forms, swimming forms, bottom-dwelling forms and soil forms. Plankton forms, though also present in fresh water, are characteristically found in the sea. They are Protozoa that, for the most part, although unprovided with any special motile organs, are able to float in the water and are carried by the currents.



FROM LEGER, 'REPRODUCTION SEXUEE CHEZ LES STYLORHYNCHUS" (GUSTAV FISCHER)

FIG. 25.—DIAGRAM OF THE LIFE-CYCLE OF A GREGARINE

(A) Two gregarines encysted together; (B) beginning of nuclear division; (C) later stage of nuclear division; (D) cutting off of the gametes; (E) gametes fully developed: (left) female, (right) male; (F) wall between the gametes dissolved, and gametes come together; (G–H) male and female gametes; (I–K) union of the gametes and of their nuclei; (L–N) nuclear division in the xygote (spore); (O) division of the contents of the spore into numerous sporozoites

Swimming forms (Nectonta) are protozoans that swim about with cilia and flagella, and in so far as they are heterotrophic do not as a rule waft in their prey but actually chase it. We find them in all kinds of water, from the sea down to mere puddles.

Bottom dwellers (creeping forms) live only on the bottoms and sides of ponds, lakes and so on, and creep only upon firm ground; some can swim a little, others are rooted firmly in their place. Their food is varied; at very great depths the autotrophic forms cannot of course exist because they need light, but they occur nevertheless in every possible kind of watery place. Most foraminiferans and amoebae are typical bottom dwellers.

Parasitic Forms.—Amongst Protozoa endoparasites are in the majority. Most parasitic Protozoa flourish in or on animals including other Protozoa, and there is scarcely any animal group that is free from them. A few forms parasitize plants; some, *e.g.*, flagellates, are found in the latex (or "milk") of the spurges (*Euphorbia*). Ectoparasites are naturally commonest on water animals and on moist or mucilaginous parts of the skin of land animals; these can either creep about or swim or remain rooted to one place. Most ectoparasites however are not true parasites, and merely use their foothold on their host to extract food for their environment, moving away as occasion requires.

Endoparasites inhabit body-cavities like the gut, veins, gall-bladders and so forth, as well as every conceivable tissue, where they lie between the cells, as tissue parasites, or bore their way inside the cells, as cell-parasites. Some move about fairly freely, others are almost immobile.

The great majority of the endoparasites feed by osmotic absorption; that is they live on dissolved nutriment that they either find ready for them, as in the blood or the digestive tract, or that they have to prepare by secreting substances to dissolve the cells of the host.

Most parasitic protozoa are transferred from one host to another by forming cysts, which escape into the open and are then picked up by the new host quite by chance—usually by being eaten. Direct transmission from one animal to another of the same species-is rare; it is found in *Trypanosoma equiperdum,* which causes the so-called stallion plague, and is transmitted from mare to stallion and vice versa at coitus. The germs of other protozoans penetrate into the eggs while in the bodies of the females and are thus carried on to the next generation. Very frequently a second host serves as a carrier; this is the case in those trypanosomes that pass between human or mammalian blood and the intestines of insects such as mosquitoes; the insect when biting absorbs blood and at the same time injects its saliva into the wound. The insect is called in these cases the intermediate host. In other instances the host plays a more passive part, as in the transmission of the coccidian Aggregata: the asexual reproduction of this protozoan takes place in the gut of a crab; the germs (or merozoites as they are called) pass into the gut of a second—the chief—host, the cuttle-fish Sepia that feeds on the crab. In the cuttle-fish the merozoites develop into male or female gametes; fertilization follows and the spores produced by the zygote pass cut with the excrement. The spores are eaten again by the crab.

Adaptation of Parasites.—Parasites, as we have mentioned before, are for the most part so well adapted to their habit of life that they are incapable of feeding or of multiplying outside their host; trypanosomes from the blood put into water die immediately. Yet we cannot escape the question as to how parasitism started, for we cannot assume that all parasites have been parasites since the beginning of time; on the contrary, they must have arisen from free-living forms. We have now a few facts that make the transition from a free-living to a parasitic form if not entirely clear at least to some extent intelligible.

For one thing the resistance of many free-living Protozoa to the digesting fluids released by insectivorous plants, *e.g.,* pitcher plant, shows a remarkable degree of adaptability. Another thing is the extraordinary adaptability of some parasitic protozoans; the gut-parasites of the frog tadpole live for instance in the gut of the horse-leech, which eats the tadpole, and there grow and multiply; and some gut-parasites can live equally well in the blood of their host, if by chance they should get into it.

Most striking are the reproductive adaptations of the parasites, for the reproductive mechanism is often governed absolutely by its requirements in relation to its host or hosts as the case may be. First the remarkable fertility of parasites must be mentioned as an adaptation to their form of life, for in spite of their easy existence the possibility of their dying in or with their hosts is a serious menace to the maintenance of parasitic species, for only a minute proportion of the germs can have a chance of finding another host. We have already referred to an adaptation of an entirely different order, namely the division of the life-cycle into two periods spent in different hosts; the combination of an alternation of hosts with an alternation of generations. The classical example of this is that of the malaria parasite. The bite of the mosquito injects the sporozoites into the blood; there they bore their way into the red blood corpuscles and develop into the agamonts; these break up by multiple division into the merozoites and in doing this burst the corpuscles whose substance is already depleted by the parasite. The merozoites bore into fresh corpuscles and repeat the story, or they can transform themselves into macrogametocytes and microgametocytes, which wait for some time until chance takes them into the stomach of a sucking mosquito. If they have to wait too long they die, but if they succeed in getting into the mosquito's stomach without undue delay they are able to complete their life-cycle; the microgametocyte breaks up into microgametes, these fertilize the macrogametes and the motile zygote bores into the stomach-wall of the mosquito. Here it grows, its nucleus divides many times and finally the sporont, as we now call the adult zygote, breaks up into a number of sporozoites. These migrate to and collect in the salivary glands of the mosquito and, if this should bite a human being, make their way with the injected saliva into the bloodstream of the victim. The cycle is now complete.

Relations of Parasite and Host.—The most important of the conditions governing the relationship of host and parasite have already been discussed. The host offers the parasite, unwilling to be sure, board and lodging; hence the name. In many cases however, the host seeks to protect himself from his guest or even if possible to destroy it; he sends out his phagocytes against the intruder, and these are frequently able to eat it; he isolates the parasite as far as possible, by shutting it off from the neighbouring tissue in a capsule; and finally makes and releases into his body-juices all kinds of poisons, anti-bodies, agglutinins and lysins (see IMMUNITY) which cripple or even destroy the parasite. A host that can build up enough of such protective materials can not only annihilate the enemy but can actually protect himself for some time against any repetition of the attack; he is said to be immune.

When we speak of parasitism it is difficult to avoid thinking that the host is necessarily injured by the parasite. Most parasitic Protozoa however are actually harmless; they live on surplus food and body-substance and do their host no harm at all. Every man, every frog, cockroach and earthworm, shelters innumerable parasitic protozoans without being injured by them in the slightest degree. Other protozoans on the contrary injure their host in a greater or less degree, not by taking away food, but by demolishing the body-cells of their host. Some types secrete poisons (toxins). As we have already mentioned, the malaria parasite destroys the red blood corpuscles of man. (See MALARIA.)

The malaria parasite is not the only pathogenic (*i.e.,* disease-causing) protozoan. Trypanosomes (fig. 7) have been shown to be the cadse of African sleeping-sickness and of a human disease not rare in South America, schizotrypanosis. *Leishmania donovani* (fig. 20) causes the kala-azar disease in India; Entamoeba histolytica (fig. 21) the tropical amoebic dysentery of man; many trypanosomes cause serious cattle plagues. A coccidian is responsible for a dangerous rabbit disease, some microsporidians are a great danger to fish and others attack the silk-worm caterpillar. These are only a few examples of the menace that parasitic protozoans constitute to other organisms. The pathogenic forms, however, are few in number compared with the harmless ones.

There are further the symbiotic Protozoa, which not only do no injury to, but actually benefit, their host; some to such an extent that they have become indispensable. We will begin with this latter group. In the gut of all wood-eating termites live peculiar flagellate protozoans, the so-called Trychonymphidae. These protozoans eat small particles of wood, the masticated food of the termite, and digest them; and it has now been determined that this activity of the trychonymphid is essential to the life of the termite.

This is certainly an extreme case of symbiosis between a protozoan and a higher animal. In the stomachs of the ruminants (cattle and sheep) vast numbers of infusorians are found, which consume the cellulose of the host's food and are probably as useful as the flagellates are to the termites; but they are not indispensable. Most of this work is done by bacteria, which also inhabit the stomach. Similarly, some radiolarians can easily do without the autotrophous peridineans that live with them.

ECOLOGY AND DISTRIBUTION

Many autotrophic planktonic Protozoa serve as food for other plankton organisms, such as the larvae of worms, sea-urchins and fishes—not exclusively, indeed, for the diatoms which far surpass them in number are more important as a source of food. In so far as, with diatoms, they supply food for fishes and smaller animals eaten by fishes, these protozoans are not without importance to man, fish being one of his staple sources of food supply.

Other marine Protozoa (Radiolaria and Foraminifera) that form shells of mineral matter, play quite a different part. In certain circumstances they can go to form solid rock. The shells of dead individuals collect, often in enormous numbers. on the sea-floor and form, generally with other mineral particles but sometimes without any other constituent, the fine silt or ooze that covers the bottom of the deep sea. In the Pacific (Rose atoll) a cubic metre of *Globigerina* ooze is laid down yearly over a surface of 150 sq m.; in other words a layer 0·66cm. thick every year or over two feet in a hundred years. 29.2% of the whole floor of the ocean, *i.e.*, over 40 million square miles, is covered with *Globigerina* ooze; the area covered with radiolarian ooze is estimated at nearly 12%. Chalk and sandstone are nothing but the ooze and silt of antediluvian seas; and certain rocks consist, entirely or almost entirely, of the shells of fossil Protozoa, Foraminifera, Radiolaria and Coccolithophorida.

As compared with the marine forms the fresh water Protozoa play a modest part; they certainly provide food for some animals, but they do not figure very largely in the diet as a whole. In waters with much decomposing animal and vegetable débris the protozoans take some part in what is called biological water-cleansing. In a ditch or pond containing much decaying matter the water is polluted with all kinds of bodies, but gradually cleans itself. First the decaying matter is broken down by bacteria and partly consumed. In this materials are found—mostly evil-smelling—that are needed by certain Protozoa for food and the water is therefore freed of them. The bacteria themselves are eaten by other protozoans. A similar part is played apparently by the soil Protozoa. In one gramme of earth from 100–50,000 amoebae, 1,000–100,000 flagellates and as many as 1,000 infusorians have been found. On the one hand they keep down the nitrifying bacteria (*see* BACTERIOLOGY) so necessary for higher plants; on the other hand they may effect nitrogen fixation themselves and so have the same effect as manure.

The species of fresh water and soil Protozoa are cosmopolitan; the protozoan fauna of pools and rivers is the same in Africa as in North America. This is due to the fact that the conditions of life in pools are much the same all over the world, and that the fresh-water protozoans can be carried very easily, especially in the encysted form, by wind and animals. In the sea the case is rather different; the water of the Pacific is distinctly different in salt content, temperature and other respects from that of the Mediterranean and corresponding to these differences we find different species limited to different seas. As an example of a cosmopolitan species on the other hand we have *Noctiluca miliaris,* the luminous flagellate (fig. 18). The geographical distribution of parasites naturally follows that of their hosts.

HISTORY OF PROTOZOOLOGY

Protozoa were first discovered in the latter half of the 17th century by A. van Leeuwenhoek (1632–1723) a Dutch amateur naturalist and chamberlain to the sheriff of Delft. Leeuwenhoek carried on his investigations with magnifying glasses and microscopes he had designed and made himself.

A systematic investigation and description of all known Protozoa was undertaken for the first time by the Dane, O. F. Miiller (1730–84). In the 19th century C. G. Ehrenberg, professor of zoology in Berlin (1795–1876), tried to show that Protozoa had an organization similar to that of the higher organisms. This attempt failed because Ehrenberg's scientific opponent, the Frenchman Dujardin, was able to demonstrate the unicellularity (in essence at least) of the Protozoa. The fact that Protozoa were unicellular was enunciated by the German zoologists M. Schultze (1861) and von Siebold. In the era of Darwinism the Protozoa were principally looked at from the point of view of the evolutionary theory; in them were seen the rbot-forms of the higher animals. Later on protozoans were recognized as causers of disease; the first pathogenic protozoan, *Nosema bombycis,* was discovered by Pasteur. The greatest advance in the study of pathogenic Protozoa began with the investigation of the Nagana cattle plague by David Bruce; by showing that this disease was caused by *Trypanosoma brucei* he opened a new era of activity in protozoological research which has carried us on to the present day. In this period the study of the body-structure, life-cycles and physiology have equally received attention. Amongst these the classical researches of the Englishman Ronald Ross and of the Italian B. Grassi deserve special mention, on account of their achievement with malaria, also the work of the German F. Schaudinn (1877–1906) on the life-cycle of the Coccidia and of many other Protozoans especially in regard to cytology.

CLASSIFICATION

We have already mentioned the fact that the different forms of life included under the name Protozoa do not show the same relationships as the different classes that we recognize amongst the vertebrates; indeed that many of them cannot be shown to have any relationship whatever with one another. This is true for some, but not for all, classes and orders of the Protozoa; some of these, such as the Flagellata, Protomonadina, Rhizopoda, Heliozoa, are not to be regarded as natural groups at all. They are convenient assemblages of organisms not demonstrably related.

We divide the Protozoa into five great classes:—

1. Mastigophora (Flagellata)
2. Rhizopoda
3. Telosporidia
4. Neosporidia
5. Ciliophora (Infusoria)

It should be clearly understood that (1) and (2) are both unnatural groups.

1. Class Mastigophora. (Flagellata).—Amongst the Mastigophora we count all Protozoans in which the vegetative individual is provided with flagella. The class itself is artificial; the first six of its nine orders are, however, natural. The Protozoa belonging to these orders are mainly autotrophic, but nearly all of these orders include colourless forms that are believed to have arisen by loss of their chromatophores; this process has been directly observed in some cases. Amongst these flagellates we ought therefore to regard the green forms as more primitive than the heterotrophous. Protozoa actually without a flagellum but showing a close relationship structurally to flagellate forms are naturally included in the Mastigophora.

1. Order *Chrysomonadina.* Very small autotrophic flagellates; one or two flagella; always free-living, in fresh and salt water; the chromatophores usually contain a brown pigment. The cyst, furnished with plugged hole, is characteristic of many Chrysomonadina; its membrane contains silicic acid. Unicellular and uninucleate; reproduction by simple fission; fertilization processes are only known in a few forms. A very large order in the number of its species; the most important family is the Coccolithophoridae consisting of marine chrysomonadines, which have shells composed of chalk disks and are important as food for many plankton organisms. Important types: *Chromulina, Oclzromonas, Dinobryon, Syracosphaera.*

2. Order *Cryptomonadina.* Biflagellate, autotrophic, entirely free-living flagellates of fresh water and sea. Chromatophores chiefly brown, characteristic flattened form of cell, unicellular, uninucleate. Reproduction by simple fission. Fertilization processes unknown. Important types: *Cryptomonas, Cltilomonas* (colourless).

3. Order *Chlorontonadina.* One or two flagella autotrophic; chromatophores with bright green colouring matter, the nature of which is not yet exactly known. One-celled, uninucleate.

4. Order *Euglenoidina.* Most have one, a few two, flagellae; usually autotrophic with a peculiar cystostome; (fig. 16); some of the autotrophic forms as well as the heterotrophic kinds can also eat solid food. Chromatophore green. In stagnant ponds and cesspools. The structure and division of the nucleus is characteristic. Unicellular and uninucleate. Reproduction by simple fission; fertilization only known in certain heterotrophic forms such as *Scytomonas.* Important types: *Euglena, Phacus, Trachelomonas, Peranenta* (heterotrophic).

5. Order *Dinoflagellata.* Usually with two flagella, lying in a special and characteristic way in two body furrows, one disposed longitudinally and the other spirally around the body (fig. 17). Both the structure and method of division of the nucleus are also characteristic. Most dinoflagellates are autotrophic; but

there are also some that eat living organisms, heterotrophic, and many parasitic forms which flourish in marine animals; these do not possess a flagellum. The autotrophic dinoflagellates are most generally provided with a plated cellulose armour. They live for the most part as plankton organisms in the sea. Usually unicellular—a few of the parasitic forms are multicellular—and uninucleate. Reproduction by simple fission or multiple division (swarm-spore formation) fertilization processes unknown. Important types: *Ceratium, Gymnodinium* (naked) *Blastodinium* (parasitic) *Oödinium* (parasitic).

The organism responsible for phosphorescence is *Noctiluca miliaris* (fig. 18) a rather large swollen bladdery uniflagellate protozoan, faintly red-coloured, heterotrophic, eating living organisms, which produces an intense light at night but only under the stimulus of a physical or chemical shock. The relationship of this form with other dinoflagellates is shown by the organization of its swarm cells.

6. Order *Phytomonadina* (Volvocineae). A group containing entirely free-living autotrophous biflagellate species with cup-shaped green chromatophores; a very few species are destitute of chromatophores and feed themselves in the way described above. The lower phytomonadines are unicellular, the higher, multicellular. Uninucleate. Reproduction by simple fission, or, in the multicellular forms, by rapidly succeeding divisions (fig. 2). Fertilization: in the lower forms (*Chlamydomonas*) hologamous and morphologically isogamous; in the higher forms (*Volvox*), oögamous. The zygote has a resting period and following this, in the unicellular forms four individuals slip out, and in the multicellular forms, a colony. The reduction division takes place shortly before the germination of the zygote. Important types:—*Chlamydomonas* (fig. 1), Polytoma (heterotrophous) *Gonium, Eudorina* (fig. 2), *Pleodorina,* Volvox (fig. 19). See also ALGAE.

7. Order Protomonadina (an artificial group). Heterotrophous organisms with one or two flagella. To this group belong the most important of the parasitic flagellates, the trypanosomes which are put with other forms in the family Rerpetomonadinae. The possession of a so-called blepharoplast is characteristic of the trypanosomes and various closely related forms. This organoid is a little ball of protoplasm lying directly under the basal granule of the flagellum; it resembles the nucleus in several characteristic properties and divides by simple fission (fig. 7). Earlier it was often regarded as a second nucleus, and was even given the name "kinetonucleus," but this view cannot be supported. The trypanosomes have only one flagellum; this is developed in the blood parasites as a characteristic undulating membrane (fig. 7). The equally parasitic Trypanoplasmae have also a second free flagellum; the free-living Bodonidae have two free flagella. The trypanosomes are blood parasites of the mammals, birds, amphibians and fishes; they swim in the blood plasma and are for the most part carried from one host to another by blood-sucking insects, or (in the case of fishes and frogs) by leeches. The related Leishmaniae are cell-parasites which only pass through the body fluids and are normally not equipped with flagella (fig. 20). Other relatives of the trypanosomes, the Leptomonadae, live in the intestines of insects that do not suck blood and are supposed to be the ancestral forms of the trypanosomes. Some trypanosomes are harmless, great numbers on the other hand are pathogenic; *e.g., Trypanosoma* gambiense, the cause of African sleeping sickness of man; Trypanosoma rhodesiense, cause of another kind of sleeping sickness; *Schizotrypanum cruzi* cause of schizotrypanosis of man in Brazil; Leishmania *donovani* (fig. 20) cause of the kala-azar disease of man; Leishmania *tropica,* cause of Oriental sore; *Trypanosoma brucei* (fig. 7) cause of the Nagana pest of hoofed animals in Africa; Trypanosoma evansi, cause of the surra pest of hoofed animals in India; *Trypanosoma equiperdum,* cause of the stallion plague (dourine) of horses.

The Trypanoplasmae flourish in the blood and intestines of many fishes as well as in the intestines of many invertebrates; it is not yet certain whether any of them are pathogenic. All parasitic Herpetomonadina feed osmotically. The group is unicellular and uninucleate, and reproduction is by simple or occasionally by multiple division. Sexual processes are unknown.

Another important family of the Protomonadina that must be mentioned is the Craspedomonadidae; it consists of free-living, unicellular, heterotrophic flagellates; they have a delicate collar around the flagella. They are unicellular and uninucleate. Reproduction by simple division, fertilization unknown. Important types: Codosiga, *Salpingoeca.*

8. Order *Polymastigina.* Flagellates, parasitic and "eating," with a very characteristic division of the nucleus. The lower forms (trichomonads) have 2–5 flagella, the higher (hypermastigina) have often several hundred. All are innocuous intestinal parasites of vertebrates, including man, and of insects. The Trichonymphidae are symbiotic with the wood eating termites (see above). The Polymastigina are unicellular and usually uninucleate; only a few of the higher forms such as *Calonympha* are multinucleate. Reproduction is by simple fission, no sexual process being known. Important types: *Trichomonas* (T. *intestinalis* is a harmless intestinal parasite of man, T. *buccalis* Iives in the tooth-insertion of man), *Trichonympha.*

9. Order *Distomatina.* Heterotrophic, free-living and eating living organisms or parasitic; they have the appearance of two flagellates stuck together. They have two nuclei and two flagellar apparatuses. Reproduction is by simple fission; fertilization processes are unknown. Important type: Giardia, an intestinal parasite (probably innocuous) of man and many other mammals,

2. **Class Rhizopoda.**—These are heterotrophic protozoans in which the vegetative individual moves and feeds with the aid of pseudopodia. It is an altogether unnatural group; this faculty of producing pseudopodia cannot be regarded as a specific character, for it' is found in such widely distinct structures as leucocytes (white blood corpuscles) and some spermatozoa of animals and even in the gametes of some algae.

1. Order *Amoebina.* Rhizopoda that have amoeboid movement, *i.e.,* they travel by means of broad pseudopodia produced over the whole body surface. This group is as unnatural as the class Rhieopoda (see above). The amoebae were for a short time regarded as the most primitive, because structurally the simplest, of living organisms. Nowadays this view is not held. We know, for instance, that certain Chrysomonadae are definitely without flagella and show amoeboid movement; they are amoebae. Yet in every other character they are typical Chrysomonadae. It is therefore entirely reasonable to imagine that many amoebae are extreme secondarily altered forms of the other groups of Protozoa. All amoebae are heterotrophic and feed on living organisms; many are free-living, in fresh water, sea water and soil; some are parasitic, as a rule in the gut. They are entirely unicellular and for the most part uninucleate. Reproduction is by simple fission or multiple division in cysts (Entamoeba fig. 21). Fertilization processes are known only in very few species. The amoebae are divided according to their method of nuclear division. Important types:—*Wahlkampfia* (fig. 15) and *Hartmanella* (free-living, feeding on bacteria), Amoeba *proteus* (living in water), Entamoeba histolytica (fig. 21), the cause of amoebic dysentery of man, Entamoeba *coli,* an innocuous gut-parasite of man, Entamoeba gingivalis, a parasite, possibly harmless, of the slime covering the tooth-bases of man. (See also AMOEBA.)

2. Order Thecamoebina. Free-living Rhizopoda whose bodies are surrounded by a cup- or flask-shaped shell. Pseudopodia are extruded from the opening in the shell. Characteristic also is the presence of layers or zones of protoplasm which stain deeply with the so-called nuclear stains, and are therefore described as chromidia (see above). The shell may be composed either of a stiff protoplasmic skin or of "pseudochitin" or of plates of silica, produced by the animal itself (*Euglypha*), or of foreign bodies picked up by it as it goes along and saved for the purpose (*Difflugia*). The group is entirely unicellular and as a rule uninucleate. Reproduction is by simple fission, or, in the hard-shelled forms, characteristically by gemmation. The mother individual extrudes a portion of its protoplasm from its aperture and this grows a new shell. In the "wall-building" forms the "building materials" accumulated by the mother-animal pass to the surface of the gemma; only then does a daughter-nucleus from the newly divided mother-nucleus wander into the gemma,

which then becomes free. Fertilization is unknown in this order.

3. Order Foraminifera. Relatively large Rhizopoda; the body is enveloped in a many-chambered porous calcareous shell. The pseudopodia, usually branched, make their way through the pores. They are free-living, heterotrophic, and feed on living organisms; entirely marine. Inland they appear only in salt-lakes—residues of earlier seas—as in Transylvania. The shells of many Foraminifera are very complex in structure but the principle is always the same. The germ-cell (agamete or zygote) surrounds itself with a shell and usually resembles a *Thecamoeba;* after some time, protoplasm makes its way out of the opening in the shell, spreads over a part of the shell-surface and forms a new shell; this makes the second chamber. This process goes on until the number of chambers in an adult animal may exceed a hundred. Only rarely are all the chambers arranged in a row, usually they are rolled up to form a spiral like a snail-shell, (fig. 13). Very frequently each chamber is completely built around by the one following. The shell-material is either the chalk that the animal excretes or extraneous material (grains of sand, etc.). There are also Foraminifera with unchambered shells and others whose shells are imperforate.

Most foraminiferans live on the bottom of the sea, only a few are plankton forms. All are unicellular and most uninucleate. Reproduction is by multiple division and gamete formation. Fertilization is effected by flagellate gametes. An alternation of generations is established. The Foraminifera, especially some fossil forms, are the largest unicellular organisms. They are of practical importance as stone-formers. Important types: Rotalia, Polystomella (figs. 13, 14), *Globigerina* (plankton, see GLOBIGERINA), *Miliolina, Nummulites* (fossil).

4. Order Heliozoa. Relatively small Rhizopoda characterized by the possession of so-called axopodia. Entirely free-living, heterotrophic, feeding on living organisms. Pound as a rule in fresh water. A small group; the only natural sub-order is the Centrohelidia, ball-shaped protozoans with a so-called central granule; this is a cytoplasmic structure capable of division, which lies in the middle of the cell and serves as the *point d'appui* of the axopodium. It was earlier thought to be a true centrosome, but it really is nothing of the kind. Some primitive forms (Dimorpha) have a true centrosome which functions both as a basal granule and as the insertion-point of the axopodium. Many species have a peculiar shell made of loosely packed silica needles. They are unicellular and chiefly uninucleate. Reproduction is by simple fission or gemmation; the gemmae grow into flagellate "swarming" individuals. Fertilization processes unknown. Important types:—Acanthocystis, *Dimorpha* (always provided with two flagella), Wagnerella (sessile, with a stalk; marine).

The remaining Heliozoa are probably related neither with one another nor with the Centrohelidia. Actinophrys (fig. 11) is unicellular, uninucleate, in fresh water, fertilization paedogamous. *Actinosphaerium* is multinuclear, the fertilization process as in *Actinophrys;* every individual breaks up into numerous gamonts, each one of which behaves like an Actinophrys preparing for fertilization. *Clathrulina* elegans has a ferruginous lattice-work shell: fertilization process unknown. *Nuclearia* is like *Clathrulina* without a shell; reproduction by simple fission.

5. Order Radiolaria. Relatively large Protozoa. The body of the protoplasm is divided into two parts by an internal membrane, the central capsule; the so-called intra-capsular cytoplasm contains the nucleus or nuclei and in the extra-capsular cytoplasm the food is digested. They are usually provided with a silica skeleton and also with a gelatinous sheath. The pseudopodia are intermediate in form between the Rhizopodia and Axopodia. Always free-living, heterotrophic, eating living organisms, marine plankton organisms. Some are capable of devouring multicellular animals as big as a water-flea. Many Radiolarians contain symbiotic Dinoflagellates, so-called Zooxanthellae. For the most part these forms are unicellular and uninucleate. Reproduction by simple fission and multiple agamete formation; the agametes are flagellate and may sometimes show a strong resemblance to dinoflagellates; some contain peculiar crystals. The life-cycle of Radiolarians is still very imperfectly understood, part of it being carried through in the deep sea. The Radiolaria are classified according to their skeleton and the form of the central capsule into four sub-orders:—

(a) Sub-order Spurnellaria. Central capsule pierced in all directions by fine pores. Skeleton may be wanting or may be composed simply of fine, loose needles. Some species form colonies. Important types: *Collozoum,* Thalassicolla.

(b) Sub-order Acantharia. Central capsule pierced in all directions; skeleton consists generally of 20 needles sticking together in the central capsule. Myonemes are attached to the needles and their contraction stretches the gelatinous integument and makes the animal lighter. Important types: Acanthometra, *Xiphacantha.*

(c) Sub-order Nasselaria. Central capsule provided with only one complicated aperture. Skeleton very complex.

(d) Sub-order Tripylea. Central capsule with three complex apertures. Skeleton very highly developed. Important types:—*Aulacantha,* Coelacantka.

6. Order Mycetozoa, also known as slime moulds but are not true fungi. (a) True Mycetozoa (Myxogasteres). These are Rhizopoda whose vegetative stage, the so-called plasmodium, is a gigantic Amoeba with thousands of nuclei. A contracted plasmodium of Fuligo *varians,* "flowers of tan," can be as large as a man's fist. These Amoebae are not compact, but form a peculiar net in whose meshes the endoplasm flows back and forth. The creeping forward movement of the plasmodium is caused by the fact that the plasma streams longer in one direction than in the other. The plasmodia live in moist earth, dung and rotten wood and they live partly on particles of decaying vegetable matter and partly on bacteria. The plasmodia cannot as a rule multiply vegetatively, they can only increase in size and in number of nuclei. When the plasmodium dries it changes to a number of thickly crowded multicellular cysts and is then known as a sclerotium. When food runs short the plasmodium forms fruiting bodies, the protoplasm collecting itself into little clumps at various parts of the net; from every clump a stalked ball-shaped body grows up; this fruiting structure is surrounded by a firm membrane and contains a great number of unicellular cysts or spores. At the formation of the fruit-bodies only a portion of the protoplasm is used up in the formation of spores; the rest goes to the making of the stalk, fruit-body membrane and fibres of a particular kind called elaters, which lie between the spores. The spores can stand drought, but as soon as they come in contact with water uniflagellate swarm-spores escape from them which either mate immediately or change first into Amoebae, losing their flagellae. The amoeboid zygote then grows straight on into a new plasmodium. Important types: *Didymium nigripes,* on dung and garden soil; Fuligo *varians,* on tanner's bark.

(b) The Acrasiaeae are also counted with the Mycetozoa although in no way related to them. The vegetative stage is a uninucleate amoeba multiplying by fission; on the formation of fruit-bodies many thousands of these organisms come together, and gradually build ball-shaped fruit-bodies which are often stalked; some of the amoebae are transformed into stalk cells, others into the membrane, the greater number form uninucleate spores. Important type: Dictyostelium mucoroides.

(c) Perhaps other plasmodia1 Rhizopoda such as *Labyrinthula, Leptomyxa* and such forms should belong to the Mycetozoa but we know as yet little of their life cycles. (See FUNGI.)

3. Class Telosporidia.—A small group of exclusively parasitic Protozoa whose zygotes break up inside a membrane into numerous sporozoites. Nutrition purely osmotic. Chromosome reduction at the first division of the zygote nucleus.

1. Order Coccidiomorpha. Telosporidia in which the vegetative individual dispenses with every cell organoid; they flourish inside cells and reproduce by multiple division.

(a) Sub-order Coccidia. From the sporozoites or merozoites arise the vegetative individuals or macrogametocytes and microgametocytes, which give rise to a large number of gametes. The zygote breaks up inside its membrane into several sporoblasts which themselves grow an enveloping membrane to become spores and whose protoplasm breaks up into sporozoites. Coccidians are found in many different groups of animals, including man, and in the most diverse tissues, very often in gut cells; some cause dangerous diseases, as *Eimeria stiedae*, a serious intestinal complaint of the rabbit; others are practically innocuous. Important types: *Eimeria stiedae* (rabbit), *Eimeria schubergi* (intestine of *Lithobius forficatus,* a centipede), *Aggregata eberthi* (intestine of *Sepia* and crabs).

One family of the Coccidia, the Haemogregarinae, provides the transition to the Haemosporideae. The Haemogregarinae are distinguished from other coccidians, with which the resemblance is otherwise very close, in that the zygote, called the ookinete because it is at first motile, is enveloped in a membrane; the sporozoites have no spore membrane. The haemogregarines are parasites of the red blood corpuscles of reptiles, frogs and mammals; some of them have a similar alternation of host to that of the Haemosporideae; some are pathogenic, such as *Hepatozoön perniciosum,* of the wild rat. Important types: *Karyolysus* (chief host, lizards, intermediate host, mites), *Hepatozoon* (rats).

(b) Sub-order Haemosporidia. Coccidiomorpha whose zygotes are without a membrane; they show alternation both of generations and of hosts. They are parasites of the red blood corpuscles of mammals and birds. Many pathogenic. Important types: *Plasmodium vivax*, *P. falciparum* (the cause of ague or tertian fever in man), *Plasmodium malariae* (quaternary malaria), *Laverania malariae* (tropical fever of man), *Haemoproteus* (various birds).

The Babesiae lie very close to the true haemosporidians but their fertilization and development are insufficiently known. They are parasites of the red blood corpuscles (intermediate hosts, ticks) and often pathogenic. Important types: *Theileria parva* (coastal fever of cattle in Africa), *Babesia bigemma* (Texas fever of cattle in America), *Babesia canis* (malignant jaundice of dogs).

2. Order *Gregarinidae.* Telosporidia whose bodies have usually a definite individual shape. The zygote changes into a spore which contains many sporozoites.

(a) Sub-order Eugregarinaria (Gregarines). The body of the typical gregarine is made of at least two elements—the protomerite and the deuteromerite, the latter containing the nucleus *(see* fig. 25); a third element when present is called the epimerite, and is usually developed as an attachment organ. The possession of longitudinal and circumferential myonemes is highly characteristic; the peculiar creeping movement described earlier is also characteristic. The gregarines are parasites of the gut and body-cavities of invertebrate animals and are for the most part harmless. They occur chiefly in insects and annelid worms, living not inside the cells but (at least in their young stages) clinging to them by the epimerite. The mature animals are usually quite freely motile. Alternation of hosts does not occur. True gregarines cannot reproduce agametically but only sexually, as shown above. It should also be mentioned that the cysts in which the gametes are enclosed can produce processes of various forms which assist in the distribution of the spores. Important types: *Monocystis* (in the seminal vesicles of various earthworms), *Gregarina blattarum* (in the gut of the cockroach), *Gregarina cuneata* (in the gut of the larvae of the meal-bug).

(b) Sub-order Schizogregarinaria. These gregarines are transitional forms between the true gregarines and the coccidians; the vegetative individuals are not far removed in body structure from the gregarines but can reproduce asexually like the coccidians by multiple division. Fertilization however is like that in the gregarines; but only small numbers of gametes and spores are formed. The Schizogregarinaria flourish in various invertebrate animals, such as insects and crabs, but are for the most part innocuous. Some, such as *Porospora,* have an alternation of hosts. Important types: *Ophryocystis* (Malpighian tubules of the meal-bug), *Porospora* (gut of the lobster and other crustaceans, with fertilization in mussels).

4. Class Neosporidia.—Multinucleate plasmodial Protozoa almost destitute of cell organoids; the spores are equipped with a complex polar capsule. Entirely parasitic, nutrition osmotic. No flagellate stage. Some forms show an amoeboid movement.

1. Order *Myxosporidia.* The vegetative individuals are more or less formless clumps, often showing amoeboid movement; they contain in the fully developed condition many thousands of nuclei. They are able to reproduce themselves asexually both by simple fission and by gemmation; they can also form spores, though whether fertilization precedes this process, or follows it, we cannot say. The Myxosporidia flourish in the tissues and body cavities (such as gut and gall-bladders) of fishes and amphibians, and some are pathogenic. Important types: *Myxobolus pfeifferi* (cause of barbel-pest), *Myxobolus neurobius* (forms swellings in the brain and spinal marrow of trout and graylings), *Myxidium lieberkühnii* (urinary bladder of pike; harmless).

a. Order *Microsporidia.* The vegetative individuals look just like those of the Myxosporidia and simply multiply asexually. The Microsporidia are all cell-parasites of various animals; many are pathogenic for the vegetative individuals may grow to an enormous size and thus cause swellings. Important types: *Glugea anomala* (in stickleback, pathogenic), *Thelohania* (in larvae of gnats), *Nosema apis* (cause of Isle of Wight disease of bees), *Nosema bombycis* (cause of *pébrine* disease of silk worms).

3. Order *Haplosporidia.* The true Haplosporidia are probably Microsporidia whose spores do not produce a polar capsule. They occur in the tissues of animals, chiefly invertebrates; distinctly pathogenic forms have not been found. Important types: *Haplosporidium* (in various worms), *Ichthyosporidium* (in marine fishes, such as *Crenilabrus*).

Many forms of "Sporozoa" have been included in this group about whose developmental history nothing exact is known; for example, *Rhinosporidium seeberi,* which produces tumours in the mucous membrane of the nose in man. Some of these forms belong perhaps to the Haplosporidia; others, however, to the fungi.

4. Order *Actinomyxidia.* The vegetative stages of these protozoans are not yet well known. Spore-formation probably follows a course broadly the same as that described for the Haplosporidia; there is for instance a paedogamous fertilization. The spores are very complex, of triradiate symmetry and containing three polar capsules. A very peculiar character is the way the spore-shell, in some species, is formed not around the amoeboid germ but quite apart from it, the germ only slipping into the shell when the latter is complete. Almost all known Actinomyxidia live in the Tubificidae (relatives of the earthworm) and are more or less harmless. Important types:—Sphaeroactinomyxon, *Triactinomyxon.*

5. Order *Sarcosporidia.* It is still doubtful if these protozoans are related to the Neosporidia or not, their life-cycle being as yet imperfectly known. The vegetative individuals or "utricles" are usually oval or spindle-shaped multinucleate clumps, which may attain to a considerable size—as much as two inches long. The Sarcosporidia are muscle-parasites of vertebrates, chiefly mammals; the utricle in its young stages lies in the muscle-fibres, the adult utricle lies between them. Some species are markedly pathogenic, for example *Sarcocystis miescheriana* of the pig, which may lead to laming of the hind legs. It is noteworthy that it was in the Sarcosporidia that toxins were first recognized. Important types: *Sarcocystis miescheriana* (pig), *Sarcocystis tenella* (sheep).

5. Class Ciliophora. Protozoa that move by means of numerous cilia;. free-living or parasitic.

1. Order *Opalinida.* Uniformly ciliate Protozoa, usually multinucleate, whose nuclei (in contradistinction to those of the Ciliata) are all alike (fig. 24). Harmless intestinal parasites, feeding osmotically. Reproduction by simple fission; fertilization is by copulation, this being a second distinction from the Ciliata. Important types:—*Opalina ranarum* (rectum of the grass frog).

2. Order *Ciliata.* (Infusoria.) More or less uniformly ciliate, nuclei varying from two to many, always of two kinds, macro- and micronuclei (fig. 4). Only the latter kind can divide mitotically, the macronuclei degenerate at conjugation. Most ciliates are free-living and take in food by gulping it or whirling it in. The same applies to most of the parasitical forms—the greater part of which are external or intestinal parasites; but there are also parasitic forms that feed osmotically. Alternation of hosts does not occur. These organisms are unicellular throughout but sometimes form colonies. Reproduction by simple transverse fission

or (more rarely) by multiple division in a cyst. Fertilization by conjugation.

The Ciliata are divided according to the arrangement of the cilia and other characteristics into numerous groups which need not be further discussed here. Important *types:* — *Paramaecium* (fig. 4), *Stylonychia, Vorticella, Stentor* (fig. 3), *Chilodon* (fig. 8), *Didinium* (fig. 5) (all free-living pond-dwellers), *Tintinnus* (and related marine plankton forms, with cup- or jug-shaped shells), *Ichthyophthirius multifiliis* (parasitic on the skins of fresh-water fish, trout, etc.; pathogenic), *Balantidium coli* (gut of man and of the pig; possibly not quite harmless), *Ophryoscolex, Entodinium* and related forms (characterized by meagre ciliation and possession of a strong cellulose armour; enormously abundant in the stomachs of almost all the hoofed animals-cattle, sheep, pigs, horses, antelopes, etc.), probably symbionts like the Trichonymphidae, but not indispensable.

3. Order *Suctoria.* These Protozoa although without cilia show their close relationship to the ciliates in the possession of macro- and micro-nuclei and by their conjugation. For the most part they are free-living and sessile. They feed themselves by sucking tubules, to which the passing prey sticks. remains attached and is finally sucked up. The parasitic forms — almost all ectoparasites — also feed themselves in this peculiar way. The Suctoria are usually uninucleate, always unicellular. Reproduction by simple or multiple gemmation; sometimes the gemma forms inside the mother-animal in the so-called brood-pouch; the liberated gemmae are freely-moving ciliate organisms at first, only becoming sessile later. Fertilization: conjugation. Important types: *Tokophrya, Sphaerophrya pusilla* (one of the few protozoans that live on other protozoans, such as *Paramaecium* and other ciliates); *Dendrocometes paradoxus* (an ectoparasite on the gill-plates of the fresh-water shrimp *Gammarus).*

BIBLIOGRAPHY.—Only the most important general text-books are given. The literature of special groups is quoted in these books. O. Biitschli, *Protozoen* in Bronn's *Klassen und Ordnungen des Tierreichs,* three volumes (1880–89), out-of-date in many ways, but good for the Ciliata; von Prowazek-Noller, *Handbuch der pathogenen Protozoen* (Leipzig, 1911–28), in many parts considerably out-of-date; E. A. Mindin, *An Introduction to the Study of the Protozoa with special reference to the parasitic forms* (London, 1912), out-of-date in many particulars; M. Hartmann and C. Schilling, *Die pathogenen Protozoen und die durch sie verursachten Krankheiten* (Berlin, 1917), primarily a survey of the pathogenic forms; *A.* Kiihn, *Morphologie der Tiere in Bildern,* "Flagellata" (Berlin, 1922); "Rhizopoda" (1926), deals only with anatomical structure; W. Noller, *Die wichtigsten parasitischen Protozoen des Menschen und der Tiere* (Berlin, 1922), one volume, "General & Rhizopoda," only at present out and the book deals only with parasites; G. N. Calkins, *The Biology of the Protozoa* (1926), deals very thoroughly with the Ciliata; C. M. Wenyon, *Protozoology* (1926), only deals completely with parasitic forms, but in this respect the best modem book; Doflein-Reichenow, *Lehrbuch der Protozoenkunde* (Jena, 1927–28), the best exhaustive modern work. See also R. W. Hegner, *Protozoology* (1930). (K. T. B.)

PROUDHON, PIERRE JOSEPH (1809–1865), French socialist and political writer, was born on Jan. 15, 1809, at Besanqon. He came of poor parents, and was mainly self-educated. At 19 he became a working compositor; and later, as a proofreader, he acquired a competent knowledge of theology and Hebrew, which he compared with Greek, Latin and French. On the strength of the knowledge acquired in this way he wrote an *Essai de grammaire générale.* In 1838 he obtained the *pension Suard,* a bursary of 1,500 francs a year for three years, for the encouragement of young men of promise, which was in the gift of the academy of Besançon.

In 1839 he wrote a treatise *L'Utilité de la célébration du dimanche* which contained the germs of his revolutionary ideas, and in the following year, after a short sojourn in Paris, he published *Qu'est-ce que la propriété?* His famous answer, "La propriété, c'est le vol" (property is theft), displeased the academy of Besanqon, and there was some talk of withdrawing his *pension;* but he held it for the regular period. For his third memoir on property, which took the shape of a letter to the Fourierist, Considérant, he was tried at Besanqon but was acquitted. In 1846 he published his greatest work, the *Systbme des contradictions économiques ou philosophie de la misère.* In 1847 he settled in Paris, and in the following year gained notoriety during the revolution. He was the moving spirit of the *Représentant du peuple* and other journals of advanced views, and as member of assembly for the Seine department he proposed an impost of one-third on interest and rent, which was rejected. His attempt to found a bank which should operate by granting gratuitous credit was also a complete failure. For his violent speeches, Proudhon suffered three years of imprisonment at Paris. As Proudhon aimed at economic rather than political innovation, he accepted the second empire, and lived in comparative quiet till the publication of his work, *De la Justice dans lo révolution et dans l'eglise* (1858), in which he attacked the church and other existing institutions. To escape imprisonment he fled to Brussels, returning later to France in broken health. He died at Passy on Jan. 16, 1865.

Personally Proudhon was one of the most remarkable figures of modern France. His life was marked by the severest simplicity; he was affectionate in his domestic relations, a loyal friend, and strictly upright in conduct. He opposed the prevailing French socialism; and, though an enemy of the dominant ideas and institutions, he was free from feelings of personal hate. In all that he said and did he was the son of the people, who had not been broken to the usual social and academic discipline; hence his roughness, his one-sidedness, and his exaggerations; but he is always vigorous, and often brilliant and original.

Although in his own words "the great part of his publications formed only a work of dissection and ventilation, so to speak, by means of which he slowly makes his way towards a superior conception of political and economic laws," yet the groundwork of his teaching is clear. He believed in the absolute truth of a few moral ideas, with which it was his aim to mould and suffuse political economy. Of these fundamental ideas, justice, liberty and equality were the chief. What he desiderated, for instance, in an ideal society was perfect equality of remuneration on the principle that the duration of labour is the just measure of value. He pursued this theory to its logical conclusion, but looked forward to a period in human development when the present inequality in the capacity of men would be reduced to an inappreciable minimum. From the principle of service as the equivalent of service is derived his axiom that property is the right of *aubaine, i.e.,* the right in virtue of which the sovereign, from the earliest monarchy, claimed the goods of an unnaturalized stranger who had died in his territory. Property is a right of the same nature, with a like power of appropriation in the form of rent, interest, etc. Proudhon's aim was to realize a science of society resting on principles of justice, liberty and equality thus understood; "a science absolute, rigorous, based on the nature of man and of his faculties, and on their mutual relations, a science which we have not to invent, but to discover." But he saw that such ideas could only be realized through a long process of social transformation. He attacked the schools of Saint-Simon and Fourier for thinking that society could be changed off-hand by a ready-made and complete scheme of reform.

In social change Proudhon distinguishes between the transition and the perfection of achievement. With regard to the transition he advocated the progressive abolition of the right of *aubaine,* by reducing interest, rent, etc., but he had no clear conception of the goal. The organization he desired was one on collective principles, a free association which would take account of the division of labour, and which would maintain the personality both of the man and the citizen. Connected with this was his famous paradox of *anarchy,* as the goal of the free development of society, by which he meant that through the ethical progress of men government should become unnecessary. "Government of man by man in every form," he says, "is oppression. The highest perfection of society is found in the union of order and *anarchy."* Proudhon, indeed, was the first to use the word *anarchy,* not in its revolutionary sense, but to express the highest perfection of social organization.

A complete edition of Proudhon's works, including his posthumous writings, was published at Paris (1875). *See* also *P. J. Proudhon, sa vie et sa correspondance,* by Sainte-Beuve (1875); Beauchtry, *Économie sociale de P. J. Proudhon* (Lille, 1867); Spoll, *P. J. Proudhon, ttude biographique* (1867); Marchegay, *Silhouette de Proudhon* (1868); Putlitz, *P. J. Proudhon, sein Leben und seine positiven Ideen* (1881);

Diehl, *P. J. Proudhon, seine Lehre und sein Leben* (Jena, 1888–89); Miilberger, *Studien über Proudhon* (Stuttgart, 1891); Desjardins, *P. J. Proudhon, sa vie, ses oeuvres et sa doctrine* (1896); Miilberger, *P. J. Proudhon* (Stuttgart, 1899).

PROUST, JOSEPH LOUIS (1754–1826), French chemist, was born on Sept. 26, 1754, at Angers, where his father was an apothecary. After beginning the study of chemistry in his father's shop he came to Paris and became apothecary in chief to the Salpetrikre, also lecturing on chemistry at the *musée* of the aeronaut J. F. Pilâtre de Rozier, whom he accompanied in a balloon ascent in 1784. Next, he went to Spain, where he taught chemistry first at the artillery school of Segovia, and then at Salamanca, finally becoming in 1789 director of the royal laboratory at Madrid. In 1808 he lost both his position and his money by the fall of his patron (Charles IV.), and retired first to Craon in Mayenne and then to Angers, where he died on July 5, 1826. Proust's great contribution to chemistry was his establishment of the fundamental principle of the constant composition of many compounds. On this subject he maintained a long controversy with C. L. Berthollet, who was led by his doctrine of mass-action to deny that substances always combine in constant and definite proportions. Proust, on the other hand, maintained that compounds always contain definite quantities of their constituent elements, and that in cases where two or more elements unite to form more than one compound, the proportions in which they are present vary per saltum, not gradually. In 1799 he proved that copper carbonate, whether natural or artificial, always has the same composition, and later he showed that the two oxides of tin and the two sulphides of iron always contain the same relative weights of their components and that no intermediate indeterminate compounds exist. His analytical skill enabled him to demonstrate the inaccuracy of the researches by which Berthollet attempted to support the opposite view, and to show among other things that some of the compounds which Berthollet treated as oxides were in reality hydrates containing chemically combined water, and the upshot was that by 1808 he had fully vindicated his position. Proust also investigated the varieties of sugar that occur in sweet vegetable juices, distinguishing three kinds, and he showed that the sugar in grapes, of which he announced the existence to his classes at Madrid in 1799, is identical with that obtained from honey by the Russian chemist J. T. Lowitz (1757–1804).

Besides papers in scientific periodicals he published *Indagaciones sobre el estañada de cobre, la vajilla de estaño y el vidriado* (1803); *Mémoire sur le sucre de raisins* (1808); *Recueil des mdmoires relatifs á la poudre à canon* (1815); and *Essai sur une des causes qui peuvent amener la formation du calcul* (1824).

PROUST, MARCEL (1871–1922), French man of letters, was born in Paris on July 10, 1871. His father was a professor of medicine, and his mother was of Jewish extraction. He was educated at the lycée Condorcet, and about 1892 he was for some time associated with Léon Blum, Louis Mirhlfeld and Tristan Bernard on the Revue Blanche, a periodical conducted by a select group of intellectuals, mostly Jewish. Becoming a favourite in the salons–especially those of Mme. de Caillavet and Madeleine Lemaire—he wrote a number of society love-stories (collected in 1896 under the title Les *plaisirs et* les *jours*) distinguished by their psychological subtlety. He also attained reputation as a clever writer of *pastiches.* He became an enthusiastic admirer of John Ruskin and translated several of his works into French, including the Bible of *Amiens,* to which he contributed a valuable preface.

In 1902 Proust's health began to fail. Thenceforward he was reluctantly obliged to lead an extremely retired and careful life, and for many years it looked as if he had altogether abandoned literature, in which his name hitherto had not been known outside a small circle of friends. He was reading and writing a great deal, however. The interminable discursiveness of Ruskin, which French readers do not suffer gladly, was to him a constant source of delight, and Saint-Simon, ever one of his favourite authors, exerted a powerful influence upon him at this time. Thus it came about that, having unlimited time at his disposal, he embarked upon a long and leisurely work, full of minute detail, in which was imprisoned, as in a net, his whole experience of life; in which the *salon* life he loved was revived in all its details and observances like the court life in Saint-Simon's memoirs; in which the people he had known provided the materials for new, fuller and richer characters (M. de Charlus, for example, is a blending of three different people of Proust's acquaintance), and in which the author sought out and lived the past over again. Hence the general title given to the 15 volumes of the series, *A* la recherche *du* temps perdu (1913, etc.).

This lengthy work had almost been completed when Proust published the first part, Du *côté* de *chez Swann,* in 1913. The freshness and minuteness of the recollections of childhood attracted some attention, but none the less Proust, who had had to publish the first part at his own expense, had difficulty in finding a publisher for the second, *L'ombre des jeunes filles* en *fleurs.* When it did appear its qualities were at once appreciated by Léon Daudet, whose enthusiastic articles, followed by the award of the Prix Goncourt in 1918, brought Proust's name prominently before the public, and he was read, discussed and criticised everywhere. Two more parts appeared during Proust's lifetime—Le *côté* de Guermantes and *Sodome* et *Gomorrhe,* both in 1921. When he died in Paris, Nov. 18, 1922, he left three parts still in manuscript—La *prisonnière,* published in 1924, Albertine *Disparue* (1926) and Le temps retrouvk (1926).

Proust's influence, especially since his death, has been considerable. He introduced into the novel an analytic method which has a superficial resemblance to that of Meredith, but is more properly comparable with that of Freud. That the name and notion of time should appear in the general title of his great work is not without significance. By a curious coincidence he was related by marriage to Bergson, the philosopher of "creative time," and the term "creative time" aptly describes the psychological time which Proust explores, seeks and recovers. His people are never given as "characters" in the fashion of La Bruyère or Balzac; they are always in process of development, change and continual creation.

Part of Proust's success was due to the very thing that is likely to tell against his lasting reputation, viz.: the fact that his characters, beginning with the "I" of the book, are exceptional, an erotic and mysterious group having little in common with the generality of mankind. This is true not only of *Sodome* et Gomorrhe and Proust's emphasis upon homosexuality, but also of the idle life and ultimate nothingness of the people of his world, their lack of all interests other than those of social life, and the indifference that the ordinary reader must always feel as to their fate. On the other hand, there will be a taste for Proust so long as there is a taste for pyschology as an end in itself, and so long as the play of memory, the searching and brooding that pertain to the conquest of the past, afford to some men a sufficient reason for living or a romantic manner of not living. The following translations by C. K. Scott Moncrieff appeared in English: *Swann's* Way (1922); Within a Budding Grove (1924); *The* Guermantes Way (1925); Cities of the Plain (trans. of *Sodome* et Gomorrhe) (2 vols. 1927); The Captive (1929). (A. T.)

See Marcel Proust, an English tribute, collected by C. K. Scott Moncrieff (1923); Jacques Rivitre, *Marcel Proust* (1924); L. Pierre-Quint, *Marcel Proust, sa vie, son oeuvre* (1925, Eng. trs. 1927); Benoist-Méchin, *La Musique et l'immortalité dam Poeuvre de Marcel Proust* (1926); R. Dreyfus, *Marcel Proust à dix-sept ans* (1926), and *Souvenirs sur Marcel Proust* (1926); G. Gabory, *Essai sur Marcel Proust* (1926); *Marcel Proust,* by various writers, with bibliography (1926); P. Souday, *Marcel Proust* (1927); R. Fernandez, *Les Cahiers de Marcel Proust* (1927); and Clive Bell, Proust (1928). His *Lettres inédites* were published with a preface by Camille Vettard in 1926. *Chroniques,* a selection of his articles chiefly from *Le Figaro,* was edited by R. Proust (1927).

PROUSTITE, a mineral consisting of silver sulpharsenite, Ag_3AsS_3, known also as light red silver ore, and an important source of the metal. It is closely allied to the corresponding sulphantimonite, pyrargyrite, from which it was distinguished by the chemical analyses of J. L. Proust in 1804, after whom the mineral received its name. Many of the characters being so similar to those of pyrargyrite (*q.v.*) they are mentioned under that species. The colour is scarlet-vermilion and the lustre adamantine; crystals are transparent and very brilliant, but on exposure to light they soon become dull black and opaque. The streak is scarlet, the hardness 2·5, and the specific gravity 5·57. The mode of occurrence is the same as that of pyrargyrite, and the two minerals are sometimes found together. Magnificent groups of large crystals have been found at Chañarcillo in Chile; other localities which have yielded fine specimens are Freiberg and Marienberg in Saxony.

PROUT, SAMUEL (1783–1852), English water-colour painter, was born at Plymouth on Sept. 17, 1783. He spent whole summer days, in company with the ill-fated Haydon, in drawing the quiet cottages, rustic bridges and romantic water-mills of Devon. It was not however, until about 1818, when he visited the Continent and first saw the quaint streets and market-places of continental cities, that Prout discovered his proper sphere. All his faculties sprang into unwonted activity. His eye readily caught the picturesque features of the architecture, and his hand recorded them in drawings which were admirable in line, composition and colour. At the time of his death, on Feb. 10, 1852, there was scarcely a nook in France, Germany, Italy and the Netherlands which his quiet, benevolent, observant eye had not searched for antique gables and sculptured pieces of stone. In Venice especially there was hardly a pillar which his eye had not lovingly studied and his pencil had not dexterously copied.

See a memoir of Prout, by John Ruskin, in Art Journal for 1849, and the same author's Notes on *the Fine* Art Society's *Loan* Collection of Drawings by *Samuel* Prout and William Hunt (1879–80); *see* also the "Winter Number" of the *Studio* (1914–15), for reproductions of his sketches.

PROUT, WILLIAM (1785–1850), English chemist and physician, was born at Horton, Gloucestershire, on Jan. 15, 1785, and died in London on April 9, 1850. His life was spent as a practising physician in London, but he also occupied himself with chemical research He was an active worker in physiological chemistry, and found in 1803 that the acid contents of the stomach contain hydrochloric acid which is separable by distillation. In 1815 he published anonymously in the Annals of Philosophy a paper in which he calculated that the atomic weights of a number of the elements are multiples of that of hydrogen; and in a second paper published in the same periodical the following year he suggested that the πρώτη ὕλη of the ancients is realized in hydrogen, from which the other elements are formed by some process of condensation or grouping. This view, generally known as "Prout's hypothesis," at least had the merit of stimulating inquiry, and many of the careful determinations of atomic weights undertaken since its promulgation have been provoked by the desire to test its validity. It is also particularly interesting in view of recent developments in the study of atomic structure (see ATOM).

PROVENCAL LANGUAGE AND LITERA'MJRE. The term Provencal is employed in two different meanings. (1) *Lato sensu,* it embraces all idioms of Latin origin spoken in Southern France over a zone extending south of a line which starts at the mouth of the Gironde, passes through Bordeaux, Libourne, Mussidan, Péngueux, Nontron, Mouhet, Bellac, Limoges, Guéret, Chénérailles, Montluçon, Verneuil, Clermont-Ferrand, Saint-Bonnet-le-Chhteau, Saint Sauveur-en-Rue, Gilhoc, Saint-Vallier, Romans, Die, Montmaur and finishes at Puy-Saint André. (2) *Stricto* sensu, it is applied to the idioms spoken in the Alpes-Maritimes, Basses-Alpes, Var and Bouches-du-Rhône departments. It was long customary to distinguish the dialects of Southern France by the names of the old provinces in which they occur, viz., Béarnais, Languedocien, Rouergat, etc. The classification now generally adopted is: (1) Gascon, (2) Provençal moyen and Provencal alpin (from Agen to Mentone), (3) Auvergnat and Limousin, (4) Catalan (*q.v.*).

With the 12th century arose a literary language used as a κοινή by the Troubadors. As some of the most celebrated of these poets, Bernard de Ventadour, Arnaud Daniel, Bertrand de Born and Jaucelm Faidit came from the Limousin, this κοινή was long known as *lengua lemosina;* a name, however, not to be misinterpreted. The literary language was not homogeneous, but composite.

The Troubadors conveyed this form of Provençal with them to Northern France, Italy, Spain and Portugal. When Languedoc passed to the House of France (1272) two languages, Latin almost exclusively and French to a very limited degree, were employed for administrative purposes. Minute examination of the documents contained in the archives of Southern France has recently proved that French exerted only inappreciable influence upon Provencal down to the close of mediaeval times. The Frenchification was not the outcome of a long, slow process. Indeed at the end of the Hundred Years' War, Provencal was still highly vigorous both in administrative and general use; it was then, from 1450 to 1600, very rapidly penetrated by French. First to yield was Northern Limousin; it was followed next by Périgord, Bordelais, Agenais, then Gascony, and finally by the Pyrenees which resisted till the last years of the 18th century. The initial period of this penetration may be placed about 1540 (see A. Brun, Recherches *historiques sur l'introduction* du *français dans les* provinces du midi, 1923). The various patois, continuing to be spoken by the middle class and peasantry developed freely. The new lease of life upon which the Southern idioms entered during the second half of the 19th century, must not be regarded as an unexpected accident. It had been prepared by the reawakening sense of nationality and promoted by the efforts of scholars, historians and men of letters, all of whom united in lauding the qualities of the ancient tongue and urging the Southerners to voice their native feelings and aspirations in their native "language." Amongst the leading representatives of the movement must be mentioned F. Mistral, not only on account of his literary masterpieces, especially his immortal *Mirèio* (1859), but also for his publication of *Lou* Tresor d'ou *Felibrige* (1878–86), the Provencal French dictionary which conferred *lettres* de noblesse on the new classical language of Provence, sprung from divers patois of the Bouches-du-Rhône. Provençal (including Catalan) is spoken by some 10,000,000 persons in France.

The Provencal dialects are less divergent from Latin than is the case with French. The following particulars will help to make clear what has been called "the archaic character" of Provencal and give, at the same time, a concise view of its special phonetic features.

I. VOWELS

(a) Latin tonic free vowels: L. *amAre,* Pr. *amAr* (later *amA*), F. *amEr* (later *aimEr*). L. *pEdem,* Pr. *pE,* F. *pIE* (later spelt *piEd*). L. *credEre,* Pr. *crezEr* (later *creSE* in some parts), Bearnais *credEr* (later *credE*); F. *crEIre* (later *croIre*); L. *solum,* Pr. sol, Fr. *sUEl* (later *SEUl*); L. *florem,* Pr. *flor,* F. flour (later *flEUr*).

(b) Latin tonic free diphthong au: L. *AUrum,* Pr. *AUr,* F. or.

(c) Posttonic a: L. *clarA,* Pr. *clarA* (later claro), F. *clerE* (later *clAIre*).

(d) Latin intertonic free a: L. *durAmente,* Pr. *durAmen,* F. *durEment.*

II. CONSONANTS

(e) Latin C and G before *A* were kept C and G in Provençal (except Limousin and Auvergne) and became CH (first pronounced TCH) and *J* (first pronounced DJ) in French (except Normanno-Picard dialect where they persisted as C and G, like Provencal): L. *caballum,* Pr. *Caval,* F. *CHeval;* L. *Gallina,* Pr. *Galina* (later *Galino*), F. *Geline.*

(f) Latin intervocalic C: L. *paCare,* Pr. *paGar* (later *paGa*), F. *paGer;* L. *seCurum,* Pr. *seGur* (in part of Basses-Pyrénées secur). Latin intervocalic G: L. *plaGa,* Pr. *plaGa* (later *plaGo*), F. *plaie;* L. *ruGa,* Pr. *ruGa* (later *ruGo*), F. rue. Latin intervocalic T: L. *viTa,* Pr. *viDa* (later *viDo*), F. vie; L. *quaTernum,* Pr. cazern, F. cahier. Latin intervocalic D: L. *creDere,* Pr. *crezer* (in part of Basses-Pyrénées *creDer*), F. creire (later croire).

N.B. In some parts of Mod. Pr. there is a form creire which represents the state of evolution to be found in France till the 13th century. Latin intervocalic DR, TR: L. *quaDratum,* Pr. *caIrat,* F. *caRRé,* L. *paTrem,* Pr. *paIre,* F. *pére* (later *père*).

(gi In the group Sf 1 or 2 consonants, *s* has been kept in Provençal spelling and pronunciation; from French pronunciation it disappeared since the 13th century, although it was preserved in spelling till the middle of the 18th century (suppressed in the 3rd edition of the *Dictionnaire de l'Académie Française,* 1740); L. scribere, Pr. *escriure,* F. *escrire* (later *écrire*); L. *castellum,* Pr. *castel,* F. *chasteau* (later *château*).

(h) Among the final consonants let us quote *p,* v, *s,* Vulg. L. *capum* (cl. L. *caput*), Pr. cap (a regression of *cat*—a form which is not attested in the documents at our disposal), F. *chief*; L. brevem, Pr. *brèu,* F. *bref.* Final *s* has been preserved both in spelling and pronunciation in the greatest part of Provencal; it disappeared from the pronunciation of French in the course of the 13th century. L. *causas,* Pr. cauzas (later *cauzos*), F. *choses.*

Among the Provencal dialects Gascon has quite peculiar features, the following three are most specially characteristic: (a) Change of Latin intervocalic *ll* to *r;* L. *appellare,* Gasc. *aperar* (later *apera*); (b) change of Latin final *ll* to t: L. *agnellum,* Gasc. *agnet*; (c) change of Latin f to aspirate *h:* L. *femina,* Gasc. Femna till the end of the 13th century, then *Hemna* (later *Henno*).

Note that there are two other peculiar features (d) the pronunciation of b as in Spanish (*i.e.,* an intermediary sound between b and v); (e) the fall of Latin intervocalic *n* as in Portuguese: L. *gallina,* Gasc. garia (later gario). But (d) has gone beyond Gascony since the middle ages, and (e) is not to be found in Bordelais.

As general remarks on the morphology it may be pointed out that the declension of nouns and adjectives ceased to exist earlier than in French: the 13th century is the limit reached by the distinction between the two cases. In some parts like Béarn no trace of any declension at any time is to be found. In the conjugation we find (a) a past simple ending in—ei (like cantei, *cantest,* cantet, *cantem,* cantetz, canteron; vendei, vendest, etc.), most likely corresponding to L.—*ĕdi*—*ĕti,* as in dedi *steti.* (b) a remnant of Latin pluperfect ending in *aram* (contracted from *averam*), *īram* (contracted from iveram), ederam, e.g., cantara or *cantera,* partira, *vendera* used in the meaning of a conditional.

There is a great similarity in the aspect of old and modern Provencal. The only important facts since the 15th century are (a) the change of final a into o (except in some parts where it has persisted as a, and in others where it became *e,* closer than in French).

(i) The great simplification of the conjugations, many verbs having passed to the—ar conjugation. (L. B.)

LITERATURE

Provenqal literature is much more easily defined than the language in which it is expressed. Starting in the 11th and 12th centuries in several centres it thence gradually spread out, first over the greater portion, though not the whole of southern France, and then into the north of Italy and Spain.

Origin.—It took poetic form; and its oldest monuments show a relative perfection and a variety from which it may be concluded that poetry had already received a considerable development. The honour of being the oldest literary monument of the Provencal language must be assigned to a fragment of 257 decasyllabic verses preserved in an Orleans ms. and frequently edited and annotated since it was first printed by Raynouard in 1817 in his *Choix des poésies originales* des troubadours. The writing of the ms. is of the first half of the 11th century. The peculiarities of the language point to the north of the Provencal region, probably Limousin or Marche. It is the beginning of a poem in which the unknown author, taking Boethius's treatise De *consolatione philosophiae* as the groundwork of his composition, adopts and develops its ideas and gives them a Christian colouring of which there is no trace in the original. Thus from some verses in which Boethius contrasts his happy youth with his afflicted old age he draws a lengthy homily on the necessity of laying up from early years a treasure of good works. A little later, at the close of the same century, we have the poems of William IX., count of Poitiers, duke of Guienne. They consist of 11 very diverse strophic pieces, and were meant to be sung. We also know from Ordericus Vitalis that William IX. had composed various poems on the incidents of his ill-fated expedition to the Holy Land in 1101. And it must further be mentioned that in one of his pieces (Ben voil que *sapchon li plusor*) he makes a very clear allusion to a kind of poetry which we know only by the specimens of later date, the partimen, or, as it is called in France, the jeu *parti.* William IX. was born in 1071 and died in 1127. The contrast in form and subject between the Boethius poem and the stanzas of William IX. is an indication that by the 11th century Provencal poetry was being rapidly developed in various directions. Whence came this poetry? How and by whose work was it formed? That it has no connection whatever with Latin poetry is generally admitted. The view which seems to meet with general acceptance, though it has not been distinctly formulated by any one, is that Romanic poetry sprang out of a popular poetry quietly holding its place from the Roman times, no specimen of which has survived—just as the Romanic languages are only continuations with local modifications of Vulgar Latin. There are both truth and error in this opinion. Romanic versification, as it appears in the Boethius poem and the verses of William IX., and a little farther north in the poem of the Passion and the Life of St. *Leger* (10th or 11th century), has with all its variety some general and permanent characteristics; it is rhymed, and it is composed of a definite number of syllables certain of which have the syllabic accent. This form has evident affinity with the rhythmic Latin versification, of which specimens exist from the close of the Roman empire in ecclesiastical poetry. The exact type of Romanic verse is not found, however, in this ecclesiastical Latin poetry; the latter was not popular. However, it may be assumed that there was a popular rhythmic poetry from which Romanic verse is derived.

Again, as regards the substance, the poetic material, we find nothing in the earliest Provencal which is strictly popular. The extremely personal compositions of William IX. have nothing in common with folk-lore. They are subjective poetry addressed to a very limited and probably rather aristocratic audience. The same may be said of the Boethius poem, though it belongs to the quite different species of edifying literature; at any rate it is not popular poetry. Vernacular compositions seem to have been at first produced for the amusement, or in the case of religious poetry, for the edification, of that part of lay society which had leisure and lands, and reckoned intellectual pastime among the good things of life. Gradually this class, intelligent, but with no Latin education, enlarged the circle of its ideas. In the 12th century, and still more in the 13th, historical works and popular treatises on contemporary science were composed for its use in the only language it understood; and vernacular literature continued gradually to develop partly on original lines and partly by borrowing from the literature of the "clerks."

From what class of persons then did it proceed? Latin chroniclers of the middle ages mention as *ioculares,* ioculatores, men of a class not very highly esteemed whose profession consisted in amusing their audience either by what we still call jugglers' tricks, by exhibiting performing animals, or by recitation and song. They are called *joglars* in Provencal, *jonglers* or *jongleurs* in French; and they were the first authors of poetry in the vernacular both in the south and in the north of France. (See Edmond Faral, Les Jongleurs en France au moyen *âge,* Paris, 1910, and R. Menéndez Pidal, Poesia juglaresca y *juglares,* Madrid, 1924.)

Poetry of the Troubadours.—Centres of poetic activity are found first in Limousin and Gascony. In Limousin lived a viscount of Ventadour, Eble, who during the second part of William of Poitiers's life seems to have been brought into relation with him, and according to a contemporary historian, Geffrei, prior of Vigeois, *erat* valde *gratiosus* in *cantilenis.* We possess none of his compositions; but under his influence Bernart of Ventadour was trained to poetry. Bernart gained the love of the lady of Ventadour, and when on the discovery of their amour he had to depart elsewhere, received a gracious welcome from Eleanor of Guienne, consort (from 1152) of Henry II. of England. Of Bernart's compositions we possess about 50 songs of elegant simplicity, some of which may be taken as the most perfect specimens of love poetry Provenqal literature has ever produced. At the same period, or earlier, flourished Cercamon, a Gascon, who composed, says his old biographer, "pastorals" according to the ancient custom (*pastorelas a la uzansa antiga*). Among the earliest troubadours is Marcabrun, a pupil of Cercamon's, from whose pen we have about 40 pieces, those which can be approximately dated ranging from 1135 to 1148 or thereabout. His songs, several of which are historical, are free from the commonplaces of their class, and contain curious strictures on the corruptions of the time.

We cannot here do more than enumerate the leading troubadours and briefly indicate in what conditions their poetry was developed and through what circumstances it fell into decay and finally disappeared: Peter of Auvergne (Peire d'Alvernha), who in certain respects must be classed with Marcabrun; Arnaut Daniel, remarkable for his complicated versification, the inventor of the *sestina,* a poetic form for which Dante and Petrarch express an admiration difficult for us to understand; Arnaut of Mareuil, who, while less famous than Arnaut Daniel, certainly surpasses him in elegant simplicity of form and delicacy of sentiment; Bertran de Born, now the most generally known of all the troubadours on account of the part he is said to have played both by his sword and his *sirventescs* in the struggle between Henry II. of England and his rebel sons, though the importance of his part in the events of the time seems to have been greatly exaggerated; Peire Vidal of Toulouse, a poet of varied inspiration who grew rich with gifts bestowed on him by the greatest nobles of his time; Guiraut de Borneil, *lo maestre dels trobadors,* and at any rate master in the art of the so-called "close" style (*trobar clus*), though he has also left us some songs of charming simplicity; Gaucelm Faidit, from whom we have a touching lament (*planh*) on the death of Richard Coeur de Lion; Folquet of Marseilles, the most powerful thinker among the poets of the south, who from being a troubadour became first a monk, then an abbot, and finally bishop of Toulouse (d. 1231).

The troubadours could hardly expect to obtain a livelihood from any other quarter than the generosity of the great. It will consequently be well to mention the most important at least of those princes who are known to have been patrons and some of them practisers of the poetic art. They are arranged approximately in geographical order, and after each are inserted the names of those troubadours with whom they were connected.

France.—ELEANOR OF GUIENNE, Bernart de Ventadour (Ventadorn); HENRY CURTMANTLE, son of Henry II. of England, Bertran de Born (?); RICHARD COEUR DE LION, Arnaut Daniel, Peire Vidal, Folquet of Marseilles, Gaucelm Faidit; ERMENGARDE OF NARBONNE (1143–1192), Bernart de Ventadour, Peire Rogier, Peire d'Alvernha; RAIMON V., count of Toulouse (1143–1194), Bernart de Ventadour, Peire Rogier, Peire Raimon, Hugh Brunet, Peire Vidal, Folquet of Marseilles, Bernart de Durfort; RAIMON VI., count of Toulouse (1194–1222), Raimon de Miraval, Aimeric de Pegulhan, Aimeric de Belenoi, Ademar lo Negre; ALPHONSE II., count of Provence (1185–1209), Elias de Barjols; RAIMON BERENGER IV., count of Provence (1209–1245), Sordel; BARRAL, viscount of Marseilles (d. *c.* 1192), Peire Vidal, Folquet de Marseilles; WILLIAM VIII., lord of Montpellier (1172–1204), Peire Raimon, Arnaut de Mareuil, Folquet de Marseilles, Guiraut de Calanson, Aimeric de Sarlat; ROBERT, dauphin of Auvergne (1169–1234), Peirol, Perdigon, Pierre de Maensac, Gaucelm Faidit; GUILLAUME DU BAUS, prince of Orange (1182–1218), Raimbaut de Vacqueiras, Perdigon; SAVARIC DE MAULÉON (1200–1230), Gaucelm de Puicibot, Hugh de Saint Circq; BLACATZ, a Provençal noble (1200?–1236), Cadenet, Jean d'Aubusson, Sordel, Guillem Figueira; HENRY I., count of Rodez (1208–1222?), Hugh de Saint Circq; perhaps HUGH IV., count of Rodez (1222?–1274) and HENRY II., count of Rodez (1274–1302), Guiraut Riquier, Folquet de Lunel, Serveri de Girone, Bertran Carbonel; NUNYO SANCHEZ, count of Roussillon (d. 1241), Aimeric de Belenoi; BERNARD IV., count of Astarac (1249–1291), Guiraut Riquier, Amanieu de Sescas.

Spain.—ALPHONSE II., king of Aragon (1162–1196), Peire Rogier, Peire Raimon, Peire Vidal, Cadenet, Guiraut de Cabreira, Elias de Barjols, the monk of Montaudon, Hugh Brunet; PETER II., king of Aragon (1196–1213), Raimon de Miraval, Aimeric de Pegulhan, Perdigon, Ademar lo Negre, Hugh of Saint Circq; JAMES I., king of Aragon (1213–1276), Peire Cardinal, Bernart Sicart de Maruejols, Guiraut Riquier, At de Mons; PETER III., king of Aragon (1276–1285), Paulet of Marseilles, Guiraut Riquier, Serveri de Girone; ALPHONSO IX., king of Leon (1138–1214), Peire Rogier, Guiraut de Borneil, Aimeric de Pegulhan, Hugh de Saint Circq; ALPHONSO X., king of Castile (1252–1284), Bertran de Lamanon, Bonifaci Calvo, Guiraut Riquier, Folquet de Lunel, Arnaut Plages, Bertran Carbonel.

Italy.—BONIFACE II., marquis of Montferrat (1192–1207), Peire Vidal, Raimbaut de Vacqueiras, Elias Cairel, Gaucelm Faidit (?); FREDERICK II., emperor (1215–1250), Jean d'Aubusson, Aimeric de Pegulhan, Guillem Figueira; Azzo VI., marquis of Este (1196–1212), Aimeric de Pegulhan, Rambertin de Buvalelli; Azzo VIII., marquis of Este (1215–1264), Aimeric de Pegulhan.

The first thing that strikes one in this list is that, while the troubadours find protectors in Spain and Italy, they do not seem to have been welcomed in French-speaking countries. This, however, must not be taken too absolutely. Provençal poetry was appreciated in the north of France. There is reason to believe that when Constance, daughter of one of the counts of Arles, was married in 998 to Robert, king of France, she brought along with her Provençal jongleurs. Poems by troubadours are quoted in the French romances of the beginning of the 13th century; some of them are transcribed in the old collections of French songs, and the preacher Robert de Sorbon informs us in a curious passage that one day a jongleur sang a poem by Folquet of Marseilles at the court of the king of France.

The decline and fall of troubadour poetry was mainly due to political causes. When about the beginning of the 13th century the Albigensian War had ruined a large number of the nobles and reduced to lasting poverty a part of the south of France, the profession of troubadour ceased to be lucrative. It was then that many of those poets went to spend their last days in the north of Spain and Italy, where Provençal poetry had for more than one generation been highly esteemed. Following their example, other poets who were not natives of the south of France began to compose in Provençal, and this fashion continued till, about the middle of the 13th century, they gradually abandoned the foreign tongue in northern Italy, and somewhat later in Catalonia, and took to singing the same airs in the local dialects. About the same time in the Provençal region the flame of poetry had died out save in a few places—Narbonne, Rodez, Foix and Astarac—where it kept burning feebly for a little longer. In the 14th century composition in the language of the country was still practised; but the productions of this period are mainly works for instruction and edification. As for the poetry of the troubadours, it was dead forever.

Form.—Originally the poems of the troubadours were intended to be sung. The poet usually composed the music as well as the words; and in several cases he owed his fame more to his musical than to his literary ability. Two manuscripts preserve specimens of the music of the troubadours, but, though the subject has been carefully investigated, we are not able to form a clear opinion of the originality and of the merits of these musical compositions. The following are the principal poetic forms which the troubadours employed. The oldest and most usual generic term is *vers,* by which is understood any composition intended to be sung, no matter what the subject. At the close of the 12th century it became customary to call all verse treating of love *canso*—the name *vers* being then more generally reserved for poems on other themes. The *sirventesc* differs from the *vers* and the *canso* only by its subject, being for the most part devoted to moral and political topics. The *tenson* is a debate between two interlocutors, each of whom has a stanza in turn. The *partimen* (Fr. *jeu parti*) is also a poetic debate, but it differs from the tension in so far that the range of debate is limited. This poetic game is mentioned by William, count of Poitiers, at the end of the 11th century. The *pastoreta,* afterwards *pastorela,* is in general an account of the love adventures of a knight with a shepherdess. All these classes have one form capable of endless variations: five or more stanzas and one or two envois. The *dansa* and *balada,* intended to mark the time in dancing, are pieces with a refrain. The *alba,* which has also a refrain, is, as the name indicates, a waking or morning song at the dawning of the day. All those classes are in stanzas. The *descort* is not thus divided, and consequently it must be set to music right through. Its name is derived from the fact that, its component parts not being equal, there is a kind of "discord" between them. It is generally reserved for themes of love. Other kinds of lyric poems, sometimes with nothing new about them except the name, were developed in the south of France; but those here mentioned are the more important.

Chansons de Geste and Historical Poems.—Northern France remains emphatically the native country of the *chanson de geste;* but, although in the south different social conditions, a more delicate taste, and a higher state of civilization prevented a similar profusion of tales of war and heroic deeds, Provencal literature has some highly important specimens of this class. The first place belongs to *Girart de Roussillon,* a poem of ten thousand lines, which relates the struggles of Charles Martel with his powerful vassal the Burgundian Gerard of Roussillon. The existing recension seems to have originated on the borders of Limousin and Poitou; but it is a recast of an older poem no longer extant, probably either of French or at least Burgundian origin. To Limousin also seems to belong the poem of *Aigar and Maurin* (end of the 12th century). Of less heroic character is the poem of *Daurel and Beton* (first half of the 13th century). Midway between legend and history may be classified the Provencal *Chanson of Antioch,* a mere fragment of which, 700 verses in extent, has been recovered in Madrid and published in *Archives de l'Orient latin,* vol. ii. This poem (*see* G. Paris, in *Romania,* xxii. 358), is one of the sources of the Spanish compilation *La gran conquista de Ultramar.* To history proper belongs the Chanson of the crusade against the Albigensians, which, in its present state, is composed of two poems one tacked to the other: the first, containing the events from the beginning of the crusade till 1213, is the work of a cleric named William of Tudela, a moderate supporter of the crusaders; the second, from 1213 to 1218, is by a vehement opponent of the enterprise. The language and style of the two parts are no less different than the opinions. Finally, about 1280, Guillaume Anelier, a native of Toulouse, composed, in the *chanson de geste* form, a poem on the war carried on in Navarre by the French in 1276 and 1277. It is an historical work of little literary merit. All these poems are in the form of *chansons de geste,* viz. in stanzas of indefinite length, with a single rhyme. *Gerard of Roussillon, Aigar and Maurin* and *Daurel and Beton* are in lines of ten, the others in lines of twelve syllables. The peculiarity of the versification in *Gerard* is that the pause in the line occurs after the sixth syllable, and not, as is usual, after the fourth.

Narrative Poems.—We possess but three Provencal romances of adventure: *Jaufré* (composed in the middle of the 13th century and dedicated to a king of Aragon, possibly James I.), *Blandin of Cornwall* and *Guillem de la Barra.* Connected with the romance of adventure is the novel (in Provençal *novas,* always in the plural), which is originally an account of an event "newly" happened. Some of those novels which have come down to us may be ranked with the most graceful works in Provençal literature; two are from the pen of the Catalan author Raimon Vidal de Besalú. One, the *Castia-gilos* (the chastisement of the jealous man), is a treatment, not easily matched for elegance, of a frequently-handled theme—the story of the husband who, in order to entrap his wife, takes the disguise of the lover whom she is ex. pecting and receives with satisfaction blows intended, as he thinks, for him whose part he is playing; the other, *The judgment of Love,* is the recital of a question of the law of love, departing considerably from the subjects usually treated in the novels. Mention may also be made of the novel of *The Parrot* by Arnaut de Carcassonne, in which the principal character is an eloquent parrot, who assists the amorous enterprises of his master. Novels came to be extended to the proportions of a long romance. *Flamenca,* which belongs to the novel type, has still over eight thousand lines, though the only ms. of it has lost some leaves both at the beginning and at the end. This poem, composed in all probability in 1234, is the story of a lady who by very ingenious devices, not unlike those employed in the *Miles gloriosus* of Plautus, eludes the vigilance of her jealous husband. No book in mediaeval literature betokens so much quickness of intellect or is so instructive in regard to the manners and usages of polite society in the 13th century. From the south of France the novel spread into Catalonia, where we find in the 14th century a number of novels in verse very similar to the Provencal ones, and into Italy, where in general the prose form has been adopted.

Didactic and Religious Poetry.—The more important works are: Daude de Prades (early 13th century), *Auzels cassadors,* one of the best sources for the study of falconry; a translation by Raimon d'Avignon (about A.D. 1200) of Rogier of Parme's "Surgery" (*Romania,* x. 63 and 496); the Boethius poem (unfortunately a mere fragment) already mentioned as one of the oldest documents of the language, and really a remarkable work; an early (12th century?) metrical translation of the famous *Disticha de moribus* of Dionysius Cato (*Romania,* xxv. 98 and xxix. 445). More original are some compositions of an educational character known under the name of *ensenhamenz,* and, in spme respects, comparable to the English nurture-books. The most interesting are those of Garin le Brun (12th century), Arnaut de Mareuil, Arnaut Guilhem de Marsan, Amanieu de Sescas. Their general object is the education of ladies of rank. Of metrical lives of saints we possess about a dozen (see *Histoire littéraire de la France,* vol. xxxii.), among which two or three deserve a particular attention: the life of Sancta Fides (A. Thomas and E. Hoepffner's editions), written early in the 12th century; the life of St. Enimia (13th century), by Bertran of Marseilles (C. Brunel's edition) and that of St. Honorat of Lerins by Raimon Feraud (about 1300), which is distinguished by variety and elegance of versification, but it is almost entirely a translation from Latin. Lives of saints (St. Andrew, St. Thomas the Apostle, St. John the Evangelist) form a part of a poem, strictly didactic, which stands out by reason of its great extent (nearly 35,000 verses) and the somewhat original conception of its scheme—the *Breviari d'amor,* a vast encyclopaedia, on a theological basis, composed by the Minorite friar Matfre Ermengaut of Béziers ca. 1288–1300.

Drama.—The dramatic literature of southern France consists of mysteries and miracle plays seldom exceeding two or three thousand lines, which never developed into the enormous dramas of northern France, whose acting required several consecutive days. Generally those plays belong to the 15th century or to the 16th. Still, a few are more ancient and may be ascribed to the 14th century or even to the end of the 13th. The oldest appears to be the *Mystery of St. Agnes* (edited by Bartsch, 1869), written in Arles. Somewhat more recent, but not later than the beginning of the 14th century, is a Passion of Christ (not yet printed) and a mystery of the Marriage of the Virgin, which is partly adapted from a French poem of the 13th century (see *Romania* xvi. 71). A manuscript, discovered in private archives (printed by Jeanroy and Teulié, 1893), contains not less than 16 short mysteries, three founded on the Old Testament, 13 on the New. They were written in Rouergue and are partly imitated from French mysteries. At Manosque (Basses Alpes) was found a fragment of a *Ludus sancti Jacobi,* inserted in a register of notarial deeds (printed by C. Arnaud, Marseilles, 1858). The region comprised between the Rhone and the Var seems to have been particularly fond of representations of this sort, to judge by the entries in the local records (see *Romania* xxvii. 400). At the close of the 15th and the beginning of the 16th centuries many mysteries were played in that part of Dauphiné which corresponds to the present department of Hautes-Alpes. Five mysteries of this district, composed and played somewhere about 1500 (the mysteries of St. Eustace, of St. Andrew, of St. Pons, of SS. Peter and Paul and of St. Anthony of Vienne), have come down to us, and have been edited by Abbé Fazy (1883), the four others by Canon P. Guillaume (1883–1888). The influence of the contemporary French sacred drama may to some extent be traced in them.

Prose.—In the 12th century we find in Languedoc sermons, whose importance is more linguistic than literary (*Sermons du XII^e siècle en vieux provençal,* ed. by F. Armitage, Heilbronn, 1884). About the same time, in Limousin, were translated chapters xiii.–xvii. of St. John's Gospel (Bartsch, *Chrestomathie provençale*). Various translations of the New Testament and of some parts of the Old have been done in Languedoc and Provence during the 13th and 14th centuries (see S. Berger, "Les Bibles provenqales et vaudoises," Romania xviii. 353; and "Nouvelles recherche~sur les Bibles provenqales et catalanes," ibid, xix. 505). The Provenqal prose rendering of some lives of saints made in the early part of the 13th century (Revue des *langues romanes,* 1890) is more interesting from a purely linguistic than from a literary point of view. To the 13th century belong certain lives of the troubadours intended to be prefixed to, and to explain their poems. Many of them were written before 1250, when the first anthologies of troubadour poetry were compiled; and some are the work of the troubadour Hugh of Saint Circq. Some were composed in the north of Italy, at a time when the troubadours found more favour east of the Alps, than in their own country. Considered as historical documents these biographies are of a very doubtful value. To the same period must be assigned Las Razos de trobar of the troubadour Raimon Vidal de Besald (an elegant little treatise touching on various points of grammar and the poetic art), the Donatz *proensals* of Hugh Faidit, and the Life of St. *Douceline,* who died in 1274, near Marseilles, and founded an order of Béguines.

The leading prose-work of this period is the treatise on grammar, poetry and rhetoric known by the name of Leys *d'amors.* (*See* J. Anglade, Las leys d'amors, 4 vol., Toulouse, 1919–1920.) The Leys d'amors (composed in Toulouse circa 1350) was to be the starting-point and rule of the new poetry; it is the best production of this abortive renaissance. The decay of Provenqal literature, caused by political circumstances, arrived too soon to allow of a full development of prose. This accounts, in some measure for the complete absence of historical compositions. The 14th and 15th centuries were in no respect a prosperous period for literature in the south of France. In the 15th century people began to write French both in verse and prose; and from that time Provenqal literature became a thing of the past. From the 16th century such poetry as is written in the vernacular of southern France is generally dependent on French influence. The connection with ancient Provençal literature is entirely broken.

See Joseph Anglade, Les Troubadours, Paris, 1908; and *Histoire sommaire* de la litttrature *méridionale au* moyen *âge.* Both volumes contain a bibliography. Documents and dissertations on various points of Provençal literature will be found in almost all the volumes of Romania (Paris, in progress since 1872, 8vo), and the Revue des *langues romanes* (Montpellier, in progress since 1870, 8vo). See also the other journals devoted to the Romanic languages, passim.

(X., L. B.)

MODERN PROVENÇAL LITERATURE[1]

Provencal literature never died out entirely. The Academy of Toulouse, founded in 1324, was flourishing in the 14th century, and, after many vicissitudes, is flourishing still. The poets crowned by this body between 1324 and 1498 stand in the same relation to the troubadours as the *Meistersinger* do to the *Minnesänger:* academic correctness takes the place of inspiration. The institution flourished, even to the extent of establishing branches in Catalonia and Majorca; and in 1484, when its prosperity was threatened, a semi-fabulous person, Clémence Isaure, is said to have brought about a revival by instituting fresh prizes. The town of Toulouse never ceased to supply funds of some kind. In 1513 French poems were first admitted in the competitions, and under Louis XIV. (from 1679) these were alone held eligible. This arrangement held good till 1893, when the town very properly transferred its patronage to a new *Escolo moundino,* but very soon restored its support to the older institution, on learning that Provencal poetry was again to be encouraged. In the two centuries that followed the glorious mediaeval period we have a succession of works, chiefly of a didactic and edifying character, which served to keep alive some kind of literary tradition. Religious mystery plays, which, though dull to us, probably gave keen enjoyment to the people, represent a more popular genre; the latest that have come down to us may be placed between the years 1450–1515.

[1]In accordance with general usage, we are employing the term Provenqal for the whole of the south of France, save where special reservation is made.

In the 16th century there are signs of a revival and we may single out the following: the Gaston Pey de Garros who translated in 1565 the psalms into his dialect, and two years later published a volume of poems; Auger Gaillard (*c.* 1530–1595); du Bartas (in his trilingual *Salut,* 1579); Louis Bellaud de la Bellaudibre (1532–1588).

Post-Renaissance.— Later on come: Claude Brueys (1570–1650), remarkable chiefly for comedies that deal largely with duped husbands (*Jardin* deys *musos* provensalos, not published till 1628); Gaspard Zerbin (La *Perlo* deys *musos* et coumedies *prouvensalos,* 1655). The most consistently popular form of poetry in the south of France was always the noel. Nicholas Saboly (1614–1675), produced the best pieces of this class. In Languedoc four poets are cited as the best of the age—Goudelin, Michel, Sage and Bonnet. This is certainly so in the case of Pierre Goudelin (Goudouli, 1579–1649), of Toulouse, the most distinguished name in south French literature between the period of the troubadours and that of Jasmin. Goudelin essayed and was successful in almost every short genre (Lou Ramelet Moundi, 1617, republished with additions till 1678), the piece of his which is most generally admired being the stanzas to Henri IV. Other writers worth mentioning in the 17th century are: Jean Michel, of Nîmes; Daniel Sage, of Montpellier (Las Foulies, 1650); the *avocat* Bonnet, author of the best among the open air plays that were annually performed at Béziers on Ascension day: a number of these (dated 1616–1657) were subsequently collected, but none can compare with the opening one, Bonnet's *Jugement* de *Pâris;* Nicolas Fizes, of Frontignan, whose vaudeville, the *Opéra* de *Frontignan* (1670), dealing with a slight love intrigue, and an idyllic poem on the fountain of Frontignan, show a real poetic gift. A number of Toulouse poets, mostly *lauréats* of the Academy, may be termed followers of Goudelin: of these Franqois Boudet, who composed an ode, Le *Trinfe del Moundi* (1678), in honour of his native dialect deserves mention. The classical revival that may be noted about this time is also generally ascribed to Goudelin's influence. Its most distinguished representative was Jean de Valès, of Montech, who made excellent translations from Virgil and Persius, and wrote a brilliant burlesque of the former in the manner of Scarron (Virgile deguisat, 1648).

The best of the pastoral poets was Franqois de Cortete (1571–1655), of Prades, whose comedies, Ramounet and Miramoundo (published, unfortunately with alterations, by his son in 1684), are written with such true feeling and in so pure a style that they can be read with real pleasure. A comedy of his dealing with Sancho Panza in the palace of the Duke has been edited. Daubasse (1664–1727), of Quercy, who belonged to the working classes, was patronized by the nobility in exchange for panegyrics. Gascony produced two typical works in the 17th century: Ader's *Gentilhomme* gascoun (1610) and G. d'Astros's Trinfe de la *lengo* gascouo (1642). Gabriel Bedout (Parterre *gascoun,* 1642) is chiefly noted for his amorous *solitari.* Louis Baron (b. 1612), celebrated with great tenderness his native village of Pouyloubrin.

In the 18th century the number of authors is much larger, but the bulk of good work produced is not equally great in proportion. The priests are mainly responsible for the literary output of Languedoc. The chief of the band is the Abbé Favre (1727–1783), the prior of Celleneuve, whose Ou *sermoun* de *Moussu Sistre* delivered a drunken priest against intemperance, is a masterpiece. He also wrote a successful mock-heroic poem (*Siège* de Caderouss) travesties of Homer and Virgil, a prose novel depicting the country manners of the time (Histoudro de Jean-l'an-prks), and two comedies, which likewise give a vivid picture of the village life he knew so well. Two genuine poets are the brothers Rigaud of Montpellier: Auguste's (1760–1835) description of a vintage is deservedly famous; and Cyrille (1750–1824) produced an equally delightful poem in the Amours de *Mounpëié.* Pierre Hellies of Toulouse (d. 1724) a poet of the people, whose vicious life finds an echo in his works, has a certain rude charm, at times distantly recalling Villon. In Provence Toussaint Gros (1698–1748), of Lyons, holds undisputed sway. His style and language are admirable, but unfortunately he wasted his gifts largely on trivial *pièces d'* occasion. Coye's (1711–1777) comedy, ou *Novy* para, is bright and still popular, while Germain's description of a visit paid by the ancient gods to Marseilles (Bourrido dei *Dious,* 1760) has considerable humour. In Gascony the greatest poet is Cyrien Despourrins (1698–1755).

The 19th Century. — The Revolution produced a large body of literature, but nothing of lasting interest. Scholars like Raynouard (1761–1863), of Aix, occupied themselves with the brilliant literary traditions of the middle ages; newspapers sprang up (the Provencal *Bouil-Abaisso,* started by Désanat, and the bilingual Lou *Tambourin* et le *menestrel,* edited by Bellot, both in 1841); poets banded together and collected their pieces in volume form (thus, the nine troubaire who published Lou Bouquet *prouvençaou* in 1823). Much has been written about the *précurseurs* de *Félibrige,* and critics are sorely at variance as to the writers that most deserve this appellation. We shall not go far wrong if we include in the list Hyacinthe Morel (1756–1829), Louis Aubanel (1758–1842); Auguste Tandon, "the troubadour of Montpellier"; Fabre d'Olivet (1767–1825); Diouloufet (1771–1840); Jacques Azaïs (1778–1856); D'Astros (1780–1863), Castil-Blaze (1784–1857); the Marquis de Fare-Alais (1791–1846). While these writers were all more or less academic, and appealed to the cultured few, four poets of the people addressed a far wider public: Verdié (1779–1820), of Bordeaux, who wrote comic and satirical pieces; Jean Reboul (1796–1864), the baker of Nîmes, who never surpassed his first effort, *L'Ange* et *l'enfant* (1828); Victor Gelu (1806–1885), relentless and brutal, but undeniably powerful of his kind (Fenian et *Grouman;* dix chansons *provengales,* 1840); and, greatest of them all, the true and acknowledged forerunner of the *félibres,* Jacques Jasmin (*q.v.*).

Roumanille and Mistral. — In 1845 Joseph Roumanille (1818–1891) of Saint-Remy became usher in a small school at Avignon, which was attended by Frédéric Mistral (*q.v.*). Roumanille had composed some pieces in French; but, finding that his old mother could not understand them, he determined thenceforth to write in his native dialect only. These poems revealed a new world to young Mistral, and spurred him on to the resolve that became the one purpose of his life—de remettre en *lumière* et conscience de sa gloire cette noble race qu'en *plein'89* Mirabeau nomme encore la nation *provençale.* There is no doubt that Mistral's is the more puissant personality, and that his finest work towers above that of his fellows; but in studying the Provencal renaissance, Roumanille's great claims should not be overlooked, and they have never been put forward with more force than by Mistral himself (in the preface of his Isclos d'oro). Roumanille's secular verse cannot fail to appeal to every lover of pure and sincere poetry (Li Margaritedo, 1836–1847; *Li Sounjarello,* 1852; *Li* Flour de *Sauvi,* 1850–1859, etc.), his noels are second only to those of Saboly, his prose works (such as Lou mege de Cucugnan, 1863) sparkling with delightful humour. He it was who in 1852 collected and published *Li Prouvençalo,* an anthology in which all the names yet to become famous, and most of those famous already (such as Jasmin), are represented. In 1853 he was one of the enthusiastic circle that had gathered round J. B. Gaut at Aix, and whose literary output is contained in the *Roumavagi* dei Troubaire and in the shortlived journal Lou gay saber (1854). At the same time the first attempt at regulating the orthography of Provencal was made by him (in the introduction to his play, La Part dou bon Dieu, 1853). And in 1854 he was one of the seven poets who, on May 21, foregathered at the castle of Font-ségugne, near Avignon, and founded the *Félibrige.* (See Emile Ripert, La Renaissance *Provençale.*) The other six were Mistral, Aubanel, A. Mathieu (a schoolfellow of Mistral's at Avignon), E. Garcin, A. Tavan and P. Giera (owner of the castle). Of these, Théodore Aubanel (1829–1886, of Avignon, son of a printer and following the same calling) has alone proved himself worthy to rank with Mistral and Roumanille. "Zani," the girl of his youthful and passionate love, took the veil; and this event cast a shadow over his whole life, and determined the character of all his poetry (Lou *mióugrano entre-duberto,* 1860; *Li* Fiho *d'Avignoun,* 1883). His is, without a doubt, the deepest nature and temperament among the fe'libres, and his lyrics are the most poignant. His powerful love drama Lou pau dou peccat was received with enthusiasm at Montpellier in 1878, and successfully produced (some years later in Arène's version) by Antoine at his Théâtre Libre.

We need not do more than glance at the work of the fourth of the group of poets who alone, amidst the numerous writers of lyrics and other works that attain a high level of excellence, appear to us to have so far secured permanent fame by the magnitude of their achievement. Félix Gras (1844–1891) settled at Avignon in his youth. His rustic epic, Li *Carbounié* (1876) is full of elemental passion and abounds in fine descriptions of scenery, but it lacks proportion. The heroic geste of *Toloza* (1882), in which Simon de Montfort's invasion of the south is depicted with unbounded vigour and intensity, shows a great advance in art. *Li Roumancero provençal* (1887) is a collection of poems instinct with Provencal lore, and in *Li Papalino* (1891) we have some charming prose tales that bring to life again the Avignon of the popes. Finally, the poet gave us three tales dealing with the period of the Revolution (Li Rouge *dou miejour,* etc.).

Since the end of the 19th century the Félibrige has considerably developed: it now constitutes important groups in the different parts of Southern France from the Pyrenees to Auvergne, Velay and Dauphiné. These groups represent the most varied opinions in politics and religion, and for the expression of their ideas they resort to the whole range of dialects and patois actually used in Southern France. The spirit of the movement, is purely literary; it has never been expressed with greater terseness, force and truth than in the three verses set by Félix Gras at the head of his *Carbounié:* "I love my village more than thy village; I love my Provence more than thy province; I love France more than all."

See Emile Ripert, *Le Félibrige* (Paris, 1924. Contains an excellent bibliography). (H. O.; L. B.)

PROVENCE, a province in the south-east of ancient France, bounded on the north by the Dauphiné, on the east by the Alps and Italy, on the west by the Rhone, and on the south by the Mediterranean sea. About 600 B.C., according to tradition, some traders from Phocaea founded the Greek colony of Massalia (Marseille). Other colonies in the neighbourhood, such as Antibes, Agde, Nice, originated in this settlement. During the wars which followed the inhabitants of Massalia asked assistance from the Romans, who thus made their first entry into Gaul (125 B.c.), and conquered the territories between the Alps, the sea and the Rhone (with the province of Narbonne on the right bank of this river). These lands formed the Provincia romana, and the name was retained by Provence. The town of Aix (Aquae Sextiae) was founded to form the capital of this conquered land. Under the empire the territory of the former Provincia was divided into the new provinces of Narbonensis II., of the Maritime Alps and of Viennois, and formed an important centre of Roman learning and civilization. Arles was made the chief town of the province, becoming after the capture of Trèves by the barbarians (A.D. 418) the capital of Gaul. By the 5th century bishoprics had been founded in all the cities of Provence.

At the beginning of this century Provence was attacked by the Visigoths. In 480 Arles was captured by Euric I., and the country south of the Durance thus came definitely under Visigothic rule. The more northern cities, such as Orange, Apt and Trois-Chbteaux, were joined to the kingdom of Burgundy. Towards 510 Visigothic Provence was ceded to Theodoric, king of the Italian Ostrogoths, by Alaric II. in return for the support given to him during the war against the Franks, and soon afterwards the Ostrogoths took advantage of the wars between the Franks and the Burgundians to extend their lands in the north as far as Gap and Embrun. Witigis, king of the Ostrogoths, ceded Provence to the kings of the Franks about 537, when the northern cities and those on the coast (Arles, Marseille, Toulon, Antibes, Nice) were given back to Burgundy, whilst a narrow strip of territory, with Avignon, Apt, Cavaillon, Riez, etc., extending from the west to the east as far as the Alps, was added to the kingdom of Austrasia, and from that time followed the fortunes of its dependency of Auvergne.

In the 8th century western Provence was for a time conquered by Arabs from Spain. In 739 they were expelled by Charles Martel, who brought the country definitely under Frankish rule. Under Charlemagne and Louis the Pious the history of Provence became incorporated with that of the rest of the empire. At the partition of Verdun (843) Provence fell to the share of the emperor Lothair I., who joined it to the duchy of Lyons in 855 to form a kingdom for his youngest son, Charles. On the death of the latter in 863 his inheritance was divided between his two brothers, when Lothair II., king of Lorraine, received the northern part, Lyonnais and Viennois, and the emperor Louis II., king of Italy, received Provence. At his death in 875 Provence passed into the hands of Charles the Bald, and he entrusted the government to his brother-in-law, Duke Boso, who reconstituted the former kingdom of Charles, the son of Lothair, and in 879 was acknowledged as its sovereign at Mantaille in Viennois. Thus arose the kingdom of Provence (Provence, Viennois, Lyonnais and Vivarais), sometimes called Cisjuran Burgundy.

Boso died in 887, having succeeded in maintaining his independence against the united Frankish princes. His widow Ermengarde, daughter of Louis II., with the assistance of the emperor Arnulf, had her son Louis acknowledged king at an assembly held at Valence in 890. Louis attempted to seize the crown of Italy in 900, and in 901 was even crowned emperor at Rome by Pope Benedict IV.; but in 905 he was surprised at Verona by his rival Berengar, who captured him, put out his eyes, and forced him to give up Italy and return to Provence, where he lived till his death in 928, leaving an illegitimate son, Charles Constantine. The principal figure in the country at this time was Hugo "of Arles," count, or duke, of Viennois and marquis of Provence, who had been king of Italy since 926. To strengthen his position there he gave the kingdom of Louis the Blind to Rudolph II., king of Burgundy (*q.v.*), and thus the kingdom of Burgundy extended from the source of the Aar to the Mediterranean. But the sovereignty of Rudolph II. and his successors, Conrad (937–993) and Rudolph III. (993–1032), over Provence was little more than nominal, and conditions changed little when, on the death of Rudolph III., the kingdom of Burgundy passed into the hands of the German kings, who now bore the title of kings of Arles.

Local Countships.—At the beginning of the 10th century Provence was in a state of complete disorganization. All the real power was in the hands of local counts. It is probable that from the 9th century several of the Provençal countships were united under one count, and that the count of Arles had the title of duke, or marquis, and exercised authority over the others. In the middle of the 10th century this position was held by a certain Boso, of unknown origin, who left it to his two sons William and Roubaud (Rotbold). From the end of the 10th century the descendants of the two brothers, without making any partition, ruled over the different countships of Provence, only one of them, however, bearing the title of marquis. The counts of Provence had, from about the middle of the 11th century, a tendency to add the name of their usual residence after their title, and thus the lordships, known later under the names of the countships of Provence, of Nice and of Venaissin grew up. At last, by the marriage of an heiress in 1112 to Raymund-Bérenger, count of Barcelona, the marquisate of Provence, with the overlordship of this region, passed to the house of Barcelona. The definite establishment of the countships of Provence, Venaissin and Forcalquier belongs to this period.

After the death of Raymund-Bérenger III. (1166) his cousin Alphonso II., king of Aragon, took the title of count of Provence. His succession was disputed by the count of Toulouse, Raymund V. Most of the lay and ecclesiastical lords of Provence recognized Alphonso, who in 1176 signed a treaty with his competitor, by which Raymund V. sold his rights to the king of Aragon. Alphonso was represented in Provence by his brothers Raymund-Bérenger and Sancho in turn, and in 1193 by his son Alphonso, who succeeded him. This Alphonso gave Aragon and Catalonia to his brother Peter (Pedro), and kept only Provence for himself, but on the death of his father-in-law, Count William II., in 1208, whose son had been disinherited, he added to it the county of Forcalquier. He was able to protect Provence from the consequences of the war of the Albigenses, and it was not until after his death (1209), during the minority of his son Raymund-Bérenger IV., that Provence was involved in the struggle of the count of Toulouse against Simon de Montfort, when the part played by the city of Avignon in the Albigensian movement finally led to Louis VIII.'s expedition against the town. Raymund-Bérenger had also to fight against Raymund VII., count of Toulouse, who had received from the emperor in 1230 the countship of Forcalquier. The intervention of St. Louis, who in 1234 had married Margaret, the eldest daughter of the count of Provence (the second Eleanor married Henry III. of England in 1236), put an end to the designs of the count of Toulouse. Raymund-Bérenger died in 1245, leaving a will by which he named as his heiress his fourth daughter, Beatrice, who shortly afterwards, in 1246, married the celebrated Charles of Anjou (see CHARLES I., king of Naples), brother of the king of France. After her death, in 1267, Charles still maintained his rights in Provence. The countship of Venaissin was left to him by his sister-in-law, Jeanne, countess of Toulouse, but in 1272 King Philip III. took possession of it, giving it up in 1274 to Pope Gregory X., who had claimed it for the Roman Church in pursuance of the treaty of 1229 between Raymund VII. of Toulouse and St. Louis. Charles of Anjou was continually occupied with his kingdom of Naples. His government of Provence was marked by his struggles with the towns. In the first part of the 12th century the towns of Provence began to form municipal administrations and consulates, independent of the viscounts, who in theory represented the authority of the count in the towns. Marseille, Arles, Tarascon, Avignon (whose consulate laws date from the 12th century), Brignoles and Grasse had become self-governing and elected their magistrates, sometimes negotiating with the count, as a power with a power, and concluding political or commercial treaties without consulting him. The city of Nice, which was joined to Provence in 1176, had retained its freedom. This state of affairs was in direct opposition to the arbitrary policy of Charles of Anjou. In 1251 he seized Arles and Avignon and placed them under a *viguier* (vicar) nominated by himself. In 1257 Marseille was also subdued, and ministers nominated by the court performed their duties side by side with the municipal officials.

Annexation to France.—The successors of Charles of Anjou were chiefly interested in maintaining their rights over the kingdom of Naples. Charles II. (1285–1309) lived in Provence during the latter years of his reign, and tried to introduce reforms into the administration of justice and finance. Robert of Calabria (1309–43), his son, was succeeded by his granddaughter Joanna, widow of Andrew of Hungary, who sold her rights over the city of Avignon to Pope Clement VI. in 1348 to raise money to continue the struggle against the house of Aragon in Naples. Charles IV. resided in Provence and had himself crowned king of Arles in 1365. He gave up his claims to Louis, duke of Anjou, brother of Charles V., but the expedition which this prince made to take possession of Provence only resulted in the seizure of Tarascon, and failed before Arles (1368). Joanna had nominated as her heir Charles of Anjou-Gravina, duke of Duras, who had married her niece Margaret, but to provide herself with a protector from Louis of Hungary, who accused her of murdering her first husband Andrew and wished to dispute her right to the kingdom of Naples, she married again and became the wife of Otto of Brunswick. Charles of Duras therefore took part against her, and she in her turn disinherited him and named Louis of Anjou as her eventual successor (1380). He took possession of Provence, whilst Charles of Duras made the queen prisoner at Naples and gave orders for her to be put to death (1382). Louis of Anjou also made an expedition to Naples, but did not arrive till after her death, and he died in 1384. His son Louis II. (1384–1417), only resident in Provence towards the end of his life, established a *parlement* in 1415. The wars carried on by his successor, Louis III. (1417–34), against the kings of Aragon, his rivals at Naples, were the cause of the temporary ruin of Marseille by the Aragonese fleet. René, duke of Lorraine (*q.v.*), Louis's brother and successor, after an unsuccessful attack on Naples (1460–61), retired to France, and after 1471 generally resided in

Provence, where he built the castle of Tarascon and interested himself in art, literature and pastoral amusements. In 1474 he left his territories by will to his nephew Charles, count of Maine, who on his death in 1482 bequeathed Provence to Louis XI., king of France. Under Louis's successor, Charles VIII., Provence was definitely annexed to France, though even then it preserved a certain individuality. In laws relating to this country the sovereigns added to their title of king of France "and count of Provence and of Forcalquier," and Provence always preserved a separate administrative organization.

Religious Troubles.—In the 16th century Protestantism made its appearance in Provence. A sentence passed in 1540 by the *parlement* of Provence against the heretics was carried out with great severity in 1545 by the president d'Oppède and the baron de la Garde. The movement drew a fair number of followers from the ranks of the lesser nobles. Charles IX.'s journey in Provence in 1567, followed by the establishment in the parlement at Aix of a court (chambre), in which Catholics and Protestants had an equal number of seats, led to a momentary cessation of hostilities. These were resumed between the *Carcistes* (Roman Catholics) and *Razats* (Protestants), and again interrupted by the peace of 1576, which gave some guarantees to the Protestants, with La Seyne as a place of security, and also by the plague of 1579, which affected the whole country. The League, on the other hand, made rapid progress in Provence, and the governors of Épernon and La Valette vainly tried to pacify the country. La Valette and the political party or Bigarrats were finally more or less reconciled to the Protestants, and, at the time of the death of Henry III., the struggle was no more than a question of local politics. In 1596 the religious wars in Provence were definitely ended by the capitulation of Marseille.

Under Richelieu the restriction of local freedom led to a rising which Condé suppressed in 1630–31. At the time of the Fronde additional taxes were levied by the parlement at Aix, and a period of local unrest began which culminated in an insurrection at Marseille in 1660 followed by the abolition of the last remaining municipal liberties of the town. Provence was severely tried by the imperialist invasions of 1706 and 1746, and the great plague of 1720.

Administration.—Provence, with its own language and its law so closely related to Roman law, was quite separate from the other French provinces. Until 1639 it retained its provincial estates, the origin of which has been traced back to the 12th century. They met annually, and included representatives of three orders: for the clergy, the archbishop of Aix, president *ex officio* of the estates, the other bishops of Provence, the abbots of St. Victor at Marseille, of Montmajour and of Thoronet; for the nobility, all the men of noble birth until 1623, when this privilege was restricted to actual holders of fiefs; for the third estate the members of the 22 chief towns of the vigueries divisions corresponding to the *prévôtés* of the rest of France, and 15 other privileged places, among which were Arles and Marseille. There were theoretically no taxes, but only supplies given freely by the estates and assessed by them. The administrative divisions of Provence were constantly changing. At the end of the *ancien régime* the government (gouvernement) of Provence, which corresponded to the *généralité* of Aix, was made up of eight *sénéchaussées,* those of Lower Provence—Aix, Arles, Marseille, Brignoles, Hyères, Grasse, Draguignan, Toulon; and four of Upper Provence—Digne, Sisteron, Forcalquier, Castellane. For judicial purposes the parlement of Aix had replaced the former conseil eminent or *cour souveraine.* There was a chambre des *comptes* at Aix, and also a cour des aides. A decree, dated Dec. 22, 1789, divided Provence into the three departments of Bouches du Rhône, Basses-Alpes and Var, and in 1793 Vaucluse, the former county of Venaissin, which belonged to the pope, was added to these. The boundaries of Var were modified in 1860 after the annexation, when the department of the Alpes Maritimes was formed.

Bibliography.—There is no good general history of Provence. For a complete work consult the ancient works of H. Bouche, *Chorographie et histoire, chronologique* de *Provence* (2 vols., Aix, 1664); J. P. Papon, *Histoire générale* de Provence (4 vols., 1777–86); L. Méry, *Histoire de Provence* (3 vols., Marseille, 1830–37). For special periods of history see P. Cabasse, *Essais historiques* sur *le* parlement *de Provence* (3 vols., Aix, 1826); G. Lambert, *Essai* sur le *régime* municipal et *l'affranchissement* des communes en Provence (Toulon, 1882); F. Kiener, *Verfassungsgeschichte der Provence, 510–1200* (Leipzig, 1900); R. Poupardin, *Le Royaume* de Provence *sous les Carolingiens* (1901); G. de Manteyer, *La* Provence *du 1er au xiie siècle* (1907). (R. P.; X.)

PROVERBS, BOOK OF.

PROVERBS, BOOK OF. This Old Testament book falls into nine sections. Each of these has its special stylistic and other characteristics, some of them containing evident traces of compilation from earlier collections, one (as has only lately been recognized) being almost completely paralleled in an extant Egyptian book, while individual proverbs are found to bear traces of the "international" character of their origin and are variously related to the culture of Egypt, Babylonia, Greece, etc. (see Wisdom Literature). Moreover the tradition preserved in the book itself which ascribed certain parts of the book to Solomon (x. 1, xxv. 1), the "sages" (xxii. 17, xxiv. 23), Agur (xxx. 2), King Lemuel's mother (xxxi. 2) militates against the view that any one author was responsible for the composition of these various sections of the book: the ascription to Solomon in i. 1 probably referred originally to chs. i.–ix.—though this was probably the last section to be compiled.

Wellnigh the only characteristics common to all sections of the book may be summed up under three heads and these are not confined to the Book of Proverbs but are to be found in nearly all the extant gnomic literature of the Hebrews—the presuppositions that "wisdom" comes from Jehovah, that wisdom is, or should be, the guiding principle of life, and that cardinal social virtues such as industry, thrift, discretion, truthfulness, honesty, chastity, thought for others, including the lower animals, should be inculcated. Consequently in its present form the book represents the last stage in a long compilatory history and provides many useful examples of Hebrew proverbial and gnomic thought at various stages of its development. The date of each section and sub-section must be alternately determined by the character of its contents, the relation in which the latter stands to the extant gnomic literature of other peoples, and the stage or stages of moral and theological development reflected in it.

Chapters **i.–ix.**—The first section serves as an introduction to the whole book, but in origin it is of late date and its contents suggest that, like the book as a whole, it was compiled from more than one source. At times, for instance, the motive advanced for good conduct is moral and religious (*e.g.*, ii. 5–8): at times it is frankly utilitarian (*e.g.*, vi. 1–5). Instead of a series of unrelated proverbial couplets, such as those in the following section, comparatively long discourses follow on each other. The sage addresses his remarks to young men. Though not confining his warnings to these two offences, he warns them more especially against highway robbery and adultery—unless indeed the latter is an only too thinly veiled warning against Hellenism (cf. "Madam Folly" in ch. ix. 13–18) conceived of as a prostitute enticing the uninstructed ("ye simple ones") from their allegiance to their true love, the "wisdom" which comes from Jehovah, incarnate, as it were, in His religion, Judaism. Somewhat similar warnings against woman's wiles are given by Egyptian sages such as Amenophis and Ptah-hoteph, and by the Mesopotamian author of the Wisdom of Ahikar. The section is chiefly remarkable for the developed thought contained in viii. 1–31 as to "wisdom," her relation to God, the universe and man. It is perhaps more developed than, not only Eccles. xxiv. 1–19, but also the descriptions of her in the Book of Wisdom. "Wisdom" claims to have existed prior to the universe (*cf.* "in the beginning" with the first words of Gen. i. 1 and John i. 1) as a possession of God (viii. 22 sff.), to have witnessed the creation of the universe, and even to have acted as a clerk of the works or architect in the process of the creation, unless, as the parallelism of the verse makes probable, the vocalization of the Hebrew word translated "master workman" should be altered to justify the rendering "nursling." But it is questionable whether even here the Hebrew author does more than poetically *personify* the *principle* of wisdom: he scarcely gives her a real hypostasis and does not go so far in this direction as did Philo in his description of the Logos as "a second god."

It is not, however, outside the bounds of possibility that the author of the prologue to the Fourth Gospel was considerably influenced by this description of wisdom rather than by Philo's descriptions of his Logos, even though he substituted the latter term for "wisdom." This advanced thought as to wisdom is not confined to ch. viii., but seems to be more or less presupposed throughout the section. The author's philosophy of life otherwise shows little of a pronouncedly modern character. Righteousness and wickedness are rewarded in this life (*e.g.*, ii. 21); the sacrificial worship is inculcated (ii. 9, iii. 9); the words "law" and "commandment" are used now of the Mosaic system, now of parental injunctions, now of the sage's advice. It is the language and philosophy of life characteristic of Deuteronomy which are most prominent; suffering is divine chastisement administered, however, in love (iii. 12).

Chapters **x.–xxii.**—The second section illustrates earlier stages in the literary productions and ideals of the exponents of wisdom. Each proverb is confined to two lines, antithetical in form if we except a few in which synonymous parallelism occurs. The utilitarianism of the compiler of this section is often overemphasized: it contains, on the contrary, sentiments which anticipate some of the highest ideals expressed in the New Testament and to which the latter owe their literary form (*e.g.*, x. 12 cf. 1 Cor. xiii. 7, 1 Pet. iv. 3, James v. 20; xiv. 31; xvii. 5, cf. Matt. xxv. 40, 45; xx. 11, *cf.* Matt. vii. 16; xx. 22, *cf.* Matt. v. 39, Rom. xii. 17, 19, etc.). It reflects, moreover at times the "prophetic" revolt against the hollowness of merely external sacrificial worship (xv. 8, xxi. 3) cf. the emphasis on the *national* virtue demanded by Amos (xiv. 34) and on inner purity (xx. 9) and on the omniscience of Jehovah (xv. 3, 11). Thus, in date, the section shows no trace of the developments of religious, theological and philosophical thought for which the latter post-exilic Judaism was responsible; on the other hand, along with much which might be the product of any period, it presupposes, at least in the above respects, the very latest products of pre-exilic piety.

Chapters **xxii. (17) to xxiv. (22)**.—The third section bears the title "words of the wise." Its contents are presented to the reader in a strophic form, forming a miniature discourse, and having four lines to a strophe, as in the newly deciphered Egyptian "Teaching of Amenophis." It is the remarkable similarity of the section to this latter book which has especially concentrated attention upon it since 1924. The similarity between the two continues, with certain exceptions, throughout a considerable portion of the section and creates a problem which is scarcely solved by the theory that both reflect gnomic sayings which were common to all nations of the orient. Indeed so close is the relationship that it is possible to emend with a fair degree of certainty, on the basis of the Egyptian tradition, passages in which the Hebrew text is manifestly corrupt: thus "excellent things" (xxii. 20) without any change in the consonantal text, should be read as "thirty (sayings)," the exact number of the "chapters" into which The Teaching of Amenophis is divided. It would appear unlikely that the Egyptian sage borrowed from the Hebrew, and we are therefore compelled to suppose that either a copy of the Egyptian book penetrated into Palestine and its contents gradually became "Hebraised," its Egyptian theology slowly yielding to that of the Hebrews and proverbs from other sources gradually attaching themselves to it; or a Hebrew sage, visiting or living in Egypt, became acquainted with it, expurgated its Egyptian polytheism and made it acceptable to those who saw in Jehovah the only God who ruled every department of life. Either of these alternatives can best be visualised as happening in pre-exilic rather than late post-exilic days, but to dogmatise as to the exact date, whether the reign of Hezekiah, the early years of the exile or otherwise is to substitute guesswork for reason. An outstanding one among the many sayings common to the Hebrew and Egyptian gnomic writers occurs in the next section (xxiv. 23–34, an appendix to the present one) as well as already in the preceding one (xx. 22): it is the earliest extant form of "the golden rule," later extolled by Hillel and Jesus, which is thus proved to be in its origins Egyptian rather than Hebrew or Jewish.

Chapters **xxv.–xxix. (27)**.—The fifth section, attributed traditionally to Hezekiah's scribes (xxv. 1), contains, like the second section, chiefly short independent proverbial aphorisms; but it has some of two or more verses in length, and advances from the consideration of worldly matters in chs. xxv.–xxvii. to matters of more specifically religious import in chs. xxviii., xxix., where the observance of "the law" in particular is emphasized, and prophecy is specified as a sine qua non of popular self-restraint (xxix. 18). In spite of the presence in this section of proverbs which occur elsewhere, it contains several of considerable interest. It reflects a somewhat hostile attitude to the monarchical form of government, but attempts to deflect criticism from the person of the king to his courtiers. Whether "the king" is a native Jewish ruler, Davidic or Maccabaean, or a Ptolemaic or Seleucid overlord, or merely figures impersonally in a set of proverbs of international vogue cannot be decided: consequently it gives no real help in fixing the date of the section. In at least two respects this collection provided the inspiration for practical and ethical advice too often supposed to have originated in Christian circles, namely xxv. 7 which evidently inspired Luke xiv. 8–11, and xxv. 21 which is quoted in Rom. xii. 20.

Chapter **xxx. (1–16)**.—The sixth section has the cryptic and not very convincing title "The words of Agur, the son of Jakeh, of Massa (R. V. mg.)," followed by a line which has defied all efforts to translate it. This, like xxxi. 1, though a frank confession by the Jewish sages that they were prepared to welcome aphorisms of foreign origin, and having done so, openly to ascribe them to a foreign author, really throws no light upon the origins and background of the present section. It would appear to date from a period when problems of theology and philosophy were being discussed ad nauseam and to emanate from an author who found little comfort, but much disturbance of faith in speculations of this nature. Consequently confessing his own limitations of intellect (*v.* 2 *seq.*), he plaintively asks who in point of fact has ever penetrated into the supra-mundane sphere to return with a knowledge adequate to justify him in propounding such riddles (v. 4). And so he takes refuge in the revealed "word" of God and utters a warning against human endeavours to supplement it or detract from it in self-confidence or insolence. He ends by pointing out the shortcomings of his generation (vv. 5–14). It is the answer of a religious obscurantist rather than, as is too commonly supposed, of a pious agnostic.

Final Section.—The seventh section, chap. xxx. 15–33, consists of miscellaneous dicta introduced by an unintelligible line and bound together by their "numerical" form of introduction. In these few words is concentrated a wealth of insight into the normal and abnormal, the obvious and mysterious in life and nature, which, as it were in a nut-shell, illustrates the keenness and the breadth of observation to which the "wisdom" writers, the humanists of Israel, trained themselves.

The eighth section, chap. xxxi. 1–9, purports to be a further instance of foreign wisdom, again from "Massa," and indeed an illustration of a king's instruction by his mother. The vices against which he is warned include impurity, drink and maladministration of justice. These vices were prevalent in most oriental courts of the period during which the section could have been written, and do not necessarily presuppose the vices which Hellenism in particular communicated to the petty kings of oriental states into which it penetrated.

The ninth and last section, chap. **xxxi.** 10–31, is perhaps the masterpiece of this remarkable collection of the literary output of the humanists of Israel. Incidentally it is an "alphabetical" poem, each verse beginning with a letter of the Hebrew alphabet, and each letter appearing in its correct sequence. The lie is here given to the depressing picture, though one too often fully justified, which is mostly drawn in the Old Testament, of woman's personal and economic position among the Hebrews as the slave and chattel of her husband who was legally free to possess not one but many wives. But practice reinforced by economic necessity, probably rose in this respect above precept. At any rate, in the wealthy and prosperous household here depicted monogamy is presupposed and the poet depicts the wife as its master-mind as well as its mainstay. To what extent such a régime pressed heavily on the female slaves and other underlings we do not know since no literature emanating from them has survived.

Next to their passion for the highest morality of their day, and their unswerving loyalty to their ancestral faith, certain of the Hebrew gnomic writers whose work has survived in the Book of Proverbs will be held in honour most of all for their ability, which, as stated at the outset, is only now beginning to be realized, to master the gnomic literature of Egypt and of Mesopotamia, of Edom and of Massa, to expurgate from it what was unworthy, and to transform it into an instrument for the instruction of successive generations of the worshippers of Jehovah. Only a study of the Book of Proverbs in the light of the comparative study of gnomic literature can make the reader realize this; for instance in addition to close relationship with the Egyptian *Teaching of Amenophis,* there are more than 70 dicta in the Wisdom of Ahikar (*q.v.*) and of these more than half find an echo in this book.

BIBLIOGRAPHY.—For the literature, which is considerable, *see* the commentaries of Toy (1898), and especially W. O. E. Oesterley, *The Book of Proverbs* (1928) in the *Westminster Commentaries,* who gives striking parallels and references to the latest literature. *See* also Cheyne, *Job and Solomon* (1887); id., in *Sem. Studies* (ed. Kohut, 1897); id., *Jew. Relig. Life* (1898); Montefiore in *Jew. Quart. Review* (1898–1890); Cohen, *Ancient Jewish Proverbs;* Elmslie, *Studies in Life from Jewish Proverbs;* Goldman, *Proverbs of the Sages* (1911). For materials for the comparative study of Hebrew proverbial literature and that of other ancient nations, *see* D. C. Simpson, *The Hebrew Book of Proverbs and The Teaching of Amenophis* in *Journal of Egyptian Archaeology* (1926); Oesterley, *The Wisdom of Egypt and the Old Testament* (1927); Langdon, *Babylonian Wisdom* (1923); Hindu: Monier-Williams, *Indian Wisdom* (1875); Arabic: Jacob, *Altarab. Parallelen z. A. T.* (1897). (D. C. S.)

PROVIDENCE, the capital and largest city of Rhode Island, U.S.A., a port of entry and the county seat of Providence county; at the head of Providence river (the north arm of Narragansett bay), 27 m. from the Atlantic ocean, 45 m. S.S.W. of Boston and 185 m. E.N.E. of New York city. It is on Federal highways 1 and 6; and is served by the New York, New Haven and Hartford railroad, and 4 steamship lines. There are several privately owned airports in and near the city and a state airport at Hillsgrove.

Pop. in 1930 was 252,981 and in 1940 it was 253,504 by the federal census (36% of the total population of the state).

The city has a land area of 18.34 sq.mi., diversified in natural character and irregularly laid out. The Seekonk and the Providence rivers bound it on the east; the Providence and the Moshassuck divide it into east and west sides; and the Woonasquatucket divides the west side into north and south sections. The east side (the part of most historic interest) embraces hills rising to a height of 200 feet. The newer business district lies along the west bank of the Providence river, and some of the largest buildings stand on made land. Most of the factories are on the banks of the Woonasquatucket and the Moshassuck. The names of the older streets (such as Benevolent, Benefit, Hope, Friendship, P'eace, Pound, Sovereign, Shilling, Dollar and Doubloon) recall the religious spirit of the early city and its commercial character. From the Union station one steps directly into the civic centre, a broad open plaza surrounded by government (Federal, city and county) and business buildings and hotels. Aloof on a hill to the west, but only half a mile distant, the most conspicuous feature of the landscape and commanding a wide view of city, bay and surrounding country, is the large State house (designed by McKim, Meade and White and completed in 1902) of Georgia marble and white granite, surmounted by a marble dome 235 ft. high. In it is a full length portrait of Washington, by Gilbert Stuart (who was born in Rhode Island), and many other interesting paintings, and here is preserved the original charter of the Colony, framed in wood from the "Gaspee." Adjacent to the civic centre on the east is the retail shopping and business district, where tall modern structures of steel and stone rise above the older buildings. An interesting building is the Arcade (1828) with six massive Ionic columns at each entrance.

The old Market house was built in 1773 and in it a local "teaparty" mas held on March 1, 177j, and Rochambeau's troops were quartered later.

Behind the business area College hill rises steeply, covered with historic landmarks. On its slopes lies the campus of Brown university (*q.v.*), where Revolutionary troops were quartered in university hall. At its foot stands the First Baptist meetinghouse (built in 1775 to house the church organized by Roger Williams in 1636), which has one of the finest church spires in America, and a beautiful interior, with a crystal chandelier in use since 1792. Its bell still rings the curfew at nine o'clock. Near by is the old Colony house, where the Rhode Island Declaration of Independence was signed on May 4, 1776, two months before the event in Philadelphia. Farther up the hill are the museum and library of the Rhode Island Historical Society, the ivy-covered Athenaeum, and Pendleton house (a museum), furnished with one of the finest collections of early American furniture in existence. Among the old mansions still standing are the homes of John Brown (built in 1786), Thomas Poynton Ives (1806), Col. Joseph Nightingale (1791), Joseph Russell (1772), Peter Randell (1748), Stephen Hopkins (1742) and that of Esek Hopkins (1718–1802), commander of the American navy during the Revolution, standing in a park formed from his estate. The Providence Art club occupies the homes of Nicholas Brown (1787) and Siril Dodge (1793). Many more modest colonial houses (usually of red brick with white marble trimmings, and occasionally set in a walled garden) add to the charm of this section of the city. The Friends' meeting house was erected in 1759. The first Unitarian church (organized 1773) has a bell cast by Paul Revere and his son. The city's parks and playgrounds cover 790 ac., and there are also large reservations under the control of the State. Chief among the municipal parks is Roger Williams park (451 ac.), part of the original tract ceded to Williams by Miantonomo, in which is the cottage (1775) of Betsy Williams, a lineal descendant. The North burial ground contains the graves of many men of prominence in the early history of the State and the nation.

In addition to Brown university, Providence has within its limits the Rhode Island college of education (1854); the Rhode Island school of design, affiliated with Brown (1876); Providence college (Roman Catholic; 1919); the Rhode Island institute for the deaf (1876); and several private secondary schools of high standing. The public-school system has profited in various ways by the presence of Brown university, and has been a pioneer in such educational schemes as transition classes between kindergarten and primary grades and open-air classes for delicate children. There are three daily nenspapers. The *Journal* (Independent) was established in 1829. Among the numerous charitable institutions are the Butler Hospital for the Insane, one of the oldest institutions of its kind in the country (established by a bequest of Nicholas Brown in 1841), and the Dexter Asylum for the Poor, endowed by the Dexter fund, which limits. its beneficiaries to those who have a legal settlement in Providence (*i.e.,* have paid taxes for five years on $200 worth of property) and consequently is very restricted in its application. The privately supported welfare agencies and philanthropic organizations unite in a joint annual campaign for funds.

Providence river and harbour have been under improvement by the United States since 1852. The channel to the ocean is 30 ft. deep at mean low water and from 600 to 1,800 ft. wide. A State pier (built in 1913) and a municipal wharf provide modern terminal facilities for the public on equal terms, and there are 5 wharves owned by steamship lines, 10 by the railroad, and 43 by other private interests. Providence is the principal port of southern New England. Its water-borne commerce averaged 4,566,147 tons annually for the years 1935–40, and in 1940 amounted to 5,223,621 tons. The great bulk of the domestic commerce consists of incoming coal, lumber, crude and fuel oil and petroleum products.

Providence is one of the leading centres of the country for the manufacture of jewellery, silverware, worsteds, textile machinery and tools.

Its aggregate factory output in 1937 was valued at $198,783,188, of which $34,568,035 represented worsteds and $27,594,756 jewellery (29% of the total made in the United States). Among the long-established firms of national reputation are the Gorham Manufacturing Company, which introduced the jewellery and silverware industry; the American Screw Company, the Brown and Sharpe Manufacturing Company and the Nicholson File Company. Here the famous Corliss engines were first made in 1847. The city operates under the original charter of 1832, with various amendments, providing for a mayor and council form of government. The franchise is limited to persons who pay a tax on $134 worth of real property or $200 worth of personal property. A town meeting is still held annually for the administration of the Dexter fund.

The levy of general property taxes in 1936 was $9,403,000. Bank debits in 1938 aggregated $2,091,000,000.

Providence was founded in 1636 by Roger Williams after his banishment from the Massachusetts Bay Colony. He bought a tract of land from the Narragansett sachems Canonicus and Miantonomo, built a house opposite the confluence of the Moshassuck and the Woonasquatucket rivers (50 ft. east of North Main street), and with a few followers who had accompanied him into exile promptly set up a town government. In 1637, after the arrival of a few more settlers, a plantation covenant was adopted, embodying the novel principle of complete separation of religious and civil affairs. Providence was incorporated as a town by the colonial assembly in 1649, and was chartered as a city in 1832. The name was chosen by Roger Williams in recognition (he says) of "God's merciful providence unto me in my distress." Between 1730 and 1760 its area was reduced from 370 sq.m. to 5.5 sq.m. by the setting off of Scituate, Gloucester, Smithfield, Cranston, Johnston and North Providence, some of which were further subdivided subsquently; and since 1860 the 5·5 sq.m. have been increased to over 18 by re-annexations of contiguous territory. During King Philip's War, in 1676, the town was attacked by Indians and the northern half was burned. In June 1772, a British schooner, the "Gaspee," running aground at what has since been known as Gaspee point, was captured and burned by Abraham Whipple (1733–1819) according to a plan devised by John Brown (1736–1828), one of the town's prominent merchants. During the Revolution, Providence was a centre of privateering, and in consequence of the occupation of Newport by the British, took over much of the foreign commerce of that port. It remained an important port for 40 or 50 years, but after 1830 manufactures became the dominating interest. Since 1900 its water-borne commerce has again increased, more than doubling in volume in the first quarter of the century. Providence shared with Newport the honour of being the seat of the State government until 1900; since 1900 it has been the sole capital.

PROVINCE, a term applied in ancient Rome (Lat. *provincia*) to the sphere of duty assigned to one of the higher magistrates, the consuls and praetors (*qq.v.*). Only those magistrates who had military power (*imperium*) had a province. When the province of a quaestor is mentioned it refers to the province of the consul or praetor to whom the quaestor is subordinate

When the government of conquered countries grew to be one of the most important duties of the higher magistrates, the term province, from designating the government of a conquered country as one particular duty of a Roman magistrate, came to be used generally as a designation of the country itself.

The provinces paid tribute to Rome, for it was a recognized principle that they were the estates of the Roman people and were to be managed for its benefit. The constitution of a province was drawn up by the victorious Roman general, assisted by ten commissioners appointed by the senate, and the province was governed on the lines laid down in this constitution or charter (*lex provinciae*). For administrative purposes the province was divided into districts, each with its capital, for judicial purposes into circuits (conventus) and in the chief town of each circuit the governor of the province held assizes.

The lands of cities captured by force of arms were turned into Roman domains, and were let out by the censors to private persons. Royal domains, such as those of Macedonia and Cyrene, were also confiscated. Communities which surrendered were usually allowed to retain their personal freedom and private property; but all the lands were subjected to a tax, consisting either of a payment in kind (*vectigal*) or of a fixed sum of money (*tributum, stipendium*). It is to this class of communities (the civitates vectigales or *stipendiariae*) that the majority of the provincial states belonged. In a better position were those states whose freedom was guaranteed by Rome on the ground of old alliances or special loyalty. Their freedom was recognized either by a treaty or by a decree of the Roman people or senate. As a decree of the people or senate could at any time be recalled, the position of the free states without a treaty was more precarious than that of the treaty states (civitates foederatae). The latter enjoyed internal freedom, retained their lands, paid no taxes, and were bound to render those services only which were expressly stipulated for in the original treaty. Amongst such treaty states were Massilia (Marseille), Athens, Rhodes and Tyre. The privileges of the free states without a treaty were somewhat similar. All political distinctions, save that between slave and freeman, disappeared when Caracalla bestowed the Roman franchise on the whole empire (A.D. 212).

Provincial Diets.—Every province had, under the empire, a provincial assembly or diet of its own (concilium or *commune*), and these diets are interesting as the first attempts at representative assemblies. The diet met annually. and was composed of deputies (legati), from the provincial districts. It arranged for the celebration of religious rites and games, especially for the worship of the emperor. The celebration was under the conduct of the high priest of the province. The diet also passed votes of thanks to the outgoing governor, or forwarded complaints against him to Rome; and it had the right of sending embassies direct to the senate or the emperor.

The Provincial Governor.—The provinces were administered by governors from Rome, who held office for a year. From the formation of the first provinces in 227 B.C. down to the time of Sulla (82 B.C.) the governors were praetors (see PRAETOR); from the time of Sulla to that of Augustus the praetors remained in Rome during their year of office, and at the end of it assumed the government of a province with the title of propraetor. A province which was the seat of war, or was in a disturbed state, was committed to the care either of one of the consuls for the year, or of a commander specially appointed for the purpose, with the title of proconsul. The senate determined which provinces were to be governed by consuls and which by praetors, and the consuls arranged between themselves which of the provinces each should have, and similarly with the praetors. The Sempronian law of 123 B.C. provided that the senate should nominate the two consular provinces before the election of the consuls, and that the consuls should, before their entry on office, arrange which of the two provinces each should have. The Pompeian law of 53 B.C. enacted that no one should hold the governorship of a province till at least five years after his consulship or praetorship. This law was repealed by Caesar, but was re-enacted under Augustus; it severed the connection between an urban magistracy and the governorship of a province, and turned the latter into an independent office. A provincial governorship was regularly held for one year; but it could be prolonged by a vote of the people or a decree of the senate. The necessary supplies of men and money were voted to the governor by the senate. His staff included one or more lieutenants (legati) and a quaestor (*q.v.*). Besides these the governor took with him young men of the upper classes to assist him in the government. These were known as the companions (comites) or suite of the governor. They were chosen by the governor himself, but they were maintained at the expense of the state, and under the empire, received regular pay. In addition there was a crowd of subordinates. Before setting out for his province the governor, clad in the purple military robe of his office, offered sacrifice on the Capitol; then immediately after receiving the *imperium* or military command he marched out of the city (for the *imperium* could only be exercised outside of Rome and was forfeited by staying in the city), preceded by his lictors and accompanied by his suite. His year of office began from the day he set foot in his province. In the hands of the governor all powers military and civil were united. He commanded all the troops in the province, and had power to raise levies of Roman citizens as well as of provincials, and to make requisitions of war material. He possessed both criminal and civil jurisdiction; as criminal judge he had the power of life and death, and from his sentence none but Roman citizens could appeal; as civil judge he was guided partly by the charter of the province (*lex provinciae*), partly by the edict which it was customary for him to issue before his entrance on office (see PRAETOR).

Condition of the Provinces under the Republic. — The Roman people regarded the provinces as so many estates from which they were to derive revenue. Hence agriculture and commerce were encouraged, settlements were made, roads and aqueducts were constructed; in short, the Roman aimed at exploiting his empire by a system of prudent economy. But the Roman governors were apt to look on their provinces as their own peculiar prey; they had usually bought their way to office at vast expense, and they now sought in the provinces the means of reimbursing themselves for the expenditure they had incurred at Rome. Redress was to be had by a complaint to the senate; after 149 B.C. there was a court established at Rome for the trial of cases of extortion (repetundae) by provincial governors. But, even when the provincials had arraigned their oppressor, it was difficult to secure his condemnation at the hands of juries composed of men who had a fellow-feeling for the offender because they had themselves committed, or hoped for means of committing, similar offences. Besides the governor, two classes joined in wringing the uttermost farthing from the unhappy provincials. These were the *publicani* (*q.v.*) or farmers of the taxes, and the money-lenders (negotiatores). Both these classes were recruited from the equites (*q.v.*) and, since from 122 B.C. the juries were drawn at first exclusively and after 70 B.C. partially from that order, the provincial governor could not check their excesses without risking a condemnation at the hands of their brethren. Accordingly he generally made common cause with them.

The Provinces under the Empire.—Under the empire the provinces fared better. Romans and provincials were reduced to a common level of subjection to the emperor, who meted out equal justice. The first centuries of the Christian era were for some of the countries included in the Roman empire the happiest of their history.

Augustus, in 27 B.C., divided the provinces into imperial and senatorial. Those which required the presence of an army were placed under the direct control of the emperor; those which needed no troops were left to the senate. (1) The senatorial provinces were ruled by annual governors called proconsuls. Their powers were much the same as they had been under the republic, except that they had now no troops, or only a handful to maintain order. (2) The imperial provinces were governed by imperial lieutenants (legati Caesaris), who were nominated by the emperor and held office at his pleasure; all of them had the power of the sword (*ius gladii*). For the administration of the finances these lieutenants had procurators under them, while the governors of the senatorial provinces continued to have quaestors. Certain other possessions were regarded as domains of the emperor, and were managed by a procurator or praefect (see PRAEFECT), responsible to the emperor

See T. Mommsen, *Roman Provinces under the Empire* (1884); T. M Taylor, *Constitutional History of Rome* (1899); J. E. Sandys, *Companion to Latin Studies* (1921), with useful bibliography. For imperial domains, see H F. Pelham, *Essays on Roman History* (1911), pp. 275–299

PROVINCETOWN, a town of Barnstable county, Massachusetts, U.S.A., on the tip of Cape Cod; it is on federal highway 6 and is served by the New York, New Haven and Hartford railroad, and steamboats to Boston. The population was 3,808 in 1930; 3,668 in 1940 federal census. There are many visitors in summer, among whom are a large number of artists, attracted by the beauties of the sand dunes and the marine views. The town is almost surrounded by water, and there are three lighthouses on its coast. Its harbour (to the south) is protected on three sides by land. A magnificent beach stretches for 30 mi. along Cape Cod bay to Eastham. Provincetown is a port of entry. The principal industries still (as since its settlement) are the catching, curing, packing and selling of fish, chiefly cod and mackerel. The large whaling fleet of former days has entirely disappeared. It was in Provincetown harbour that the Pilgrims, in the cabin of the "Mayflower," drew up their memorable Compact, before proceeding to Plymouth. There John Carver was chosen as the first governor of Plymouth Colony, and this was the first landing-place (on Nov. 11 [O.S], 1620) of the Pilgrims in the New World. There has been a settlement there since 1620. The town was set off from Truro and incorporated in 1727. Much of the territory was originally "Province land" (hence the name) and there is still a large State reservation between the village and the back ocean shore, which has been stocked with game birds and planted with beach grass and pine trees.

PROVINS, a town of northern France, capital of an arrondissement of the department of Seine-et-Marne, at the junction of the Durtain with the Voulzie (an affluent of the Seine), 59 mi. E.S.E. of Paris by rail. Pop. (1936) 8,688. Provins began to figure in history in the 9th century. Passing from the counts of Vermandois to the counts of Champagne, it quickly became prosperous. Cloth and leather were its staple manufactures, and its fairs were attended by traders from all parts of Europe, throughout which its money had currency. Plague and famine reduced the population in the 14th century and the Hundred Years' War completed its ruin. During the religious wars it sided with the Catholic party and the League, and Henry IV. obtained possession of it in 1592 only after thirteen days' siege. The town has mineral waters which contain iron, lime and carbonic acid, and also a trade in roses. Provins is divided into two quarters — the *ville-haute* and the less ancient *ville-basse*—which in the 13th century were surrounded by fortifications. In the ville-haute stands the large tower known as the king's, Caesar's or the prisoners' tower, a very curious 12th century keep. The base is surrounded by a thick mound of masonry added by the English in the 15th century when they held the town. The tower serves as belfry to the church of St. Quiriace, which dates from the 12th century. The palace of the counts of Champagne, some fragments of which also belong to the 12th century, is occupied by the communal college. The old tithe-barn is a building of the 13th century with two fine vaulted chambers, one of which is below ground. The church of St. Ayoul dates from the 12th to the 16th centuries, the transept being oldest; it is dilapidated and the choir is used as a storehouse. St. Croix belongs partly to the 13th century. There is a sub-prefecture and a tribunal of commerce. There is an active trade in grain, livestock and wool, and the industries include nursery-gardening, brickmaking and the manufacture of porcelain, gas and petrol engines, agricultural implements and sugar.

PROVISION, in ecclesiastical law signifies the act by which an office or benefice is conferred by a person having competent authority for the purpose; and the word is specially used of appointments made by the pope in derogation of the rights of ecclesiastical patrons. Innocent III. (1198–1216) seems to have been the first pope who directed prelates to collate his nominees to canonries and other benefices, but it was during the pontificate of Innocent IV. (1243–1254) that the practice first assumed alarming proportions. The English parliament held at Carlisle in 1307 petitioned the king for a remedy against this abuse, but though he promised redress nothing was done. Meanwhile the popes had been asserting claims to appoint bishops in certain events on their own initiative, and at last Clement V. (1305–1313) reserved to himself the right of appointment in all cases. After his time there is scarcely an instance of an English bishop being elected in accordance with the older procedure by the cathedral chapter. If an election were made the pope usually either overrode it by another appointment or, ignoring the election, appointed the elected clerk by a bull of provision. The Hundred Years' War caused an outburst of indignation against the use of papal provisions when non-resident French clerics were appointed to English benefices. To remedy the evil the first "Statute of Provisors" was enacted in 1351, the "Statute of Praemunire" in 1353, and a second "Statute of Provisors" in 1364 These appear to have had little effect until in 1389, a third "Statute of Provisors" was enacted which provided that the statute of 1351 should be firmly holden for ever and "put in due execution from time to time in all manner of points."

BIBLIOGRAPHY.—*Statutes of the* Realm; Calendar of Papal *Registers;* J. Le Neve, Fasti ecclesiae *anglicanae; Rolls of Parliament;* F. W. Maitland, *Canon Law in the Church of England;* W. Stubbs, *Constitutional* History oj England; Anglia sacra.

PROVISIONAL ORDER, in Great Britain, a direction by a Government department sanctioning (usually at the instance of a local authority or public undertaking) some project otherwise unattainable without private bill legislation, *e.g.,* the compulsory taking of land or the building of a tramway. Originally the order is "provisional" because subject to parliamentary veto. The objects depend upon the enabling statute.

The procedure generally involves: (1) preliminary local enquiry and report by a departmental inspector; (2) departmental decision as to the framing of the order; and (3) inclusion of the order (singly or grouped with others) in a provisional order conformation bill introduced into parliament by the minister concerned. Such bills, if opposed, are referred to a select committee; they also go before examiners who see that the contents comply with standing orders. An early instance is the Inclosures Act of 1845 whereby commissioners could provisionally- order the enclosure and regulation of commons. In 1853 the Charity Commissioners were authorized to give provisional approval to new schemes for the application and management of charities Gradually the system was extended to the varied purposes of local government (especially the alteration of areas), public health, gas, water and electricity supply, acquisition of school and housing sites, formation of pilotage and drainage districts, facilities for harbours, docks, railways and other forms of transport, fishery regulation, validation of marriages, etc. The early enactments have mostly been superseded and the process of devolution has been progressively developed. Two railway acts in 1864 initiated the provisional certificate which embodied schemes for railway construction or working agreements, and, unless the schemes were opposed, required no express parliamentary sanction. A further delegation of legislative power enabled a local authority to make orders for the acquisition of land (as under section 9 of the Local Government Act, 1894), if not objected to, they had the full force of a statute; if objected to, they could be confirmed not by parliament but by the department concerned Later a "special order" procedure was evolved whereby a draft of the proposed order is published and (on objection) a local enquiry is held but a confirmatory act of parliament is not required. The National Health Insurance Act of 1928 even authorizes a "provisional special order." Under this variant (invented in 1912 to accelerate the action of special orders under the 1911 Act) the appropriate Minister, instead of waiting for criticisms of his draft orders, can bring them into force forthwith provided that he certifies the expediency of such action. Some special orders, such as those which decide the application of unemployment insurance or trade boards legislation to particular trades, take effect forthwith, subject to annulment on adverse resolution by either house of parliament within a time limit; others, *e.g.,* those under the Electricity (Supply) Act of 1919 or the Gas Regulation Act of 1920, require the affirmative resolution of both houses. Special orders are often allowed to do all that a provisional order could formerly do. Scotland has her own machinery under the Private Legislation (procedure) Scotland Act, 1899, operated through the Scottish Office, with special panels of commissioners for holding enquiries. Northern Ireland follows the Westminster model. (C. T. C.)

See Clifford, Private Bill *Legislation,* II., c. 18.

PROVO, a city of Utah, U.S.A., on the Provo river, 3 mi. E. of Utah lake and 45 mi. southeast of Salt Lake City; the county seat of Utah county. It is on federal highways 91, 89 and 50, and is served by the Denver and Rio Grande Western, the Union Pacific, the Utah, and the Salt Lake and Utah (electric) railways. The population was 10,303 in 1920 (90% native white) and was 18,071 in 1940 by the federal census. The city has an altitude of 4,549 ft., in a region of fine scenery. It is the seat of the Utah State (mental) hospital and the Brigham Young university (founded and endowed by President Young in 1875), which has an enrolment of 3,000. Provo is a "garden city," surrounded by the richest agricultural and horticultural district of Utah, created by irrigation and industry out of the desert. It is the centre of the mining interests of the state, and of the developing iron and steel industries. Manufactures within the city are small, but at Ironton and other suburbs there are large iron and steel works, creosoting plants, and factories making cast-iron pipes, concrete pipes, brick and tile, etc. The city was settled by the Mormons in 1849 and was chartered in 1851. It has a commission form of government.

PROVOST, a title attached to various ecclesiastical and secular offices. In ecclesiastical usage the word *praepositus* was at first applied by the Church fathers to any ecclesiastical ruler or dignitary. It early, however, gained a more specific sense as applied to the official next in dignity to the abbot of a monastery, or to the superior of a single cell. In England the title "provost" has thus everywhere given way to that of "dean"; in Germany, on the other hand, *"Probst"* is still the style of the heads of certain chapters. The name *praepositus* was also sometimes used for the secular *advocatus* of a monastery. With the ecclesiastical use of the title is connected its English application to the heads of certain colleges; "provost" is still the style of the principals of Queen's, Oriel and Worcester colleges at Oxford, of King's college at Cambridge, of Trinity college at Dublin and of Eton college, where, however, the head-master, though technically subordinate to the provost, is the effective head of the school.

As a secular title *praepositus* is also very old; we need only instance the praepositus sacri *cubiculi* of the late Roman empire, and the *praepositus palatii* of the Carolingian court. The important developments of the title in France are dealt with below. From France the title found its way into Scotland, where it survives in the style (provost) of the principal magistrates of the royal boroughs ("lord provost" in Edinburgh, Glasgow, Aberdeen, Perth and Dundee), and into England, where it is applied to certain officers charged with the maintenance of military discipline. A provost-marshal is an officer of the army appointed when troops are on service abroad for the prompt repression of all offences. He may at any time arrest and detain for trial persons subject t~ military law committing offences, and may also carry into execution any punishments to be inflicted in pursuance of a court-martial (Army Act, 1881, *s.* 74). A provost-sergeant is an officer responsible for the maintenance of order when soldiers are in Great Britain. A provost-sergeant may be either garrison or regimental, and he has under his superintendence the garrison or regimental police.

The Provost in France— The word *prévôt* (provost) in old French law had many applications. In conformity with its etymology (*praepositus*) it could be applied to any person placed at the head of a branch of the public service, a position which, according to the old principles, habitually carried with it a right of jurisdiction. It is thus that there was at Paris the "provost of Paris," who was a royal judge, and the "provost of the merchants" (*prévôt des marchands*), the head of the Paris municipality. There were besides—to mention only the principal provosts—the "provosts of the marshals of France" (*prévôts des maréchaux de* France), of whom more below; "the provost of the royal palace" (*prévôt de l'hôtel du roi*) or "grand provost of France" (*grand prévôt de France*), and the "provost general" (*prévôt général*) or "grand provost of the mint" (*grand prévôt des monnaies*). But the most important and best known provosts, who formed part of a general and comprehensive organization, were the "royal provosts" (*prévôts* royaux), the lower category of the royal judges. It must be borne in mind, however, that the magistrates belonging to the inferior category of royal judges (juges subalternes) had different designations in many parts of France. In Normandy and Burgundy they were called *châtelains,* and elsewhere—especially in the south—*viguiers.*

Some time in the 11th century the provosts replaced the viscounts wherever the viscounty had not become a fief, and it is possible that in creating them the Crown was imitating the ecclesiastical organization in which the provost figured, notably in the chapters. The royal provosts had at first a double character. In the first place they fulfilled all the functions which answered locally to the royal power. They collected all the revenues of the domain and all the taxes and dues payable to the king within the limits of their jurisdiction. Doubtless, too, they had certain military functions, being charged with the duty of calling out certain contingents for the royal service; there survived until the end of the *ancien régime* certain military provosts *prévôts d'épée* (provosts of the sword) who were replaced in the administration of justice by a lieutenant. Finally, the provosts administered justice, though certainly their competence in this matter was restricted. Their second characteristic was that their office was farmed for a time to the highest bidder. It was simply an application of the system of farming the taxes. The provost thus received the speculative right to collect the revenues of the royal domain in the district under his jurisdiction; this was his principal concern, and his judicial functions were merely accessory. By these short appointments the Crown guaranteed itself against another danger: the possible conversion by the functionary of the function into a property. Very early, however, certain provostships were bestowed *en garde; i.e.,* the provost had to account to the king for all he collected. The *prévôtés en ferme* were naturally a source of abuses and oppression, the former seeking to make the most of the concession he had bought. They disappeared in the 16th century, by which time the provosts became regular officials, their office being purchasable.

Other transformations had previously taken place. The creation of the royal *baillis* reduced the provosts to a subaltern rank. Each *bailli* had in his district a certain number of provosts, who became his inferiors in the official hierarchy. When appeals were instituted (and this was one of the earliest instances of their introduction) the provost, the sphere of whose competency was limited, was subject to an appeal to the *bailli,* though his judgment had hitherto been without appeal. Moreover, in the 14th century they had ceased to collect the revenues of the royal domain, except where the *prévôté* was *en ferme,* and royal collectors (*receveurs royaux*) had been appointed for this purpose. The summoning of the feudal contingents, the *ban* and *arrière-ban,* had passed into the hands of the *baillis.* Thus the provosts were left for their sole function as inferior judges for non-nobles. (*See* BAILIFF AND BAILIE.)

The "provosts of the marshals of France," mentioned above, were non-legal officials (*officiers de la robe courte*) forming part of the body of the *maréchaussée* which was under the *ancien régime* what the *gendarmerie* was after the Revolution. Their original function was to judge offences committed by persons following the army, but in the course of the 14th and 15th centuries they acquired the right of judging certain crimes and misdemeanours, by whomsoever committed. They became stationary, with fixed spheres of authority, and the offences falling within their competency came to be called *cas prévôtaux.* These were the worst crimes of violence, and all crimes and misdemeanours committed by old offenders (*repris de justice),* who were familiarly known as the *gibier des prévôts des maréchaux* (gaol-birds).

(J. P. E.)

PROXY (short for "procuracy"), a term denoting either (1) a person who is authorized to stand in place of another; (2) the legal instrument by which the authority is conferred. Proxies are now principally employed for certain voting purposes. A proxy may in law be either general or special. A general proxy authorizes the person to whom it is entrusted to exercise a general discretion throughout the matter in hand, while a special proxy limits the authority to some special proposal or resolution. Formerly a peer could give his vote in the British parliament by proxy, by getting another peer to vote for him in his absence, temporal peers only voting for temporal and spiritual peers for spiritual. However, on March 31, 1868, on the recommendation of a committee, a new standing order was adopted by which the practice of calling for proxies on a division was discontinued. In English and American bankruptcy proceedings creditors may vote by proxy, and every instrument of proxy, which may be either general or special, is issued either by the official receiver or trustee. Under the English Bankruptcy Act of 1914 and the American Bankruptcy Act of 1898 a creditor may still vote by proxy in the manner prescribed. A shareholder in a limited liability company may vote by proxy, and regulations to that effect prescribing the requirements are usually embodied in the articles of association. In England a proxy to vote at a meeting must bear a revenue stamp. (*See* PROCURATION.)

In the early practice of the admiralty courts a proxy was the authority by which the proctor or advocate appeared for either party to a suit. In the ecclesiastical courts a proxy is the warrant empowering a proctor to act for the party to a suit. Two proxies are usually executed, one authorizing the proctor to institute, the other to withdraw, proceedings. They are signed by the parties, attested by two witnesses, and deposited in the registry of the court (Phillimore, *Ecclesiastical Law).* In the convocations of the Church of England those who are absent are allowed to vote by proxy. (*See* also PROCURATION.) Marriage by proxy or deputy was a custom recognized either for reasons of State or ceremonial. The extension of the doctrine to ordinary marriages was recognized in a few wartime cases in the United States.

PRUDENTIUS, AURELIUS CLEMENS (348–*c.* 410), the most remarkable of the earlier Christian poets in the West, was probably born at Tarraco. The meagre autobiographical preface, which he affixed to the complete edition of his works when he was fifty-seven years old, makes it clear that he received a liberal education — being of noble family — practised as a lawyer and entered official life, and finally held some high office under Theodosius. At the age of fifty-seven he retired to a monastery, but died shortly afterwards.

Bentley calls Prudentius "the Horace and Virgil of the Christians," but his diction is stilted and his metre often faulty. The list of his works given in the preface mentions the hymns, poems against the Priscillianists and against Symmachus and *Peristephanon.* The *Diptychon* or *Dittochaeon* is not mentioned. The twelve hymns of the *Cathemerinon liber* ("Daily Round") consist of six for daily use, five for festivals, and one intended for every hour of the day. Prudentius shows Ambrose as his master here, but gives to Ambrose's mystic symbolism much clearer expression. The *Apotheosis* and *Hamartigenia* are polemic, the first against the disclaimers of the divinity of Christ, the latter against the gnostic dualism of Marcion and his followers. In them Tertullian is the source of inspiration. Of more historical interest are the two books *Contra Symmachum,* of 6j8 and 1,131 hexameter verses respectively, the first attacking the pagan gods, the second directed against the petition of Symmachus to the emperor for the restoration of the statue of Victory which Gratian had cast down.

The *Peristephanon* consists of fourteen hymns to martyrs. These were mostly Spanish, but some were suggested to Prudentius by sacred image, in churches or by the inscriptions of Damasus. This book, with tke *Cathemerinon liber* and the *Psychomachia,* was among the most widely read books of the middle ages. Its influence on the iconography of mediaeval art was great. The *Psychomachia* is aesthetically inferior, but had the greatest influence of all of Prudentius's writings. In it he depicts the struggle of Christendom with paganism under the allegory of a struggle between the Christian virtues and the pagan vices. The *Dittochaeon* is a series of quatrains, probably intended to explain forty-nine pictures of a basilica. The work is more interesting for archaeology than for literature.

Prudentius's works were published by Giselin at Antwerp in 1564, and by F. Arevalo at Rome in 1788, with complete commentary. This last is the edition reprinted in J. P. Migne's *Patrologia Latina,* vols. lix.–lx. (Paris, 1847). More recent editions are by Obbarius (Tübingen, 1845) and A. Dressel (Leipzig, 1886), while a critical edition has been undertaken by J. Bergmann.

See also J. Bergmann, *Lexicon prudentianum, fasc.* i. [a-adscendo] (Upsala, 1894); M. Schanz, *Gesch. d. rom. Lit.* (Munich, 1904); A. Ebert, *Allgem. Gesch. d. Lit. des Mittelalters,* vol. i, 2nd ed. (Leipzig, 1889); M. Manutius, *Gesch. d. christl. lat. Poesie* (Stuttgart, 1891); T. R. Glover, *Life and Letters in the Fourth Century* (Cambridge, 1901); C. Brockhaus, *Aur. Prud. Clem. in seiner Bedeutung f. d. Kirche seiner Zeit* (Leipzig, 1872); A. Puech, *Prudence: étude sur la poésie latine chrét. au IV^e siècle* (Paris, 1888); F. St. John Thackeray, *Translations from Prudentius* (London, 1890); F. Maigret, *Le Poète chrétien Prudentius* (Paris, 1903); E. O. Winstedt, "The Double Recension in the Poems of Prudentius," *The Classical Review,* vol. xvii. (1903).

PRUD'HON, PIERRE (1758–1823), French painter, born at Cluny on April 4, 1758, was the thirteenth child of a mason.

The monks of the abbey undertook his education, and by the aid of the bishop of Mâcon he was placed with Devosge, director of the art school at Dijon. In 1778 Prud'hon went to Paris armed with a letter to Wille, the celebrated engraver, and three years later he obtained the triennial prize of the States of Burgundy, which enabled him to go to Rome, where he became intimate with Canova. He studied the work of Correggio and the affinity of his style with that of the great Italian has given him the name of "Corrège Français." He returned to Paris in 1787. The illustrations which he executed for the *Daphnis* and Chloe published by Didot brought him into notice, and his reputation was extended by the success of his decorations in the Hôtel de Landry (now Rothschild), his ceiling painting of "Truth and Wisdom" for Versailles (Louvre), and of "Diana and Jupiter" for the Gallery of Antiquities in the Louvre. In 1808 he exhibited "Crime pursued by Vengeance and Justice" (Louvre), which had been commissioned for the assize courts, and "Psyche carried off by Zephyrs." These two compositions brought Prud'hon the Legion of Honour; and in 1816 he entered the Institute. Consoled for the misery of his marriage by the devoted care of his pupil, Mlle. Mayer, Prud'hon's situation seemed cnviablc; but Mlle. Mayer's tragical suicide in 1821 brought ruin to his home, and Prud'hon died two years later on Feb. 16. 1823.

See P. Gauthiez, ***Prud'hon*** (1891); E. Bricon, ***Prud'hon*** (1907); C. Clement (chief work), ***Puud'hon;*** sa ***vie, ses oeuvves et sa correspondance*** (1880).

PRUNE: see PLUM.

PRUNELLA, a term obtained from the French *Prunelle*, and applied to worsted or woollen twill fabrics of light but strong texture, produced with the three-end $\left(\frac{2}{\quad 1}\right)$ warp-face twill weave and usually woven from hank-dyed yarn of a dark purple colour both for warp and weft, or else piece-dyed in the same colour and formerly much used for clerical garments. It is now made in various grades of texture both plain and striped and used as dress material, ladies' sport skirts, and other articles of clothing both for men and women. A stronger and heavier texture of prunella cloth of a similar character to "everlasting," is also produced from a worsted warp and cotton weft and woven with the double-stitch five-end warp-face satin weave, and used for ladies' shoe-tops The three-end warp-face twill weave is also described as the "prunella" twill, irrespective of the class of fabric to which it is applied. (H. N.)

PRURITUS, an ailment characterized by intense itching of the surface of the body. It may occur in jaundice, diabetes digestive disorders, etc., or as the result of the irritation produced by skin parasites. The most serious form affects old persons, and is often a cause of great suffering, depriving the patient of sleep. In such cases it is probably due to atrophic changes in the skin. No eruption is visible, except such marks as are produced by scratching. The treatment is, general, by tonics and, local, by soothing lotions.

PRUSSIA, a former German kingdom, now the largest, most populous and important Land of the German reich. Prior to 1938 it was bounded on the north by the Baltic, Mecklenburg, Denmark and the North sea, on the east by Lithuania and Poland, on the south by Czechoslovakia, the *Land* of Saxony, Thuringia, Bavaria and Hesse, on the west by Alsace-Lorraine, Luxembourg, Belgium and the Netherlands. Oldenburg and Mecklenburg run like wedges from the coast into Prussian territory; Brunswick and other small German states form Prussian enclaves. The *Land* of Prussia forms a tolerably compact mass of territory in northern Germany.

Physical Features. — The greater part of Prussia belongs to the great north European plain, and may be generally characterized as lowlands. The plain is much wider on the east, where only the southern margin of Prussia is mountainous, than on the west, where the Hanoverian hills approach to within less than 100 mi. of the sea. A line drawn from Dusseldorf through Halle to Breslau would, roughly speaking, divide the flat part of the cauntry from the hilly districts. In the southeast, Prussia is separated from Bohemia by the Sudetic chain, which begins at the valley of the Oder and extends thence towards the northwest. This chain includes the Riesengebirge, with the highest mountain in Prussia (Schneekoppe), and subsides gradually in the hills of Lusatia. The Harz mountains, however, beyond the Saxon plain, follow the same general direction and may be regarded as a detached continuation of the system. To the south of the Harz the Prussian frontier intersects the northern part of the Thuringian forest, which is also prolonged towards the northwest by the Weser Gebirge and the Teutoburger Wald. The southwest of Prussia is occupied by the plateau of the lower Rhine, including on the left bank the Hunsriick and the Eifel, and on the right the Taunus, the Westerwald and the Sauerland. Between the lower Rhenish and Thuringian systems are interposed the Vogelsberg, the Rhon and other hills belonging to the Triassic system of the upper Rhine. The Silesian mountains are composed chiefly of granite, gneiss and schists, while the Harz and the lower Rhenish plateau are mainly of Devonian and Silurian formation. To the north of the Sauerland is the important Carboniferous system of the Ruhr, and there are also extensive coalfields in Silesia; a considerable portion of the Silesian coalfield was, however, ceded to Poland in 1921. With the exception of the Danube, Prussia is traversed by all the chief rivers of Germany, comprising almost the entire course of the Oder and the Weser (see also GERMANY).

Climate. — The climate of Prussia may be described as moderate, and is generally healthy. The greatest contrasts of temperature are found between the east and west, the mean annual temperature in the bleak and exposed provinces of the northeast being about 44" F., while that of the sheltered valley of the Rhine is 5° higher. In winter the respective means are 27° and 34"; in summer the difference is not above 2° to 4°. The highest monthly average is about 66" in July. The rainfall in the lowlands is about 25 in. at Cologne, 23 in, at Berlin and 25.5 in. at Konigsberg, but in the east it diminishes inland to 19 in. or less. It is greater on the outstanding heights.

Area and **Population.**—Prussia is made up of the following provinces, viz., East Prussia, Brandenburg, Berlin, Pomerania, Grenzmark, Silesia, province of Saxony, Schleswig-Holstein, Hanover, Westphalia, Hessen-Nassau, Rhine province and Hohenzollern, with a total area of 117,883 sq.mi. and a population (according to the 1939 census) of 41,762,042, excluding the Saar district, but including Waldeck. The state of Waldeck was incorporated with Prussia, April 1, 1929. The population is densest in the mining and manufacturing district of the Rhine, which is closely followed by Westphalia; next to these come Hessen-Nassau, Silesia and Saxony. After 1919, and especially after 1933, there was a tendency for the industrial population to increase more rapidly in the central and eastern provinces than in the more densely settled Rhine and Westphalian provinces of the west which would be more likely to be invaded or bombed in case of war. In 1939 Prussia contained 61 towns with upwards of 100,000 inhabitants each.

Communications. — With most internal means of communication Prussia is excellently provided. On April 1, 1920, the railways became the property of the reich, and on Oct. 11, 1924, as a result of the Dawes agreement, their management was put in the hands of a private company, though they remained state property. In 1938 the railways (including the German State railway or *Reichsbahn* and a few private and side lines) within Prussia totalled 16,728 mi. in length. The most important trunk line of Prussia is that which enters the western frontier near Aachen and runs through Cologne, Düsseldorf, Hanover and Berlin, and crosses to Danzig, proceeding via Konigsberg to the eastern frontier at Eydtkuhnen. Generally speaking, the principal lines of the country either radiate from Berlin or run alongside the frontiers and boundaries.

Prussia possesses also an extensive system of natural and artificial waterways. The most important of the canals are the Kiel canal, connecting the North sea and Baltic, the Elbe-Trave canal (to give Liibeck access to the Elbe), the Dortmund-Ems canal and its continuation, the Dortmund-Rhine canal, and the Mittelland canal, opened in 1938, which connects the inland waterways of the central and western provinces.

Agriculture. — The northeastern provinces of Prussia contain a high proportion of poor soil, and in the northwest occur large tracts of heath and moor. The reclaimed marshlands in both districts, as well as the soil in the neighbourhood of the rivers, are usually very fertile, and tracts of fruitful ground are found in the valleys of the Rhine and its affluents, and in the plain around Magdeburg, the so-called Bohrde. The most fertile Prussian province is Saxony, while the least productive are East Prussia and the Grenzmark. The principal crop in Prussia is rye, of which the ordinary bread of the country is made; it grows in all parts of the country, especially in the north and east, and occupied an area of nearly 7,700,000 ac. in 1937. Oats occupy an area equal to about two-thirds of that devoted to rye, and are also grown most extensively in the northeastern districts. Wheat, which is chiefly cultivated in the south and west, covers only about a third as much ground as rye. Barley also covers about a third as much ground as rye. Other grain crops are spelt (chiefly on the Rhine), buckwheat (Hanover and Schleswig-Holstein) and millet; maize is grown for fodder in some districts. Potatoes, used both as food and for the distillation of spirits, are cultivated over an area of about 4,800,000 ac. (1937), and are specially predominant in the eastern provinces, The common beet is extensively grown for the production of sugar in the provinces of Saxony, Hanover, Silesia, Pomerania and Brandenburg. Flax and hemp occupy considerable areas in East Prussia, Silesia and Hanover. There is some cultivation of rape-seed for oil. Agriculture in Prussia is on a high level, with much application of the latest scientific improvements, including widespread utilization of electrical power. The number of farms of less than 2 hectares each (*i.e.,* about 5 acres; 1 ha.= 2.471 ac.) in 1933 was 493,489; farms ranging from 2 to 5 ha. numbered 420,019; farms ranging from 5 to 20 ha. numbered 577,571; farms ranging from 20 to 50 ha. numbered 131,675; and farms exceeding 50 ha., 38,254.

The cultivation of the beetroot for sugar has had a far-reaching effect upon Prussian agriculture, especially in the provinces of Saxony, Silesia, Hanover, Pomerania, Brandenburg, the Border province and the Rhine province. Also owing to the deep cultivation of the soil and the incessant hoeing which the beet crop requires, the three or four crops which follow it are invariably good, and the liability to failure of the immediately succeeding crop is reduced to a minimum. Moreover, the fiscal policy of the Prussian government has been of first-rate assistance to the Prussian farmer, Beet tops are often fed to the cattle as fodder. The principal centres for the manufacture of beetroot sugar in Prussia are Magdeburg, Berlin and Breslau. Chicory is produced chiefly in the Prussian province of Saxony.

Live Stock. — The province of East Prussia, with the principal government stud of Trakehnen, is the headquarters of horse-rearing. The horses bred there are generally suitable for the lighter kind of work only, and are in great request for military purposes. Horses of a stouter type are bred in Schleswig-Holstein and on the Rhine, but heavy draught horses ordinarily have to be imported from France, the Netherlands, Belgium and Denmark. The best cattle are reared in the maritime provinces of the west.

Forests.—Prussia contains a large proportion of woodland. The most extensive forests are in East Prussia, Silesia and Brandenburg, where coniferous trees prevail, and in the Rhenish and Hessian districts, where oaks and beeches are the most prominent growths. The northwest is almost entirely destitute of timber, and peat is used universally there as fuel. The admirably managed government forests form a considerable proportion of the whole, and the state also controls the management of forests in private possession.

Viticulture. — The principal wine-growing districts of Prussia are the Rheingau and the Rhine province, though wine is also produced in Silesia, Westphalia and a few other districts. The valleys of the Nahe, Saar, Moselle and Ahr all produce excellent wine. German vine-growers have suffered in common with vine-growers in other countries of Europe, from the *Oidium tuckeri* and the Phylloxera, and the government has spent large sums of money in endeavouring to arrest the ravages caused.

Fisheries. — The fisheries on the Baltic sea and its bays, and on the North sea, are important. In the former the take consists mainly of herrings, flatfish, salmon, mackerel and eels, while the chief objects of the latter are cod and oysters. Inland fishery has been encouraged by the foundation of numerous piscicultural establishments and by the enactment of close-time laws. Carp, perch, pike and salmon, the last-named especially in the Rhine, are the principal varieties; sturgeon are taken in the Elbe and Oder, and the Iakes of East Prussia swarm with bream and lampreys. Game of various kinds abaunds in different parts of Prussia, and the lakes are frequented by large flocks of waterfowl.

Mining **and** Metal **Industries.**—Prussia is the largest producer of coal, zinc, salt, lead and copper among the *Länder* of the German reich. The Rhenish-Westphalian district produces the largest quantity. An extremely important role was played in the coal industry of Prussia by the Rhenish-Westphalian Coal syndicate, which succeeded in regulating the production and price of the coalfields generally. Almost all the zinc produced in Germany comes out of the Silesian mines, but two-thirds of them were transferred to Poland after World War I. They again became available to Germany, however, during World War II. The chief iron-producing regions are the Rhine province, Westphalia, Hessen-Nassau and Silesia. Lead and manganese are also produced. Salt is mined principally in the province of Saxony (Stassfurt, Aschersleben, Erfurt, Halle, Merseburg, Sangerhausen), the kali salts near Magdeburg and Glauber salts in the Rhine province and Hessen-Nassau. Iron is worked principally in the districts of Arnsberg, Diisseldorf, Oppeln in Silesia, Trier and Coblenz, and zinc for the most part near Oppeln in Silesia; lead and silver near Aachen, Oppeln and Wiesbaden, and sulphuric acid in all the mining districts, as well as near Potsdam, Breslau, Magdeburg and Merseburg. Petroleum is extracted to a limited extent at a couple of places in the province of Hanover, which also contains considerable potash deposits. Amber has been mined in East Prussia. A little is also collected on the coast near Pillau.

Industries. — It was during the last quarter of the 19th century that Prussia became a great manufacturing country, industry being interwoven with agriculture, and both being dependent on the highest organization of technical skill. The educational system was remarkably adapted to this end, and skill in the use of foreign languages became a special feature. The chief industrial districts are, of course, those which yield coal with, in addition, the great cities — Berlin, Magdeburg. Hanover, Breslau, Gorlitz, Stettin, Essen, Dortmund, Elberfeld-Barmen, Diisseldorf, Cologne, Aix-la-Chapelle, Crefeld, Halle, Frankfurt-am-Main, Solingen, Remscheid, Konigsberg, and many others. The iron and metal industries, especially the making of machinery, electrical plant, tramway plant, and the production of articles in wrought copper and brass, rank in the forefront. In these branches Berlin and more lately its suburbs, as well as Magdeburg and Cologne, played an active role, but the old centres of the metallurgical and iron and steel industries in the Rhine province and Westphalia remained outstandingly important. Austrian and Bohemian centres grew rapidly after 1938. The chemical industries, essentially a German specialty, take front rank, *e.g.,* those which produce aniline dyes, artificial indigo, illuminants (acetylene gas, Welsbach mantles, etc.), explosives, various chemical salts, pharmaceutical preparations, cellulose, glycerine, artificial (chemical) manures and perfumes. German shipbuilding is highly developed.

Government. — The Constitution of Prussia of Nov. 30, 1920, provided for a diet or landtag of 450 members, elected for *a* period of four years by universal secret suffrage on a basis of proportional representation. This constitution was infringed in July 1932, when President von Hindenburg appointed Franz von Papen as federal commissar of Prussia in place of Otto Braun, who had been prime minister for a dozen years. The constitution was completely superseded in 1933 by Hitler's appointment of Hermann Goering as deputy federal governor (*Reichsstatthalter*) of Prussia and of several national socialist leaders (Gauleiters) for the different districts of Prussia, and by the final abolition of the Prussian legislature in 1934.

Religion. — The centre of Prussia is predominantly Protestant, the proportion of Roman Catholics increasing towards east and west and reaching its maximum on the Rhine and in the Slavonic provinces. East Prussia, however, with the exception of Ermeland, is Protestant, The Roman Catholics greatly outnumber the Protestants in the Rhine provinces, and in Upper Silesia. Absolute religious liberty was guaranteed in the Weimar republic, but was greatly interfered with after 1933. In 1933 the Evangelical Protestants in Prussia numbered 25,212,026, the Roman Catholics 12,555,647, the Jews 360,141 and those of other beliefs 1,564,353. The Evangelical or Protestant Church of Prussia was formed by a union of the Lutherans and Calvinists. effected under royal pressure in 1817. Those who were unable from conscientious scruples to join the union became Separatists or Old Lutherans and Old Calvinists, but their numbers were and are insignificant. The Evangelical Church was governed by "consistories," or boards elected by the people. There were also synods in most circles and provinces, and general synods representing the old provinces only. The organization of the Roman Catholic Church differs in the various provinces. Altogether, in Prussia, there are two archbishops and ten bishops.

Education. — Before 1933 education was compulsory, and the general level attained was very high. Every town or community maintained a school, supported by local rates and under the supervision of the state. All parents were compelled to have their children properly taught or to send them to one of these elementary schools. By the Constitution of 1850, all persons were permitted to instruct, or to found teaching establishments, provided they could produce to the authorities satisfactory proofs of their moral, scientific and technical qualifications. Both public and private educational establishments were under the surveillance of the minister of public instruction, and all public teachers were regarded as servants of the state (Staatsbeamte).

The expenses of the primary schools (Volksschulen) before Hitler's time were borne by the communes (*Gemeinden*), aided when necessary by subsidies from the state. The teachers for the elementary schools were trained in normal seminaries or colleges established and supervised by the state. The secondary schools of Prussia were roughly divided into classical and modern. The classical schools proper consisted of Gymnasia. In these boys were prepared for the universities and the learned professions, and the full course lasted for nine years. The modern schools, or *Realgymnasia,* also had a nine years' course; Latin was taught, but not Greek, and greater stress was laid upon modern languages, mathematics and natural science. Ranking with the *Realgymnasia* were the *Oberrealschulen,* which differed only in the fact that Latin was entirely omitted, and the time thus gained devoted to modern languages. The gymnasia1 "certificate of ripeness" (*Maturitätszeugniss*), indicating that the holder had passed satisfactorily through the highest class, enabled a student to enrol himself in any faculty at the university.

After 1933 the standard of education deteriorated seriously. Schools became agencies for the inculcation of national socialist doctrines rather than for training in Christian morality and scientific methods and for the imparting of sound and unbiased information. The period of compulsory school education was shortened. School work was impaired by the amount of time which pupils had to spend in evening attendance at national socialist youth meetings and week-end marches and athletic training. Many new special schools were established for the training of nazi party functionaries, the most important of which were the *Ordensburgen* for the training of an elite group of future state and party leaders. Education was taken out of the hands of Prussian local officials and placed under the control of the central government of Germany.

Prussia possesses 12 of the 23 German universities (not including the lyceum at Braunsberg; the medical academy at Diisseldorf and the Roman Catholic seminary at Münster). The largest Prussian university is that of Berlin, while Breslau, Bonn, Gottingen and Halle are the next in size. The oldest is the university of Greifswald, founded in 1456. Like the schools, the universities are state institutions, and the professors are appointed and paid by the government, which also makes annual grants for apparatus and equipment.

Ranking with the universities are numerous technical high schools. Music is taught at several *conservatoria,* the best known of which are at Berlin and Frankfurt-am-Main.

The science and art of Prussia found their most conspicuous external expression in the academies of science and art at Berlin, both founded by Frederick I; and each town of any size throughout the kingdom has its antiquarian, artistic and scientific societies. Recognized schools of painting exist at Berlin and Düsseldorf, and both these towns, as well as Cassel. contain excellent picture galleries. The scientific and archaeological collections of Berlin are also of great importance. Besides the university collections, there are numerous large public libraries, the chief of which is the Reichsbibliothek at Berlin. (N. D.; S. B. F.)

See *Statistisches* Jahrbuch *für* den Freistaat *Preussen,* the *Statistisches Jahrbuch* fur das *deutsche Reich,* and other publications of the statistical offices of Prussia and Germany. In addition, see Landeskunde *Preussens* (Berlin, 1901), edited by Beuermann, various volumes of Forschungen *zur deutschen Landes-* und Volkskunde: British Diplomatic and Consular Reports; and the bibliography for GERMANY.

HISTORY

The state of Prussia, which has played so great a part in the history of Germany, came into being gradually, being formed out of wholly dissimilar components. The chief of these were the mark of Brandenburg and the State of the Teutonic Order in Prussia. The history of each of these, up to their union, must be treated separately.

The Mark of Brandenburg. — The territory between the Elbe and the Oder, which had been abandoned by the Germans in the time of the great migrations, and occupied by Slavonic tribes in the succeeding centuries, was gradually reconquered by the Germans after the 10th century. To secure the safety of the new frontier districts, marks were set up, the overlords of which — the markgrafs—enjoyed wider powers than the counts in the interior of the empire. The northernmost of these marks was the Nordmark, founded by Henry I and enlarged by Otto I. Those parts of this mark which lay east of the Elbe were, however, lost to German rule after the great rising of the Slavs in 983; only the present Altmark remained in German hands.

The markgraf Albert the Bear, of the Ascanian dynasty (1134–70), was the true founder of the state of Brandenburg. He conquered Priegnitz and the Havelland and at first took the title of markgraf of Brandenburg. His descendants, who remained masters of these districts until 1320, conquered the Ukermark, the districts of Stargard and Lebus, and the so-called Neumark, beyond the Oder. They were already aiming at possession of Pomerania, in order to obtain direct access to the sea. The Ascanian markgrafs invited a large number of German settlers into the country and founded a number of German towns, which soon attained considerable prosperity.

On the extinction of the Ascanians, Louis the Bavarian, the then German king, bestowed their lands on his younger sons (1324). The Wittelsbachs were unable, however, to retain for long their hold on these territories, which lay far distant from their family possessions. Finally they ceded them to the emperor Charles IV (1373), who attempted to combine them with Bohemia and Silesia in one great East German state. After his death, however (1378), his extensive dominions were divided up. The mark fell first to his youngest son Sigmund, who gave it in pledge to his cousin, Jobst of Moravia. On the death of the latter (1411), the mark reverted to Sigmund, who had in the meantime become German king. In 1415 he conferred it on one of his most faithful adherents, the burgrave Frederick of Nurnberg, of the house of Hohenzollern.

The "Zollerns" are first mentioned in a document of 1061. Their ancestral home was a Swabian castle near the source of the Danube. An elder branch of the family remained in the old home and founded the principality of Hohenzollern-Sigmaringen. A younger branch, established by Conrad of Hohenzollern about 1170, took military service under Frederick Barbarossa, and was appointed burgrave of Niirnberg. His descendants soon acquired the lands of Ansbach and Bayreuth near Niirnberg and became powerful princes, The two first electors of the house of Hohenzollern, Frederick I. (1415–40) and Frederick II. (1440–70) had a hard struggle against the nobles and towns of the Mark to restore the authority of the overlord and recover the frontier districts, some of which had been occupied by neighbours. Under the next electors, Albert Achilles (1470–86) and John (1486–99) the overlord's power was further consolidated. Joachim I. (1499–1535) founded a university in Frankfurt-an-der-Oder, and was one of the keenest partisans of the old Church in the struggles provoked by Luther's movement. His son, Joachim II. (1535–71), however, was converted to Protestantism and introduced the Reformation into the Mark. The next electors, John George (1571–98) and Joachim Frederick (1598–1608) are of little importance for the further development of the State. John Sigmund (1608–19), by his marriage with the heiress of Prussia and Julich, paved the way for the great change which the acquisition of those territories brought about.

The Teutonic Order.—In 1226 the Polish Duke Conrad of Masovia invited the Teutonic Knights into his territory to combat the heathen Prussians. After a difficult struggle, the Order conquered the territory of the heathen Prussians, exterminated most of the native population, and invited German peasants and townspeople into the country as settlers. In the 14th century the State ruled by the Knights was a power in north-eastern Germany. It acquired Pommerellia and for a time the Neumark also, and through its connection with the Order of the Sword, of Livonia, extended its influence as far as Estonia. A string of flourishing cities sprang up along its coast. In Marienburg, since 1309 the seat of the Grand Master of the Order, the splendid castle was built which to this day testifies to the past glories of the Order, and formed the centre of its admirably organized administrative system. But even in the 14th century the Order was beginning to decline, owing mainly to the fact that once the struggle against the heathen was ended, it lost its original spiritual character, occupied itself only with purely mundane tasks, and thus lost touch with its original purpose. The rule of the Knights, who admitted none of the local nobility into their ranks, came to be felt by the inhabitants as a foreign rule. When Poland and Lithuania united into a powerful State at the end of the 14th century, and the rulers of this State began to aspire to possession of the Baltic coast, the Order could not rely fully either on the nobles or on the towns in its territory. After the defeat of their army at the battle of Tannenberg (1410) the Knights were forced to cede part of their territory to Poland. In a second war the Poles took Marienburg, and at the Peace of Thorn (1466) forced the Order to cede them West Prussia and Ermeland, with Danzig and Thorn, and to acknowledge the suzerainty of the Polish king for the rest of their territory. At the beginning of the 16th century, the Reformation began to penetrate these regions also, and the Grand Master of the day, Albert of Brandenburg, a grandson of the Elector Albert Achilles, proceeded, with the consent of the king of Poland, to take the decisive step which was tantamount to the end of the Order's rule. He went over to Protestantism, at the same time proclaiming himself hereditary duke of Prussia (1525). As his only son, Albert Frederick (1568–1618) was an imbecile, the power passed almost wholly to the Estates. Albert Frederick's eldest daughter, Anna, married the Elector John Sigmund, and through her Prussia passed in 1618 to the electors of Brandenburg. As Anna was also co-heiress through her mother of the great territories which had been united under the rule of the dukes of Julich, Cleve and Berg on the lower Rhine, and as this ducal house had become extinct a few years previously (1609), the electors of Brandenburg could hope to acquire not only Prussia, but also considerable domains in west Germany.

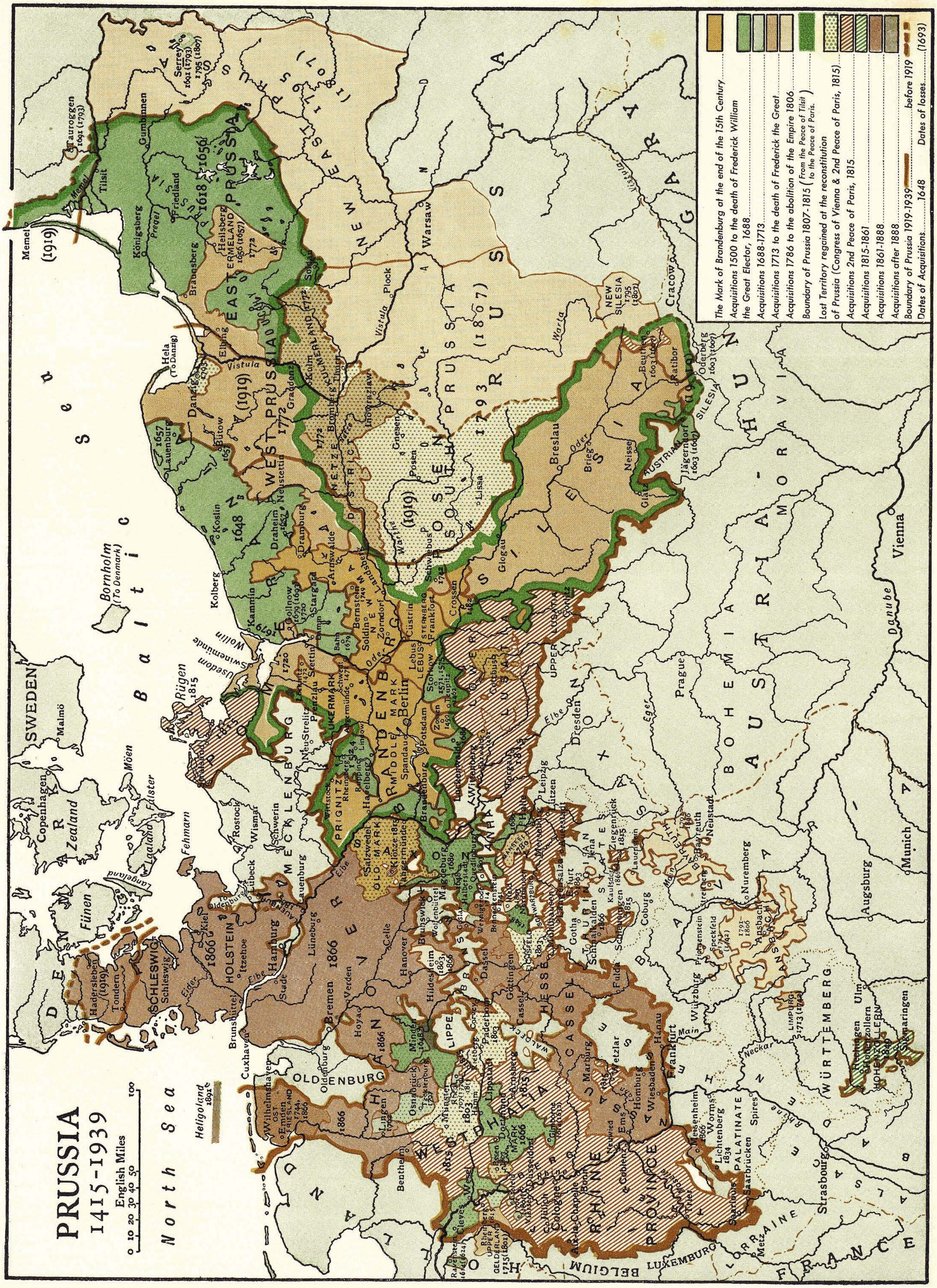
The Great Elector.—Under the Treaty of Xanten (1614), John Sigmund had reached an understanding with the count Palatine of Neuburg, his most dangerous rival for the Jiilich succession, securing for himself the reversion of Cleve, Mark and Ravensberg. In order to obtain from the Calvinistic princes of west Germany the support which he needed to keep these acquisitions secure, he had become a convert to Calvinism—a step which aroused great discontent in his ancestral domains, which were wholly Lutheran, and in Prussia, which was also Lutheran. The Thirty Years' War broke out at the end of John Sigmund's reign, and his son George William (1619–40), a weak ruler, found himself confronted with a situation of extraordinary difficulty. Although he urgently desired to remain neutral, both the Danes and Wallenstein's troops invaded his territory. After his cousin, Gustavus Adolphus, landed in Germany, it was no longer possible to preserve neutrality. He was forced to conclude an alliance with the king, but on the latter's death at once attempted to make peace with the emperor; later he even took sides against Sweden, who refused to grant him possession of Pomerania, to which he had laid claim, on the strength of old succession treaties, on the death of the last member of the old ducal family (1637). The Mark of Brandenburg consequently again became the theatre of war, and the elector was obliged to flee to Prussia, where he died in 1640.

His young son, Frederick William, at that time only 20 years of age, became the real second founder of the Prussian State. He concluded an armistice with Sweden, and, in the face of great difficulties, organized for himself a small army of his own, with the object of achieving greater independence. In the Peace of Westphalia (1648) he succeeded in acquiring Further Pomerania (Vorpommern), and the secularized bishoprics of Minden, Halberstadt and Magdeburg as compensation for Hither Pomerania (*Hinterpommern*), which was assigned to Sweden. The last-named districts, however, only actually passed to him in 1680, after the death of the previous administrator.

In the decade which followed the Peace of Westphalia, Frederick William reinforced his army. In the first Northern War (1655–60) he was thus a valuable ally to either of the contending parties, Sweden or Poland. First he joined the Swedes, and helped them to win the decisive victory near Warsaw (1656). When, however, King Charles Gustavus was forced by the Danish attack to return to Sweden, the elector negotiated with Poland. By adroit manipulation of the situation he managed in the Peace of Oliva (1660) to secure from all parties concerned recognition of his full sovereignty over East Prussia.

The importance of the great elector's reign was even greater for the internal development of the Prussian State. His creation of a standing army gave him an instrument which could be turned against the claims of his own subjects also. After a vigorous struggle with the Estates, which assumed acute form in East Prussia, he succeeded in restricting their rights in important respects. The system of taxation was radically reformed; the old administrative system, which was largely controlled by the Estates, was reinforced by new official bodies, which were purely State organs. The elector's privy council, which had hitherto been a purely Brandenburg institution, was made into the central organ of the whole State. In important deliberations the elector presided personally, and all subordinate officials were accustomed to send in regular reports on their work to the privy council. All these measures bore clear witness to the elector's ambition to create a unified single State out of the different territories, scattered throughout Germany, which had gradually come into his family's possession. When Frederick William died in 1688, his State was already the most powerful and the best administered in northern Germany. (For a detailed account of early Prussian history see BRANDENBURG.)

Frederick William I.—Under the elector's son, Frederick III. (1688–1713) the internal development of the State was temporarily arrested. In the international sphere, however, Frederick scored an important success when, by promising to support him in the War of the Spanish Succession, he induced the emperor to consent to his assuming the title of king. As the electorate of Brandenburg formed part of the German empire, and was under the suzerainty of the emperor, the title of king could only be attached to those lands which the elector ruled as sovereign prince, viz., the duchy of Prussia. On Jan. 18, 1701, Frederick took the title of "King in Prussia," and solemnly assumed the royal crown in Konigsberg. So it came about that "Prussia," and not the old family domain of Brandenburg, came


PRUSSIA
1415-1939
English Miles
0 10 20 30 40 50 100
The Mark of Brandenburg at the end of the 15th Century
Acquisitions 1500 to the death of Frederick William the Great Elector, 1688
Acquisitions 1688-1713
Acquisitions 1713 to the death of Frederick the Great
Acquisitions 1786 to the abolition of the Empire 1806
Boundary of Prussia 1807-1815 (From the Peace of Tilsit to the Peace of Paris)
Lost Territory regained at the reconstitution of Prussia (Congress of Vienna & 2nd Peace of Paris, 1815)
Acquisitions 2nd Peace of Paris, 1815
Acquisitions 1815-1861
Acquisitions 1861-1888
Acquisitions after 1888
Boundary of Prussia 1919-1939 before 1919
Dates of Acquisitions 1648 Dates of losses (1693)
Baltic Sea
North Sea

to be used as the generic name for the Hohenzollern dominions. The new king kept up a splendid court, and thereby ruined the economic equilibrium which his father had laboriously achieved. He also took a lively interest in intellectual matters. He founded the Academy of Arts and the Academy of Sciences in Berlin (1701).

His successor, Frederick William I. (1713–40) has long been unjustly represented as a crude tyrant. He was a sober-minded man, without any strong intellectual interests, but a first-class organizer and imbued with a stern sense of duty, based on religious sentiment, and he deliberately devoted his whole soul to the service of the State. He resumed the work begun by his grandfather, and is the true father of the Prussian administrative system and Prussian officialdom. He created a new central administrative service in the shape of the General Directory, for which he drew up the instructions himself (1723). This organ acted as a general ministry, in which the agenda was distributed to the several members, partly by subject, partly on local lines, while all important measures were decided in general conference. The king reserved to himself the final decision. Each official received a commission stating his duties, emoluments and exact official regulations. All official bodies had to keep a record of, and send in a weekly report on their activities. In most cases officials were nominated by the king at his full discretion; only in the selection of the Landrate, who were in charge of the provincial districts (*Kreise*) the nobles still had a certain voice. Officials and magistrates were obliged to pass through a definite course of training, and could not be appointed unless they had passed the prescribed examination. The king organized a regular procedure of judicial appeal, making the *Kammergericht* in Berlin the supreme judiciary instance for the whole State. Judicial procedure was also simplified and improved in important respects. In the financial administration he introduced the strictest economy. He succeeded in increasing the revenue from the royal domains and prerogatives and from the indirect taxes to a considerable degree, and in achieving an annual surplus. This he put into a State exchequer, which contained 7,000,000 thaler at his death. He made special efforts to encourage trade and industry, following the principles of the mercantile system, which at that time were everywhere accepted. As the country was thinly populated, he encouraged the immigration of efficient labour. Just as his grandfather had admitted a large number of the Huguenots expelled from France after the repeal of the Edict of Nantes by Louis XIV., so Frederick allowed the Protestants expelled by the archbishop of Salzburg to enter his kingdom, settling most of them in East Prussia. First and foremost a soldier, the king devoted especial attention to the training of the standing army, the numbers of which he raised from 40,000 to 89,000. It was still a mercenary army, recruited from volunteers at home and abroad. He took pains, however, to ensure that as high a proportion as possible should be composed of his own subjects and divided the whole Prussian territory into recruiting districts, the so-called "cantons"; each district was obliged to supply the men for one specified regiment. The recruiting was often done in a very arbitrary fashion, which gave rise to many complaints. Definite instructions were drawn up and regular inspections carried through to ensure uniformity of training; the army thus created was superior to those of most other States. It was Frederick William who first gave Prussia the characteristic stamp of a military and bureaucratic State.

For all his military inclinations, Frederick William was an unusually peaceable man by nature, and in his foreign policy always avoided military entanglements. When he came to the throne, Prussia was embroiled in the Northern War; at the conclusion of peace he succeeded in securing Hither Pomerania up to the Peene, which had formerly been in the hands of Sweden, with the important commercial town of Stettin. He failed, however, to secure support for his claims which were based on old succession treaties, to further portions of the Cleves-Jülich heritage, and to parts of Silesia. As a loyal German, he thought it his duty to maintain as good relations as possible with the emperor; but encountered profound mistrust in Vienna, where the growing strength of the Prussian State was watched with concern, and towards the end of his life was forced into an increasingly sharp opposition to the house of Habsburg.

Frederick the Great.—Frederick William died in 1740. He was succeeded by his son, Frederick the Great (1740–86), who was at that time 28 years of age. He had had violent conflicts with his father in his younger days, as his passionate and freedom-loving nature revolted against the severe discipline which his father thought necessary. Furthermore, the younger man's inclinations led him towards the new ideas of the Aufklarung, while the old King was a strict Calvinist. The crown prince's attempted flight (1730) brought this conflict to a head. The king had his son imprisoned, and even had an idea of excluding him from the succession; Frederick was only able to buy a reconciliation at the price of complete submission to his father's will. He was obliged to pass through a strict training in the administrative service and the army, a training which did much to prepare him for his later career.

For Frederick's conflicts with Maria Theresa in the first half of his reign, see GERMANY; AUSTRIA-HUNGARY; AUSTRIAN SUCCESSION, WAR OF, etc. They ended in the acquisition of Silesia, with the exception of a few small districts south of the Riesengebirge, which remained in the hands of Austria. Frederick's successful resistance in the Seven Years' War against Austria, France and Russia raised his prestige enormously. From this time onward his State was recognized as a European great Power. In addition to Silesia, he had also acquired East Frisia, which came to him in 1744 on the extinction of the old princely house, through a succession treaty. At the first Partition of Poland (1772) he also acquired West Prussia (except Dantzig and Thorn), a particularly important district, as it bridged the gap between East Prussia and the Brandenburg family dominions. Frederick carried on the internal development of the Prussian State on the lines laid down by his father. He instituted a general civil code for his State in the shape of the Prussian Landrecht—a work not completed until after his death; accelerated judicial procedure, abolished torture, and introduced the principle that the Crown should not interfere with the course of justice. In administrative matters, he sought to pay special consideration to the local peculiarities of the different provinces, and paid frequent journeys of inspection to satisfy himself that his orders were being carried out. The fiscal system was further developed; but an attempt to introduce the farming of taxes, on the French model (1766), proved unsuccessful and had to be abandoned. Under his rule the State revenue increased largely; on his death he left 55,000,000 thaler in the State exchequer. He had the low lying country of the Oder and the Warthe drained, settled villages of colonists in the Pomeranian forests, arranged for the plantation of hops and potatoes, and founded factories. He left several detailed exposés of his administrative and political principles, notably in his famous political testaments of 1752 and 1767, which were designed to serve as a guide to his successor. Like his father, he considered himself the first servant of the State, and expressed the thought that the duty of the prince was to govern as though he had to render account to his subjects for all his measures. The political philosophy of the day, however, was absolutist, and Frederick too was convinced that the conduct of a great State demanded a single guiding will, which could only be that of the monarch, and he called for unconditional obedience, not only from his officials, but also from each of his subjects. He rarely consulted with his ministers in person; he called for reports from them in writing, and dictated the answers, which he sent to them in writing. His liberal views in matters of religion led him to adopt the policy of toleration, on principle, towards the different Churches: a policy which was also naturally dictated by practical considerations in a State which included a Protestant majority and a strong Catholic minority. His lively interest in all intellectual questions led him to take measures to improve the level of public education. In the upper schools the classics were made the principal subject of instruction. The king would have wished to establish compulsory primary education for the whole population, from the fifth to the thirteenth year, but lack of means made it impossible to carry this out. Although Frederick was deeply influenced by the humanitarian ideas of the *Aufklärung,* and considered the furtherance of the people's welfare and of popular education to be among the monarch's essential duties, yet his guiding thought remained always to raise the forces of his comparatively small, weak State, by better organization, so as to maintain the position of power which he had won,

Collapse and Reform.—As Frederick left no issue from his marriage, contracted at his father's orders, with a princess of Brunswick, and as his eldest brother, Augustus William, had predeceased him, the latter's son, Frederick William II., succeeded him on the throne (1786–97). He was indolent and dissipated, squandered the State Exchequer and left the cares of government to his favourites. Under his reign no progress was made in the domestic organization of the State. In foreign affairs his participation in the war against revolutionary France brought him only losses, while the large accessions of territory that the second and third Partitions of Poland (1793 and 1795) brought him were gains of but doubtful value. For the Prussian State, which after 1795 extended as far as Warsaw and Kovno, thus received so large a percentage of Polish blood that had these frontiers proved permanent, its German character would have been endangered.

His son, Frederick William III. (1797–1840) was a man of the best intentions, but pedantic, vacillating and narrow. The Government fell more and more into the hands of the cabinet councillors who, under the system introduced by Frederick the Great, formed the sole channel of communication between the king and the ministers. But while under Frederick the councillors had been only executive organs of the king's will, under his weak successors they became the all-important personal advisers of the monarch. The Prussian State still kept the outward form given it by Frederick William I. and Frederick the Great; but the living spirit was gone from it, and its swift and complete collapse after the first great military reverse (Jena, 1806), is easily comprehensible. Under the Peace of Tilsit (1807) Frederick William was obliged to cede his entire territory west of the Elbe and the greater part of his acquisitions in Poland; he retained only Brandenburg, Pomerania, Prussia and Silesia. This fearful collapse, however, also released the forces of reconstruction which still lived on within the State, and during the so-called "period of reform" a complete reconstruction of the State was begun. The king himself always remained disassociated from, and at heart hostile to these efforts, which appeared to him as a concession to Jacobinism; but as he knew no plan of his own for reconstructing the shattered State, he was forced to let the apostles of the new ideas have their way.

Freiherr von Stein became the leading figure in the administration. He had long been urging reforms, but before 1806 without success. His fundamental idea was that in a modern State the people itself must be required to help in the conduct of public affairs, because the State cannot exist unless it can count upon the willing co-operation and devotion of its citizens. The most important measures which he carried through were the liberation of the peasants from serfdom, the reintroduction of municipal self-government under the Municipal Act of 1808, and the abolition of cabinet government. He also planned to introduce self-government in the rural districts and participation of representatives of the people in the provincial administration and the central Government. He was unable, however, to carry these measures into practice, being dismissed in the autumn of 1808, at Napoleon's order. The reforms were taken up again by Freiherr von Hardenberg, in 1810, on his appointment as head of the ministry, although on lines rather different from those intended by Stein. Hardenberg really inclined more to enlightened despotism than to Stein's ideas of self-government. His principal achievements were the reorganization of the finance and of the administrative system, the abolition of restrictions in industrial life, and the edict of 1811 which made the peasants free proprietors of their holdings, in return for the cession of a part of them to the former landlords. The peasants were thus required to buy their ownership at the price of giving up part of their holdings. Moreover, as the smaller holdings were excluded from the measure, the landlords could now take full possession of them, and their former cultivators sank to the position of propertyless agricultural labourers.

These years also saw a great reorganization of the army, carried through by Generals von Scharnhorst and von Boyen. The underlying principle was the transformation of the mercenary army into a national army. Universal service was introduced, degrading punishments abolished, admission to the Corps of Officers revised and the internal organization of the army rearranged in more practical form. But for these reforms in all directions, the little State would have been incapable of the great achievements which it performed during the Wars of Liberation.

The 'Wars of Liberation'—The pressure of the alien rule of France evoked the first great popular movement in German history since the peasant wars of the 16th century. After Napoleon's defeat in Russia, popular opinion carried the doubtful and hesitating king with it, and led finally to the expulsion of the French from Germany and to a complete remodelling of conditions in Germany. The State of Prussia, too, was altogether reshaped through the decisions of the Congress of Vienna in 1815.

As compensation for the Polish districts ceded to Russia, Prussia then received new Hither Pomerania, the northern part of the kingdom of Saxony, the whole of Westphalia and the Rhineland. Of the ten million inhabitants of Prussian territory in 1816, nearly four belonged to the newly-acquired territory. It was only now that Prussia lost the character of a purely Northeastern Germanic state; it had assimilated elements from western Germany, and from now onward began to dominate Germany. The old Prussian nobility and bureaucracy found it no easy task to adapt themselves to the inhabitants of the new districts, who had grown up in quite other traditions. They succeeded, however, in maintaining their hegemony for several decades longer. The western districts, and especially the Rhineland, now began to form the principal focus of the Liberal movement.

This met at first with small success. The danger once over, Frederick William III abandoned the tendencies of the reform period altogether. He had in 1815 promised to introduce a "United Diet," but this was now forgotten; only meetings of the provincial estates for the individual provinces were introduced and these were only given an advisory voice in local affairs (1823). By economical administration and abstaining from external entanglements, the king managed to do with the existing taxes and excises. He opposed an obstinate resistance to all demands of the Liberals.

The 1848 **Revolution.**—On the death of Frederick William III., his eldest son, Frederick William IV. (1840–61) ascended the throne. He had grown up in an age when the theories of romanticism had dominated Germany; these theories swayed him, and, like his father, he was averse at heart to the modern political demands. After long consideration, however, he determined in 1847 to convoke the members of all provincial diets to a "United Diet" at Berlin. This body, however, immediately put forward a demand to be convoked at regular intervals, and recognized as a partner, with equal rights, in the legislature. The king refused to admit such claims, and the deliberations led to no practical result. Nevertheless, it was an event of no small importance that representatives of all parts of the Prussian State had, for the first time, met for common parliamentary debates.

Soon after this, the revolution broke out in all Germany. Although the military remained the victors in the street fighting of March 18 in Berlin, the king nevertheless decided to give way and withdraw the troops from Berlin. He agreed to the convocation of a Constituent National Assembly, which was to meet in Berlin and collaborate with him in drawing up a Constitution. But as democratic elements gained the upper hand in this Assembly, the king dissolved it and enacted a constitution (Dec. 5, 1848), with the proviso that a freshly elected parliament should negotiate further on its final form. These negotiations proving very protracted, the parliament was again dissolved in the spring of 1849, and it was only when a chamber was elected on the three-class franchise that agreement was at last reached on a definitive constitution, to which the king took the oath on Feb. 4, 1850. Prussia now received a parliament, consisting of two chambers; the first chamber, called the *Herrenhaus* after 1854, was composed of representatives of the large landed proprietors and of the larger towns, and of members nominated by the king, either for life, or as hereditary members. The second chamber was elected by all tax-paying citizens. but as the electors were divided into three categories, according to taxes paid, electors with larger incomes were given much greater influence than the poorer classes.

During the revolution of 1848 an attempt had already been made to place the king of Prussia at the head of a German empire, to include all the German states except Austria. These plans, however, met with resistance, both from the king himself, and from the Prussian nobles and bureaucrats. Ever since the Wars of Liberation, wide circles of the population had become convinced that a strongly united Germany could only be achieved by an alliance between Prussia and the Liberal elements which formed the backbone of the movement for union. The creation of the German *Zollverein* (*q.v.*), under Prussia's leadership (1834), which created an economic unity out of all German States, except Austria, seemed to be a step along this road. The king's legitimist views, however, revolted against making common cause with the revolution to force the other princes into a position of subordination and his national sentiments, swayed by the tendencies of romanticism, were shocked at the thought of excluding the Germans of Austria, while the nobles and official classes feared that they would be unable to maintain their existing influence in a German empire with parliamentary government. Accordingly, Frederick William IV. refused the imperial crown offered him on April 3, 1849, by the Frankfurt National Assembly. As his efforts to weld Germany into closer unity by agreement with the other princes were also unsuccessful, the movement towards unity led at the time to no results.

William I.—After 1850 a period of reaction set in in Prussia and the rest of Germany. Attempts were made to restrict the rights of the newly-created parliament, as far as possible. During Frederick William IV.'s last years, a feudal Party Government reigned in Prussia. In 1857 the king succumbed to an incurable mental disease; his younger brother William assumed the regency, and on Frederick William's death (Jan. 2, 1861) ascended the throne as William I. (1861–88). He, too, was a thorough conservative at heart, but saw more clearly than his brother the necessity of making concessions to the spirit of the times. Even during his regency he admitted liberal-minded men into his cabinet, and announced that his Government would stand above parties. Nevertheless, he became involved in a severe struggle with parliament when he demanded large sums for the reinforcement and reorganization of the army, which he held to be absolutely necessary. As the king refused to agree to the conditions made by the second chamber (two-year service and an independent *Landwehr*), parliament, after agreeing provisionally to the extra grants for military purposes on several occasions, ended by rejecting them. The king adhered to his plans and refused to dismiss his existing ministers in favour of advisers enjoying the confidence of the second chamber; thereupon the chamber rejected the whole budget. The king saw in this behaviour an attempt to rob him of his sovereign rights. At first he thought of abdicating in favour of his son; then replied by appointing Bismarck minister-president. The constitutional conflict dragged on for several years more, and was only solved after the successful outcome of the war of 1866 had brought about a change in the composition of parliament. The new parliament sanctioned the expenditure of the previous years retrospectively by the so-called Indemnity Act. The importance of this struggle lay in the fact that the Crown's independence of parliament in its choice of advisers for Prussia was now assured; parliament's attempt to secure a supreme control over State affairs similar to that existing in England had failed in Prussia. And as at this time Prussia took the leading place in Germany, these views also became current for the new German empire, and the growth of Prussian ascendancy continued.

Campaigns of 1864–71 which led to union of Germany under Prussia's leadership cannot be told here. (*See* SCHLESWIG-HOLSTEIN QUESTION; GERMANY; AUSTRIA-HUNGARY; FRANCO-GERMAN WAR.) The acquisition of Hanover, Kurhesse, Nassau and Frankfurt-am-Main after the war of 1866, gave Prussian territory a wholly new aspect. Its eastern and western halves, which up to this date had been separated by these districts, were now linked up into a single great North German State, containing nearly two-thirds of the total population of Germany (in 1914, 40,000,000 out of a total population of 65,000,000). The great problem which arose for Prussia out of the unification of Germany was, how far the independence and individuality of the Prussian State were to be retained within the new empire. Bismarck attempted to solve this problem by uniting the offices of administrative head of the empire (*Reichskanzler*) and Prussian minister-president in one person, just as the dignity of the German emperor was indissolubly united with that of king of Prussia. Attempts to divide the two offices having proved impracticable, this arrangement lasted until 1918.

The alliance concluded by Bismarck with the Liberals at the time of the foundation of the empire had important effects. The Local Government Act of 1872 increased the autonomy of the rural districts, thus linking up with the traditions of the age of Freiherr von Stein. The so-called *Kulturkampf*—the struggle against the Catholic Church which was waged in the '70s—was also in accord with Liberal ideas. It ended, however, finally, with the State restoring to the Church its control over the preliminary training of the clergy, and retaining only a right of veto over appointments to ecclesiastical posts.

During the short reign of Frederick III. (March–June 1888) acd under William II., the situation remained in essence unchanged. The new Rural Districts Act (*Landgemeindeordnung*) of 1892 carried existing institutions a step further. The fiscal reform carried through about the same time by von Miquel made self-assessment the basis of taxation, and provided relief for the poorer classes and heavier contributions from large incomes. On the other band, the repeated efforts to introduce a radical reform of the franchise for the second chamber and abolish the three-class franchise, led to no result.

After the revolution of 1918 Prussia became a *Land* of the Weimar republic, and adopted a republican and democratic form of government. From 1919 to 1933 there was a remodelling of the bureaucracy by which the Social Democrats under their minister-president, Otto Braun, sought to replace the old conservative element by persons mare in sympathy with the democratic and socialist majority. During these years Prussia's liberal government was often in conflict with the more militaristic and nationalist central government of Germany.

Aiter 1933 the Prussian constitution was set aside by the National Socialists, its legislature was abolished and its ministries were merged with Hitler's central German ministries.

The Prussian state was thus dissolved into its former provinces, which were ruled with the rest of Germany by the central regime at Berlin. (*See* also GERMANY: *History*.)

BIBLIOGRAPHY.—Early *Period.* H. von Treitschke, *Das deutsche Ordensland Preussen* (in his *Historische und politische Aufsatze*, 1865); F. Holtze, *Geschichte der Mark Brandenburg* (1912); S. B. Fay, *The Rise of Brandenburg-Prussia to 1786* (1937).

Later Period. L. von Ranke, *Zwölf Bücher Preussiscker Geschichte* (Works), vols. 25–27 (1865–90); J. G. Droysen, *Geschichte der preussischen Politik bis 1756* (2nd ed. 14 vols., 1868); E. Berner, *Geschichte des Preussischen Staates* (2nd ed., 1896); G. Schmoller, *Umrisse und Untersuchungen zur Verfassungs-, Verwaltungs-und Wirtschaftsgeschichte, besonders des preussischen Staates* (1898), and *Preussische Verfassungs-, Verwaltungs- und Finanzgeschichte* (1921); H. Prutz. *Preussische Geschichte* (4 vols., 1899–1902); A. Waddington, *Histoire de Prusse* (to 1740, 1911–22); R. Koser, *Geschichte der brandenburgisch-preussischen Politik,* vol i., to 1648 (1915); O. Hintze, *Die Hohenzollern und ihr Werk* (5th ed.. 1916); H. von Treitschke, *Historische und politische Aufsätze* (4 vols., 1908); H. Tuttle, *History of Prussia* (1757, 4 vols., 1884–96); *Hohenzollern Jahrbuch* (1897ff.); *Forschungen zur Brandenburgischen und Preussischen Geschichte* (1888ff). (E. BRA.; X.)

PRUSSIA, in the original sense, a territory of Germany, stretching along the Baltic coast for about 220 m., and occupying an area of 24,083 sq.m. The eastern part of this territory formed the duchy of Prussia, conquered and colonized by the Teutonic Order and acquired by the elector of Brandenburg in 1618, furnishing his successor with his regal title in 1701. The western part, severed from the eastern half and assigned to Poland in 1466, was not annexed to Prussia until the partition of Poland in 1772, while the towns of Danzig and Thorn remained Polish down to 1793. The two districts were temporarily (1824–78) united to form a single province.

PRUSSIC ACID, also called hydrocyanic acid and hydrogen cyanide, is a compound of hydrogen, carbon and nitrogen (HCN), best known on account of its exceedingly poisonous nature. It is a very volatile colourless liquid boiling at 25·7° C and freezing at −13° C. As the parent substance of the cyanides it gives, on substitution of the hydrogen atom by metals, salts of prussic acid, *e.g.,* potassium cyanide, KCN; while substitution by organic radicals gives the organic cyanides, *e.g.,* methyl cyanide, $CH_3{\cdot}CN$. In its chemical character the radical, CN, resembles the halogen elements, *e.g.,* chlorine, in being acidic (electronegative) and univalent, corresponding compounds having similar formulae, *e.g.,* KCl and KCN, and analogous chemical behaviour.

Prussic acid was discovered in 1782 by Scheele who obtained it from Prussian blue. In variable but generally very small proportions it is widely distributed among plants in the form of compounds with sugars, the glucosides (*q.v.*) *e.g.,* amygdalin (*q.v.*), contained in bitter almonds, from which the free acid can readily be obtained by hydrolysis.

Preparation.— The most convenient method of obtaining prussic acid in the laboratory is to add a concentrated solution of sodium cyanide gradually to sulphuric acid (about 70%), when hydrogen cyanide vapour is rapidly evolved: $NaCN+H_2SO_4=HCN+NaHSO_4$ (more concentrated acid gives carbon monoxide, see below). On the large scale this process may be carried out in large covered iron vessels lined with lead and provided with mechanical stirrers. The vapour of hydrogen cyanide, after drying by calcium chloride, is condensed to an almost anhydrous liquid, from which the last traces of water may be removed by distillation with phosphoric oxide. An older method consists in distilling potassium ferrocyanide with dilute sulphuric acid:

$$2K_4Fe(CN)_6+3H_2SO_4=3K_2SO_4+K_2Fe[Fe(CN)_6]+6HCN.$$

Hydrogen, carbon and nitrogen at very high temperatures, as in the electric arc, combine directly, with the absorption of much energy, to form hydrogen cyanide, which is thus an endothermic substance. Instead of the three elements, their compounds such as ammonia NH_3, cyanogen C_2N_2, acetylene C_2H_2, methane CH_4, oxides of nitrogen N_2O or NO, may be used, often with advantage in the direction of greater yield and lower temperature of reaction. If alkaline substances are present, cyanides (*q.v.*) are formed. These high-temperature reactions account for the presence of hydrogen cyanide in crude coal gas.

Physical and Chemical Properties.— In many of its physical properties hydrogen cyanide resembles water. Like the latter it is an ionizing solvent, many salts dissolving in it to form solutions which are good conductors of electricity. This property of liquids is associated with high dielectric constant, the magnitude of which is even greater for hydrogen cyanide than for water, indicating great electric polarity of the molecules (compare as a rough illustration a magnet with its north and south poles). Such polar molecules are more firmly held together than in liquids composed of non-polar molecules, and combination between them may occur to some extent, giving rise to association (*q.v.*). The physical properties of such "associated" liquids exhibit many characteristic abnormalities as compared with those of normal non-polar liquids; thus hydrogen cyanide has a latent heat of evaporation greater than the value expected if it were normal.

The vapour of prussic acid burns freely in air with a violet flame yielding nitrogen, carbon dioxide and water. As indicated by its structural formula $H{-}C{\equiv}N$ or $H{-}N{=}C$, prussic acid is chemically unsaturated. It is capable of adding other atoms to its molecule as well as of substituting other atoms for its hydrogen. Thus it combines with hydrogen giving methylamine $H_3C{-}NH_2$, and yields addition compounds with hydrogen chloride. Substitution occurs with halogens, *e.g.,* chlorine gives cyanogen chloride: $HCN+Cl_2=CNCl+HCl$. The cyanides, being similarly unsaturated, also undergo addition reactions. Thus molten potassium cyanide readily unites with free or combined oxygen giving potassium cyanate KCNO, or with sulphur giving potassium sulphocyanide (thiocyanate) KCNS, and accordingly at elevated temperatures potassium cyanide reduces many metallic oxides and sulphides to the free metal.

Prussic acid combines with water slowly when heated, more rapidly in the presence of mineral acid. The addition of water occurs in two stages thus:

$$H-C\equiv N + H_2O = H-C\genfrac{}{}{0pt}{}{\nearrow O}{\searrow NH_2} \quad \text{(formamide)}$$

$$H-C\genfrac{}{}{0pt}{}{\nearrow O}{\searrow NH_2} + H_2O = H-C\genfrac{}{}{0pt}{}{\nearrow O}{\searrow ONH_4} \quad \text{(ammonium formate).}$$

With concentrated sulphuric acid the last substance is converted by loss of water into ammonia NH_3 (which combines with the sulphuric acid) and carbon monoxide gas CO thus:

$$H{\cdot}CO{\cdot}ONH_4=NH_3+CO+H_2O;$$

consequently sodium cyanide with concentrated sulphuric acid yields not hydrogen cyanide but carbon monoxide. Ammonium formate on heating is reconverted into formamide, which again on heating with phosphoric oxide or a catalyst (see CYANIDES) yields prussic acid. Solutions of cyanides on boiling slowly react to give ammonia and a formate: $KCN+2H_2O=NH_3+H{\cdot}CO{\cdot}OK$ (potassium formate).

In common with many cyanogen compounds, liquid hydrogen cyanide readily undergoes polymerization (*q.v.*), that is combination with itself. The pure substance may be kept indefinitely without change, but in the presence of traces of ammonia or any alkaline material (even that furnished by common soda-glass vessels) it is gradually transformed into a solid brownish-black insoluble mass called azulmin, an imperfectly known mixture of complex compounds containing some $H_3C_3N_3$. Liquid hydrogen cyanide has even been known to explode spontaneously, probably owing to rapid polymerization in closed vessels with development of heat. It is commonly stabilized by the addition of small quantities of mineral acid, *e.g.,* phosphoric acid, or other substance which "kills" any polymerizing agent. (See CYANIDE.)

An aqueous solution of prussic acid, unlike its analogue hydrochloric acid, is an extremely poor conductor of electricity. It contains the ions H^+ and CN^- to a minute extent only, and is thus one of the weakest of acids. A comparison of their dissociation constants shows that carbonic acid, itself a very weak acid, is about 200 times stronger than prussic acid. In a decinormal solution (2·7 g. of the acid per litre) only 0·01% of the acid is present in the form of ions, a degree of acidity too small to affect the colour of indicators (*q.v.*).

The Cyanides of the Metals, while resembling the halogen salts, exhibit divergencies in chemical behaviour due to the extreme weakness of prussic acid, the decomposability of the CN radical, and its great tendency to form complex salts.

The cyanides of the alkali metals, *e.g.,* potassium cyanide, are all white crystalline salts, very soluble in water. The solutions are alkaline, being hydrolysed or partially decomposed by water into the component non-volatile strong base and volatile weak acid: $KCN+H_2O=KOH+HCN$. Since the extent of salt hydrolysis increases with the weakness of the acid the amount of free prussic acid and caustic potash in solutions of these cyanides is relatively large (in a decinormal solution 1% of the salt is hydrolysed), consequently they smell of prussic acid and lose it on evaporation. The carbonic acid of the air, being a relatively strong acid, slowly expels prussic acid from soluble cyanides leaving a residue of carbonate. These factors complicate the preparation of pure cyanides by the usual process of evaporating the solutions by boiling and crystallizing out. (For the manufacture of alkali cyanides, *see* CYANIDES.) The cyanides of the alkaline earth metals, calcium, strontium and barium, *e.g.,* $Ca(CN)_2$, are very similar to those of the alkali metals except that their solutions are much more extensively hydrolysed.

Tha simple cyanides of the heavy metals are insoluble in water, with the notable exception of mercuric cyanide, $Hg(CN)_2$ which is remarkable for its minute degree of ionic dissociation.

If aqueous potassium cyanide is added to a solution of silver nitrate, a white precipitate of silver cyanide, $AgCN$, is formed which dissolves when more potassium cyanide is added. This behaviour is typical of the cyanides of the heavy metals. The solution of silver cyanide in potassium cyanide on evaporation deposits crystals of potassium argento-cyanide $KAg(CN)_2$, or ($KCN+AgCN$), but in solution this "complex salt" gives practically only the cation K^+ and the complex anion $[Ag(CN)_2]^-$, the ions Ag^+ and CN^- being present in such minute amount that some analytical tests fail to reveal their presence. This behaviour may be contrasted with that of typical "double salts," *e.g.,* $KCl,MgCl_2,6H_2O$, which gives only the ions K^+, Mg^{++}, Cl^- in solution. The tendency to form complex cyanides is most marked in the metals of Group VIII., and contiguous metals (the transition elements, see PERIODIC LAW).

The numerous complex cyanides vary in stability. Some, like potassium ferrocyanide $K^+[Fe(CN)_6]^{\equiv}$, satisfy no ordinary test for Fe^{++} and CN^- ions, and even yield with cold mineral acid the corresponding stable complex acid $H_4Fe(CN)_6$. Others, like $K_2^+[Zn(CN)_4]^=$, are easily decomposed by acids with liberation of prussic acid; and hydrogen sulphide added to a solution of $K_2Zn(CN)_4$ reveals the presence of a small proportion of Zn^{++} and CN^- ions by precipitating the zinc completely as zinc sulphide (the corresponding copper compound is not so precipitated). Most complex cyanides are of the following types: $K[R(CN)_2]$, where R is Cu, Ag, Au; $K_2[R(CN)_4]$, where R is Zn, Cd, Hg, Ni, Pd, Pt; $K_4[R(CN)_6]$, where R is Cr, Mn, Fe, Co, Ru, Os, Ir; $K_3[R(CN)_6]$, where R is Cr, Mn, Fe, Co, Rh, Ir; $K_4[R(CN)_8]$, where R is Mo or W.

Potassium ferrocyanide, $K_4Fe(CN)_6$, composed of $4KCN+Fe(CN)_2$ (ferrous cyanide), was formerly manufactured by heating nitrogenous organic refuse with iron and potassium carbonate, extracting the salt with water, and crystallizing out. The cyanogen compounds recovered from crude coal gas have for many years been converted by various methods into potassium ferrocyanide. The most recent process consists in melting calcium cyanamide, $CaCN_2$, with common salt, dissolving out the resulting sodium and calcium cyanides, and converting them into sodium ferrocyanide by treatment with ferrous sulphate and sodium carbonate. Potassium ferrocyanide is a stable, yellow, crystalline salt (yellow prussiate of potash), not poisonous like the cyanides. On heating with dilute acid prussic acid is liberated; cold acid gives the white crystalline hydroferrocyanic acid $H_4Fe(CN)_6$. Potassium ferricyanide. $K_3Fe(CN)_6$, composed of $3KCN+Fe(CN)_3$ (ferric cyanide), is conveniently prepared by oxidizing the ferrocyanide in solution by means of chlorine:

$$2K_4Fe(CN)_6+Cl_2=2K_3Fe(CN)_6+2KCl.$$

It forms dark red crystals (red prussiate of potash) from which acid displaces hydroferricyanic acid $H_3Fe(CN)_6$. Of the many salts of the complex iron-cyanogen acids it must suffice to mention only "insoluble Prussian blue," ferric ferrocyanide $Fe_4[Fe(CN)_6]_3$ and "soluble Prussian blue," potassium ferric ferrocyanide $KFe[Fe(CN)_6]$. The complex cyanides being typical co-ordination compounds (see VALENCY and CO-ORDINATION), many derivatives are known in which the CN group is partly replaced by other groups such as H_2O, CO, KO, etc., *e.g.,* $H_2[Fe(CN)_5(NO)]$ and its salt $Na_2[Fe(CN)_5(NO)]$, sodium nitroprusside. The latter is a useful reagent for detecting sulphur in organic compounds since with alkaline sulphides it gives a characteristic purple colour.

The Organic Cyanides.—The removal of hydrogen and oxygen as water from ammonium salts of organic acids of the type R·CO·OH (where R is an organic radical like methyl, CH_3) leads to the replacement of the CO·OH group by CN in the following manner:

$$\underset{\text{Acid}}{R{\cdot}CO{\cdot}OH} \rightarrow \underset{\text{Ammonium salt}}{R{\cdot}CO{\cdot}ONH_4} \xrightarrow{-H_2O} \underset{\text{Acid amide}}{R{\cdot}CO{\cdot}NH_2} \xrightarrow{-H_2O} \underset{\text{Nitrile}}{R{\cdot}CN.}$$

Acetic acid $CH_3{\cdot}CO{\cdot}OH$ gives $CH_3{\cdot}CN$, methyl cyanide, generally called acetonitrile (a member of the class of "nitriles"), and formic acid H·CO·OH gives prussic acid H·CN which may thus be regarded as formonitrile. This general method of formation indicates that nitriles have the structure $R-C\equiv N$, the corresponding structure of prussic acid being $H-C\equiv N$.

Nitriles are also formed when cyanides of the alkali metals react with iodides of organic radicals: $KCN+RI=KI+RCN$. But if silver or mercury cyanide is used the product, which has quite different properties although the same composition, is an *isomeride* of the nitrile and termed an iso-cyanide or "carbylamine." Since methyl cyanide certainly has the structure $CH_3-C\equiv N$, that of the isocyanide can only be $CH_3-N=C$, where the C atom of the CN group is bivalent. These structures are in full agreement with the chemical behaviour of nitriles and carbylamines. The latter are the less stable, being converted into the former on heating.

Constitution of Prussic Acid and Cyanides.—If one assumes a simple exchange of partners without any change of structure in the reaction $RI+MCN=MI+RCN$ (M=metal), it would appear that silver cyanide is $Ag-N=C$ and potassium cyanide $K-C\equiv N$, although only one form of hydrogen cyanide is known. However, potassium cyanide yields a little methyl isocyanide with the main product of cyanide, and silver cyanide with acetyl chloride $(CH_3CO)Cl$ gives acetyl cyanide, not isocyanide. What is the true constitution of the simple cyanides of the metals, and how is it that prussic acid can yield simple salts which behave so differently? Although these problems date from the discovery of isocyanides by Gautier in 1866, and in spite of all efforts to solve them, no entirely satisfactory solution has even yet been found. The isocyanide structure of all metal cyanides has been generally favoured, but a recent study of the question does not confirm this.

The chemical evidence as to the constitution of prussic acid itself is very conflicting. Some reactions indicate the nitrile ($H-C\equiv N$) structure, others the carbylamine ($H-N=C$) structure. With diazomethane, CH_2N_2, it yields both cyanide and isocyanide. It must therefore be regarded as a typical "tautomeric" substance, behaving in some reactions as $H-C\equiv N$, in others as $H-N=C$. The liquid may be composed of both molecules in dynamic equilibrium with each other ("dynamic isomerism"), the equilibrium being rapidly re-established if disturbed in any way, so that the substance may react either as $H-C\equiv N$ or $H-N=C$. (See ISOMERISM.) Its physical properties indicate that liquid prussic acid consists almost entirely of $H-C\equiv N$, and this view is generally accepted.

Detection and Estimation.—Prussic acid has a characteristic smell, but this test is unreliable because of the remarkable fact that to many people it is odourless. Small quantities of the acid and its salts can be detected by converting them into intensely coloured derivatives, *e.g.,* Prussian blue or red ferric sulphocyanide, $Fe(CNS)_3$, and such tests may be made quantitative by the methods of colorimetric analysis. Larger amounts are generally precipitated and weighed as insoluble silver cyanide (or as silver), or the solution may be conveniently titrated with standard silver nitrate, the first appearance of turbidity marking the exact conversion of the cyanide into argentocyanide $KAg(CN)_2$.

Pharmacology, Therapeutics and Toxicology.—The chief pharmacopoeia1 preparations of prussic acid are a 2% aqueous solution (dose 2–6 minims), and compound tincture of chloroform and morphia containing a half-minim of the 2% solution per 10 minims. The therapeutic applications of the acid depend on its action as an anodyne. It allays itching and is useful in some forms of neuralgia. Taken internally it relieves vomiting and gastric pain, and in cases of asthma and phthisis it is of value in relieving painful cough.

The foxic action of prussic acid and cyanides is due to their inhibition of the normal oxidative processes in the tissues, resulting in a form of asphyxia with paralysis of the heart and respiratory organs. Inhalation of air containing sufficient hydrogen cyanide gas produces in rapid succession, giddiness, headache, palpitation, pain in the chest, followed in a few seconds by loss of consciousness, laboured respiration and death. On removing the case into fresh air recovery is rapid provided respiration has not stopped, and even if it has, artificial respiration with stimulation (*e.g.,* by cold water) may be effective (*Official History of the War,* vol ii., p. 465). The toxic action of prussic acid and cyanides is so rapid that the use of antidotes is generally out of the question.

As a poison gas, prussic acid (in gas shell) played only a very minor part in the World War. It probably caused fewer casualties than any other war gas. Investigation revealed the remarkable fact that different species of animals (even though of the same size) differ greatly in susceptibility to prussic acid poisoning, dogs being particularly sensitive. J. Barcroft breathed air containing 1 part of prussic acid in 2,000 without ill effect for 1½ min., but within this time the dog which accompanied him died. The effect is non-cumulative; for death to ensue the determining factor is that the rate of inhalation of the poison shall exceed its rate of elimination by the body. The lethal concentration for man is relatively high. (For prussic acid as insecticide, *sea* CYANIDE.)

BIBLIOGRAPHY.—Sir E. Thorpe, "Cyanides," *Dictionary of Applied Chemistry* (1921); H. E. Williams, *The Chemistry of Cyanogen Compounds* (1915); Y. Henderson and H. W. Haggard, *Noxious Gases and the Principles of Respiration Influencing Their Action* (1927). (J. E. Co.)

PRUTZ, HANS (1843–1929), German historian, son of Robert Eduard Prutz (1816–1872), the essayist and historian, was born at Jena on May 20, 1843, and studied at Jena and Berlin. His *Preussische Geschichte* (4 vols., Stuttgart, 1899–1902) is an attempt to apply scientific rather than patriotic canons to a subject which has been main'~in the hands of historians with a Prussian bias. In 1902 Prutz resigned the chair of history in the university of Konigsberg, which he had held since 1877.

His other works include: *Aus Phönicien,* a collection of historical and geographical sketches (1876); *Quellen-beiträge zur Geschichte der Kreuzzüge* (1876); *Kulturgeschichte der Kreuzzüge* (1883); *Staatengeschichte des Abendlandes im Mittelalter* (1885–87); *Geheimlehre und Geheimstatuten des Tempelherrenordens* (Danzig, 1879); *Entwickelung und Untergang des Tempelherrenordens* (1888); *D. geistl. Orden,* (1907).

PRYNNE, WILLIAM (1600–1669), English parliamentarian, son of Thomas Prynne, born at Swainswick near Bath, was educated at Bath Grammar School and at Oriel College, Oxford. He was called to the bar at Lincoln's Inn in 1628. He was Puritan. In 1629 Prynne came forward as the assailant of Arminianism in doctrine and of ceremonialism in practice, and thus drew down upon himself the anger of Laud. *Histrio-mastix,* published in 1633, was a violent attack upon stage plays in general, in which the author pointed out that kings and emperors who had favoured the drama had been carried off by violent deaths, and applied a disgraceful epithet to actresses, which, as Henrietta Maria was taking part in the rehearsal of a ballet, was supposed to apply to the queen. After a year's imprisonment in the Tower Prynne was sentenced by the star chamber on Feb. 17, 1634 to be imprisoned for life, and also to be fined £5,000, expelled from Lincoln's Inn, rendered incapable of returning to his profession, degraded from his degree in the university of Oxford, and set in the pillory, where be was to lose both his ears. The latter portion of the sentence was carried out on May 7, and the rest of his punishment inflicted except the fine and part of the imprisonment. There is no reason to suppose that his punishment was unpopular.

In 1637 he was once more in the star chamber, together with Bastwick and Burton. In *A Divine Tragedy lately acted* he had attacked the Declaration of Sports, and in *News from Ipswich* he had assailed Wren and the bishops generally. On June 30 a fresh sentence, delivered on the 14th, was executed. The stumps of Prynne's ears were shorn off in the pillory, and he was branded on the cheeks with the letters S.L., meaning "seditious libeller," which Prynne, however, interpreted as *"stigmata laudis."* He was removed to Carnarvon Castle, and thence to Mont Orgueil Castle in Jersey, where he occupied himself in writing against popery.

Immediately upon the meeting of the Long Parliament in 1640 Prynne was liberated. On Nov. 28 he entered London in triumph, and on March 2, 1641, reparation was voted by the Commons, at the expense of his persecutors. Prynne now attacked the bishops and the Roman Catholics and defended the taking up of arms by the parliament. He showed a vindictive energy in the prosecution of Archbishop Laud. He manipulated the evidence against him, and having been entrusted with the search of Laud's papers, he published a garbled edition of the archbishop's private "Diary," entitled *A Breviate of the Life of Archbishop Laud.* He also published *Hidden Works of Darkness brought to Light* in order to prejudice the archbishop's case, and after his execution, *Canterbury's Doom . . .* an unfinished account of the trial commissioned by the House of Commons. Prynne supported a national church controlled by the state, and issued a series of tracts against independency. He denounced Milton's *Divorce at Pleasure,* was answered in the *Colasterion,* and contemptuously referred to in the sonnet "On the Forcers of Conscience." He also opposed violently the Presbyterian system, and denied the right of any Church to excommunicate except by leave of the state (e.g., *Four Short Questions* [1645]; *A Vindication of Four Serious Questions* [1645]). He was throughout an enemy of individual freedom in religion.

Prynne took the side of the parliament against the army in 1647, supported the cause of the eleven impeached members, and visited the university of Oxford as one of the parliamentary commissioners. In 1648 Prynne was returned as member for Newport in Cornwall. He at once took part against those who called for the execution of Charles; the result was his inclusion in "Pride's Purge" on Dec. 6, when, having resisted military violence, he was imprisoned. After recovering his liberty Prynne retired to Swainswick. On June 7, 1649, he was assessed to the monthly contribution laid on the country by parliament. He not only refused to pay, but published *A Legal Vindication of the Liberties of England,* arguing that no tax could be raised without the consent of the two houses. He was imprisoned in various places from 1650 to 1653, and on his release renewed his pamphleteering activities.

On the restoration of the Rump Parliament by the army of the 7th of May 1659 fourteen of the secluded members, with Prynne among them, claimed admittance. He was prevented from taking his seat, and a second attempt in December also failed. He was returned for Bath to the Convestion parliament and to the parliament of 1661. During 1663 he served constantly on committees, and was chairman of the committee of supply in July, and again in April 1664. The last time he addressed the House appears to have been in Nov. 1667.

Prynne died unmarried, in his lodgings at Lincoln's Inn, on Oct. 24, 1669, and was buried in the walk under the chapel there.

BIBLIOGRAPHY.—Article by C. H. Frith in the *Dict. of Nat, Biography;* Life of Prynne, in Wood's *4th. Oxon.,* ed. by Bliss, iii. 844; *Documents relating to the Proceedings against Prynne,* ed. by S. R. Gardiner for the Camden Society (1877); *Hist. of Swainswick,* by R. E. M. Peach; Gardiner's *Hist. of England, of the Civil War and of the Commonwealth; Notes and Queries,* 8th series, vol, viii., p. 361 ("Letter to Charles II., May 2, 1660"), 9th series, vol. ii. p. 336.

PRYOR, ROGER ATKINSON (1828–1919), American soldier and jurist, was born near Petersburg, Va., on July 19, 1828. He graduated at the law school of the University of Virginia in 1848, and in 1849 was admitted to the bar. He served as a Democrat in the National House of Representatives, 1859–61, and was re-elected for the succeeding term, but owing to the secession of Virginia did not take his seat. He served in the provisional Confederate congress (1861) and also in the first regular congress (1862) of the Confederate constitution. He entered the Confederate army as a colonel, became a brigadier-general (April 16, 1862), and took part in the battles of Williamsburg, Seven Pines, second Bull Run and Antietam. Owing to a disagreement with President Davis he resigned his commission in 1863, and entered Gen. Fitzhugh Lee's cavalry as a private. He was taken prisoner Nov. 1864, but was released on parole by order of the president. In 1865 he removed to New York city, where he practised law. He was judge of the New York court of common pleas, 1890–94, and of the New York supreme court, 1894–99, when he retired from the bench. He died in New

York city on March 14, 1919.

PRYTANEUM AND PRYTANIS. 1. In ancient Greece, each State, city or village possessed its own central hearth and sacred fire; the fire (cf. at Rome the fire in the temple of Vesta) was kept alight continuously, tended by the king or members of his family, The building in which this fire was kept was the Prytaneum (Πρυτανεῖον), and the chieftain (the king or prytanis) probably made it his residence. The word prytanis is applied to those who, after the abolition of monarchy, held the chief office in the State. Rulers of this name are found at Rhodes as late as the 1st century B.C. The Prytaneum was regarded as the religious and political centre of the community. When colonists Went out they took with them a brand from the Prytaneum altar to kindle the new fire in the colony; the fatherless daughters of Aristeides, regarded as children of the State at Athens, were married from the Prytaneum as from their home; foreign ambassadors and citizens who had deserved especially well of the State were entertained in the Prytaneum as public guests. In Achaea, this central hall was called the *Leïton* (town-hall), and a similar building is known to have existed at Elis. The site of the Prytaneum at Athens cannot be definiteiy fixed. The Prytaneum mentioned by Pausanias, probably the original centre of the ancient city, was situated somewhere east af the northern cliff of the Acropolis. Curtius places the original Prytaneum south of the Acropolis in the old Agora, and regards that of Pausanias as a building of Roman times (*Stadtgeschichte,* p. 302). Many authorities hold that the original Prytaneum of the Cecropian city must have been on the Acropolis. From Aristotle's Constitution *of Athens* (ch. 3) we know that the Prytaneum was the official residence of the archons, but, when the new Agora was constructed they took their meals in the *Thesmotheteion* for the sake of convenience. There was also a court of justice called the court of the Prytaneum; it tried murderers who could not be found, and inanimate objects which had been the means of causing death.

2. For the PRYTANEIS of the Boulē see BOULE.

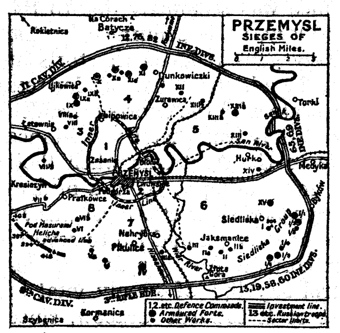
PRZEMYSL, a town of Poland, in the province of Lemberg (Lwow), 60 mi. W. of Lwow by railway. Pop. (1931), 51,379, mostly Polish. It is situated on the river San, ahd is the seat of a Roman Catholic and a Greek Catholic bishop, the cathedral dating from the 15th century. The industries comprise the manufacture of machinery, the refining of naphtha, corn-milling and the sawing of timber. On the hill above the town are the ruins of an old castle, said to have been founded by Casimir the Great,

Przemysl was founded at an early date on the borderland between Poland and Russia. Russian princes founded a state there in the 11th century, which became absorbed in the principality af Galich or Halicz and was annexed by Casimir the Great after 1340. It was occupied by Austria from 1773 to 1915. Polish after 1918, it was occupied by the U.S.S.R. in 1939 and Germany in 1941.

PRZEMYSL, SIEGES OF, In 1914 Przemysl was protected by a ring of forts 36 m. in circumference. Some of the forts were of recent construction, but the fortress as a whole was not strictly up-to-date. To clear the foreground in front of the fortified line no fewer than 18 villages and some five miles of forest were levelled to the ground on mobilization, The armament of the fortress included four large modern howitzers of about 12in. calibre and some gin, and 6in. howitzers of older pattern. There were in all about 1,000 guns in the fortress, but more than half of these were old, short-range weapons of little value except for close defence. There were 114 machine-guns, of which two-thirds were mobile.

The eventual garrison left in the fortress when the Austrian armies retreated from the San on Sept. 18, 1914, consisted of: $61\frac{1}{2}$ battalions (of which $40\frac{1}{2}$ were Landsturm), seven squadrons, four field batteries, 43 fortress artillery companies, 48 Landsturm artillery brigades, eight sapper companies, and various technical and administrative units. The total strength was approximately 130,000 men and 21,000 horses. Provisions were available for three months.

The First Siege.—The Austrian armies withdrew from the San on Sept. 18; by Sept. 24 the investment of the fortress was complete. On the south-west front the garrison held a line a mile or two in advance of the ring of forts; elsewhere the Line of the forts was held. The siege of the fortress was undertaken by Radko-Dimitriev's III. Army. While the arrival of the siege artillery material was still delayed by the state of the communications, the Austrians renewed the offensive in the early days of Oct. (bee VISTULA-SAN, BATTLES OF THE). In the hope of capturing Przemysl by a coup de *main* before the progress of the enemy offensive compelled the raising of the siege, Radko-Dimitriev carried out several violent assaults between Oct. 5–8 against the Siedliska group of works to the south-east of the town. These assaults broke down with heavy loss, and the approach of the Austrian III. Army necessitated the withdrawal of the investing forces. The fortress was entered by Austrian infantry of the field armies on Oct. 11, on which date Radka-Dimitriev's III. Army retreated to the east bank of the San.



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Period Between the First and Second Sieges.—During the Austrian attempts to force the San line, which lasted throughout October, the fortress lay in the centre of the battle line and its garrison took an active part in the operations. Its reserves of supplies and material were also largely drawn on by the field armies to make good the deficiencies caused by the poor working of the lines of communication. During their retreat the Russians had systematically destroyed the railways and bridges, and the continued wet weather had rendered the roads almost impassable. Thus it was natural that the reserves of Przemysl should be used for the benefit of the field armies, from whose operations great results were expected at the time. But when the offensive proved fruitless and Russian pressure necessitated a retirement which would leave the fortress again isolated, special efforts were made hastily to reprovision it. They were so far successful that the fortress was enabled to hold out for $4\frac{1}{2}$ months in the second siege.

Second Siege, Nov. 6,1914–Match 22,1915~—Thestrength of the garrison was approximately the same as in the first siege, but a detachment of aeroplanes had been added. Kusmanek had how laid out new entrenched positions from one to two miles in advance of the line of forts, to give more depth to the defence and to keep the Russian siege artillery at a greater distance. On Nov. 9 the investment of the fortress for the second time was complete. The siege was now undertaken by a specially formed XI. Army under General Selivanov, consisting of four divisions of second-line troops. It had been decided to reduce the fortress by blockade rather than by assault. During November and December such fighting as occurred was initiated rather by the sorties of the garrison than by the attacks of the besiegers.

During February and the first half of March the Austrian field armies made repeated efforts to advance to the relief of the fortress, but unsuccessfully (see CARPATHIANS, BATTLES OF THE). Meanwhile the Russians had gradually closed in and had commenced a systematic bombardment of the fortress. On March 13 they carried the advanced positions on its north front. Kusmanek's situation was now desperate; his supplies and munitions were almost exhausted, and the final effort of the field armies to come to his rescue had definitely been abandoned. He determined on an attempt to save a portion of the garrison by a breakthrough to the east. The effort was made on the morning of the 19th, but was soon brought to a stand. The fate of the fortress was now sealed. On the morning of March 22 Kusmanek surrendered, after destroying the works and military stores as far as possible. The numbers of the garrison then amounted to about 110,000.

Recapture of the **Fortress.**—The Russians did not hold the fortress for long. At the beginning of May Mackensen's offensive on the Dunajec broke through the Russian line and drove their armies back to the San (see DUNAJEC-SAN). On May 30 the

Austrians attacked on the south-west and the Germans on the north of the fortress. The former made little progress, but the German heavy artillery, which included 42 cm. howitzers, made short work of the northern group of forts. On the night of June 2 the Russians abandoned the fortress.

Conclusions.—Przemysl was the only land fortress of the World War which stood a prolonged siege after complete investment, but the length of its resistance was seemingly due to the Russians' lack of efficient siege artillery, as is confirmed by the speed with which Mackensen's heavy guns reduced the forts at the time of its recapture. Nor can it be admitted that the fortress served any strategical aim commensurate with the efforts expended on its defence and attempted relief. It is true that its resistance during the first siege was of value to the Austrians when their armies again advanced to the San, in assuring to them a bridgehead over the river. But during the second siege Przemysl was an embarrassment rather than a source of strength and led to several ill-considered efforts at relief which cost the Austrian field armies dearly. The fortress did not control any line of supply vital to the Russian armies operating west of it towards Cracow, since there was a railway available through Jarostow. The Russians could therefore afford in the second siege to resort to a simple blockade by second-lme troops, so that the fortress did not even weaken their field armies to any appreciable extent.

BIBLIOGRAPHY.—H. Hillger, *Krieg und Sieg, Befreiung vor Przemysl* (1915); E. Ludendorff, *My War Memories* (trans. 1919); E. von Falkenhayn, *General Headquarters, 1914–1916, and its Critical Decisions* (trans. 1919); J. Daniloff, *Russland im Weltkriege, 1914–1915* (1925); A. W. F. Knox, *With the Russian Army, 1914–17* (1921). *See* also WORLD WAR: (Bibl). (A. P. W.)

PRZHEVALSK: see KARAKOL.

PSALMANAZAR, GEORGE (c. 1679–1763), French adventurer. After various escapades, including a pilgrimage to Rome in the guise of a Japanese convert, he came to London, where he imposed on many people, notably on the bishop of London, who employed him to translate the Catechism into what was supposed to be Japanese. In 1704 and 1707 he published fictitious works on Formosa. Eventually he confessed to his imposture. He died in London on May 3, 1763. His memoirs, Memoirs of . . . commonly *known* by *the name* of George Psalmanazar (1764) do not disclose his real name or the place of his birth.

His fictitious publications include: Historical and Geographical Description of Formosa (1704); *Dialogue* between a Japanese and a Formosan (1707); *An Enquiry* into the Objections . . . *with* George *Psalmanazar's* Answer (undated).

PSALMS, the first in order and importance (cf. Luke xxiv. 44) of the third division of the Hebrew Old Testament, known as the "Writings." The Hebrew name of the Psalms is tehillim, or "praise-songs," which expresses a predominant, though by no means the entire, character of the collection. This anthology of Hebrew poetry also includes petitions (iv.), laments (xliv.), imprecations (lviii.), meditations (cxix.), historical reviews (cvi.), and even a marriage ode (xlv.). But there can be no doubt that the purpose of the collection was to gather the sacred poetry of Israel for use in the post-exilic worship of the temple. This is shown by the technical and professional titles of the psalms, as well as by their general character and their occasional references (note the definite allusions to the destruction of Jerusalem, the exile or the dispersion in li. 18, lxxxix. 38, 44, cvi. 47, cxxvi. 1, cxxxvii. 1, cxlvii. 2).

As the book lies before us, it is a collection of collections, being divided into five books, which themselves contain certain smaller distinguishable groups of psalms. The first four books are each closed by a doxology, at least as old as the Septuagint version (second half of 2nd century B.C.). In Bk. I. (i.–xli.) practically all the psalms are ascribed to David (the exceptions can be explained). In Bk. II. (xlii.–lxxii.) there is more variety, xlii.–xlix. being ascribed to "the sons of Korah," l. to Asaph, li.–lxv. to David. lxvi., lxvii. simply to "the chief musician" or choir-conductor, lxviii.–lxx. to David, lxxii. to Solomon (lxxi. is anonymous). The editorial note at the end of this book, "Finished are the prayers of David the son of Jesse," shows there was once a collection of "Davidic" psalms, and that there has been a rearrangement of material bringing psalms of other groups above the rubric. In Bk. III. (lxxiii.–lxxxix.) there is an "Asaph" group (lxxiii.–lxxxiii.) followed by a miscellaneous appendix (Korah, David, Ethan). We have clear evidence of other editorial work in the overwhelming predominance of the name "Elohim" for God in Psalm xlii.–lxxxiii. as compared with the personal name, "Yahweh" (the occurrences are 200:43; in Psalms, i.–xli. 15:272); this is confirmed by the fact that Ps. xiv. of the first Book reappears as Ps. liii., with its fourfold "Yahweh" changed into "Elohim" (so also in Pss. xl. 13–17 and lxx.). In Bks. II. and III. alone do we get psalms ascribed to guilds of temple-singers. Bks. IV. and V. are divided by the doxology of cvi. 48 (cf. 1 Chron. xyi. 35, 36, where a liturgical formula has been transformed into a historical statement). But the division seems artificial (perhaps made to get five books of psalms corresponding with the five books of the law), since Psalms cv.–cvii. are closely related in subject-matter. If, therefore, we take Bks. IV. and V. together, we find in them a distinct group of "Pilgrim" psalms (cxx–cxxxiv.), and a scattered one of "Hallelujah" psalms (civ.–cvi., cxi.–cxiii., cxv.–cxvii., cxxxv., cxlvi.–cl.) largely liturgical. Ps. cviii. seems to have been made by combining lvii. 7–11 and lx. 5–12, which again proves the existence of separate collections, since the same material would not originally appear twice in the same collection.

The Hebrew psalms are in rhythmical, but unrhymed verse, the most frequent type being that of the three-beat line. The other characteristic of Hebrew poetry is its parallelism ("synonymous," li. 2; "antithetic," i. 6; "synthetic," cxxi. 4). The musical accompaniment was melodic unison, not the harmonies of modern music, so that its chief use, beyond support to the singers, was to synchronize the beats, as by cymbals (1 Chron. xv. 19, xvi. 5). Six distinct instruments are named in Ps. cl. (see Wellhausen, Psalms, Appendix, "Music of the Ancient Hebrews"). The singing was by professional choirs with a response ("Amen," "Hallelujah") from the worshippers (1 Chron. xvi. 36, 2 Chron. xxix. 27, 28). For a glowing description of the ritual see Ecclus. l. 11–21.

At first sight, the contents of the Psalter may seem to occasion relatively little difficulty to the exegete, as compared with the prophecies. The psalms are for the most part simple and often conventional in language, and without those references to obscure historical events which make the writings of the prophets so difficult. But the apparent gain is really a great loss to historical exegesis. Whilst the absence of reference to contemporary events makes the psalms much more capable of use then than now in worship and devotion—it was in some measure due, we may suppose, to elimination and adaptation—yet it also makes the investigation of the original meaning more difficult. Thus it is usually impossible to give a precise historical background to a particular psalm. The titles professing to do this, and to ascribe authorship, are of little use for critical purposes, and represent a late and usually worthless conjecture. Scholars have now generally abandoned the earlier attempts to ascribe particular psalms to precise events from the Davidic down to the Maccabean age; there is considerable variety of opinion as to the nature, date, authorship and origin of the psalms considered individually.

Four main questions arise: (1) to what extent are the psalms primarily and originally "cultic," more or less officially composed for use in public worship, and to what extent are they private religious lyrics, gathered from many sources, and subsequently adapted to use in the temple-services? (2) In close relation with this question comes another as to the significance of the speaker in many of the psalms; does the "I" mean the whole community, or is it an individual person who is speaking? (3) To what period of the religious history of Israel do the psalms chiefly belong, and to what extent are they pre-exilic in origin, though admittedly post-exilic in present adaptation and arrangement? (4) Are they a native product or are they dependent on Babylonian or Egyptian models, as the creation stories of Genesis are dependent on Babylonian mythology? It will be seen that these are not merely academic questions, for each of them may affect the exegesis of a particular psalm. A quarter of a century ago, the answers to these four questions generally given by critical scholarship were as follows: (1) the psalms are chiefly poems of the individual, though some were intended from the outset for use in the temple; (2) the "I" of the psalms usually represents the community; (3) the psalms are almost wholly post-exilic in origin; (4) they are native products. All these answers are now being met with vigorous criticism. At the present moment the protagonists in this criticism are the German scholar, Gunkel, and the Norwegian scholar, Mowinckel. Some account of their views must be given, as they cannot be neglected by the modern student of the psalms.

Gunkel's leading principle is that the psalms should be studied in their "classes" (Gattungen) or types, of which he finds four of chief importance, viz., "hymns" (*e.g.,* cxlv., cxlvii., cxlviii., cl.), "national laments" (*e.g.,* xliv., lxxix., lxxx., lxxxiii.), "individual laments" (iii., xiii., liv., lxxxviii.) and "individual thanksgivings" (xxx., lxvi., 13 seq.). These classes are differentiated by the use of regular formulae, such as "Deliver us, Yahweh," or "I will thank Yahweh," and by more or less regular forms of composition, so that we are not left to subjective impressions only when deciding as to what class a particular psalm belongs. On the basis of this differentiation Gunkel constructs a general history of the "classes," partly from internal evidence, such as the greater length, individualization, or composite character of the later representatives of the class, and partly from the parallels with psalm-like compositions found elsewhere in the Old Testament, which it is possible to date with confidence, such as the Song of Miriam (Exod. xv. 21), the song of the seraphim heard by Isaiah in the temple (vi. 3), the lyrics of Jeremiah and the "Psalms of Solomon" (1st century B.C.). Gunkel's general conclusion is that hymns of praise and national laments were found at an early date, whilst individual laments arose later, but prior to Jeremiah. He admits that prophecy influenced the language, eschatological outlook and spirituality of the Psalms, but claims that this influence was exerted before as well as after the exile. He argues that the existence of similar compositions in Babylonia and Egypt at a much earlier date confirms the intrinsic evidence that "Psalm-composition belongs to the earliest periods of Israel's history."

Mowinckel, whilst recognizing and using the classification of psalms by their type, throws his emphasis on their cultic character, and indeed barely admits the existence of any psalms not cultic in origin (his exceptions are i., cxii., cxxvii.). The psalms were composed by the temple-singers, whom he regards as existing from the early days of the temple. The class of psalms to which he gives primary attention is that containing references to the enthronement of Yahweh as king (xlvii., xciii., xcv.–c., with which many others are to be linked). These he connects with an alleged festival of the New Year (originally beginning in the autumn), a festival after the analogy of that celebrated at Babylon in honour of Marduk. The cultic acts of this festival (*e.g.*, the procession bringing the ark into the temple) were realistically conceived, *i.e.,* they were supposed to help in bringing about that which they "dramatized." Thus they anticipated the future (eschatology) while recalling the past (mythology). There is a similar "realism" in Mowinckel's interpretation of the numerous petitionary psalms, which are held to attribute misfortune and sickness to magicians and sorcerers, who are the original "workers of iniquity" so frequently mentioned. Such psalms were employed, with suitable accompanying rites, as part of the temple-cult; they counteracted adverse magic by exorcisms and imprecations of these "enemies." There were prophets as well as priests, or priest-prophets, attached to the temple, who gave oracles; thus the petition of Ps. lxxxv. 1–7 is answered by the oracle of vv. 8–13. It should be said that a "cultic" interpretation of the psalms as a whole has been independently urged by other scholars, *e.g.,* by J. P. Peters, who further conjectures that the "Elohistic" psalms belonged to northern temples (cf. the northern "Elohistic" saga-writers), the Korahite to Dan, the Asaphite to Bethel, and were afterwards incorporated in the liturgy of Jerusalem.

It will be seen, therefore, that there is considerable division of opinion at the present time in regard to our first question, the cultic element in the Psalter, Mowinckel regarding practically the whole Psalter as cultic in origin, whilst Gunkel regards the majority of the psalms as of private and occasional origin, though subsequently introduced into the cult. On this point Gunkel's view seems more convincing, from the intrinsic evidence and from the general probabilities. Like a modern hymn-book, the Psalter seems to contain many poems not originally intended for use in worship, but subsequently adapted to it—indeed, the religious wealth of the Psalter seems largely due to this variety of origin. On the other hand, Mowinckel does make a strong case for the special interpretation of the psalms of the enthronement of Yahweh, even though he brings far too many under this head. His explanation of the "eschatological" features is also attractive; less so seems his too sweeping connection of sickness and misfortune with magic, though there is probably an element of real truth in his contentions (the tendency of those who discover some neglected truth is to generalize to excess on the basis of it). In a collection so extensive and varied as the Psalter we need not regard any one explanation or theory as necessarily applicable to more than a part of the material. Variety of origin almost follows from variety of date, and their issue is most naturally variety of meaning, even where the same conventional phrases may be used.

In regard to the closely linked question as to the collective or individual interpretation of the speaker in the psalms, Gunkel follows Balla in reaction from the view that was general a quarter of a century ago (*e.g.,* Smend, Cheyne), *i.e.,* that the "I" of the Psalms is collective, personifying the nation. Mowinckel agrees with Gunkel so far as the "individual laments" are concerned, but recognizes a primitive "corporate personality" finding utterance through the leader or king as its representative. We may ask whether this principle does not admit of a wider application than even Mowinckel allows. It seems to go a long way towards explaining the puzzling combination of "collective" and "individual" elements in such a psalm as the xxii., and the rapid transitions so often found (cf. xliv. 5–7 and 14, 15). The same phenomena occur in relation to the Servant of Yahweh in Deutero-Isaiah, and admit of the same explanation—that the primitive mind draws no such hard and fast limits between the individual and the community as we do (see *The* Cross of the *Servant,* by H. Wheeler Robinson, pp. 32–36; The Psalmists, ed. D. C. Simpson, pp. 82 seq.). We may often find it impossible to decide whether a psalm is collective or individual—because the ancient category was neither one nor the other, but a third category including both.

In regard to dating the composition of individual psalms, there seems to be some danger of a similar excessive reaction from the view associated with the name of Wellhausen, open as that is to criticism. The arguments of Gunkel and Mowinckel, amongst others, do show in their different ways that psalms were composed in the pre-exilic period, a fact which has been too grudgingly admitted. The intrinsic evidence of some of the psalms, such as the reference to a human king, or the processional features of the second part of xxiv. ("Lift up your heads, O ye gates"), or the primitive cosmology of the first part of xix., confirms the probability that some of these pre-exilic productions would survive in a post-exilic Psalter. So long as we are thinking of the origin and original meaning of a particular psalm, we must always be prepared to admit that it may go back to a relatively early date, however much modified in its present adaptation to the needs of the second temple. On the other hand, we use any psalm in its present form as an early document only at considerable risk; we may conjecture, but we cannot prove. The main reasons for regarding the contents of the Psalter as largely post-exilic remain unaffected by recent criticism, *i.e.,* those that spring from the general relation of the religion of the psalms to the prophetic religion. If with Gunkel we regard the majority of the psalms as the expression of individual piety, we have to ask whether such wide-spread piety is conceivable before the work of the great prophets. The psalms represent a partial fulfilment of the prophecy of the New Covenant made by Jeremiah; is it likely that they preceded it? We cannot reasonably doubt that the prophets of the 8th and 7th centuries were pioneers, and that they taught truths that were new to their contemporaries, even though they may have used forms of expression and even of thought which were more or less conventional. Nor can there be any doubt that the religion of the Psalter as a whole is closely related to the prophetic teaching. We seem to have parallel phenomena, in the formulation of Israel's laws (Deuteronomy, the Law of Holiness, the Priestly Code) and in the Wisdom Literature; in all three cases ancient elements are given a new setting, but the new setting gives them a pew meaning. Laws, proverbs and psalms are alike reinterpreted and restated in the light of the prophetic teaching, which had certainly taken time to permeate the nation's religion. Nothing has come to us through the editorial sieve that could not be given a plausibly orthodox meaning according to post-exilic standards. Thus the psalms as a whole must still be treated as a post-exilic book. This might be confirmed by the subtler test of psychological usage, hardly to be simulated; the word "spirit," for example, is used of man in the psalms with psychical predicates in a way not found elsewhere in the pre-exilic literature of the Old Testament.

As for the relation of the psalms to the similar compositions of Babylonia, we find many interesting and instructive parallels of form, language and thought, but not less striking differences which must not be ignored, due to the far higher religious standpoipt of Israel, and the suppression of magic in the interests of religion (though some of the older forms and expressions doubtless continued to be used). The resemblances may be partly explained by the independent development of closely related peoples (G. R. Driver, in The *Psalmists,* pp. 109 seq.), and partly by the entrance of the Hebrews into a land dominated by Mesopotamian influence (as the Tell el-Amarna tablets prove); but it is quite possible that there was some direct influence also, even prior to the exile. This possibility also applies, but in a much smaller degree, to the influence of Egypt; there is the well-known parallelism of the "Hymn to the Sun" af Ikhnaton with Ps. civ., which matches the close relation of the "Teaching of Amenophis" to our canonical Book of Proverbs. But whatever contributions came directly or indirectly from without, there is good ground for holding that in all that really matters the Psalter is a native prqduct, and that to Israel still belongs the undiminished glory of carrying the religious lyric to its highest point of development.

Any attempt to characterize the teaching of this anthology must be made with the full consciousness of its variety of authorship, purpose and date. It is the most varied of the books of the Old Testament, and offers many unreconciled antitheses. Devotion to the sacrificial system and ritual of the temple is found side by side with prophetic protests against the popular reliance on them. Faith in the exact retributive justice of God within the limits of earthly life does not exclude the perplexities of those who could not be blind to the sufferings of the innocent and the prosperity of the wicked. The nationalistic demand for supremacy over, and even for vengeance on, enemies is neighbour to the universalistic sense of Israel's missionary stewardship for all the world. The recoil from the shadow of death, which leaves no light of Yahweh's presence beyond the grave, does not wholly prevent the conviction of a fellowship with God that virtually conquers death. But certain comprehensive truths may be usefully remembered in the study of the Psalms.

The central religious principle is, of course, the idea of God. The monotheism is sometimes implicit rather than explicit, for there are a number of references to other "gods" (lxxxvi. 8, lxxxix. 6, xcv. 3, etc.); yet these are perhaps no more than the survival of ancient phraseology. The general standpoint of the psalms is that of an exalted and imageless monotheism (cxv.), unlimited in power, universal in range. The most prominent attributes of Yahweh are "lovingkindness" (*chesedh*) and "righteousness" (*ṣedheḳ, ṣedhaḳah*), combined in cxlv. 17, expanded in xxxvi. 6–11; they are complementary, not antithetical. To these must be added the mystery and majesty of God—the quality which we have come to call "the numinous," best expressed in Ps. xc.; the wrath of God cannot be measured by human norms of right and wrong. This great God is omnipresent (cxxxix. 7–12), and eternal (xc. 1, 2; cii. 26–28). Around this great and exalted personal centre in heaven, but on the lower level of earth, we may trace a series of concentric circles in nature, history, human society, the temple, narrowing at last to the personal religion in which man can look right up to God. Nature is directly controlled in all its detail by God, and no "laws of nature" come between Him and His creation. The cosmology of the "nature" psalms (viii., xix. 1–6, xxix., lxv., civ., cxlviii.) is crude; man walks on a flat earth, with the "shades" of Sheol beneath his feet, and Yahweh with His angels above his head, on the solid firmament; round about the earth is the primaeval ocean and its monsters, overcome long since by Yahweh's creative power. The great facts which emerge from this primitive setting of man's life are the dignity and glory of his high place (viii.) amid the glories of Yahweh's creation (xix. 1–6) and His universal providence (civ.), The power of the enthroned Yahweh is manifest in the majesty of the thunderstorm which sweeps the earth, whilst in the heavenly palace His angels glorify Him (xxix.).

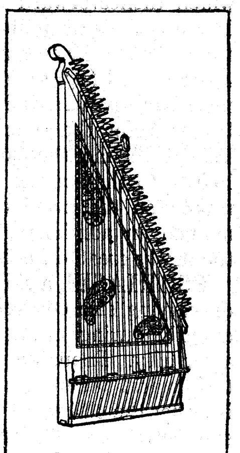
The peculiar providence of God is, however, best seen in the redemptive history of Israel (lxxxi. 10). At great crises. Yahweh has intervened to save His chosen people (cxiv.). The God of the past (cv., cvi.) will be the God of the future, when His rule shall be proved supreme over all (xlvii., and the other "enthronement" psalms). A prince of the house of David shall be his vicegerent (lxxxix. 35 *seq.; cf.* ii., lxxii.) and the final judgment of men shell vindicate His righteousness (i. 5). This is the essential faith of the righteous, the company of those who fear Yahweh and are remembered by Him (*rf.* Mal. iii. 16), the group to whom we seem to owe the most "spiritual" of the psalms. They live in a society of mingled elements, and have many enemies, without and within, for there are imprecations against unworthy Israelites (lxix., cix.) as well as against the ungodly heathen (cxxxvii., lxxxiii., lix., lviii.), and they may be under unjust rulers (lii.). Their great problem is that which troubled the best minds and hearts of Israel, and found no solution within the Old Testament, *i.e.,* the strange and perplexing prosperity of the wicked and the adversity of the righteous in a world governed by an omnipotent and righteous God (xlix., xxxix., xxxvii., lxxiii.).

The sacramental centre of this faith is the Temple in Jerusalem, to which the exile turns with passionate longing (xlii., xliii.—originally a single psalm). (The devotion to the "Law" came later, except for i., xix. 7–14, cxix.) To the temple come the pilgrims from afar (cxx.–cxxxiv.), full of pride in the holy city (xlviii.), the spiritual home af many proselytes as well as of Jewish exiles (lxxxvii.). The temple is Yahweh's earthly dwelling-place (cxxxii. 13, 14) to which His "guests" may come (xv., xxiv.) ; its sacrifices (lxvi. 13–15, cxvi. 13) and processions (lxviii. 24–27, cxviii., xxvi. 6) mark supreme moments of religious experience. This is the normal attitude of the Psalmists towards the temple; but the emphasis of the Book is prophetic rather than priestly, and this finds utterance sometimes in the contrast of "spiritual" religion with external rites (xl., l., li., except for the added verses, li. 18, 19). The personal religion of the psalmists is marked by trust in Yahweh based on history and experience (xvi., xxiii., xci., ciii.), by the consciousness of "righteousness" (xviii. 20–24), not divorced from fundamental ethical qualities (xv., xxiv., ci., l.), by the awakening to a sense of sin and of the need of forgiveness, usually, it would seem, through misfortune, sickness, the fear of death (xxxii., li., cxxx.), and in the highest examples, by a victorious conviction of fellowship with God (lxxiii. 23–26) which even death will not be able to break. This last is the more noteworthy, because there does not seem to be either here or elsewhere in the psalms any explicit teaching of immortality or resurrection (some have found the hope in xvi., xvii.. xlix j.

Such is the relatively simple faith of the most influential book of the Old Testament, which has claimed so supreme a place in the public worship and private devotion of Jew and Christian. Its magical secret lies in its simple and concrete expression of universal religious experience. Its value is altogether independent of our enquiries into its sources; indeed, it has won its place by its lowly submissiveness to reinterpretation in order to meet the ever-changing needs of the unchanging human heart.

BIBLIOGRAPHY.—T. K. Cheyne, *The Book of Psalms* (1st edition) (1888), and *The Origin and Religious Contents of the Psalter* (1891); J. Wellhausen, *The Book of Psalms* (Eng., 1898); B. Duhm, *Die Psalmen* (1899); F. Baethgen, *Die Psalmen* (1904); S. R. Driver, *The Parallel Psalter* (trans., 1904); C. A. Briggs, *The Book of Psalms* (2 vols. 1906, 1907); R. E. Prothero, *The Psalms in Human Life* (1914); C. F. Kent, *Songs, Hymns & Prayers of the Old Testament* (1914); W. G. Jordan, *Religion in Song* (1917); C. G. Montefiore, "The Psalter: its Contents and Date," *Quarterly Review*, July 1918, pp. 1–20; J. E. McFadyen, *The Psalms in Modern Speech* (trans., 1916); W. E. Addis, in Peake's *Commentary* (1919); S. Mowinckel, *Psalmenstudien* (i.–vi. 1921–24); J. M. P. Smith, *The Religion of the Psalms* (1922); R. Kittel, *Die Psalmen* (1922); J. P. Peters, *The Psalms as Liturgies* (1922); A. Lods, *Les Idées de M. Mowinckel* (*Revue de L'Histoire des Religions*, 1925, pp. 15–34); H. Gunkel, *Die Psalmen* (1926–28); A. C. Welch, *The Psalter in Life, Worship and History* (1926), D. C. Simpson (ed.), *The Psalmists* (1926); H. Gunkel, in *Old Testament Essays* (Griffin & Co.; a convenient summary of his views in English); N. Nicolsky, *Spuren Magischen Formeln in den Psalmen* (1927). (H. W. R.)

PSALTERY, PSALTERION or **SAWTRIE,** an ancient stringed instrument twanged by fingers or plectrum, and mentioned many times in the English Bible, though precisely what form of instrument is implied by these various references is doubtful. In its mediaeval form it consisted of a shallow box-sound-chest over which strings varying in number were stretched, being fastened at one side to pegs and at the other to wrest pins. In the early rectangular form the strings, numbering 10 to 12, were of uniform length, the pitch being varied by their thickness and tension. When the triangular form succeeded the rectangular, the stringing was that of the harp, pitch being dependent on the length. The psaltery was held in an upright position against the chest of the performer, until, owing to the increasing number of strings, it grew too cumbersome, when it was placed flat on a table or on the knee. From the psaltery descended the spinet and the harpsichord.



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THE PSALTERY, A MEDIAEVAL INSTRUMENT PLAYED BY FINGERS OR PLECTRUM

PSAMMETICHUS (Egypt. *Psammetk*), the name of three kings of the Saite, XXVIth Dynasty, called by Herodotus respectively Psammetichus, Psammis and Psammenitus. The first of these is generally considered to be the founder of the dynasty; Manetho, however, carries it back through three or four predecessors who ruled at Sais as petty kings under the XXVth, Ethiopian, Dynasty. It is known from cuneiform texts that 20 local princelings were appointed by Esarhaddon and confirmed by Assur-bani-pal to govern Egypt. Niku (Necho), father of Psammetichus, was the chief of these kinglets, but they seem to have been quite unable to hold the Egyptians to the hated Assyrians against the more sympathetic Ethiopian. The labyrinth built by a king of the XIIth Dynasty is ascribed by Herodotus to the Dodecarchy, or rule of 12, which must represent this combination of rulers. If the dynasties were numbered thus before Manetho, the numeral may be the cause of Herodotus's confusion.

After his father's death Psammetichus I. (664–610 B.C.) was able to defy the Assyrians and the Ethiopians, and during a long reign marked by intimate relations with the Greeks restored the prosperity of Egypt. The short reign of the second Psammetichus (594–589 B.C.) is noteworthy for the graffiti of his Greek, Phoenician and Carian mercenaries at Abu Simbel (*q.v.*). The third of the name was the unfortunate prince whose reign terminated after six months in the Persian conquest of Egypt (525 B.C.). It has been conjectured that the family of the Psammetichi was of Libyan origin; on the other hand, some would recognize negro features in a portrait of Psammetichus I., which might connect him with the Ethiopian rulers.

See EGYPT: *History;* on the name, F. Ll. Griffith, *Catalogue of the Rylands demotic papyri;* the portrait H. Schäfer in *Zeitschrift für aegyptische Sprache*, xxxiii. 116. (F. LL. G.)

PSELLUS, MICHAEL CONSTANTINE "the younger," (1018–*c.* 1079), Byzantine writer, was born at Nicomedia, or Constantinople, of a consular and patrician family. Under Constantine Monomachus (1042–1054) he became one of the most influential men in the empire. As professor of philosophy at Constantinople he revived the cult of Plato at a time when Aristotle held the field. At the height of his success as a teacher he was recalled to court, where he became state secretary and vestarch, with the honorary title of Ὕπατος τῶν Φιλοσόφων (prince of philosophers). Presently he entered the monastery of Olympus (near Prusa in Bithynia), where he assumed the name of Michael. But, finding the life little to his taste, he resumed his public career. Under Isaac Comnenus and Constantine Ducas he exercised great influence, and was prime minister during the regency of Eudocia and the reign of his pupil Michael Parapinaces (1071–1078). It is probable that he died soon after the fall of Parapinaces.

In character Psellus was servile, unscrupulous and weak. But as a literary man, he will be remembered as the forerunner of the great Renaissance Platonists His works embraced politics, astronomy, medicine, music, theology, jurisprudence, physics, grammar and history.

Of his works, which are very numerous, many have not yet been printed. We may mention: *Chronographia* (from 976–1077); three Epitaphioi or funeral orations over the patriarchs Cerularius, Lichudes and Xiphilinus, and nearly 500 letters. The most important of his works have been published by C. Sathas, who has also edited the *Chronographia* in Methuen's Series (1899), in his Μεσαιωνικὴ βιβλιοθήκη, iv. 5. On Psellus himself *see* Leo Allatius, *De Psellis et eorum scriptis* (1634); J. E. Sandys, *Hist. of Classical Scholarship* (1906), i. 411; P. Würthlein, *Rhetorische Studien*, Paderborn (1919).

PSEUDO-DIPTERAL, in architecture, a term applied to a temple in which the single row of columns at the side of the cella is separated from the cella wall by a space equal to the distance between two pairs of adjacent columns, so that the width of the whole is the same as if the colonnade on each side were a double one.

PSEUDO-PERIPTERAL, in architecture, a term applied to a building or temple in which the cella or enclosed portion has engaged or attached columns which line with the side columns of the front porch or portico, and thus simulate a surrounding colonnade. Examples are: the temple of Zeus at Agrigentum in Sicily (probably late 6th century B.C.), in which the cella wall includes all the columns of the exterior; and the more normal *Maison Carré* at Nîmes (probably about A.D. 1). In certain Roman examples, such as the temple at Tebessa in Algeria (probably of the Antonine period), pilasters replaced the engaged columns.

PSEUDOPOD, PSEUDOPODIUM, an extension of the naked protoplasm of certain Protozoa for crawling or for the prehension of food, but not for active swimming (*see* AMOEBA).

PSICHARI, ERNEST (1883–1914), French author, grandson of Renan, and son of Jean Psichari, director of studies at the École des Hautes Études in Paris, was killed on the Western Front on Aug. 22, 1914. He was one of the leaders of the young generation before the World War who sought to "rationalize" war and the defence of their country; he sought to provide the psychological basis for heroic action. His work is that of an intellectual who must justify the "great sacrifice." In the year before the World War *L'Appel des armes* had a powerful moral effect among young intellectuals. It is the story of a captain in the Algerian army who converts to the military ideal the anti-militarist son of an internationalist, who finds mental peace in military obedience. This book was followed by *Les Voix qui crient dans le désert. Le Voyage du Centurion* appeared as the finished form of this work. In 1917 Jean Psichari presented to the Luxembourg library his collection of 25,000 volumes on mental subjects, in memory of his son Ernest. A second son, Michel, was killed in May 1917.

See Henri Massis, *La Vie d'Ernest Psichari* (1916); L. Aguettant, *Ernest Psichari* (1920); H. D Noble, *Ernest Psichari; sa conversion religieuse* (1924); A. M Goichon, *Ernest Psichari, etc.* (1925).

PSILOMELANE, a mineral consisting of hydrous manganese oxide with variable amounts of barium, potassium, etc., of importance as an ore of manganese. The amount of manganese present corresponds to 70–80% of manganous oxide with 10–15% of "available" oxygen. The mineral is amorphous and occurs as botryoidal and stalactitic masses with a smooth shining surface and submetallic lustre. The name has reference to this characteristic appearance, being from the Greek ψιλός (naked, smooth) and μέλας (black); a Latinized form is calvonigrite, and a German name with the same meaning is Schwarzer Glaskopf. Psilomelane is readily distinguished from other hydrous manganese oxides (manganite and wad) by its greater hardness (H=5·5); the sp.gr. varies from 3.7 to 4.7. The streak is brownish-black and the fracture smooth. The mineral is soluble in hydrochloric acid with evolution of chlorine, and occurs under the same conditions and has the same commercial applications as pyrolusite (*q.v.*). It is found at many localities; amongst those which have yielded typical botryoidal specimens may be mentioned the Restormel iron mine at Lostwithiel in Cornwall, Brendon Hill in Somerset and Hoy in the Orkneys. With pyrolusite it is extensively mined in Vermont, Virginia, Arkansas, Nova Scotia and India. A distinctly crystallized variety from India has been called hollandite.

PSITTACOSIS, an acute disease often with typhoid-like characteristics (see TYPHOID FEVER) and ending fatally in a large proportion of cases. It is conveyed to man by parrots suffering from the disease, either directly or by way of their dried excreta. A bad outbreak of the disease occurred in Argentina in 1929 and in England in 1928–29. Cases have also occurred in other parts of Europe and in the United States. It is doubtful whether the cause is due to Bacillus psittacosis, first isolated in 1892 or to a filter-passing virus (*q.v.*). (See Brit. Med. Jn. 1930, i. 197.)

PSKOV, in German, Pleskau, a town of Russia in the Pskov district of the Leningrad area, in 57° 48' N., 28" 22' E., situated on both banks of the Velikaya river, 9 m. S.E. from Lake Pskov. Pop. (1933) 52,600. The chief part of the town, with its kremlin on a hill, occupies the right bank of the river, to which the ruins of its old walls (built in 1266) descend. The old cathedral in the kremlin has been four times rebuilt since the 12th century; the present edifice (1691–99) contains some very old shrines, as also the graves of the bishops of Pskov and of several Pskov princes. The church of Dmitriy Solunskiy dates originally from the 12th century; there are others of the 14th and 15th.

History.—Pskov, formerly the sister republic of Novgorod and one of the oldest cities of Russia, maintained its independence and its free institutions until the 16th century, being thus the last to be brought under the rule of Moscow. It already existed in the time of Rurik (9th century); and Nestor states that in the year 914 that Olga, wife of Igor, prince of Novgorod, was brought from Pleskov (*i.e.,* Pskov). The Velikaya valley and river were from a remote antiquity a channel for the trade of the south of Europe with the Baltic coast. Pskov being an important strategic point, its possession was obstinately disputed between the Russians and the Germans and Lithuanians throughout the 11th and 12th centuries. It became in the 12th century a *prigorod* of the Novgorod republic—*i.e.,* a city having its own free institutions, but included in certain respects within the jurisdiction of the metropolis, and compelled in time of war to march against the common enemy. Pskov had, however, its own prince (*defensor municipii*); and in the second half of the 13th century Prince (Timotheus) Dovmont fortified it so strongly that the town asserted its independence of Novgorod, with which, in 1348, it concluded a treaty wherein the two republics were recognised as equals. Its rule extended over the districts of Pskov, Ostrov, Opochka and Gdov (farther north on the east side of Lake Peipus). The *vyeche* or council of Pskov was sovereign, the councils of the subordinate towns being supreme in their own municipal affairs. The council was supreme in all affairs of general interest, as well as a supreme court of justice, and the princes were elected by it; these last had to defend the city and levied the taxes, which were assessed by 12 citizens. But while Novgorod constantly showed a tendency to become an oligarchy of the wealthier merchants, Pskov figured as a republic in which the influence of the poorer classes prevailed. Its trading associations, supported by those of the working classes, checked the influence of the wealthier merchants,

Its strong walls and its 40 large and wealthy churches bear testimony to the wealth of the inhabitants, who then numbered about 60,000. As early as the 13th century Pskov was an important station for the trade between Novgorod and Riga. A century later it became a member of the Hanseatic League. Its merchants and trading associations had factories at Narva, Reval and Riga, and exported flax, corn, tallow, skins, tar, pitch, honey and timber for shipbuilding. Silks, woollen stuffs and all kinds of manufactured wares were brought back in exchange. In 1399 the prince of Moscow claimed the privilege of confirming the elected prince of Pskov in his rights; and though, 50 years later, Pskov and Novgorod concluded defensive treaties against Moscow, the poorer classes continued to seek at Moscow protection against the rich.

After the fall of Novgorod (1475) Pskov was taken (1510) by Basil Ivanovich, prince of Moscow, and a voyvode or deputy was nominated to govern the city. Moscow, at the end of the 17th century, abolished the last vestiges of self-government at Pskov, which thenceforward fell into rapid decay. Near this city the Teutonic knights inflicted a severe defeat upon the Russians in 1502. Pskov became a stronghold of Russia against Poland, and was besieged (1581) for seven months by Stephen Bathory during the Livonian War, and in 1615 by Gustavus Adolphus of Sweden. Under Peter the Great it became a fortified camp. Under the Tsarist régime the government of Pskov extended from Lake Peipus to the sources of the western Dwina, and after the 1917 revolution the province of Pskov, though much diminished, remained an pdministrative unit. In 1927 it was incorporated in the newly created Leningrad area (*q.v.*).

PSORIASIS, a skin affection characterized by flat dry patches of varying size covered with silvery white scales. It occurs frequently during infancy and early adult life, and rarely begins after fifty. Though a parasitic origin has been suggested, no bacteriological factor has yet been found. The usual starting point is either the elbows or the fronts of the knees. It is nearly always symmetrical in its distribution, and spreads over the trunk and the extensor surfaces of the limbs, in contrast to eczema, which selects the flexor surfaces. The hairy scalp may also be affected. The symptoms are usually slight, there is little itching, and no pain except in a form which is associated with osteo-arthritis. The disease, though chronic, is subject to sudden exacerbations. The most effective local application is chrysarobin used as an ointment. After a hot water or alkaline bath, in order to remove all the scales, the ointment is applied, but must be used over a small area at a time, as it is apt to set up dermatitis. Unguentum picis liquidae, creosote ointment or liquor carbonis detergens, the sulphur-water baths of Harrogate, Aix-les-Bains and Aachen, radium and X-rays are also useful in some cases. The internal administration of antimony in acute cases, or of arsenic in chronic cases, is beneficial.

PSOROSPERMIASIS, the medical term for a disease caused by the animal parasites known as psorosperms or Gregarinidae, found in the liver, kidneys and ureters.

PSYCHE, in Greek mythology, the personification of the human soul. The importance, in Platonic philosophy, of love (in the highest sense) as an agent of the soul's progress leads, in art from the 4th century B.C., to representations, allegorical or playful, of Psyche (generally represented as a winged girl, a relic of the old conception of the soul as a bird or insect) in company with Eros (*q.v.*), usually in amatory scenes. The tale of Cupid and Psyche, in the Metamorphoses of Apuleius, is interesting as the only ancient fairy-tale which is told as such. In it Psyche, the youngest daughter of a king, arouses the jealousy of Venus, who orders Cupid to inspire her with love for the most despicable of men.

Cupid, however, falls in love with her and carries her off to a secluded spot, where he visits her by night, unseen and unrecognized by her. Persuaded by her sisters that her companion is a hideous monster, and forgetful of his warning, she lights a lamp to look upon him while he is asleep; in her ecstasy at his beauty she lets fall a drop of burning oil upon the face of Cupid, who awakes and disappears. Wandering over the earth in search of him, Psyche falls into the hands of Venus, who forces her to undertake the most difficult tasks. The last and most dangerous of these is to fetch from the world below the box containing the ointment of beauty. She secures the box, but on her way back opens it and is stupefied by the vapour. She is only restored to her senses by Cupid, at whose entreaty Jupiter makes her immortal and bestows her in marriage upon her lover.

BIBLIOGRAPHY.—See O. Waser in Roscher, *Lexikon*, III., 2,327, et seq.; L. C. Purser, *The Story of Cupid and Psyche* (1910).

PSYCHIATRY, a special branch of medical science dealing with the causes, symptoms, course and treatment of disorders and diseases of the mind. The ultimate aim of this branch of medicine should be to ascertain the best means to promote normal thought and action individually and collectively, and to apply the knowledge so obtained to the causation and prevention of mental defects, disorders and diseases. See ABNORMAL PSYCHOLOGY; PSYCHOSIS, etc.

The causes of mental disorders and diseases are never single, but they naturally fall into two great groups: (1) Endogenous (from within) and (2) Exogenous (from without). They may be somatic, psychical or social. The hereditary factor is the most important endogenous cause.

The Endogenous Factor of Mental Disorders.—The life of the individual begins at the moment of conception, *i.e.*, at the conjugation of the male and female germ cells. The raw material of character is a complex of inherited tendencies and dispositions impressed upon the individual by sex, species, race and ancestry, giving each individual a specific predetermined plasticity to receive and store stimuli and react to them in a particular way. Like tends to beget like—as Galton's History of Similar *and* Dissimilar *Twins* shows, in the dispositions and temperaments of the offspring.

A well-balanced mind is due to an inherent equipoise of the latent potentialities of character, and its efficient activity depends upon the potential psychophysical energy derived from the parental stocks. The study of heredity (1) by statistics, (2) by pedigrees and (3) by experience shows the importance of this factor in the causation of the true insanities which are not due to organic brain disease, where chance counts for everything and heredity for little or nothing. The raw material of mentality is conditioned by the innate potentialities of the fertilised ovum as it starts its course in life. At later stages of development, the fertilised ovum is influenced by pre-natal and post-natal exogenous environmental factors in addition to the hereditary factors.

Pre-natal Exogenous Factors.—Much may happen while the embryo is developing in the mother's womb. Owing to abnormal conditions of growth, interfering with the circulation and nutrition of the great brain, various degrees of arrest of development of the highest and latest evolutional structures of the brain may occur, viz., the cerebral hemispheres, which by their size especially distinguish the brain of man from the lower animals, and to which he owes his superior intelligence, may suffer from various congenital effects. (See INSANITY.) Likewise prolonged labour or unskilful use of instruments may damage the brain and arrest growth.

Hereditary Factors.—Study of the hereditary factor in psychoses and psychoneuroses by the construction of a large number of pedigrees extending to three, four and five generations with collaterals, and by a card system of 4,000 relatives who were or who had been in the London County Council asylums, proves that heredity plays a very important part in neuroses and psychoses.

Neuroses may be classified as follows: (1) hysteria, (2) neurasthenia, (3) obsessional psychasthenia, (4) epilepsy and (5) migraine; and psychoses as (1) paranoia (systematised delusional insanity), (2) dementia praecox, (3) manic-depressive insanity, of which there are several types, viz.: alternating periods of excitement and depression (folie *circulaire*) and recurrent periods of maniacal excitement or of melancholic depression, alternating with periods of sanity, (4) involutional melancholia occurring at the climacterium in women, also in men between the ages of 55 and 65, though less frequently met with than in women. Both the latter forms of mental disorder may terminate in dementia.

These three last-named types are in some ways related to one another, and their onset is associated with the maturation or waning of the sex instinct. An involutional melancholic or senile dement may have offspring in whom manic-depressive insanity or dementia praecox may occur in adolescence, or a parent with manic-depressive insanity may have one or more offspring with dementia praecox. This phenomenon together with the fact that not infrequently several members of the same co-fraternity suffer with either dementia praecox or manic-depressive insanity or an atypical form, coming on at puberty or adolescence, at about the same age, shows antedating and hereditary predisposition as the important factor. There may be atypical cases in some respects resembling both these forms of mental disease, and it is a matter of opinion to which category a particular case should belong. This shows how fallacious classifications may be. The many changes which Krapelin has made in his classification emphasise the fact that each case must be regarded as a biological problem with two factors to consider, viz.: what an individual was born with; and what happened after fertilisation of the ovum—that is, pre-natal and post-natal conditions. There is, it seems, a causal correspondence in these three types of insanity connected with the "life reaction" of the primal instinct of propagation.

Disintegration of Psychic Unity.—The biological concept of mental disease propounded by Hughlings Jackson in his Theory of Evolutional Levels will help in the understanding of the causes and symptoms of insanity—dissolution of the highest level bringing into relief lower levels. Thus a negative condition of the highest evolutional level of control permits of over-action of the lower level of ideation, *e.g.*, the delirium of fever. In mental disorders there may be a negative condition of the highest level of control with disordered ideation manifested by hallucinations and delusions, owing to partial disintegration of the psychic unity. Such hallucinations and delusions may determine various active uncontrolled and irresistible impulses—disorders of conduct. When the disease has sunk to a lower depth of dissolution of evolutional levels there may result emotional indifference and apathy reflected in a mask-like expression, and motor inertia or katatonic stupor with *flexibilitas* cerea. Stuporose states with mental confusion indicate a more diffuse toxic influence on evolutional levels and are more hopeful of recovery than the persistence of hallucinations and delusions, the mind remaining clear.

Post-natal Exogenous Causes.—These do not play an important part per se in the production of the true insanities. They may, however, act as exciting or contributory causes in individuals with an hereditary latent tendency. Stress per se from disease and disasters of every kind cannot be the important factor believed to be in the production of the true insanities as distinct from organic brain disease, *e.g.*, general paralysis and lethargic encephalitis. This was clearly shown during the World War by the fact that Bonhoffer, an eminent Austrian psychiatrist, only found five insane among 10,000 Serbian prisoners.

Organic brain disease may cause various symptoms of irritations such as fits, headaches, pains, stiffness of muscles, and delirium or drowsy stupor, loss of memory, paralysis and dementia, according to the pathological process and the structures affected.

BIBLIOGRAPHY.—A Brit. Med. Assn. Lecture; J. Hughlings Jackson, "The Factors of Insanities," *Medical Press and Circular* (June, 13, 1894); Mercier, *Disorders of Conduct;* White, *Outlines of Psychiatry,* Buckley, *The Basis of Psychiatry;* Sir F. W. Mott, "Articles on Dementia Praecox," *Archives of Neurology and Psychiatry,* vol. 8; Myerson, *The Inheritance of Mental Disease;* Sir T. S. Clouston, *Unsoundness of Mind* (1911); Sir F. W. Mott, "A Study of the Neuropathic Inheritance Especially in Relation to Insanity," *Archives of Neurology and Psychiatry,* vol. 6 (1914); C. G. Jung, *Analytical Psychology,* 2nd ed., authorised translation (1920); J. B. Watson, *Psychology from the Standpoint of a Behaviourist;* Hugh Elliot, *Human Character* (1922); Sir F. W. Mott, "The Biological Foundations of Human Character," *Edin. Review* (July 1923); William McDougall, *An Outline of Psychology* (1923); Maudsley, *Pathology of Mind;* W. Sullivan, *Crime and Insanity;* Sir F. W. Mott, "Psychology and Medicine," *B.M.J.* (March 10, 1923); "Memorandum of Evidence Given on Behalf of the Royal Medico-Psychological Association to the Royal Commission on Lunacy and Mental Disorder," *Journal of Mental Science,* vol. 70, No. 294; Sir F. W. Mott, "The Investigation of Some of the Causes of Insanity," Presidential address to Royal Medico-Psychological Association, *Journal* of Mental *Science,* vol. 71 (Oct. 1925).

PSYCHICAL RESEARCH is the study of the supernormal faculties (real or supposed) of human personality. The word "supernormal" is merely a short equivalent for "not recognized by general scientific opinion," and is free of all implications of the "supernatural." The function of psychical research is to collect and weigh all the available evidence for and against all such supposed faculties, to the end that they may either be accepted by general scientific opinion, or may safely be consigned to oblivion.

Thus some of the subjects mentioned in the original programme of the Society for Psychical Research (founded 1882) have already passed out of its scope, "hypnotism" for example, and "Reichenbach's rays." Mainly as the result of the labours of members of the S.P.R. in different countries, the study of hypnotism was brought to a point where it could be handed over to specialists in medical psychology, while the existence of "Reichenbach's rays" was fairly well disproved.

But, for the most part, the "debatable phenomena" of 1882 remain almost as debatable in 1929. This would be a surprising fact, in view of the number of scientists and philosophers of the highest eminence, who have interested themselves in psychical research, if the study were not one of exceptional difficulty.

"Mental" and "Physical" Phenomena. — It is customary to divide the phenomena of psychical research into two classes, "mental" and "physical." If a table is moved without the application of any force known to science, that is a "physical" phenomenon. If a medium in trance gives information outside his normal knowledge, that is a "mental" phenomenon; there is not necessarily anything supernormal in trance-speaking: the supernormality is to be found, if anywhere, in the content of the words spoken. If, however, the information is given through a trumpet floating in the air at a distance from the medium, that is both a "physical" and a "mental" phenomenon. The main problem of psychical research on the "physical" side is whether the alleged phenomena in fact occur; with the "mental" phenomena the evidence permits us to accept the occurrence of some of them as a working hypothesis, and to proceed to the further stage of attempting an explanation.

The reasons why the two branches of research vary so widely as to the progress made are not far to seek. The student of mental phenomena can avail himself of three lines of approach, and compare the results obtained along one line with those obtained along the other two. He can compare the records of professional trance mediums with a large quantity of good evidence for spontaneous phenomena on the one hand, and with the results of experiments conducted with quite non-professional automatists of good repute on the other. The student of physical phenomena is more limited: such spontaneous phenomena as Poltergeists do not, for reasons discussed later, give him much serious assistance; the unprofessional "physical" medium has been, since the death of Stainton Moses, hard to discover; he is, therefore, practically confined to the observation of professional mediums.

Unfortunately the quality of professional "physical" mediums has declined since the golden age of D. D. Home (died 1886). Home, who accepted no fees, but lived by his mediumship, and may therefore be classed as semi-professional, sat under conditions, as regards light in particular, much more favourable for observation than modern mediums will submit to, and enjoyed an immunity from exposure which most of his successors may envy. Against this it must be noted that the technique of investigation was then in its infancy, and that while many of Home's sitters were persons of distinction, such as Crookes, they were not experts in this particular line.

Spontaneous **Physical** Phenomena. — Poltergeists (a German term meaning "Racketing Spirits") constitute the principal type of spontaneous physical phenomena. The word, which has now became a technical term without any spiritistic implications, is used to describe those frequently recurring cases of strange noises, movements of furniture and breakages of crockery which appear inexplicable to the inmates of the houses where they occur, and also similar cases of stone-throwing out of doors. Cases of this kind have been recorded for many hundreds of years, and from all parts of the world, civilized and barbarous; familiar instances in England are the Tedworth Drummer (1662) and the occurrences in the Wesley household at Epworth (1716–1717).

It would at first sight appear as if Poltergeists should provide a useful standard of comparison for arriving at an opinion as to what causes, supernormal or otherwise, produce similar phenomena in the séance room. Unfortunately, they give little assistance. In the earlier cases (up to, say, 1850 or thereabouts), the observers, even where they were intelligent and responsible persons like the Wesleys, did not know what were the significant points to which to direct their attention; and nowadays the investigator who knows what to look for does not usually arrive on the scene until a crowd of enterprising journalists, dogmatic spiritualists, and sensation-hunting members of the public has hopelessly "queered the pitch," and prevented the collection of first-hand, uncoloured evidence. The best Poltergeist cases, from the student's point of view, are those investigated in the latter half of the 19th century. There is a good collection of cases occurring between 1883 and 1896, and analysed by F. Podmore, in S.P.R. *Proceedings* vol. xii.; and the spirited controversy between Podmore and Andrew Lang in vol. xvii. of the *Proceedings* is instructive.

Poltergeist cases show a degree of uniformity which is remarkable, in view of their being so widely distributed in time and space. It can almost invariably be shown that there is some one agent whose presence is essential for the production of the phenomena, although occasionally a secondary agent assists in their production; if the principal agent is removed the phenomena cease at once. The agent is usually a person of some marked mental or physical abnormality, often a girl in her "teens," less often a boy of the same age, and only rarely an adult. In some cases there is obvious trickery, easily discoverable by any fairly good observer; in others the trickery is so cleverly done that only a skilled investigator can find it out; in a few cases trickery does not seem to be an adequate explanation of the facts, assuming these to have been accurately reported. Finally, there is an absence of any apparent motive sufficient, from the point of view of a sane adult, to account for all the trouble to which the agent puts himself and others; nothing is gained by the agent but the notoriety of a nine-days' wonder.

The problem is whether the undoubted existence of fraud (usually "hysterical fraud") in many of the cases justifies us in assuming that the same factor has operated in the unexplained residue. Podmore thought that it did; Lang that it did not. The controversy remains very much where they left it, owing to the paucity of well-recorded cases in recent years.

Although Poltergeists, for the reasons stated, are not as helpful in the study of experimental physical phenomena as might be expected, or as they would be if competent observers were given a fair chance to observe them, there are, nevertheless, two ways in which they throw a useful light on doubtful problems of the dance-room. First, on the question of motive: with the evidence derived from Poltergeist cases in mind, it is less difficult to imagine that "physical" mediums, who often have a strong vein of childish vanity, may think that the sensation they create by their performances is in itself, quite apart from any material advantage, a sufficient compensation for maintaining over a long period an elaborate scheme of deception, sometimes imposing on the medium no little physical discomfort. Secondly, as to the ease and rapidity with which skill in deception is acquired: a child after a few weeks' practice and relying on its own perverted ingenuity, may produce phenomena as baffling as a professional medium who has had years in which to perfect his technique, and who has some knowledge of the methods of other mediums.

Experimental Physical Phenomena. — The word "experimental" is open to misunderstanding; the investigator of séance-room phenomena soon discovers that the limits within which he is permitted to experiment are extremely narrow, that the subject-matter of his proposed "experiments," the medium, dictates most of the crucial conditions of the investigation, and that for all practical purposes he is simply an observer.

It is impossible to classify, or eveh enumerate, all the kinds of "physical" phenomena which have been reported; they include apparent breaches of all the generally accepted laws governing matter. Two kinds, however, have received closer study and attained more credence than the rest, telekinesis and teleplasm (also called ectoplasm).

Telekinesis is the movement of objects without the application of any physical force known to science, and has a history dating back to the early days of spiritualism. Horne, Eusapia Palladino, Kathleen Goligher, Willy Schneider and "Margery" (Mrs. Crandon) may be named amongst the best known telekinetic mediums.

Teleplasm is a "substance" extruded from the medium's body; it may be either wholly invisible, or visible but amorphous, or it may take the form of a complete human figure, apparently endowed with energies of its own, like "Katie King," to whose reality Crookes testified. Among recent teleplastic mediums may be mentioned Eva C., Kluski, Kathleen Goligher, "Margery."

It will be noted that two names are common to the telekinetic and teleplastic lists, and as the result, especially of Crawford's experiments with Kathleen Goligher, it is a general opinion among those students who accept the genuineness of both classes of phenomena (and they include several scientists of repute, especially on the Continent), that it is by force exerted through teleplastic rods or structures that telekinetic movements of objects are effected. For teleplasm itself the "ideoplastic" theory has gained wide acceptance. According to this theory, teleplasm is moulded into definite shape by the thoughts of the medium and the sitters; attempts have been made to fortify the theory by analogies from the real or supposed facts of normal biology, the influence, *e.g.,* of a mother's thoughts on the development of the child within her womb.

For telekinesis pure and simple it is easy to formulate methods of control, adequate to prevent deception without being harassing to the medium. Telekinesis would rest on a firm basis if it were certain that in all cases where positive results are reported, the conditions of control stated in the reports had, in fact, been continuously exercised throughout the sittings. But telekinesis has, of recent years, become very closely associated with teleplasm, and the control adequate for telekinesis is not adequate for teleplasm. This substance is reported to possess at different times such contradictory properties as to make the task of formulating conditions for sittings where its production is anticipated extremely difficult. Too delicate to endure even the lightest touch, but strong enough to shift heavy weights; sometimes so sensitive to light as not to be able to endure even the dim glow of a red lamp, at other times so insensitive as to be capable of being photographed by flash-light; how is the researcher to plan conditions in advance, when he cannot know in which form the substance may appear?

At present there is a deadlock in the research into "physical" phenomena, owing to the encouragement given to mediums who pick and choose their sitters, and dictate conditions which seem to serve no purpose except to make control more difficult (*e.g.,* the constant presence of a "next friend" at all sittings). Such mediums can find no lack of investigators willing to take them seriously, and all the publicity they need in the all too hospitable columns of many "psychic" periodicals. Unless and until an international pact between researchers is made (and observed) not to print any report of mediums who decline to sit under reasonable test conditions (without a "next friend") to any responsible investigator who asks for a sitting, no progress can be made. Much of the literature on telekinesis and teleplasm is worthless, but a good *prima facie* case for further investigation can be found in the reports in S.P.R. *Proceedings* on Eusapia Palladino (vol. xxiii.), Eva C. (vol. xxxii.) and Willy Schneider (vol. xxxvi), and in Schrenck-Notzing's records of his sittings with the two last-named.

Combined Mental and Physical Phenomena. — Slate-writing, "spirit photography" and trumpet-mediumship all seem convincingly fraud-proof to those who have not made themselves familiar with the records of what can be, and has been, done in the way of reproducing these phenomena without recourse to the supernormal; see, *e.g.,* Hodgsop and Davey's paper in S.P.R. Proceedings, vol. iv. The "mental" and "physical" elements should be judged separately, neither being permitted either to support or to discredit the other. Thus, though the trumpet business is, in general, open to suspicion, there is some evidence for super. normality in the content of messages received through some trumpet-mediums (*e.g.,* Valiantine and Mrs. Blanche Cooper),

Mental Phenomena. — These consist, for the most part, in some form of "supernormal cognition," that is, knowledge shown by a percipient of matters which he has no normal means af knowing. ("Percipient" is here used, for lack of a better word, to include not only percipients in telepathy, but automatists of all kinds, trance mediums, etc.) The supernormal knowledge may relate to another person's thoughts, or to events distant in time or space; it may arise spontaneously, so far as the percipient is concerned, or as the result of deliberate experiment on his part. The percipient may be in the normal waking condition, or asleep, or in trance, or in the state of slight dissociation produced by *crystal-gazing* (see separate article) or other similar devices.

Telepathy and Clairvoyance. — It is best to treat these two terms as complementary and mutually exclusive, assigning all manifestations of supernormal knowledge derived from another person's mind to telepathy, and all manifestations of supernormal knowledge not so derived to clairvoyance. It is not, however, easy to say under which head every particular case should be classified: to meet this difficulty Richet has coined the inclusive word "cryptaestheoia."

Supernormal cognition in some form is the most generally accepted phenomena of psychical research. The evidence for it, both spontaneous and experimental, is impressive alike in quantity and quality. Some of it is ambiguous as between telepathy and clairvoyance; so far as discrimination is possible, the first is better attested than the second.

Spontaneous and Experimental Phenomena. — The spontaneous evidence is particularly strong. One of the first tasks of the S.P.R. was to undertake a "census of hallucinations" of various kinds, particularly of apparitions of dying or recently dead persons, seen by friends who were at a distance, and who had no normal reason for anxiety. Gurney, Myers and Podmore, who analysed the results *(Phantasms of the Living,* 1886) came to the conclusions: (1) That such apparitions occurred too frequently to be explicable by chance-coincidence: elaborate statistics are given in support of this conclusion; (2) that in the majority of cases the most probable explanation was the transmission of an impression from the mind of the dying man to the mind of his friend, and these externalized in the form of a "subjective hallucination," rather than the presence of any semimaterial wraith. The society has continued to investigate cases of this kind; a large number are collected and classified by Mrs. Sidgwick in vol. xxxiii. of its *Proceedings.*

If the experimental evidence for clairvoyance were as good as that for telepathy, veridical hallucinations could, in most cases, be attributed with equal probability to either faculty, although the rare cases, in which the agent has succeeded in consciously willing that the percipient should see an apparition of him, are clearly telepathic. At the time when *Phantasms of the Living* mas written the experimental evidence for clairvoyance was so slight as to lead the authors decisively to reject it as an explanation of the cases they were considering. The evidence for clairvoyance is rather stronger now, and in cases of veridical hallucinations not coincidental with the death of the person whose phantasm is seen, or with any other crisis, such as illness or accident, from which telepathic activity on the part of his sub-conscious mind might reasonably be inferred, the possibility of clairvoyance pure and simple cannot be excluded.

Experimental Telepathy and Clairvoyance.—Experiments in thought-transference have been conducted for many years past in most civilized countries, and the conditions of the experiments have been diverse. Sometimes the percipient has been in a normal waking condition, sometimes in hypnosis; sometimes in the same room or house as the agent, sometimes at a distance of many miles, or even in a different country. The subject matter has also varied greatly; attempts have been made to transfer impressions of numbers, simple or complex diagrams, the suit and value of playing cards, landscapes or pictures, incidents from books and imaginary scenes. Records of various experiments on these lines will be found in S.P.R. Proceedings passim, and in books such as N. W. Thomas's Thought Transference (1905), Tischner's *Telepathie und Hellsehen*, Warcollier's La *Télépathie*.

In experiments with numbers or a pack of cards it is possible to make a statistical computation as to how far (if at all) the successes exceed those which can be assigned to chance; the mathematics are not quite as simple as is sometimes supposed (see Proc., vol. xxxiv., p. 185 sq.). In experiments with diagrams, scenes and incidents, no such computation is, of course, possible.

Where agent and percipient are in the same room, the possibility of hyperaesthesia (*i.e.*, an unusual acuity of the normal senses of sight, hearing, etc.) must be taken into account. This is the explanation which Prof. Gilbert Murray is disposed to accept for the remarkable successes obtained by him in receiving impressions of incidents from books or imaginary scenes (see S.P.R. *Proceedings*, vols. xxix. and xxxiv.). Prof. Murray was not, in fact, in the same room as the agents, and for this and other reasons it is difficult to accept hyperaesthesia as the explanation. It is greatly to be regretted that Prof. Murray has not continued the experiments under conditions which would leave no reasonable doubt as to the operative cause.

Another factor, which does not always receive sufficient attention, is that of fatigue or boredom on the part of the percipient. From recent experiments in clairvoyance by Miss Jephson in England (S.P.R. Proc., vol. xxxviii.) and Estabrooks in America (Boston S.P.R. *Bulletin* 5) it is clear that there is a well-marked "fatigue curve," that is to say, there is a tendency for percipients to score most of their successes in the early stages of an experiment, while in the later stages the results may fall definitely below the line of chance probability, apparently as the result of some inhibition due to boredom or confusion.

For experiments where the agent and percipient are widely separated see S.P.R. Proceedings, vol. xxi. Experiments are now in progress between a French group, organized by Warcollier, and an English group organized by S. G. Soal.

Reference has already been made to Miss Jephson's recent experiments in clairvoyance, but so far much less has been accomplished with clairvoyance than with telepathy. The usual form of experiment is to set the clairvoyant to "guess" the suit and value of cards taken from a shuffled pack held face downwards, or the content of writings enclosed in envelopes externally identical in appearance; if the experiment is properly carried out nobody has normal knowledge of the correct answer, and telepathy is therefore excluded. Where the clairvoyant is not a person whose *bona fides* is absolutely above suspicion, the same precautions against deception and the same alertness on the observer's part are necessary as in investigating "physical" phenomena. The reading of the contents of sealed letters, in particular, is a favourite trick of dishonest mediums. For some successful experiments with sealed envelopes, in which the investigators were fully on their guard, see the Report of the Warsaw International Congress (1923), p. 201.

The **Modus** Operandi in Telepathy and Clairvoyance, While taking the spontaneous and the experimental evidence together, there is a strong case of accepting telepathy, and a fair case for accepting clairvoyance, there are still many obscure problems as to the manner in which these two faculties function. It may, for instance, be asked: Are the faculties common to all humanity, or confined to particular individuals? How far does the exercise of them depend on conscious effort? In what form are impressions conveyed, as words, as ideas, as visual images? Are they conveyed by means of any physical "waves" or "effluence"?

To some of these questions it is possible to suggest a tentative answer. Ideas may be telepathically transmitted without conscious deliberate effort on the part of either agent or percipient, transmission taking place between their subliminal minds direct. In some cases the agent justifies his name by deliberately willing to transmit impressions; in others it is possible that it is the percipient's subliminal mind which goes to look for impressions, so to speak, rather than passively receives them. The fact that the process takes place subliminally makes it impossible to estimate how frequently it occurs. It has even been suggested that every subliminal is constantly transmitting impressions to, and receiving them from, every other subliminal, and that from time to time something happens which, as regards a particular percipient, raises the height of the unperceived, ever flowing stream above the level of consciousness. It is hard to imagine any kind of evidence which could either prove or disprove such an hypothesis, which seems to have been invented simply as a weapon to be used against spiritists, when all others fail (see p. 671, "Evidence for Survival").

As regards the distribution of the faculty the experimental evidence and the spontaneous evidence taken separately would suggest different conclusions. In all the experiments which have been conducted few percipients have been discovered capable of receiving impressions as complex as those which give rise to phantasms of the dying, with the same degree of vividness and accuracy that the numerous percipients of such phantasms have displayed. The divergence seems to be due to the presence in the case of phantasms of an emotional stimulus lacking in experiments. The probable inference is that most persons are potential agents and percipients, but that some are better than others; with some the faculty is brought into action by the ordinary non-emotional type of experiment with cards or diagrams; with others the faculty will only be aroused by some strong emotion. Differences of age, sex, race, culture, education, seem to have no bearing on the distribution of the faculty.

If, as is generally supposed, telepathic impressions pass first from the agent's conscious to his subliminal mind, then from his subliminal to that of the percipient, and finally emerge from the percipient's subliminal mind to his consciousness, there are three stages at which the impression may become distorted; it is from the distortions observed in experiments where only partial success is obtained that it is possible to form some opinion as to the form in which impressions are transferred. For instance, the difficulty experienced in transmitting unfamiliar names suggests that, whatever form the impressions take, it is not usually that of definite words, still less sentences. Visual images are more easily transmitted, but it would appear that what is usually transmitted is a series of more or less generalized ideas from which the percipient, as each idea floats up into his consciousness, builds a complete impression more or less resembling that which the agent sought to convey.

This inference has an important bearing on the question whether the process of transmission is physical, by some sort of "waves" or "effluence" or purely psychic. All normal modes of communication depend on the existence of some pre-arranged code of sounds, symbols, dots and dashes, etc.; what is the code by which generalized ideas can be transmitted as such, and who arranged it? Those who assume that telepathic transmission is by some kind of "waves" may fairly be asked to be rather more precise about the nature of these waves, their length, etc., and to indicate what organ of the human body is capable of transmitting physical waves to the opposite side of the globe. Why, again. does telepathy appear to be an exception to the general law of the inverse square? There is abundant evidence, both spontaneous and experimental, that it is not affected by distance.

Until these and other questions have been satisfactorily answered, we must provisionally assume that the mode of telepathic transmission is psychic and not physical.

Psychometry and Dowsing.—"Psychometry" is the clumsy name given to supernormal knowledge of the past history or associations of objects handled by the medium. The experiments of Pagenstecher and Walter Prince reported in vols. xv. and xvi. of the Proceedings of the American S.P.R. are, perhaps, the most notable, but much more evidence will have to be obtained before psychometry receives general acceptance.

If "dowsing" (the discovery of underground water by other means than calculation based on geological knowledge) is to be reckoned one of the forms of clairvoyance, it is the best attested of them all. It is the only branch of psychical research which has yet established itself in the world of practical commercial utility. Government departments, business firms and landowners in many countries regard the employment of a dowser as an every day matter. Dowsing has a long history; it was formerly used to find other things hidden underground besides water, metals for instance, and even dead bodies *(see* Barrett and Besterman, *The Divining Rod,* 1926); and Barrett, who had made the subject a special study for many years, maintained the view that the faculty of dowsing was purely psychic, and did not depend on any electrical current or other physical nexus between the dowser and the invisible water supply. Certain German investigators, on the other hand, consider that they have established that the dowser is influenced by electricity.

Dowsers habitually, though not always, hold a forked twig, which twists in their hands when they approach underground water; the movements of the twig are, it is generally agreed, "automatic," *i.e.,* due to unconscious muscular action stimulated by the impression sub-consciously received by the dowser

Precognition. — The bulk of alleged instances of supernormal knowledge of future events will be considerably reduced if we discard: (1) "Prophecies made after the event," or so vague that they are only recognized as prophecies after the event; in no branch of psychical research are authentic contemporary records and corroborative testimony so necessary, and in none are they usually so lacking; (2) "Prophecies that bring their own fulfilment"; or the fulfilment of which rests wholly with the prophet; under this head were many of the cases where persons have accurately foretold a future illness, the fulfilment following by auto-suggestion; in some cases where a person has predicted his own death by accident, the cause of death has, on more careful investigation, been found to be suicide. (3) Intelligent anticipation based on normal knowledge. The last class shades off imperceptibly into the class of apparent true precognition. The knowledge may be normal, *i.e.,* acquired through the ordinary channels of sense, but not conscious. For instance, a quarry-owner who, however, had little expert knowledge of quarrying, shortly after visiting a quarry where everything seemed going well, was so impressed by a sense of danger that he sent a telegram to the manager instructing him to remove the men at work in a particular part of the quarry. The manager, who had not, while the owner was visiting the quarry, seen any ground for alarm, acted on the telegram. An hour later the whole face of the rock fell in. Did the owner's comparatively inexpert eye note and pass on to his subconscious mind something dangerous in the state of the rock, which the manager's expert eye had failed to detect, and did this idea lurking in his subconscious mind force its way later into consciousness, or was this a true case of precognition? *(See* S.P.R. *Proc.,* vol. xxxiii., p. 119.) This ambiguous type is not infrequent.

The outbreak of the World War set a large part of the public in all countries hunting up old prophecies to see whether any of them fitted, and some were found to fit quite well after they had received a little judicious alteration. (For a parallel in ancient times *see* Thucydides, ii. 54 on the oracle supposed to have foretold the plague at Athens.) Many of the prophecies were, however, bad misfits; a well-known medium, whose supernormal powers are undoubted, had several years before the war predicted that in the next war England and America would be leagued against France and Russia, with Germany neutral!

The "Forecasts in Scripts concerning the War," published in vol. xxxiii. of S.P.R. *Proceedings,* derive their interest not so much from the fact that they foretold the war for several years before it occurred (many persons made similar forecasts by the ordinary processes of reasoning) or that they foretold a few particular incidents of the war, *e.g.,* the sinking of the "Lusitania" (which may have been due to chance-coincidence), but from the fact that the forecasts were distributed piecemeal among several automatic writers, each ignorant of the others' scripts, so that they could only be understood by putting all the scripts together; they formed, in fact, a very complicated "cross-correspondence" (*see* p. 672). The scripts were not confined to forecasting the war; they also foretold certain developments of human affairs not to this date realized: at any rate no one can say rhey are "prophecies made after the event."

Perhaps, however, the case for precognition is strongest where the things foretold are in themselves most trivial, and farthest removed from the probability of normal inference. Instances can be found in any book dealing with "mental" phenomena. The chapter on premonitions in Richet's *Traite' de Me'tapsychique* is instructive not only for the cases quoted by the author, but for the excellent analysis and classification.

Precognition, if it is a genuine phenomenon, does not fit very easily into any theoretic scheme based on the more generally accepted phenomena, such as telepathy. Some people, however, seem to find modern ideas as to a "space-time complex" of assistance in enabling them to accept precognition. Dunne's *An Experiment with Time* is interesting on the theoretical side.

The Evidence for Survival. — Recent discussions in the daily press suggest that most persons make up their minds on the issue of survival without considering the evidence furnished by psychical research; for them the question is finally settled one way or the other by revealed religion or the dogmas of physiology. The psychical researcher must, however, politely but firmly insist that any judgment is premature which ignores the mass of well-attested relevant facts that he has accumulated. He will, of course, base his claim only on such phenomena as are above suspicion of fraud, the mental phenomena in particular, and will candidly admit that these are difficult of interpretation. To meet the objections of *à priori* materialism, he will have to put the case for telepathy as a non-material process, and will at once be answered that, unless he can put some definite limits to the operation of telepathy between living persons, he has proved too much and left nothing further to be explained.

The issue, therefore, is whether there are any mental phenomena, ostensibly spiritistic, which cannot be accounted for by telepathy between the living; and the answer depends, largely but not entirely, on whether telepathy be accepted in its widest conceivable form, a sort of universal subconscious leakage, or whether it is to be confined within the limits, vague as they may be, of the spontaneous and experimental evidence, with a reasonable margin over. Telepathy between the living must not be assigned *ad hoc* a wider field than mould be conceded if the ostensibly spiritistic phenomena had not *got* to be accounted for.

Communications Through Trance-mediums. — Several trance-mediums, whose *bona fides,* after prolonged investigation by critical sitters is generally accepted, have made correct statements of verifiable facts which, humanly speaking, were quite outside their normal knowledge, and these statements purport to have been communicated to the medium (through the "control") by discarnate intelligences. Among such mediums may be mentioned Mrs. Piper, Mrs. Thompson and Mrs. Leonard.

The verifiable matter is sometimes mixed up with quite non-evidential utterances, moral platitudes, descriptions of a future state, etc. A large proportion of "padding" is a sign of an incompetent sitter; good sitters are not seriously afflicted with it. In any case the presence of the "padding" does not depreciate the value of the evidential matter, of which there is sufficient on record in the *Proceedings* of the S.P.R. to satisfy the most diligent student. This may relate to facts present to the sitter's conscious mind; or facts once known by him and since forgotten; or facts never known to him, but known to persons with whom he is in close touch; or facts which can only be verified by enquiry among persons with whom neither he nor the medium has any close connection. At each stage telepathy between the living can be put forward as a possible explanation, but at each stage with diminishing plausibility, until at the last stage nothing will serve but the hypothesis of universal leakage, which is unsupported by any evidence. For a case which raises this problem in an instructive way *see* S. G. Soal's paper, S P.R. *Proceedings,* vol. xxxv.

"Personal Control." — But there may be more than communications of fact. The "control" may recede and allow the "communicator" to address the sitter direct. Sitters who have experienced this declare that the characteristic turns of speech and habits of mind of persons whom the medium never knew are reproduced in a startlingly lifelike way. Granted that the subconscious mind has a flair for dramatising whatever comes its way, including knowledge gained telepathically from the sitter, will this enable the medium to build up a recognizable personality complete in everything but corporeal appearance? The affirmative is argued by T. W. Mitchell (*Hibbert Journal,* Jan. 1928), but he has not, so far, succeeded in convincing those who have had experience of "personal control" at its best,

Cross-correspondences. — It was on the phenomena of trance-mediumship that Myers mainly based his argument for human survival in the work on which he was still engaged at his death in 1901 (*Human Personality and its Survival of Bodily Death*). Since then, however, a new type of phenomenon has arisen, which it is even more difficult to fit into any theory of telepathy between the living than "personal control," namely "cross-correspondences" in automatic writing. Neither the faculty of automatic writing nor much of the content of automatic scripts can claim to be supernormal. In the case, however, of a particular group of automatists (all persons whose good faith is above suspicion) it was observed that the same phrases occurred in the scripts of different automatists with a frequency not to be explained by chance-coincidence. As the scripts continued (and they have now gone on for more than 25 years), a further development was noticed: Automatist A would write a phrase X, Automatist B a phrase Y; there was no apparent connection between X and Y, but automatist C would write a phrase Z which connected X and Y and gave a coherent meaaing to the three phrases. That, in bold outline, is what is meant by a "complementary cross-correspondence," of which numerous examples are to be found in S.P.R. *Proceedings* from 1906 onwards. The importance of them is that they seem to indicate a *design* originating outside the group. In point of fact, they purport to originate with the surviving intelligence of Myers. Claims of this kind need not always be accepted at their face value; in judging, however, the validity of this claim, it must be noted that the cross-correspondences began shortly after Myers' death, that they seem to supply a defect in the evidence existing at his death of which he was fully conscious, and that their literary content is very characteristic of him.

Cross-correspondences are a difficult study. They present a tangle of quotations from authors, ancient and modern. In this maze which the plain man of ordinary literary tastes is apt to wonder whether the alleged orderly arrangement exists outside the subtle imaginations of the annotators. The sceptic of literary training will admit the orderly arrangement, but will say that it is due to telepathic influence from some living person, possibly one of the automatists.

But the automatists may fairly be acquitted. It is not suggested that any one of them was a deliberate or conscious agent, and there is no evidence which would support the view that an elaborate design could be first subconsciously formulated and then subconsciously transmitted. Moreover, practically all the original members of the group have dropped out, for death or other reasons, and still the cross-correspondences pour out with no important change of type, just as if the original group had not been replaced by a new one.

Looking, then, outside the group, we may ask, who is this remarkable person who has for 25 years been transmitting ideas to a round dozen of automatists with a success unrivalled in the history of experimental telepathy, and who still remains mute, inglorious and incognito? Unless we are prepared to accept indefinitely a verdict of telepathy by some person or persons unknown, we may have to take seriously the claims of the scripts to be inspired by Myers.

The only case in which there is any evidence for telepathy from a living person influencing cross-correspondence is the "Sevens Case" (S.P.R. *Proceedings,* vol. xxv.). But in that case, if telepathy from the living is to be involved at all, we must suppose that the subconscious minds of *two* living persons conspired to produce a design not in the conscious intention of either.

The question of design is raised in a slightly different form in the literary puzzles produced by one member of the S.P.R. group. The most interesting of these is *The Ear of Dionysius,* reported in S.P.R. *Proceedings,* vol. xxix. Readers who find the cross-correspondence too complex and tedious are recommended to study this case.

"Inspirational" Literature — When William Blake claimed to have written poems "from immediate dictation" of his "friends in Eternity," "without premeditation and even against my will" (letter April 25, 1803), was he merely mistaking the efforts of his more or less dissociated subliminal mind for the promptings of discarnate intelligences? That the sublirpinal mind can produce poetry of the highest order is shown by *Kubla Khan,* and Blake was at least as much a poet born and bred as Coleridge. For a test of external inspiration we must look for literature of a high order produced by someone not so permeated through and through by imagination as Blake. We naturally cannot expect to find work of the same quality as Blake's, but coming a little down in the scale we may find cases of work of considerable merit, purporting to be inspired by discarnate intelligences and produced by persons who, in their ordinary life, are entirely commonplace. A striking example is *The Case of Patience Worth,* examined by W. F. Prince (Boston S.P.R., 1927). Until the age of 23, Mrs. Curran had no literary tastes and was mainly interested in outdoor pursuits; she then began to write novels and *vers libres* purporting to be inspired by "Patience Worth," who said she was a settler in New England in the 17th century. The writings show a power of vivid expression and a historical knowledge which those who know Mrs. Curran well declare to be altogether beyond her normal capacity. Prince's conclusion is: "Either our concept of what we call the subconscious must be radically altered, so as to include potencies of which we hitherto have had no knowledge, or else some cause operating through but not originating in the subconsciousness of Mrs. Curran, must be acknowledged."

BIBLIOGRAPHY.—(1) Books: The "classics" of psychical research in the English language are undoubtedly *Phantasms of the Living* and *Human Personality and its Survival of Bodily Death,* both already mentioned. Abridged editions of both have been published. Next in importance come Podmore's books, especially *Modern Spiritualism, a History and a Criticism* (1902). Other important books dealing comprehensively with psychical research are Richet, *Traité de Métapsychique* (1922) (Eng. trans., *Thirty Years of Psychical Research),* and *Der Okkultismus in Urkunden,* edited by Max Dessoir (1925). This book is in two parts, dealing with physical and mental phenomena respectively, and is highly critical both of physical phenomena, and of the evidence for survival. The battle as to physical phenomena rages furiously in Germany, the positive side being ably upheld by Schrenck Notzing, *Materializations Phiinomene* (1914), (Eng. trans. 1920); *Experimente dev Firnbewegung* (1924), etc. For a good short discussion of the evidence for survival *see* Whately Smith's *The Foundations of Spiritualism.* (1920). *See* also separate articles MEDIUM, SPIRITUALISM.

(2) Periodicals: The *Proceedings* of the S.P R, are of first importance; much of the evidence regarding trance-mediumship, cross-correspondences,etc., is not to be found elsewhere. The publications of the American S.P.R. until the recent "split," and since then of the Boston S.P.R. are also important. Of Continental periodicals, *Zeitschrift fur Parapsychologie* and Z. *f. Kritischen Okkultismus* (the latter recently discontinued) may be mentioned. (W. H. SA.)

PSYCHOANALYSIS: FREUDIAN SCHOOL. In the years 1880–82 a Viennese physician, Dr. Josef Breuer (1842–1925), discovered a new procedure by means of which he relieved a girl, who was suffering from severe hysteria, of her various symptoms. The idea occurred to him that the symptoms were connected with impressions which she had received during a period of excitement while she was nursing her sick father. He therefore induced her, while she was in a state of hypnotic somnambulism, to search for these connections in her memory and to live through the "pathogenic" scenes once again without inhibiting the effects that arose in the process. He found that when she had done this the symptoms in question disappeared for good.

This was at a date before the investigations of Charcot and Pierre Janet into the origin of hysterical symptoms, and Breuer's discovery was thus entirely uninfluenced by them. But he did not pursue the matter any further at the time, and it was not until some 10 years later that he took it up again in collaboration with Sigmund Freud. In 1895 they published a book, Studien *über* Hysterie, in which Breuer's discoveries were described and an attempt was made to explain them by the theory of *Catharsis*. According to that hypothesis, hysterical symptoms originate through the energy of a mental process being withheld from conscious influence and being diverted into bodily innervation ("Con*version*"). A hysterical symptom would thus be a substitute for an omitted mental act and a reminiscence of the occasion which should have given rise to that act. And, on this view, recovery would be a result of the liberation of the affect that had gone astray and of its discharge along a normal path ("Abreaction"), Cathartic treatment gave excellent therapeutic results, but it was found that they were not permanent and that they were dependent on the personal relation between the patient and the physician. Freud, who later proceeded with these investigations by himself, made an alteration in their technique, by replacing hypnosis by the method of free association. He invented the term "psycho*analysis*," which in the course of time came to have two meanings: (1) a particular method of treating nervous disorders and (2) the science of unconscious mental processes, which has also been appropriately described as "depth-psychology."

Subject Matter of Psychoanalysis. — Psychoanalysis finds a constantly increasing amount of support as a therapeutic procedure, owing to the fact that it can do more for certain classes of patients than any other method of treatment. The principal field of its application is in the milder neuroses — hysteria, phobias and obsessional states, but in malformations of charactet and in sexual inhibitions or abnormalities it can also bring about marked improvements or even recoveries. Its influence upon dementia praecox and paranoia is doubtful; on the other hand, in favourable circumstances it can cope with depressive states, even if they are of a severe type.

In every instance the treatment makes heavy claims upon both the physician and the patient: the former requires a special training, and must devote a long period of time to exploring the mind of each patient, while the latter must make considerable sacrifices, both material and mental. Nevertheless, all the trouble involved is as a rule rewarded by the results. Psychoanalysis does not act as a convenient panacea ("cito, tute, jucunde") upon all psychological disorders. On the contrary, its application has been instrumental in making clear for the first time the difficulties and limitations in the treatment of such affections.

The therapeutic results of psychoanalysis depend upon the replacement of unconscious mental acts by conscious ones and are Qperative in so far as that process has significance in relation to the disorder under treatment. The replacement is effected by overcoming internal resistances in the patient's mind. The future will probably attribute far greater importance to psychoanalysis as the science of the unconscious than as a therapeutic procedure.

Depth-Psychology. — Psychoanalysis, in its character of depth-psychology, considers mental life from three points of view: the dynamic, the economic and the topographical.

From the first of these standpoints, the dynamic one, psychoanalysis derives all mental processes (apart from the reception of external stimuli) from the interplay of forces, which assist or inhibit one another, combine with one another, enter into compromises with one another, etc. All of these forces are originally in the nature of instincts; that is to say, they have an organic origin. They are characterised by possessing an immense (somatic) persistence and reserve of power ("repetition-compulsion"); and they are represented mentally as images or ideas with an affective charge ("*cathexis*"). In psychoanalysis, no less than in other sciences, the theory of instincts is an obscure subject. An empirical analysis leads to the formation of two groups of instincts: the so-called "ego-instincts," which are directed towards self-preservation and the "object-instincts," which are concerned with relations to an external object. The social instincts are not regarded as elementary or irreducible. Theoretical speculation leads to the suspicion that there are two fundamental instincts which lie concealed behind the manifest ego-instincts and object-instincts: namely (a) Eros, the instinct which strives for ever closer union, and *(b)* the instinct for destruction, which leads toward the dissolution of what is living. In psychoanalysis the manifestation of the force of Eros is given the name "libido."

Pleasure-Pain Principle. — From the economic standpoint psychoanalysis supposes that the mental representations of the instincts have a cathexis of definite quantities of energy, and that it is the purpose of the mental apparatus to hinder any damming-up of these energies and to keep as low as possible the total amount of the excitations to which it is subject. The course of mental processes is automatically regulated by the "pleasure-pain *principle*"; and pain is thus in some way related to an increase of excitation and pleasure to a decrease. In the course of development the original pleasure principle undergoes a modification with reference to the external world, giving place to the "reality-principle," whereby the mental apparatus learns to postpone the pleasure of satisfaction and to tolerate temporarily feelings of pain.

Mental Topography. — Topographically, psychoanalysis regards the mental apparatus as a composite instrament, and endeavours to determine at what points in it the various mental processes take place. According to the most recent psychoanalytic views, the mental apparatus is composed of an "id," which is the reservoir of the instinctive impulses, of an "ego," which is the most superficial portion of the id and one which is modified by the influence of the external world, and of a "*super-ego*," which develops out of the id, dominates the ego and represents the inhibitions of instinct characteristic of man. Further, the property of consciousness has a topographical reference; for processes in the id are entirely unconscious, while consciousness is the function of the ego's outermost layer, which is concerned with the perception of the external world.

At this point two observations may be in place. It must not be supposed that these very general ideas are presuppositions upon which the work of psychoanalysis depends. On the contrary, they are its latest conclusions and are in every respect open to revision. Psychoanalysis is founded securely upon the observation of the facts of mental life; and for that very reason its theoretical superstructure is still incomplete and subject to constant alteration. Secondly, there is no reason for astonishment that psychoanalysis, which was originally no more than an attempt at explaining pathological mental phenomena, should have developed into a psychology of normal mental life. The justification for this arose with the discovery that the dreams and mistakes ("*parapraxes*," such as slips of the tongue, etc.) of normal men have the same mechanism as neurotic symptoms.

Theoretical Basis. — The first task of psychoanalysis was the elucidation of nervous disorders. The analytical theory of the neuroses is based upon three ground-pillars: the recognition of (1) "*repression*," (2) the importance of the sexual instincts and (3) "transference."

Censorship. — There is a force in the mind which exercises the functions of a censorship, and which excludes from consciousness and from any influence upon action all tendencies which displease it. Such tendencies are described as "repressed." They remain unconscious; and if the physician attempts to bring them into the patient's consciousness he provokes a "resistance." These repressed instinctual impulses, however, are not always made powerless by this process. In many cases they succeed in making their influence felt by circuitous paths, and the indirect or substitutive gratification of repressed impulses is what constitutes neurotic symptoms.

Sexual Instincts. — For cultural reasons the most intensive repression falls upon the sexual instincts; but it is precisely in connection with them that repression mast easily miscarries, so that neurotic symptoms are found to be substitutive gratifications of repressed sexuality. The belief that in man sexual life begins only at puberty is incorrect. On the contrary, signs of it can be detected from the beginning of extra-uterine existence; it teaches a first culminating point at or before the fifth year ("early period"), after which it is inhibited or interrupted ("latency period") until the age of puberty, which is the second climax of its development. This double onset of sexual development seems to be distinctive of the genus Homo. All experiences during the first period of childhood are of the greatest importance to the individual, and in combination with his inherited sexual constitution, form the dispositions for the subsequent development of character or disease. It is a mistaken belief that sexuality coincides with "genitality." The sexual instincts pass through a complicated course of development, and it is only at the end of it that the "primacy of the genital zone" is attained. Before this there are a number of "pre-genital organisations" of the libido—points at which it may become "fixated" and to which, in the event of subsequent repression, it will return ("regression"). The infantile fixations of the libido are what determine the form of neurosis which sets in later. Thus the neuroses are to be regarded as inhibitions in the development of the libido.

The Oedipus Complex.—There are no specific causes of nervous disorders; the question whether a conflict finds a healthy solution or leads to a neurotic inhibition of function depends upon quantitative considerations, that is, upon the relative strength of the forces concerned. The most important conflict with which a small child is faced is his relation to his parents, the "Oedipus complex"; it is in attempting to grapple with this problem that persons destined to suffer from a neurosis habitually fail. The reactions against the instinctual demands of the Oedipus complex are the source of the most precious and socially important achievements of the human mind; and this probably holds true not only in the life of individuals but also in the history of the human species as a whole. The super-ego, the moral factor which dominates the ego, also has its origin in the process of overcoming the Oedipus complex.

Transference.—By "transference" is meant a striking peculiarity of neurotics. They develop toward their physician emotional relations, both of an affectionate and hostile character, which are not based upon the actual situation but are derived from their relations toward their parents (the Oedipus complex). Transference is a proof of the fact that adults have not overcome their former childish dependence; it coincides with the force which has been named "suggestion"; and it is only by learning to make use of it that the physician is enabled to induce the patient to overcome his internal resistances and do away with his repressions. Thus psychoanalytic treatment acts as a second education of the adult, as a correction to his education as a child.

Within this narrow compass it has not been possible to mention many matters of the greatest interest, such as the "sublimation" of instincts, the part played by symbolism, the problem of "ambivalence," etc. Nor has there been space to allude to the applications of psychoanalysis, which originated, as we have seen, in the sphere of medicine, to other departments of knowledge (such as anthropology, the study of religion, literary history and education) where its influence is constantly increasing. It is enough to say that psychoanalysis, in its character of the psychology of the deepest, unconscious mental acts, promises to become the link between psychiatry and all of these other fields of study.

The Psychoanalytic Movement.—The beginnings of psychoanalysis may be marked by two dates: 1895, which saw the publication of Breuer and Freud's Studien iiber *Hysterie,* and 1900, which saw that of Freud's Traumdeutung. At first the new discoveries aroused no interest either in the medical profession or among the general public. In 1907 the Swiss psychiatrists, under the leadership of E. Bleuler and C. G. Jung, began to concern themselves in the subject; and in 1908 there took place at Salzburg a first meeting of adherents from a number of different countries. In 1909 Freud and Jung were invited to America by G. Stanley Hall to deliver a series of lectures on psychoanalysis at Clark University, Worcester, Mass. From that time forward interest in Europe grew rapidly; it showed itself, however, in a forcible rejection of the new teachings, characterised by an emotional colouring which sometimes bordered upon the unscientific.

The reasons for this hostility are to be found, from the medical point of view, in the fact that psychoanalysis lays stress upon psychical factors, and from the philosophical point of view, in its assuming as an underlying postulate the concept of unconscious mental activity; but the strongest reason was undoubtedly the general disinclination of mankind to concede to the factor of sexuality such importance as is assigned to it by psychoanalysis. In spite of this widespread opposition, however, the movement in favour of psychoanalysis was not to be checked. Its adherents formed themselves into an International Association, which passed successfully through the ordeal of the World War, and at the present time comprises local groups in Vienna, Berlin, Budapest, London, Switzerland, Holland, Moscow and Calcutta, as well as two in the United States. There are three journals representing the views of these societies: the *Internationale Zeitschrift* fur Psychoanalyse, *Imago* (which is concerned with the application of psychoanalysis to non-medical fields of knowledge), and the *International* Journal of Psycfto-Analysis.

During the years 1911–13 two former adherents, Alfred Adler, of Vienna, and C. G. Jung, of Zürich, seceded from the psychoanalytic movement and founded schools of thought of their own. In 1921 Dr. M. Eitingon founded in Berlin the first public psychoanalytic clinic and training school, and this was soon followed by a second in Vienna. (See ABNORMAL PSYCHOLOGY.)

BIBLIOGRAPHY.—Breuer and Freud, *Studien iiber Hysterie* (1895); Freud, *Traumdeutung* (1900), *Zur Psychopathologie des Alltagslebens* (1904), *Drei Abhandlungen zur Sexualtheorie* (1905); *Vorlesungen zur Einfuhrung in die Psychoanalyse (1916)*. Freud's complete works have been published in Spanish (*Obras completas*) (1924), and German (*Gesammelte Schriften*) (1925); the greater part of them has been translated into English and other languages. Short accounts of the subject-matter and history of psychoanalysis will be found in: Freud, *Ueber Psychoanalyse* (the lectures delivered at Worcester, U.S.A.) (1909); *Zur Geschichte der psychoanalytischen Bewegung* (1914); *Selbstdarstellung* (in Grote's collection *Die Medizin der Gegenwart*) (1925). Particularly accessible to English readers are: *A. A.* Brill, *Psycho-Analysis (1922)*; E. Jones, *Papers on Psycho-Analysis* (1923); S. Ferenczi, *Theory and Technique of Psychoanalysis (1927)*. (S. FR.)

PSYCHOGALVANIC REFLEX. The term psychogalvanic reflex (P.G.R.) was first used by Veraguth to describe the change in electrical properties of the human body (or any living animal body) in response to nocuous (emotional) stimuli. The terms *galvanic* skin *reflex,* skin constrictor reflex and sweat *secretion reflex* have been used synonymously. This reflex is usually demonstrated in one of two ways. (a) Electrodes connect the hands directly to a galvanometer. When the subject is stimulated by a pin prick, threat of injury, etc., the galvanometer, after a latent period of about two seconds, will show a deflection indicating an increased output of electromotive force from the human body. This rises to a maximum within 2 to 10 seconds and subsides in about the same time. (b) The human subject forms the fourth arm of a balanced Wheatstone bridge electrical circuit. On stimulation the galvanometer will deflect as described above. In this case, the deflection indicates a decrease and increase in apparent ohmic resistance of the body.

This phenomenon was first described by Vigouroux (1879). It remained, however, for Veraguth (1909) to draw the attention of a large scientific audience to the psychogalvanic reflex. The physics of the "reflex" is still a matter of dispute. According to Gildemeister it is due to a change in conductivity of the human body which is dependent upon polarization of the membranes of the cells of the skin, so changing the cellular permeability to different ions. The anatomical control of the psychogalvanic reflex has been shown to lie in the sympathetic nervous fibres which lead to the smooth musculature of the walls of sweat glands and capillaries. Any stimulus resulting in activity of the sympathetic division of the autonomic nervous system will consequently result in changes in tonicity of the involuntary musculature of the skin surfaces of the body which are shown by the secretion of sweat, changes in circulation, local skin temperature, etc. This combined action leads in turn to variations in electrical conductivity (psychogalvanic reflex).

Psychologists have, for the past twenty years, been interested in this phenomenon, particularly following the suggestion of Binswanger (1907) that only emotional stimuli elicit the reflex. This view has been held by many subsequent investigators. The work of Radecki (1911) and more recently of Aveling questions the validity of this assumption. It is probable that the psychogalvanic Reflex is elicited most frequently by nocuous stimuli, but that it is not specific to "emotional" situations.

The reflex has found application in many fields of research, Otologists have used it to detect the feigning of deafness in dubious cases. Psychoanalysts have used the phenomenon together with word association tests as a means of discovering hidden complexes. Many investigators have made use of the Psychogalvanic Reflex for the demonstration of individual differences in emotionality. There seems to be fairly good evidence that such differences may be established in this fashion. Psychiatrists have made use of the reflex in differential diagnosis of organic and functional orders. Attempts toward the practical application of the reflex as an indicator of emotional stability of men who were applying for positions in hazardous occupations have not met any great success.

BIBLIOGRAPHY.—Veraguth, *Das Psychogalvanischer Reflex-phänomenon* (1909); Wechsler, *The measurement of emotional reactions* (Archives of Psychology No. 76, 1925); Landis and De Wick, "Electrical Phenomena of the Skin" (*Psychological Bulletin*, 1929). (C. LA.)

PSYCHOLOGICAL ARTICLES. The section of psychology is in some points closely bound up with philosophy. The outstanding psychological articles in the present edition are—ABNORMAL PSYCHOLOGY; APPLIED PSYCHOLOGY; EXPERIMENTAL PSYCHOLOGY; FEELING, PSYCHOLOGY OF; INDUSTRIAL PSYCHOLOGY; INSTINCT IN MAN; PHENOMENOLOGY; PSYCHICAL RESEARCH; PSYCHOANALYSIS; PSYCHOLOGY; PSYCHOLOGY, HISTORY OF, and WILL.

PSYCHOLOGISM, in philosophy, is the view that problems of epistemology, that is, problems relating to the validity of human knowledge, can be solved satisfactorily by the psychological study of the development of mental processes. Locke's *Essay on the Human Understanding* may be regarded as the classic of psychologism in this sense. A more moderate form of psychologism only maintains that psychology should be made the basis of other studies, especially of logic.

PSYCHOLOGY is the study of the mind, or of "mental phenomena," or of the higher functions of beings "endowed with mind." The last definition emphasizes the fact that ordinarily the term is restricted to the study of mental functions connected with living organisms.

Though psychological studies may be said to have begun with the *De Anima* of Aristotle they were merged in what would now be regarded as purely biological questions. An absolute separation of the two sciences only came about through the general acceptance among scientists, twenty centuries later, of the Cartesian Dualism.

A sharp distinction was drawn between matter and mind, as radically different substances with mutually incompatible attributes; psychology became then the science of mind and biology was assimilated to the group of studies concerned with material things. With this ontological dualism, a dualism of method was combined. To the study of mind was allowed a special source of information—"introspection"—the use of distinctive concepts, and explanation by reference to ends. On the other side of the chasm a rigid discipline was established. In the material sciences, facts are only admitted when guaranteed by common observation (in contrast to the alleged privacy of introspection), descriptions must be couched in purely physical terms, and the phenomena must be given a physico-chemical or "mechanistic" explanation. From the success of this discipline there has come about the general leftward trend of the sciences; chemistry is reduced to physics, biology to chemistry, and psychology has tended to play the part of the poor relation to the natural sciences.

The culmination of this movement in the twentieth century has taken the form of an attempt to establish a purely "objective" psychology—a science of the higher functions of an organism physically conceived. Since, then, both in its origin and in one of its latest developments, the postulate of a distinctive mental substance has been absent it is undesirable to embalm in the definition of psychology any reference to "the mind." To begin with, the conception of "vital functions" will cover the relevant facts. Further enquiry will show which of these may be regarded as of distinctively "mental" nature.

The wider field has come to be embraced in the psychologist's sphere of investigation in the course of a tendency to retreat psychological problems only as part of another science which might be better described as general psycho-physics. Originally, this latter term applied only to the study of certain relations obtaining between sensations and their physical stimuli. The term, however, admits of application, with equal propriety, to the study of all the inter-relations between psychical phenomena, on the one hand, and their physical and physiological antecedents, concomitants and consequents, on the other. Whatever further relations may be involved there is certainly an extensive parallelism between mental process and certain kinds of physical process. Sensations are generally paralleled by certain modes of stimulation, and probably quite invariably by certain cerebral processes. Similarly pleasure, desire and aversion correspond to certain cerebral conditions and have their outward manifestations. One consequence of this parallelism is that almost every mental state has an obvious "behaviouristic" equivalent; and where direct introspective evidence is uncertain it is natural to seek for information from the external manifestations. But the facts of behaviour admit of independent systematization from the objective point of view, and terms originally applied to the mental state come to be used for the connected bodily process in relative isolation. Sensation comes to stand simply for receptivity, perception is identified with the behaviour which constitutes its external criterion, desire means restlessness of a certain kind, and purpose is defined in terms of the behaviour by which it is expressed. In this way there has arisen a systematic duplication of the meanings of psychological terms. So far has this tendency gone that a complete presentation of contemporary psychology must involve a corresponding duplication in exposition—an account of mental process in itself, and an account of the correlative bodily life from an external point of view. In what follows we shall explore first the possibilities in the purely objective standpoint, but the reader may proceed at once to the exposition from the traditional point of view which opens in the section on *Psychology* as *the Science of Individual Experience.*

THE OBJECTIVE APPROACH

Introduction.—Among the objects presented by nature for our contemplation are living things endowed with powers which call for explanation. Vital functions, externally observed, consist primarily in movements. Movements, then, constitute our data; and so far psychology would conform to the traditional dynamical scheme of the natural sciences as a whole. The activities with which we are concerned can be arranged in hierarchical order, the lowest being found in all, even the simplest forms of life; the highest, only in beings of a very elaborate type. Nowadays, the distinction between the higher and lower functions would receive an evolutionary interpretation, but the older, Aristotelian, way of defining it has also important implications: the lower, whilst presupposed by the higher, may occur in independence. Among the former are the processes of metabolism which result in self-conservation and growth, by reference to which the animate is defined. The cycles of self-conservation are repeated in movements of a higher order, in the grosser movements of a body supplied with organs and limbs. In the higher organism we find complex forms of behaviour involving a sensitive and discriminating responsiveness to stimuli and more highly organized movements which, whilst maintaining a general self-conserving tendency, appear as the intelligent pursuit of widely differentiated ends. The hierarchy appears to be continuous, but whilst the lower functions fall clearly within the province of biology, the higher are more particularly what interest the student of psychology. Rigid demarcations are out of the question. The most that can be said from this point of view is that the psychologist commences higher up the scale, whilst the biologist is working down to foundations. The psychologist follows on a higher level, or perhaps he starts with the biological data most explored, and works in the other direction, linking up the line of explanation to the facts of those who are working higher still. Such is the programme from the objective point of view.

Reflex Action— The familiar observation that movements are often the outcome of stimulation suggests a generalization whereby these grosser movements of the body can be viewed in an orderly way. If movements are universally the result of stimulation the vertebrate organism can be treated as simply a jointed frame actuated by muscles which respond to various forces which play upon sensitive areas of the body, the link consisting in some conductive process. Stimulation starts the process, releasing potential energy expended in movements which directly or indirectly are the means of restoring the balance of energy so expended. This is self-conservation at a higher level.

The abstract unit of this secondary type of self-conserving system is the response to stimulation, based on a structural counterpart — the simple reflex arc. Three essential components are here involved, a specific receptive organ, a conductive neural bond, and a responsive muscle or gland. Receptor, Conductor and Effector are thus invariably to be sought in the interpretation of conduct. The receptors, which in their higher elaborations constitute the sense organs, are primarily specialised structures with delicately selective sensitivity to certain forms of stimulation. As contrasted with the generalized responsiveness of undifferentiated protoplasm each type of receptor has a "lowered threshold" to some specific "adequate" stimulus, such as heat, light or sound. The conductive filaments consist of chains of elongated neurones periodically interrupted by points of junction, the highly important "synapses" through which the receptor not only gains communication with its "own" effector, but also becomes functionally integrated in the system as a whole. The process terminates in contractile or secretory organs, stimulation thus evoking two distinctive modes of response — movements proper and glandular activities. The latter is an important element in emotional excitement. The two reactions are neither independent nor mutually exclusive. They are quite frequently combined. Earlier studies of reflex action led to an over-emphasis of the fixity and the inevitable character of the response, but neither feature would seem to be invariable or of fundamental importance. The total organization is of an extremely labile constitution, adaptable in the extreme and subject to various forms of inhibition and control. "Volitional" so far from being opposed to reflex action emerges from it by progressive integration.

To trace the steps of this elaboration we must commence with a modification of the foregoing abstract scheme The unit reflex arc is an undue simplification. In no developed organism do we find a single receptor linked with only one effector. Every receptor has a path to various effectors, every effector is at the behest of many receptors, the system so comprising a network of converging and diverging arcs. In this way the effects of a simple stimulus may irradiate a group of effectors producing extremely complex movements. These movements, in their turn, or their external effects, may provide the adequate stimulus for a further series of reactions. Thereby complex co-ordinated movements (simultaneous or successive) are secured, the orderly arrangement of which is further guaranteed by a system of inhibitions. A dominant reflex being evoked, all reactions of an antagonistic nature are automatically prevented from occurring.

The guiding principle of the reflex thus directly explains the more uniform and the more mechanical functions, simple "involuntary" actions such as blinking, sneezing, and withdrawing the limbs from harmful stimuli. Such rhythmic functions as breathing and orderly series of movements in processes such as swallowing all fall easily under the general scheme. Many constituent acts in locomotion and in instinctive behaviour are similarly explained. But as yet no clear light is thrown on many important features of animal behaviour. All is exceedingly wooden. We may test the theory in more detail by inquiring into four such characteristics as variability, apparent spontaneity, educability and intelligence.

Variability. — Clearly the conduct of an organism is far from comparable to the antics of a mechanical doll. Even the best established reflex has its refractory phase and is subject to inhibition. variability takes several forms. A stimulus repeated may fail to elicit any overt response at all, different responses may be called out at different times, and the same response may be provoked in various ways and in greatly varying degrees. The organization by which a receptor may distribute the Outcome of stimulation among many diverging tracts, and by which impulses separate in origin may converge upon a final common path to some effector, provides a structural basis for such variability. The problem, however, is far from being merely structural, nor are the prevailing paths of conduction, and their variations. adequately explained by the original distribution of resistance and accidental variation in conductivity, which changes in temperature or nutrition, for example, might produce. The variations in question subserve self-conservation too efficiently to be wholly explained along these lines. They suggest the presence of some specific regulative machinery.

The fact that the uniformities of behaviour are only approximate, and formulated as tendencies, not as invariable laws, suggests that we are only inadequately acquainted with the operative conditions. Generally, responses seem to depend upon multiple stimulation, or upon some receptive "pattern." Were this wholly a matter of the external receptors there would still be unexpected failures of the organism to respond to an apparently adequate stimulus, on account of certain contributory factors being overlooked, or on account of other factors working in an antagonistic sense. But sole dependence on the external receptors is (if real) the exception, not the rule. The majority of movements depend on the co-operation of internal receptive organs inaccessible to direct observation. The dog reacts to food, but only if he is hungry, and "hunger" may for the present be conceived as implying only a certain organic state. The "touchiness" of an organism "out of sorts" is proverbial. Changes in organic state would seem generally to disorganize (or adaptively re-organize) the conditions of collateral internal stimulation upon which our normal conduct depends To these factors must be added the progressive ripening and decay of instincts, involving no doubt concomitant modification of neural structure. The senile cat is unresponsive to things that fill a kitten with delight.

Spontaneity. — If spontaneity be taken to imply absolute independence of causal process, the notion can find no place in a system of thought which aims at explanation. On a less extreme interpretation, it has a certain descriptive value in relation to vital process. The causal relations between a self-conserving system and its environment are essentially reciprocal and cyclical in nature. It is therefore inappropriate to endow either with the priority which the notion of stimulus and response on the one hand, and of absolute spontaneity on the other, inevitably suggest. But the two notions are mutually corrective, The organism reacts to stimuli, but such reactions are frequently conditioned by preparatory adjustments, and themselves consist, as it were, in the search for further stimulation The organism gives as much as it receives, and if it does not receive, it will go out to find. Absence of stimuli is the occasion of exploratory movements, to which the concept of spontaneity would most directly seem to refer. But whilst worthy of emphasis in this sense the notion will serve to justify neither the conception of action from a purely central origin, nor the assumption of an intruding "mind," to supplement on occasion the function of the receptors. For facts which appear to call for such an interpretation the objective psychologist can find a ready explanation, in principle if not in detail. We wake to an alarm, but if the clock has stopped we wake "of our own accord." In this spontaneous awakening internal organic stimuli probably play their part, but even a purely cyclical process of sleeping and waking would explain the facts. Spontaneity here refers to a causal process immanent in the organism. Many apparent cases of this sort, moreover, are probably due to variable factors delaying a response to prior stimulation. The influence of contributory internal stimulations invoked in the case of variability is also relevant here.

Educability. — "Education" may broadly be taken to cover every change in conduct resulting from prior stimulation and response, excluding what is due to native constitution or natural unfolding in accordance with immanent laws. The hard outlines of our original mechanical model, slightly tempered perhaps by the qualifications so far introduced, are further softencd as we study the progressive modifications which our native constitution undergoes. The problem of learning, relating as it does to changes in neural paths, inevitably suggests the very fundamental question how a reflex arc comes to exist at all; for the factors responsible for their modification would seem, in large measure, to be responsible for their original formation. But to discuss this question would take us beyond the purview of the standpoint here adopted. For objective psychology the existence of the primary arcs is usually taken as a datum, and the questions to be raised are: how is a new response produced? and, how is an old response linked to a newer mode of stimulation? We may conveniently consider the latter, and simpler, question first.

A partial account is afforded by the principle of the conditioned reflex. Given an original connection between a stimulus A and a response R, then any other stimulus, say B, which is applied concomitantly with A tends to acquire the capacity to evoke the response R independently of the presence of A. The case is well illustrated by the "salivary reflex." Certain kinds of substance being placed in a dog's mouth (stimulus A) directly provoke a flow of saliva. If concomitantly with this a bell is rung (stimulus B).—the conjunction being repeated many times—the ringing of the bell will provoke the flow of saliva without the presence of the original stimulus. A response so acquired is said to be a conditioned reflex and the novel mode of stimulation a substitute stimulus. Much that is called education may be so explained.

Clearly, however, education covers a much wider range of modification. The principle, at best, would only account for a transference of established modes of behaviour to new situations. Our problem also relates to actual change in behaviour. *Prima facie,* four types of such modification call for explanation.

Firstly, we may note the atrophy or weakening of an old response; secondly, facilitation or the strengthening of an existent response; thirdly, the co-ordination of old responses into new and complex modes of behaviour; and lastly, the intrusion of responses absolutely new.

It is one of the present limitations of the purely objective approach that no complete and satisfactory explanation of any of these forms of modification can be offered apart from teleological considerations or some reference to mind The simplest account, as we shall later see, involves a reference to conation and to the satisfaction experienced in the course of such modification. Apart from this, all that we can do is to enumerate the quite specific conditions under which these modifications occur, and to attempt to describe the facts in purely bodily terms. The difficulties are well illustrated in the more "original" forms of response. Two cases call for consideration. First, any given response may admit of progressive modification until something quite different has emerged. This commonly occurs when partial facilitation is combined with partial atrophy. In learning a new and complex movement certain constituent acts come to be more pronounced whilst others undergo progressive elimination. We can describe the phases of the process quite objectively, but if we inquire why *this* particular movement becomes pronounced whilst *that* progressively disappears we are in general forced to refer to the utility of the change and more particularly to utility *appreciated as such.*

The second case is that in which there is a relatively abrupt intrusion of a novel mode of action, as when, for instance, we learn to manipulate a lock. But by this we are led to the question of practical intelligence.

Intelligence.—Intelligent action would seem the most difficult to reduce to a purely reflex scheme, since it essentially involves a departure from routine. But to this problem, too, objective psychology can offer some relevant contributions. Structural organization in virtue of which the organism becomes increasingly adaptable involves the integration of reflex arcs—and such adaptability is one factor in intelligence. A convenient starting point for analysis is the complex behaviour cycles which are illustrated in instinctive action. But such a cycle differs in important ways from a mere chain reflex. In the latter the unit is the simple reflex and each response to stimulation constitutes at ieast the principal factor provoking the subsequent act. Such systems are found in their greatest purity in purely immanent processes where the internal resources of the organism supply all that is necessary for the cycle to be performed. Where intercourse with the external environment is involved, variability will arise, except where the needed cues are always ready to hand. In locomotion, for instance, there is the ground to walk upon or water in which to swim. It is series of acts such as these, not unitary reflex acts, which constitute the links of a behaviour cycle, but the latter does not merely consist in a longer chain. The sections, in the first place, are of variable dimensions, and transitions from phase to phase are conditioned by critical clues. The rhythm of locomotion continues until the prey is caught, mastication ensues until it is consumed, or appetite appeased. Even here the individual actions are adapted to the character of the ground and the nature of the food. There is in short a second characteristic of the behaviour cycle of paramount importance—the organization of alternatives. One must first catch one's hare, but when caught it can be cooked in various ways. The alternatives, of course. are not wholly arbitrary, and selection will be determined by a variety of subtle factors in the total situation, including the state of the body. The organization of alternatives may proceed until an almost inexhaustible repertoire of responses is available. Such is the endowment of the fortunate beings who are never at a loss in all the emergencies of life. The elaboration of such alternatives is the function of intelligence.

We are concerned, however, not so much with the constitution of an intelligent being, as with the specific intelligent act. The critical moment is that in which a fresh alternative is found. Once discovered, its conservation as a possible neural path is merely a function of retention.

The conditions under which the intelligent act occurs would seem invariably to involve the thwarting of some pre-established cycle. There is set in action some sequence of behaviour such as the quest for food. But a cycle which uneventfully works itself out in the usual way is not itself an exercise of. intelligence. Some obstacle must arise with which the alternatives so far organized in the nervous system are inadequate to deal. The intelligent act consists in the completion of the cycle by a novel route. In this we have an objective definition of intelligence, or at least an objective criterion of its presence. The usual means of securing food constitutes such a cycle. An obstacle is provided, for example, by placing the food out of reach; whilst the intelligent act may consist in the novel use of a tool.

How does the novel route arise? Attempts have been made to explain the process of discovery by reference to the conjoint action of two factors: (a) one that maintains persistent action until the consummatory act occurs, (b) a tendency to vary, and subsequently to avoid, all responses which fail to terminate the process. On this hypothesis, given time and the physical possibility of giving the right response, every persistent tendency would, by a process of elimination, sooner or later be "successful." Perhaps success is sometimes so attained. But it would seem that the problem is sometimes solved more quickly than this hypothesis would explain—even if we assume that groups of responses are eliminated together. The facts, in short, suggest that the problem may be "thought out." What this phrase implies can no doubt be reinterpreted in purely neural terms, but the fact is, we have reached a stage of investigation at which—as a principle of method—objective psychology calls for supplementation from another point of view. In dealing with the higher functions we find it profitable to observe the process from within, and in the light of clues so gained to formulate hypotheses with regard to neural process. The study of simple reflex acts does not so obviously call for an introspective approach, but as we ascend to higher functions introspective evidence increasingly takes the lead. We may turn therefore to the study of mental process "from within," but before doing so may briefly summarise the merits and limitations of the objective method.

Value of the Objective Approach.——First, we may note that as a science in its own right, or as a sub-department of

Biology, the study of behaviour needs no defence. Its limitations are only such as are self-imposed, or such as further research is likely to remove. It cannot be condemned for its failure to solve the problem of mind, for with what is in strictness "mental" it is not directly concerned. If the principle of physico-chemical explanation is to be rejected here, it has also to be rejected wherever we deal with life. There is little plausibility in the hypothesis that, whilst the behaviour of lower organisms is explicable in purely mechanical terms, teleology is required to explain the later phases of evolution.

Secondly, as a part of what we called general Psycho-physics the objective study of behaviour provides one-half of what is required. It may, however, in addition, provide subsidiary sources of information with regard to mental process. Just as the physiology of the sense-organs has been advanced by the introspective observation of sensory experience, so are clues afforded to the nature of mental process by the correlative physical facts. In both cases, however, certain general hypotheses are required with regard to the relations of body and mind, and each presupposes a correlative but independent approach.

Limitations of the Method.—Considered as a substitute for Psychology, as some ardent exponents regard it, a purely objective study of behaviour suffers from more than a limitation. It fails to touch the essential facts. From a knowledge of bodily processes alone the existence of mental facts cannot even be presumed, much less explained. This is a limitation which is not paralleled in the distinctively psychological point of view; for, as we shall see, the analysis of experience reveals an awareness of the body. But the body as internally perceived is in strictness a different thing from the body as observed from an external point of view. Hence arises a danger of confusion, and hence, too, a need for a clearer demarcation of the alternative methods of approach.

But even in the more restricted purpose of extending our biological kno ledge it is pedantic and inconvenient to restrict ourselves to the purely objective method. Any method is justified which succeeds in advancing knowledge. So far as the parallelism holds it avails us in both directions, and it is an increasingly exemplified fact that the analysis of experience provides a valuable indirect means of securing knowledge of cerebral process. Which method has priority will depend on circumstances. To laud the objective approach in the study of lowly functions is to make a virtue of necessity, and to restrict the study of higher functions to this method is surely, when other means are available, to impose a gratuitous limitation upon the psychologist. What is required would seem to be a psycho-physical point of view which, whilst keeping the methods distinct, employs each to correct and supplement the other.

PSYCHOLOGY AS THE SCIENCE OF INDIVIDUAL EXPERIENCE

The Problem.—The desire to know "what is going on in the mind" is natural and legitimate. So far from being one that the psychologist may ignore, it is precisely that which he is called upon to meet. The challenge of those who deny the feasibility of the venture hardly calls for a *priori* argument; the answer lies in the facts which the so-called Introspective Method has succeeded in bringing to light.

The question is: what exactly do we discover, when, leaving to others the observation of behaviour from the standpoint of the natural sciences, we make ourselves subjects of investigation? The answer, in general, is that we find ourselves living through an experience which to us is "immediate" but which can be only indirectly revealed to anyone "outside." Experience admits of verbal description, and description is "behaviour," but it "makes sense" only to one who interprets it by reference to experience of his own, which he might similarly describe. It is with the nature and laws of experience that Psychology is primarily concerned. We have first to consider in a general way some fundamental concepts in the analysis of experience.

Presentations.—A tree is a physical and not a mental fact; propositions about a tree fall within the province of botany but not of Psychology. On the other hand, an idea of a tree is mental and not physical; propositions about ideas (*e.g.,* that they are distinct or indistinct, or that one is associated with, and suggests, another), are distinctively psychological. What, then, is the difference between a tree and someone's idea of a tree? The answer is that the idea of a tree is the tree itself as it seems to be to an experiencing individual, who is in some way cognisant of it and interested in it. As it appears variously to different individuals, or to the same individual in different stages of his history, we say that the idea changes and varies. Such change and variation is properly psychological. We are however debarred from using the term "idea" comprehensively for objects so far as they enter into individual experience. The reason is that, in present usage, both popular and technical, the word "idea" is applied only to what is thought of without being perceived. In perceiving a tree, we do not say that we are having an idea of it. We may remedy this defect by calling the tree as it appears in sense perception a "percept." But we still need a comprehensive term to cover both percepts and ideas. Following Ward we shall use the term Presentation in this wide sense. Anything whatever is a presentation if and so far as someone is cognisant of it and interested in it.

Sense and Thought.—Nothing can be thus present to the mind unless it is thought of. Otherwise we could not be said to be cognisant of it or interested in it at all. But presentations are not merely thought of. In part they are also sensibly experienced. In a cold bath cold is sensibly experienced. But the bather may, in anticipation or reminiscence, think of the cold as sensibly experienced without actually experiencing it. Similarly, when he sees someone else plunge into cold water, he may think of the other's sensations without having them himself. In such instances the object of thought is itself intrinsically capable of being sensibly experienced. But this is very far from being universally true. Universals and possibilities cannot as such be sensibly presented. Physical objects and their objective characters and relations, as apprehended by common sense and science, cannot be resolved into actual and possible sensations.

Thought essentially involves something in the nature of judgment however rudimentary—including under the term "judgment" questioning and supposition as well as assertion and denial. What we think of we characterise in some manner and degree as being this or that, such and such, so and so related. If we ask what the object of thought is, we cannot express it without using propositions. The bather thinks of the coldness before entering his bath as something which he may actually experience, or is about to experience. When he is actually feeling it, he thinks of it, *e.g.,* as being coldness, as actually present, as about to continue for some time, as felt by him, etc. He does not know anything unless he knows something about it; but "knowledge about" is thought or judgment.

The distinction between sense-experience and thought is not a distinction between separate and independent classes of presentation. In general neither exists without the other, so that every complete presentation involves both as essential elements. Change and development in the mental life is change and development at once on the side of thought and of sense, each conditioning, and conditioned by, the other.

Sensations and Images.—Sense-presentations are of two kinds: (a) Sensations proper, or Impressions, and (b) Images. Images are secondary and derivative, inasmuch as they presuppose the previous occurrence of sensations. They also, at least when they are definite, more or less resemble the sense-impressions from which they are derived. Hence they have been called "copies" of impressions.

Sensations are commonly defined by reference to the manner in which they are produced, as experiences immediately consequent upon the passage of an afferent impulse from a receptive organ to some region of the cerebral hemispheres. But such a definition is inappropriate to our present line of approach, the first task of which is to describe experience itself without regard to the conditions under which it may arise. A formal definition, however, is difficult to give. A typical sensation can but be pointed out and attention drawn to certain characteristics in respect of which it resembles other members of the class with which we are concerned. The clearest and most undisputed examples are afforded by bodily aches and pains. These are sensations both in the most popular and the most technical senses of the term.

Such an experience as a twinge of pain we find tc be an occurrence which manifests a certain specific quality, a certain intensity and a more or less clearly defined extensity and duration. It is also localised or felt in a certain position in a larger spatio-temporal whole. It is referred to some part of the body (of which we are aware as a larger sensory complex), and in popular usage the term sensation tends to be restricted to what is so located. Psychologists, however, have found it inconvenient so to restrict it, so that presentations of sound and colour, and other occurrences which manifest the fundamental attributes are comprised within the meaning of the term.

Theoretically, the attributes of sensation might be found in perfect duplicate in the mental image. A flash of light—say from the bursting of a rocket in the sky—is seen to wax and wane and to pass through various changes in quality and extension. The visualiser might therefore, on closing his eyes, "see" the whole performance repeated "in his mind," the image corresponding in a peculiar way in every attribute to the original impression. Practically, however, images are in various ways defective. They lack the definition, the vividness, the clearness, richness and complexity of the primary impression. But mere imperfections do not provide a suitable basis of definition, however much they may assist effective discrimination in ordinary life.

More fundamental is the relation of the image to subjective activity. An image of a statue can be "immediately" produced and does not require to be modelled by the hands, and upon this the relation—or want of relation—of the image to concomitant-impressions very largely depends.

Images have places relatively to other images within the same extensive field; so have impressions relatively to other impressions. But images and impressions are not thus related to each other. An individual's mental picture of a horse may be contained within his mental picture of a stable, but neither fall within the field of visual impressions which he experiences together with them. If they did, there would be an hallucination, and hallucinations are not images but sensations. It should be added that the place of physical objects in space cannot be identified with the place either of impressions or of images. When a candle flame is seen doubled two impressions are sensibly experienced with an interval between them; but there is only one candle flame.

The Subjective Modes of Experience.—The facts of mental life are not adequately expressed by saying that such and such presentations and simple feelings occur in such and such an order of co-existence and sequence. Objects are presentations only so far as some one is cognisant of them and interested in them. But "cognisant of" and "interested in" are predicates, not of the presentations themselves, but of the experiencing individual whose presentations they are. It is I who believe, disbelieve, doubt, suppose or inquire into, this or that. It is I who am pleased with a melody or with a piece of news. It is I who crave after a drug or choose to take a walk. Even if we abstractly consider mere sense-presentation apart from thought, the distinction is still applicable. It is I who experience colour-sensations, and sound-sensations; but what is sensibly experienced, the sensum or sensatum, as distinguished from the sensating or sensation, is not predicable of me. I am not blue or loud.

It is to subjective modes of experience that the traditional threefold scheme of Cognition, Feeling and Conation most directly refers, and to them it is most conveniently restricted. We shall first consider how the experiences distinguished under these heads are connected with each other. We shall then, for purposes of exposition, treat each of them separately, so far as it is legitimate and convenient to do so.

Interrelations Between Cognition, Feeling and Conation.—The three subjective components of experience certainly are irreducibly distinct. They are not, however, events which may occur independently. The terms refer, rather, to "aspects" of a concrete unitary whole. Even so, they are not simply concomitant and independent attributes, as colour and sound would seem to be. A better analogy is afforded by the relations of colour and extension. As the former implies the latter so the so-called elements of experience would seem to occur in a similar intimate connection.

Conation clearly implies cognition. A striving which is wholly blind is an unintelligible conception. The experient always has at least a vague awareness of the sort of thing he wants, either to "have" or to avoid. But cognition, it may reasonably be argued, equally implies conation. The relations, however, are not reciprocal, for in any given case the immediate objects are not exactly the same. It is on account of this difference that there is progressive development of experience. We apprehend an object because of some interest in the whole of which it forms a part. We become aware of it because we want to know what is there, though having found out *what,* we may in consequence lose interest. That is to say conation is presupposed only in relation to an object presented as admitting of further determination, not as already fully determined. In this lies the significance of attention Conative activity, whatever its remoter end, presupposes cognition of the situation to be changed, a fuller awareness is required of that which is, and to some extent of that which is to be. So far as conation is so directed simply to fuller cognition, the process is one of attention.

The place of feeling in the cycle of cognition, feeling and conation presents a peculiar problem. Is it the immediate consequence of cognition or does it depend upon conation? Here, as is so often the case, each of the rival theories is strong in what it affirms, and falls into error only in what it denies. It is indisputable that the apprehension of various things and their qualities (such as the taste of a dose of quinine) immediately gives rise to affective experience. But it is also plausibly contended that all pleasures are ultimately "pleasures of pursuit." In so far as conative activity is successful, pleasure is experienced, in so far as it is thwarted, pain is the consequence. Difficulties of detail arise in regard to some of the sensory pleasures and pains, and even granting that these can be shown to conform to the rule, a place will still remain to be assigned to cognition. No conative tendency can, from the standpoint of the experient, be regarded as progressive unless it is recognised as such. Travelling in the dark we may be on the right road, but if there is any serious doubt about it, we gain little satisfaction from our progress. It is the sight of familiar landmarks which conditions our satisfaction. In general it is presentational cues, *i.e.,* percepts and ideas, which mark the progress of conation. This is as true of purely instinctive action as of intelligent self-direction. The mutual implication of cognition and conation would thus seem to resolve the apparent contradiction between these rival views.

COGNITION

In the genetic treatment here adopted we may dispense with any attempt to classify the "cognitive faculties." There is only one cognitive function, which, according to the nature of its object or of the presentations which condition its exercise, is described as visual, auditory or tactile perception, and according to temporal marks, as memory, expectation or imagination. According as the object is determined as actual or possible, so the difference of mental attitude is expressed by such terms as "belief," "assumption" or "supposal." These, however, with their many subtle variations can hardly be regarded as distinct and separate functions.

For this very general function there is no wholly satisfactory term. If "Cognition" is retained, care must be taken to avoid, in a purely psychological treatment, epistemological implications. In the theory of knowledge, as often in every day speech, what is said to be cognised is thereby implied to be "true." The term in fact is restricted to what, from the psychological point of view, may be the end or terminal state of a complex process, and possesses in addition certain characters in virtue of which it is recognised as true. With these criteria the psychologist as such is not concerned, except in so far as the marks of truth are discovered by the experient himself in the course of his development. In psychology, however, the term "cognition" is required to cover the process as a whole. Believing and supposing are in the psychological sense cognitive processes. But how far what is supposed or believed really is as it is supposed or believed to be is not properly a psychological question. It is not indeed a question which the psychologist can safely ignore. In tracing the conditions under which a belief arises, it makes an important difference whether the belief is assumed to be false or true. But whether it is false or true cannot primarily be decided on psychological grounds but on grounds which the psychologist shares with others. The appeal is primarily to common sense and science. It is only in a secondary way that the psychologist can supply relevant data. Where there is otherwise room for doubt, he may show that the psychological conditions are such as to account for the genesis of a belief, without assuming it to be true or even assuming it to be false. Is a mountain which looks near really near? It is relevant to this question to point out that whether it is near or far it would for psychological reasons seem to be near,

The Development of Cognition.—Two closely connected problems are presented; to trace the development of the knowing function, and to disentangle the various phases of growth in our apprehension of the world in which we live and of ourselves as agents. In these inquiries we have to determine the primary and irreducible elements with which development could theoretically begin, and to formulate the laws of growth by the operation of which our present complexity of experience has been brought about.

It is clear that we can start neither from blank unconsciousness nor from any absolute beginning. If conscious life has had a beginning at all the point of its emergence is not known, nor can we observe such forms of experience as we plausibly postulate in primitive animal life. What is literally irreducible may perhaps never be known. It is sufficient, however, to treat as primitive that which resists analysis and cannot be derived by accepted genetic laws. How, then, are such laws to be known? The answer might also naturally seem to depend upon the evidence of primitive experience, and the difficulty has sometimes been supposed to constitute an objection to any serious attempt to solve the problem at all. There are, however, means at our disposal. The conscious life of which we have immediate awareness is consciousness in process of development, and from such changes as we there observe the principles of growth can be defined.

Primary Laws.—"Suppose that in the course of a few minutes we take half a dozen glances at a strange and curious flower. We have not as many complex presentations, which we might symbolize as F_1 F_2 F_6: But rather, at first only the general outline is noted, next the disposition of petals, stamens, etc., then the attachment of the anthers, position of the ovary, and so on; that is to say, symbolizing the whole flower as (p' [ab] s' [cd] o' [fg]), we first apprehend, say (p' s' o'), then (p' [ab] s'. o') or (p' [a] s' [c] o' [f]) and so forth." The case, adduced by Ward (Psychological *Principles,* p. 81), provides in miniature an example of the principal laws with which we are concerned. The changes admit of precise determination by experimental methods. If the object is exposed in momentary flashes by means of an instrument through which the duration of the appearance and other conditions can be accurately controlled, the phases of cognitive growth admit of clear delineation.

In general, we find that when the object is a complexly variegated whole the context immediately apprehended undergoes a process of differentiation either until its detail is exhausted or until certain limits are reached which are set by the so-called "span of attention" and the observer's powers of discrimination. Certain phases of this growth call for special attention.

(a) Differentiation.—Sense experience is sensibly continuous, each fresh item intruding not as something absolutely new, not as a presentation replacing a total absence of experience, but as a change in a pre-existent sensible field, part of which remains as a relatively indeterminate background. The darkness which is experienced in the absence of external stimulation is wholly different from the insentience of a stone. What is earlier in the process is usually lacking in variety. At first a cloudless sky will appear as a uniform blue, but attention will reveal a variety of hues between the zenith and the horizon. Differentiation which in normal perception occurs with extreme rapidity admits of detailed analysis, when, by experimental means, this process is slowed down. Under such conditions a definite order is observed in the emergence of specific colours and forms—an order which perhaps more or less accurately repeats that of cognitive development in the race. Despite the marked contrasts which now obtain between the specific qualities of a given sense the variety they manifest has only come about by slow degrees. This well may be the case with regard to the more fundamental difference of modality as well, for the hypothesis finds indirect support from the physiology add pathology of the receptive organs, ahd from what is known of sentience in the lower animals.

(b) Outline to Detail, **Implicit** to **Explicit Apprehension.**—It is the broader and larger characters of a whole which first receive attention, but '(broader" and "larger" must be interpreted in a psychological sense. It is not what is "objectively" largest that is first to be perceived. Ptoverbially, the wood may not be apprehended for the trees. The point is rather that attention is first attracted by certain convenient wholes (and convenience is relative to development) which unite within themselves a number of components which escape explicit discrimination, and it is as units in such wholes that they are subsequently known. But before discrimination they are not wholly unknown. The whole appears different on account of their existence. Hence they may be said to be implicitly apprehended. Thus in noting a "certain strangeness" about my friend I have implicitly apprehended that he is growing a moustache before I have "located" where the strangeness resides.

Even when the items of a whole are singled out by attention, the characteristics they possess are conditioned by their context. This fact is strikingly illustrated in many familiar illusions. In general, cognitive development does not proceed simply by accretions and associations. If an analogy be required it will be found rather in the emergence of structure in an organism rather than in the growth of a snowball or a crystal.

(c) **Progressive** Determination.—The original apprehension of any object is characterised by "vagueness." What is given is given to be determined, to be rendered determinate. What exists must be in its own intrinsic nature perfectly determinate, whether it be a sense-presentation or a physical thing, but as apprehended it is originally and probably always more or less vague. We perceive a thing as of a "reddish hue" and as more or less angular in shape before we apprehend it to be a perfectly determinate shade of red, and of such and such determinate angles. In the same way it is possible to be aware of something moving when we know neither what it is that is moving nor in what direction it goes.

(d) **Extension of** Temporal Range.—As we proceed from the lower to the higher forms of cognition we observe a further characteristic, one that is not involved in the example which we have so far had before us,—the extension of temporal range.

Primitive experience, there are good (though indirect) reasons to suppose, is limited in reference to the present, conceived not, of course, as a point in time, but as a short duration, involving a retrospective and a prospective phase. Just as, in general, cognition refers beyond the limits of actual sense experience, so it refers directly to the future and the past. In this sense expectation and memory are original capacities of the mind. Development consists in the gradual extension of range, though how far such immediate reference may extend is difficult to decide. Certaihly not so far as instinctive pre-adaptation might lead one to suppose. Instinctive action involves prospective cognition, but probably only a step or two ahead, and in much that passes for memory we only directly know that this is what has previously been recalled.

Apart from the extehsion of immediate cognitive range reference to past or future depends upon the emergence of "free ideas."

Retention.—Advance in mental life depends upon the fact that the effects of past experience are retained and carried forward into subsequent experience. The law may be simply espressed by saying that every experience in part owes its specific character to prior experience, and modifies in turn the nature of that which follows. Increasing familiarity in cognition and progressive facilitation in behaviour are the obvious results. It is important, however, to distinguish the effects of retention at the purely perceptual level from those which arise from association of potentially "free" ideas. Mental imagery, in its present form is a comparatively late development and cognitive development has proceeded far before it is acquired.

In its qualitative aspect the general results of retention are to be found even in the case of the repeated presentation of a comparatively simple object which does not admit of internal differentiation—say in the successive strokes of a clock. Herg the physical occurrences are identical in nature, but the successive presentations vary in a systematic way. The case may be symbolised as follows:—

$$\begin{array}{ccccc} o & \cdots & o & \cdots & o \\ \searrow & & \searrow & & \searrow \\ p & \ldots & p_{m_1} & \cdot\,.\,. & p_{m_2}, \end{array}$$

where o stands for the physical occurrence, p for the corresponding presentation and the subscripts m_1 and m_2 for the peculiar modifications which distinguish the more or less familiar from the novel.

The case may be compared with that in which the successive presentations are originally various in nature, as say in the successive notes of a melody. Here the effects of retention do not modify an experience which would otherwise be identical with what had gone before, but blend in a cyrious way with the features of a novel presentation. The case here can be represented:—

$$\begin{array}{ccccc} a & \cdots & b & \cdots & c \\ \searrow & & \searrow & & \searrow \\ p_a & \cdots & p_{b(m_1)} & \cdots & p_{c(m_2)}, \end{array}$$

a b c standing for the physical occurrences, $p_a \ldots p_{b\ m_1} \ldots p_{c\ m_2}$ corresponding presentations, m_1 and m_2 again denoting the modifications due to retention. The question is what precisely is the nature of these modifications?

The process has been described as one of "acquirement of meaning:" The later strokes of the clock have acquired a meaning which the initial experience lacked. The meaning of a presentation depends upon its place within a whole. What, then, we may ask, is meaning?

Meaning.—At a relatively developed level of mental life meaning may be conveyed by an associated image. I hear a word in a foreign language which I do not understand; it is devoid of meaning. The object to which it refers is pointed out. Thereafter the word being repeated an image of the abject may be revived. This will then convey for me the meaning of the word. In this sense meaning depends upon associated context. But this is not its most primitive form. The kitten on its second encounter with a dog has neither the time nor the inclination to call up a mental picture of its earlier adventure, but the present impression is "charged with meaning."

Meaning might here appear to consist in the altered intrinsic nature of the sense-presentation, yet this cannot be the case, No change merely in quality, intensity, extensity and duration can constitute a meaning though no doubt such changes will concurrently occur.

Primarily, meaning consists in -'objective reference," in the primary judgments of perception. What is important to the so-called "feeling" of familiarity is the implicit judgment, "this has occurred before." But the primary judgments of perception depend upon sensory experience. What, then, is the sensory basis in this case?

If it consists neither in changes in the primary attributes of sensation, nor in a distinct imaginal context, it is plausible to suppose that it lies in the less differentiated background in which the sense-presentation is set. Such background need not be all of presentational nature, but may include subjective components, *e.g.,* the experience of difficulty or ease in the process of perception. The shocks of surprise and the general "organic reverberation" of sensory experience may also play a part, though whether familiarity is a positive quality over and above the mere absence of the feeling of strangeness is difficult to decide.

Similar considerations apply to the more complex case of a succession of varied presentations. The separate items have potentially characters in their own right, but each is modified in accordance with what has gone before. The particular sense-presentation is part of a larger whole and as such it is apprehended.

Nevertheless changes in the internal nature of a sensory experience in virtue of what has gone before follows in accordance with an even wider law—what we may call the principle of the unity of experience. Physical things are thought of as remaining constant in their characters in total independence of environmental change except in response to specific *causal* laws. The colour or size of a flower does not depend upon its background. Within experience, on the contrary, there is universal relativity. The nature of a sense-presentation depends on what has gone before and upon much that simultaneously occurs. Even apparent exceptions to this rule are becoming increasingly difficult to discover as quantitative investigations become more exact and refined.

The Transition from Percepts to Free Ideas.—It is distinctively characteristic of Percepts that on the side of sense they involve impressional experience,—sensations proper as contrasted with images. But we are now able to have thoughts and trains of thoughts which are quite independent of present sense impressions. Such thoughts are free ideas and they are possible only inasmuch as on the side of sense, images are substituted for impressions, How then do images first arise? They are, as has already been remarked, a relatively late development. All the evidence would seem to point to their absence in lower stages of mental life. They emerge only when impressional experience has become sufficiently complex and differentiated. How this takes place we have already partly indicated in treating of Differentiation, Retention and acquirement of meaning. We have now to take account of another side of the same process which we have so far not expressly considered—Complication. When we see snow we are perceptually aware of it as cold, soft and wet much in the same way as we are aware of it as white and extended. There is a "forefeel" of its coldness, softness and wetness (Ward, *Psychological Principles,* p. 186). But this is inexplicable if all that is sensibly experienced in perceiving the snow is the visual impression. There must also be, and introspective analysis shows that there are, revivals of what is retained from past impressionable experiences in which we have not only seen but handled snow. Such revivals are inseparably one with or "tied to" the original impression, and, except that they are derivative not primary, are themselves impressions rather than images, or have a character intermediate between the two. They are not substituted for impressional experience but only make it more complex. Hence the process through which this comes about is fitly called Complication, which corresponds at the perceptual level to Association of Ideas.

When differentiation and complication have reached a certain stage, sensory revival is no longer tied to a present primary impression. It is capable of being set free as a mental image. Other conditions being fulfilled, this takes place when subjective interest requires it, and is coincident with the endeavour to take measures beforehand to meet situations remote in time and place.

Besides this general principle we may also refer to two special conditions which facilitate the emergence of free ideas. The first is the continued effort to attend to a percept after it has ceased to be present to the senses. There thus arises an image which is peculiarly vivid because it blends with and is reinforced by a fading impression. This is what is called the "primary memory image." The second is disappointed perceptual anticipation. What, owing to complication we preperceive as hot turns out to be cold, what we expect to resist our movements crumbles beneath our touch, the egg we are about to eat is found to be an empty shell. What is thus excluded from impressional experience becomes contrasted with it as an image and perception gives place to an idea.

Association. — The topic of association has traditionally been treated, firstly, so as to account for "complex presentations," and secondly, to explain the sequence of ideas in the course of thought.

In regard to the first problem it is important to note that association proper presupposes the prior and more fundamental phases of development with which we have been concerned. Though the various forms of complication and association are genetically continuous, the last of these terms is conveniently restricted to the organisation of the tissue of experience in which the related terms are explicitly distinct as free ideas.

The Laws of Association. — Associative processes have traditionally been formulated in terms of specific "Laws." Thus it was supposed, in the early days of the history of Psychology, that associative revival depends upon certain relations obtaining between the items of Perception: contiguity, in time or place, similarity and contrast. Reflection, however, clearly shows that there is nothing in the relations as such, in virtue of which one of the related items should recall the other. Contiguity of objects on a table would not determine the idea a percept of one or reinstate an idea of another unless the contiguity had itself been apprehended. There is no reason, independently of experience, why thought of anything whatever should induce the idea of that with which it stands in contrast. The basis of association is the co-presentation of the associated terms in some relation to each other, and any kind of relation whatever, provided that it is perceived and thought of, may serve as an associative link.

So called "association by similarity" may not, at first sight, seem to come under this general principle. A tiger may suggest a cat to a person who has had no previous knowledge of tigers such as would enable him to notice their resemblance to cats. But this difficulty is easily met. The phrase "Association by Similarity" is misleading. The associative link may be more accurately defined as the relation of both the associated terms to some common class or kind of which they are both members or instances. When we see a cat we are aware of it as a certain sort of animal. When we see a tiger we are also aware of it as a certain sort of animal. In some interesting respects and to an interesting degree, the tiger, in spite of specific differences is referred to the same general class as the cat. This is the associative link between them. A red patch may suggest a blue patch not because of any spatial or temporal contiguity between either the patches as a whole or any of their parts, but because red is apprehended as a colour and blue is apprehended as a colour too. We may speak of a partial identity in red and blue in virtue of their being colours, but the phrase here takes on a meaning radically distinct from that which it has when applied to overlapping areas or events.

It is not only in association by similarity that we have to take account of universals. The "items" of association are never bare particulars of sense. That this is the case is seen in a detailed analysis of the operation of the law. What is revived is never a simple photographic copy which is constantly related to the original impression. When such is specifically required, it calls for deliberate reconstruction. In general, however, the photographic image would be of no advantage. What is required is something much more plastic. In the reinstatement of the context of an object seen near at hand, but imaged as at a distance, such context is correspondingly reduced, and different adaptations are required in every case. Such plasticity is in fact involved in the sensory forms of reinstatements such as pre-perception or hallucination. The principle has been formulated as that of Relative Suggestion (Stout: *Analytic Psychology,* vol. ii. ch. 1), and it is in this way, rather than in terms of sensory atomism that the law of association requires to be expressed.

The point is of vital importance for a theory of imaginative construction. The vague conception that imagination works with the data of disintegrated memory, variously recombined much as a mosaic pattern might be rearranged, fails to fit even the simplest facts. Perceiving a red square and a blue triangle makes possible the immediate presentment of these figures to the imagination with their colours interchanged. With a row of such figures each of a different colour, material is provided for endless permutations. This principle affords an answer to the question with regard to that "so singular" possible exception to the rule, that we can only image that which has first been given to sense, that the mind cannot form a novel "simple impression." Could we imagine a given shade of blue when this had never been presented, given acquaintance with every other shade and every other colour? No doubt is felt if the question is raised with regard to shape, but no difference in principle would seem to be involved. Subject to the limits of discrimination (which in imagery is coarser than in sense) we can produce a number of novel members to a series which is presented to sense.

The concept of "contiguity" calls for further analysis in respect of the temporal relation between the contiguous items. The term co-presentation might, literally taken, suggest "simultaneous apprehension"; but the question may be raised whether such simultaneity when it does occur is not, to a great extent, the fruit of succession. Items successively apprehended by the "movements" of attention come, through primary retention, to be co-present to the mind. We seem to see a picture all at once, but more precise observation would reveal a progressive apprehension in which what is prior in experience is retained until the object is seen as a whole. This is quite evident in hearing a spoken sentence.

Where two items are, in this sense, co-presented, they may be simultaneously revived, and each will revive the other with equal ease. Where, however, there is succession in presentation, there is strong presumptive evidence that associations are formed primarily in the "forward direction." That which follows in experience is revived more readily than that which precedes. Nevertheless there is also undeniable evidence that weaker associations are also formed in the reverse direction. Though we repeat the alphabet more easily in the order in which the letters were learnt, we can, if necessary, say it backwards too. This, however, may be due to primary retention.

In so far as that which is presented is retained, it is carried forward in experience side by side with "objectively" later impressions, and may later become again the object of attention. In hearing a spoken sentence, the earlier words are in this way carried forward, and after attending to the meaning of the sentence as a whole we may note the mispronunciation of one of the earlier words. In which case, we may later associate with the memory of this statement the speaker's offending pronunciation rather than his subsequent conversation. In any case it is the order in experience rather than the order of stimulation which is psychologically important. And the order of experience is the order of attention. For this reason the law may be described as the "Law of Association by Continuity of Attention."

The Sequence of Ideas. — The course of experience is never wholly objectively determined nor wholly determined by subjective factors. Nevertheless, we may broadly say that perceptual process is predominantly determined by external circumstances whereas over the sequence of ideas we have a more direct control. The question arises how far does the law of association explain this latter type of sequence. As ordinarily stated the law of contiguity would suggest that the course of our ideas, whilst free from the domination of the present, is still in fetters to the sequences of the past. Except in so far as similarities provide, so to speak, a series of cross references, we find no escape from a merely historical order in our passages of thought. Obviously, however, the facts are against any such simple view. The law of association calls for considerable amplification.

In the first place a given item of experience occurs in a variety of contexts. Which of these is likely to be revived, and what of all that is similar will be selected by thought?

To these questions a partial answer is provided by what we may call the sub-laws of association, the principles of Frequency, Recency and Intensity.

Given that the revival of any item in experience will tend to reinstate its context, the more frequently any given context has occurred the more probable that specific context will be the one revived.

Similarly, with regard to Recency: the more recently any specific context has accompanied a given item, the more likely that context is to be revived.

These two sub-laws admit of a fairly precise quantitative formulation, the first being expressed by the "curve of learning," the second by the curve of oblivescence.

The "Law of Intensity" admits of a variety of interpretations, the term standing ambiguously for the intensive attribute of sensation, for intensity of feeling, or the "intensity" of attention. It is doubtful whether the mere intensity of sensation (apart from the effects upon feeling and attention) is of great importance. So far as it is, it occupies a still more subsidiary rôle among the very special laws which relate to the sensory attributes in general. Probably the best expression for the law of Intensity is as the law of Interest. The more interested the transition of attention from an item of experience to its context, the greater the tendency for the sequence to be revived. So stated, the formula is closely related to the so-called "Law of Effect," which latter refers, however, more particularly to the acquisition of skill, and to the formation of habit. In the association of movements much depends on whether the action is followed by pleasure or pain. When the "effects" are pleasant the association is "stamped in," when painful it tends to be impaired.

To speak of a law of Interest has the required impartiality of emphasis as between conation and feeling, though if the hypothesis defended in another section turns out to be justified, the emphasis should ultimately be placed upon conation. So interpreted the three sub-laws would fall into line in a general formulation: *that the strength (or revivability) of an association depends upon the frequency, recency and intensity of conative activity in a given direction.*

These laws, however, are not independent. Strictly, we should say: the more frequently or recently a conative tendency of given intensity has been furthered by the passage of thought from A to B the greater *ceteris paribus* the tendency for B to be revived by **A.** There is the possibility of interference or compensation between the effects of recency and frequency and greater frequency or recency may balance a weakness in intensity, but no amount of frequency will increase the tendency for B to be revived, when its revival would be adverse to the general conative trend. This is most evident in the special case of motor associations. The more frequently or recently a certain end has been furthered by a given response, the greater the tendency for the response to be confirmed. But where the movement is adverse to the fulfilment of purpose neither frequency nor recency will serve in the least to confirm it.

The same principles are operative in the association of ideas. Ideas tend to be revived in accordance with the conative trends of thought. It is true that painful as well as pleasant ideas tend to be revived. But, painful ideas may be relevant to the trends of thought. Apart from such relevance they fail to be revived. Similarly unpleasant actions tend to be repeated and painful habits formed in the pursuit of remoter ends, though not otherwise.

But this law, however much it may be amplified, refers only to the past, to the conditions of co-presentation and to prior conation. Explanations of mental process by reference to such conditions alone fail to take account of the influences of the present, which determine the direction of associative revival. These are factors which are selective of what is relevant to and consonant with the present direction of endeavour. Hence, "necessity is the mother of invention." Associations relevant to the present exigency are preferred.

Chief importance attaches in this connection to specific conative experiences, in particular to the awareness of the nature of the problem to be solved. The conceptual formulation of conation is what constitutes a "question," and the more clearly the question is defined, the narrower is the range of associative relevance. Associative process is thus subject to multiple control. The train of ideas does not consist in a simple linear sequence, each item directly and independently leading to the next. Any particular sequence is under the general control of a governing idea—the idea of the end more or less clearly conceived. Such governance may depend upon a complex hierarchical organization of the controlling ideas, with the most general logical notions standing at the head, and various kinds of "schemes" controlling the general lines along which the problem is treated. Where specific conation is absent we can still detect the influence of the vaguer emotive "moods." Depression favours unhappy memories, and gloomy prognostications. In joy, the train of ideas is similarly congruent with the mood. Such emotive states may be conatively defined.

PERCEPTION OF PHYSICAL THINGS

The Problem. — The second of the general problems of cognition is to account for the growth of our apprehension of a world of physical things and of the self in relation to which this world is described as "external." In this development three distinct levels would seem to be involved. There is the normal adult human perception of daily life. Below it there is a much more primitive level of perceptual apprehension, and above, the level of conceptual thought and ideal construction. Through a window I perceive a not too distant mountain In spite of appearances I take it to be of enormous size, and to be covered with white snow. This is the normal interpretation of perception. But it *appears* extremely small and, on account of the setting sun, of a distinctly reddish hue. These are the perceptual data. But neither of these accounts would seem to correspond with "scientific fact." The apparently solid and motionless mountain is explained as a whirling mass of electrons, and endowed with properties which I neither do nor can perceive nor directly infer from what I perceive. The immediate problem, however, is to disentangle the earlier levels of apprehension.

Primary **Data.**—Whatever else may be involved sensible experience must be accepted as primary. But mere sense-presentations strictly and abstractly conceived alone are not enough. The processes we have considered, operative only with such material, would not suffice to explain our apprehension of a world of physical things. It must be taken as a datum for Psychology—as a fact of experience—that we are cognisant of and active about objects which are not themselves capable of being sensibly experienced. Thought or judgment transcends not only present sense-experience but sense-experience in general.

So far as cognition is concerned thought may be psychologically considered as a tissue of beliefs and suppositions. Belief as a mental function is an irreducible component of experience, but particular beliefs are primary in another sense. The majority of beliefs are inferential or arise from mere suggestion. Beliefs not so derived may be described as "original," and original beliefs must be involved in the explanation of our apprehension of the material world.

Corresponding to every sense-presentation, involving an act of attention, there arises an original belief that something is there and is characterised in a more or less definite way. There are original judgments involved in recognition, and memory judgments asserting past experiences, as such, may similarly be "original."

Discrimination between original and derivative beliefs can only be effected in the course of a detailed investigation of the development of cognition. One very general principle, however, would seem to be involved in all the fundamental modes in which the mind refers to its objects. Such reference is conditioned by sense-experience. Every variation in the thought depends upon some variation in sense and every variation in sense-experience makes possible some variation in thought. Hence therefore, parallel to, and based upon, the development of sensory experience, thought advances in complexity, determination and range. The simplest presentation is endowed with primary meaning, secondary meaning being acquired through retention. Retention, association and reproduction of thought, depend upon analogous processes in the sensory field. The parallelism, however, is subject to complications in detail. Sometimes likeness among sense-presentations means only a corresponding likeness among the objects to which thought refers; sometimes likeness of presentations provides the basis for a judgment of *identity.* Change in the sensory field points to changes in its conditions, but not necessarily in the object singled out as the thing that is being perceived. Sensible movement in immediate experience conditions the primary judgment "something moves." According to the context the movement may be referred to various things, to the things which appear to move, to the otherwise unperceived medium or to the bodily self. In fact the explanation of the development of cognition consists in one aspect (the abstractly cognitive) in determining the nature of the sensory experience which conditions our developing apprehension.

We must start with the simplest appearances, but paradoxically the simplest appearances are not the easiest to observe. Generally one perceives that the mountain is large and covered with white snow without noticing its apparent smallness or its reddish hue. To become aware of the latter the direction of attention must be changed in a subtle way. It must be diverted from the mountain and directed to sensuous presentations in themselves. Nevertheless from such appearances we must start though not in their artificial form. What is artificial is the restriction of attention to isolated data in the field, and to certain of their characters in a similar isolation. There is no such complete restriction either in primitive or in normal developed perception. Our original apprehension is of a complex whole all the ingredients of which co-operate, without being individually apprehended, to determine the judgments of perception. The colour constituent of the sense-presentation largely determines the colour attributed to the physical object, size and shape in the sense-presentation, size and shape in the object but these factors do not operate independently of each other. Ellipticity, for example, in the sense-appearance of a plate *combined with differences in sensible depth* in different parts of the ellipse jointly determine the judgment that the plate is round, and similar considerations apply to perceptual judgments of colour and size.

Such joint determination is not wholly acquired. Moreover, not only is a given character, say ***A,*** as applied to a physical object, jointly determined by a combination of characters, say $a' + b'$ in the particular sensation, but the characters of a conjunction of distinct sense-presentations, say P', Q' and R', may also determine the character assigned to a particular physical object, say P, which corresponds to only one of them. This is exemplified by the laws of confluence and contrast.

Appearance and Reality. — Sensuous presentations, which practically may be sensibly experienced without being discriminated, singly or jointly determining our judgments of perception. The problem is to assign to these judgments their sensory conditions. We are thus concerned not with the evolution of perception out of bare sensation but with two lines of parallel and correlated growth. Knowledge of sense-presentation is not prior to knowledge of physical things. The most that we can say is that originally there is no explicit distinction between judgments with regard to such presentations and judgments with regard to physical things. The occurrence of a sense impression having the attributes a, b, c, occasion the immediate awareness that there is *something* to which these properties belong. This object is thought of neither as "my sensation" nor as "that physical thing." The distinction between sense-presentations as such and physical objects, as well as the connected distinction between appearance and reality, depends upon experienced contradictions, and more especially upon the thwarting of conative activity.

The child before he reflects upon the illusions of sense attempts to grasp the moon. Disappointed expectations of this kind imply a faulty objective reference. The awareness of coetradiction depends for its possibility upon judgment transcending the limits of actual sense-presentation, it pre-supposes in particular the reference of different sense to an identical physical thing. Only in so far as that which visually is elliptical is regarded as identical in shape with that which to touch feels round can contradiction arise. But the reference of characters of separate sensation to a single thing cannot be determined on the basis of the particular sensum considered in isolation. It depends more particularly upon concomitant variation between the sense-presentations involved and between these and the experience involved in practical experiment.

The experience of contradiction arises when conditions largely favour, but do not wholly sustain the judgment of identification. But in such cases contradiction is never complete and absolute. Where there is no approximation to concomitant variation, no synthesis, and hence no contradiction, can arise. If a series of visual forms are wholly independent of a series obtained by touch we do not treat one as a distorted appearance of the other, but refer them to wholly different things. The significant contradictions are those which constitute exceptions to a general rule, an incoherence which is partial, not complete, and calls not for the abandonment of the rule but only for a better formulation.

Some degree of truth is required even in a mere appearance. The stage at which we are aware merely of the conflict between appearances without further determination of the situation leaves open two further lines of cognitive development: which of these appearances best presents the real? And how must the false appearance be accounted for?

In the solution of these problems attention is still directed to concomitant variations. In the mere conflict between visual and other presentations (tactile and kinaesthetic) there is nothing to suggest that one is more veridical than the rest. There is no peculiar veracity, as has sometimes been supposed, in the testimony of touch. Examples are easily found where vision is the better guide. It is the series of perceptual judgments which find support and corroboration from other sources which comes to be accepted as the revelation of the real, whilst those which fail to be reinforced by independent evidence are rejected as illusion. Were it possible to reinforce the double images which arise in displacing the eye ball by a corresponding duplication of touch and to preserve the correlation through varied forms of manipulation the faulty judgment would thereby be confirmed, but such conditions are in detail impossible to obtain.

With the consciousness of the real the elementary practical requirements are generally secured, and the illusory appearances are allowed for or ignored. In fact, however, the experient does not leave the matter here. Incoherence in experience, like any form of problem, provides a motive for further activity of attention. Moreover, the data from illusions are of practical utility, and assist the growth of knowledge in other ways. Variation in the appearance of an object may provide no information about its intrinsic nature, but through it knowledge is obtained of the medium in which it stands and of the embodied self as percipient.

In the course of our practical dealings with physical things, sense-presentations arise and change in various ways independently of our own activity, In this way knowledge is primarily gained with regard to objects other than ourselves. When however, changes occur concomitantly with and follow from the exercise of our volition, we obtain a fuller apprehension of the nature and powers of the embodied self. But we cannot sharply divide sensation into two separate groups, those which are wholly independent of ourselves and those which are wholly dependent. In general changes which are partly independent and partly dependent on ourselves occur in all alike. Hence through the same sensible change knowledge is gained concerning both ourselves and other things. But what is only apparent change in external objects means real change in the percipient self, or in the medium of perception. "Appearance" and "reality" are thus relative terms. Nothing is *mere* appearance, nothing *sheer* illusion. Originally knowledge is vague and confused. Attributes within the presented field are loosely and indiscriminately referred. But the properties of things are gradually sorted out, as being either the real and inherent properties of the thing perceived, or of the medium through which we apprehend it, or of the organs of the self. Before discrimination is complete the real properties of one thing are the apparent properties of another, but nothing which enters into perception would seem to be able to stand as the property of nothing at all. There is no doubt a tendency to refer too much to that which at the time is the centre of interest — usually the physical thing perceived — and too little to the medium through which it is observed, and hardly anything at all to the organ of perception.

So far then from our apprehension of the world commencing in the awareness of "subjective modifications" giving rise to a subsequent process of "projection" of their properties to external physical things, the reverse description would be much nearer the truth. If anything, we start with an objective bias, and what is most inward is the last to be observed. A long inductive inquiry is required in order to determine just where each property is properly to be referred. The process serves to illustrate the fact that "scientific method" is implicit in cognitive development throughout. Our pre-scientific knowledge both of the external world and of the embodied self involves the use of principles which later may admit of explicit formulation and deliberate use. The employment of hypothesis, the search for verification and the use of "methods of induction" so far from being superimposed at the level of pure conceptual thought are implicitly involved at every stage. Conceptual formulation arises from reflective analysis upon processes which have practically been employed without abstract formulation or generalised expression. Here, as elsewhere, science is but the refinement and extension of common sense.

CONATION

In reviewing the functions of the embodied mind, priority of treatment, in conformity with tradition, has been accorded to cognition It is, however, very widely held that priority belongs by natural right to the experience of conation. Primarily, it is said, we are practical beings, we cognize only as a means to action. It would further seem to be implied that cognition as divorced from practical action is a late and unnatural growth.

We can in fact go further and assert that cognition is itself a mode of action, and any separation is possible only by abstraction. This, however, can be granted whilst denying priority either way. If mere cognition is an abstraction, conation divorced from it is unintelligible. The object of conatioa must be also in some manner an object of apprehension.

In the study of conation we return to the problems which are central from the objective point of view; for the experience of conation is the normal psychical antecedent to a bodily movement. But many psychologists have been curiously unwilling to endorse this common sense opinion that an action is normally the outcome and expression of a *wish* or of our wanting some change In a given situation. It is often said, for example, that for a movement to occur all that is necessary is that attention be directed to a representation of that movement or of its effects. This is the doctrine of *ideo-motor action.* It fails, however, to do justice to the unique and irreducible nature of conative experience and to assign it any intelligible function when it in fact occurs. Whilst "wanting" implies attention the latter does not exhaust the meaning of the former. It is in fact only a special case, Attention is conation directed to further cognition. Bodily action, however, implies more than curiosity with regard to the presentation of movement. We *want* the movement to occur and external effects to be produced. We shall find that a more coherent theory of behaviour can be founded on the view that conative action is primary and that ideo-motor and even reflex action are specific types of simplification of what was originally more complex.

Whenever there is experience there is the experience of conation. The statement is difficult to establish only when it is difficult to prove anything at all—in the very beginnings of mental life. But we are not dependent upon the direct observation of beginnings Here, as in the study of cognition, we rely on the analysis of mental life in its clearest form and upon the postulate of genetic continuity. Explicit desire, directed to ideally represented ends, is obviously not the beginning of conation. We strive and struggle at the perceptual level. The wish to be rid of a toothache does not involve ideal representation of the state of affairs we aim at. In its most primitive form, the aversive attitude is directed to the removal of the present pain; its end is "anything but this," and need not be further defined.

It has been asserted that the development of purposive action depends, in primitive experience at least, on the aversion which goes with present pain and not with any appetition accompanying present pleasure. In positive enjoyment, it is said, there is only a tendency to maintain the pleasant situation as it already is; and for this all that is required is attention to it and such motor adjustments as subserve attention. Aversion to a present pain, on the contrary, can be satisfied only by getting rid of the painful conditions, either by removing them or by escape from them. Its success therefore gives rise to a new state of affairs, not to a mere continuance of the pre-existing situation.

It may be doubted whether this account of the conative side of pleasant as contrasted with painful experiences is tenable. It is by no means always true that the continuance of enjoyment depends only on the uniform continuance of certain agreeable conditions. In the most important cases, what is enjoyed is enjoyed as a stage in a progressive process leading up to relatively new stages, so that, to quote Hobbes, "There is no content save in proceeding." In such experiences the end to which conation is directed is not merely "this" but "something more than this" or "this and something more." As examples at our present level of development we may refer to the pleasant excitement of reading a novel, or the pursuit of knowledge or of adventure. At a lower level, we may refer to the pleasant excitement of an animal in pursuing a prey or in courting a mate, or in other activities along the general lines of inherited instinct. If we suppose a most primitive experience in which inherited instincts as yet play no part, the experiencing individual will have to find out purely by tnal and error how to treat a given situation so as to continue and enhance the enjoyment of it. But it is equally true that under such conditions he would have to learn'partly by trial and error how to get rid of pain.

If we lay exclusive stress on pain and aversion in the first development of purposive action, it is hard to see how the development on the appetitive side can be accounted for at all. For if we adhere consistently to the general principle underlying this view, our only motive in seeking anew pleasures which we have enjoyed before, would be pain in their absence. Our only motive, for example, for eating a good dinner would be the pangs of hunger or at any rate some felt discomfort when we see it or think of it. The pleasant excitement of a healthy appetite would not suffice. If we begin only with the coercive and repressive discipline of pain it would seem that we never get beyond it. To do justice to the past we must from the outset begin with both pain and pleasure as mutually complementary. The first accounts for the development of conation, in its negative or aversive aspect, the second in its positive or appetitive aspect. Through the first we learn what to avoid, through the second what to pursue for its own sake. In one respect, however, pain is more important than pleasure. Especially in primitive experience it is frequently more intense and immediately urgent leading to more strenuous and violent action. From the biological point of view this is necessary to provide against imminent dangers which imperatively require to be met with the utmost promptness and vigour.

Levels of Conative **Development.**—Conative experience varies in respect of its qualitative modes, in intensity and duration, in the nature of its ends, and in the character of the action in which it finds expression. The most important changes in the course of mental development will be found to depend upon cognitive growth. Given presensory experience with correlative objective reference, there will be primary objects of appetition and aversion Further differentiation, itself conditioned by prior conation, will yield further objects of conation. Responses at first conditioned by isolated sensations will be increasingly controlled by attendant circumstance. The more determinate the objects of cognition, the more determinate will become the connected objects of conation, and with the extension of the cognitive range simple impulsive actions will give place to responses conditioned by retention and the presence of free ideas. In general, the laws of cognitive development apply *mutatis mutandis* to the development of conation. Our problem now is, starting from primitive conation, to trace the main phases of this development.

The Primitive **Impulse.**—With reflex action, in the physiological sense, we are not here concerned, so far, at any rate as there is no concomitant experience. But many actions which, externally viewed, appear to be purely reflex have conscious concomitants. The response to the prick of a pin involves not only an awareness of sensory pain, but also the impulse to remove it. Such experience might seem to provide a convenient point of departure for the study of conation.

In a sense, the presentation of pain is the object of the aversion, but the statement requires guarded interpretation. Sense-presentations as objects are essentially incomplete. The response is concerned with a physical source of stimulation more or less clearly so perceived. There is, moreover, a further way in which conation here relates to something beyond what is sensibly present. The object of aversion is thought of as something alterable and as something to be altered in some way. The kind of alteration required is probably never wholly indeterminate.

In conative activity at the perceptional level there is a group of presentations of paramount importance. So far as changes are effected in the external world, and thereby in the sensory field, they can only be produced by means of bodily movements similarly presented. Conation is thus subsidiarily concerned with presentation of bodily orientation and of movements to be performed. Whilst in simple reflex action awareness of bodily movement may be extremely vague, and perhaps entirely absent, this is far from being invariably the case. Thought of the movement to be performed is often quite distinct, and the awareness of the body an important controlling factor throughout the operation. If we regard such simple deliberate acts as the primary form of conation, it is possible to exhibit the reflex and the habit as a specific modification resulting from exercise. From this approach the simplest formulation of primary reactions turns out to be somewhat complex, but the path is more than proportionately smooth for an account of subsequent development. We may state the case as follows: The presentations of external objects which call for alteration, when accompanied by an awareness of bodily orientation (apprehended as admitting of similar alteration), directly evoke a movement producing change in the required direction. Symbolically:

P_1 apprehended as alterable to P_2 (P_1, P_2 being respectively objects of aversion and appetition) in conjunction with M_1 apprehended as alterable to M_2	directly evoke M_2 and indirectly P_2

Even this formulation involves excessive simplification. In the first place P_1 is apprehended in a context which from the outset plays an important part in determining the response; and a similar complexity is involved in the presentation of bodily orientation (M_1). Moreover, the latter is not simply a matter of muscular sensation. It comprises all that is relevant to an awareness of the general "organic state," such as the conditions of appetite in the narrower sense of the term. Further, the movement to be performed is apprehended as possessing a number of possible characteristics of speed, extent and direction, and the performance will vary according as one or other characteristic is relevant to the intention.

Modifications of **Conative** Process. — Primitive conative tendencies may be modified in various ways. The cognitive context admits of various forms of simplification and elaboration. Activity is not in general conditioned by single presentation but by complex presentational cues, the features of which are more or less clearly discriminated and jointly operative in producing the effect. Central features will have a context more or less stable or variable. When it is relatively stable a single subsidiary feature or merely a general impression will serve to guide activity. When the context is variable, response may call for similar variation. A second type of change relates to intensity. At first sight the frequent occurrence of the same situation appears to work in either of two directions. Conation may be intensified and specific tendencies confirmed, or there may be progressive weakening of the original impulse. Practice in a game may lead to what is at first a mild diversion becoming a ruling passion. On the other hand we become adapted to sources of irritation and lose interest in pursuits which previously held our attention. A third kind of change arises in the progressive integration of the primary tendencies. Several cases call for special consideration.

Automatisation. — It is a familiar observation that actions originally requiring attention come to be performed "unconsciously." We do not, for instance, give the same attention to the buttoning up of a coat as a child who is learning to do so. There would seem to be two stages whereby a movement becomes automatic. The first is that in which attention is merely withdrawn from the movement and concerns itself with the external cues alone. In threading our way through a crowd we do not think of the movements of turning to right or left, or increasing our speed or stopping as occasion requires. Action follows directly upon the perception of the obstacles which we have to avoid. In variable situations automatisation does not advance beyond this stage; but in relatively constant sequences of events attention can also be withdrawn to a very large extent from the external cues as well. Thus in walking on even ground we do not attend to the sensations in touching the ground though these in fact condition each successive step. If the process advances so far that attention is wholly withdrawn an act originally conscious is then indistinguishable from a reflex.

Variations in Strength. — Repetition or exercise we have noted sometimes results in a tendency becoming more pronounced, sometimes in its progressive disappearance. Behind this diversity a single principle would seem to be involved. So far as the performance of any movement produces satisfaction the tendency to perform it is confirmed, so far as it fails to promote the ends in view the tendency is weakened.

This is the well known "Law of Effect" expressed in conative terms, and is identical with the principle already dealt with as the "Law of Association." Here, too, the law has sometimes been supposed to operate in conjunction with other laws — Recency and Frequency, and the same modification is here required. Recency and Frequency are dependent and possibly counteracting laws but further determinations of the primary law. The more frequently and the more recently a given response has proved successful the more likely it is to recur.

Transference of Interest. — Interest may be transferred from one object to another, and conative activity from one direction to another. The simplest cases are among those which externally viewed, may appear to be conditioned reflex actions. An object B originally accompanying A evokes the interest and acquires the power to provoke the response originally due to **A.** Sounds of a certain kind provoke the response of fear, and attendant circumstances may acquire a similar power. So far, however. there is merely an extension of the range of objects possessing a frightening character. The term "transference" may be employed when the acquisition of interest in B is accompanied by loss of interest in A. There must, however, be conative continuity between the two situations; the interest in B must be derivative from the interest in A or both must have a common origin. Many examples are to be found in the changes in theoretical interest. Practical construction may generate an interest in Physics, and this in turn may lead to Mathematics, the original practical interest being weakened or wholly lost. A more primitive case of great importance is transference in the tendency to respond to a specific situation in a given way. The primitive response to opposition is destructive and aggressive. Under certain conditions this may be displaced by subtler and more delicate reactions. In general, the relative efficiency of different modes of response is the chief determinant of this form of modification.

Chains of Action. — Particular importance attaches to constant secondary features in a perceptual situation when they have the advantage of temporal priority. They serve then as signs and portents of what is about to come, or may be brought about. This fact accounts for the increasing predominance of the "distance receptors" such as eye and ear, in perceptual development. The secondary features will according to circumstances either immediately evoke the original response or elicit a new one calculated to hasten the situation in which this response will be appropriate. At the sound of danger, flight may ensue without awaiting the arrival of the enemy. But the distant perception of prey tends not to an immediate attempt to seize it, but to antecedent pursuit, until a situation arises in which the use of the jaws will be effective.

Situations to which the right response is known and productive of satisfaction themselves become the object of appetition. In this way chains of activity, considerable in length, will in course of time develop. This would seem to be the origin of the familiar "behaviour cycles." In following out such cycles awareness of the ultimate end is by no means likely to be present. Each step need only involve prevision of the initial phase of the next.

But as we have noted, from another point of view, such developments do not consist merely in the elaboration of actions in single file. Attention is directed not only to the central feature of the situation and its antecedents but extends to all attendant conditions. More particularly, when a given response is not consistently successful a certain hesitancy will arise conducive to further discrimination and further variation. The successful response will vary according to the context. Hence, relatively to any given presentation there will be alternative responses. The whole will constitute an extremely complex conative disposition.

Primary and Secondary **Tendencies.**—Within such complex systems a distinction must be drawn between conative tendencies which are relatively independent in their ends, and others which only come into play in a purely subsidiary rôle. The former have primary ends, but the secondary tendencies have only derivative ends. The distinction is clearly present in certain classifications of the instincts. Whilst the search for certain sensory pleasures may, *prima facie,* be regarded as providing an "absolute end," "pugnacity" is dependent upon the thwarting of some more primary impulse. The instinct of escape in some of its forms at least would also seem to presuppose some prior tendency.

The distinction is to some extent, obscured by the fact that, in accordance with the tendency for means to become ends, secondary trends may acquire a certain primary character. "Pugnacity" may become an art, and danger may be sought, but the primary and the secondary forms in this case may still clearly be distinguished by their ends. In the secondary form, pugnacity involves a tendency to break down some opposition in *order to get on with something else,* whereas, when indulged in for its own sake, a conventional or fictitious opposition. is established *in order to break it down.* "Means" and "end" from the standpoint in the first case are in the second reversed.

The secondary tendencies in general are adaptive differentiation of conative activity in response to certain typical vicissitudes of the primary conation, but such terms as "pugnacity" and "anger," "flight" and "fear" are wholly inapplicable to these tendencies in their primitive forms. The first clear lines of differentiation correspond to the distinction between relative success and failure as appreciated by the experient. "Nothing succeeds like success." Partial success, in other words, exercises a special directive influence upon the course of future endeavour. Action tends to be restricted to the lines which have proved successful, whilst in failure there is a corresponding increase in the range of experimental variation. This, relatively to any given direction of activity implies a corresponding variation in the intensity of conation. But whilst success does not admit of great difference of kind, there are many forms of failure, and certain typical kinds of obstacle call for special kinds of adjustment. The characteristic difference between pugnacity and fear will thus gradually emerge. Both have their origin in hindrance and opposition, and it is not easy to determine with precision the conditions under which one rather than the other is likely to find expression. Roughly, one may say that fear is more commonly the adjunct of an aversive reaction, whilst pugnacity is employed in the service of appetition. Exceptions, however, are many and obvious. Pugnacity tends to arise in relation to other wills or in regard to objects which admit of "personification," and when the opposition is from a source not disproportionate to the agent's powers. Fear on the other hand is more readily evoked by dangers which are inadequately understood, by impersonal forces of nature, and by opposing wills of such overwhelming power that resistance will not avail.

But in the course of conative differentiation and elaboration, many complex systems may develop, which blend in such varied ways as to render hard and fast classification, totally misleading. In tracing the course of such elaboration, certain typical systems may be selected for brief analysis.

Emotion.—Emotions have been supposed by various thinkers in turn to be almost everything which might theoretically be imagined, sensations, the memory of past feelings, peculiar mode of present affective tone, or specific forms of conation. The principal issues involved may perhaps be indicated by a brief consideration of the doctrine espoused by William James (1842–1910) that emotions are the sensations which arise from the reflexly determined actions which are generally regarded as emotional *expressions.*

The objections to this view—which it is generally felt must be mistaken—do not arise from the data of physiological observations (which at present are inconclusive) but from a question of general principle. The matter is primarily one of psychological analysis. To those who adopt a strict sensationalism (and to the sensationalistic tradition this doctrine is largely due) the issue is predetermined in favour of James's view; but once distinctively affective and conative modes of experience are elsewhere recognised, their place in the experience of emotion is not difficult to observe.

It is significant that in the most natural way of describing an emotion we refer to conative tendency. Anger is the "feeling" that we should like to break or injure the object of aversion, fear the impulse to cringe or run away, and embarrassment a wish "to drop through the floor." So far from it being adequate to say, with James, that if sensation is "thought away" nothing distinctive of the emotion will remain, it would be more to the point to assert that removing its distinctive impulse from the experience of an emotional upheaval, we should find it difficult to decide whether we were angry, frightened or in love.

The fact would seem to be that an emotion is an extremely complex state of mind, involving each of the fundamental "elements." Sensations are undoubtedly essential, but cognition feeling and conation are equally implied.

The nucleus of this complex "psychosis" consists of the primary impulses involved in emotional expression, whether of muscle or gland. Emotion is not the mere experience of sensation, but it well may be conation with sensations of the expression (as such expressions are presented to the subject) as the primary objects. In anger, there is a certain satisfaction to be derived from a clenching of the fist and biting the lips. The emotional expressions are, in fact, constituents of the total object of desire. But in themselves "expressions" are incomplete. They are at best but preparatory adjustments, and from the standpoint of the experiment there is reference to an external object, in relation to which further co-ordinated action is required. For this reason it would be untrue to say that emotional tendencies do not admit of modification. Primitive tendencies persist side by side with later developments; expression of emotion shades off imperceptibly into the manifestation of instinct, and instinctive action will be found to admit of considerable modification.

Instinct.—Earlier approaches to the subject of instinct were purely biological, the term being employed to designate certain complex trains of activity, serving a useful purpose, which are perfectly executed from the first in total independence of past experience, but blind and invariable, in the species, and, through their period of exercise, in the individual life. Close observation, however, has revealed that none of these characteristics can in strictness be assigned to actions admittedly instinctive.

The Blindness **of** Instinct.—The distinctively psychological treatment of the subject relates to the nature of the experience which accompanies the performance of instinctive actions. But once it is admitted that there is an experience at all—and the fact is indisputable—it becomes impossible to maintain that the action is wholly blind. Perception of the exciting situation is at least required, and with the possible exception of the first performance some dim recollection of the effects of prior action would seem also to be involved. But even on a first performance apprehension is not restricted to the present. The perception of a given situation as one which calls for change would seem to be an essential characteristic of conative experience. The total apprehension includes a specific reference to the future, and a vague awareness of the sort of change required. There is presumably a measure of expectation, too. The moor-hen on its first dive would at least experience surprise if, as a result of its reaction to the provocative agent, it found itself in a wholly unmodified state of affairs. How determinate expectation may be in such circumstances it is hardly profitable to inquire. What is of general importance'is that to explain the development of instinctive experience, and of intelligent foresight, some reference to the future is originally involved. Growth in respect of such experience consists not in the introduction of such reference at a certain point, but in a gradual extension of temporal range, and in progressive definiteness in what is apprehended.

The "Perfection" of the Instincts.—Here, too, closer observation has called for a modification of earlier ideas. Some more qualified term than "perfection" seems to be required, and it has reasonably been suggested that the most that we can say is that instinctive action is good enough to be serviceable when it is first employed. But serviceability is relative to the situation. The first flight of the bird will save it from falling to the ground, but will not enable it to evade the attacks of enemies from which in later life it can easily escape. A distinction, too, must be drawn between the earlier and later phases of a chain of instinctive acts. The terminal links may appear to be almost reflex, whilst the earlier may be comparatively inexpert. The distinction is obscured by the somewhat artificial restriction of such terms as "instinct" to the more automatic phases of a continuous sequence of behaviour. The distinction is of importance in regard to the range of variability, and the dependence upon previous practice. The laying of the egg may be perfectly performed, whilst the search for material with which to construct the nest may leave much to be desired. The latter, too, will allow of variability on account of local conditions, and perhaps on account of individual difference of temperament. The former does not allow the same degree of scope for originality.

The Sentiments.—The higher levels of conative activity are characterised by the organisation of many and varied tendencies in the service of dominant ends, by the formation of abiding "attachments" to persons, places and things, and by the conscious pursuit of remote and ideal ends.

In contrast the lives of the lower animals appear to consist in casual and conflicting instinctive responses to what is sensibly present, without memory, constancy or foresight.

Here, as elsewhere, the advance is conditioned by a parallel development in cognition. Permanent attachments presuppose the capacity to recognize an individual as such and not merely as a member of one's kind. It presupposes also a uniformity of emotional response. So far as in virtue of past experience an object acquires the capacity to evoke a constant emotional reaction it is said to be an object of an *emotive disposition.* But objects which evoke one emotional response will generally call forth several according to circumstances, and an organisation of a system of such dispositions constitutes a *sentiment* as the term is psychologically employed.

But the mere occurrence of a variety of emotional responses towards a single object is not enough. A mere business acquaintance may on various occasions arouse a series of distinct emotional attitudes, in consequence of which we may develop nothing more than a tendency to regard him with mingled feelings. Nor do we develop in the ordinary course of events any distinctive sentiment in relation to the weather.

Organization of conative tendencies is only brought about when some dominant impulse is in control. In such typical sentiments as love and hatred, or devotion to a cause the distinction previously drawn between primary and secondary tendencies is seen on a higher plane. A dominant conation with persistent attachment to a central object maintains in its service a system of subsidiary trends. Joy, Sorrow, Anger and Fear are four subsidiary tendencies which are generally involved. In Joy we recognize, at a later stage of development and suffused with a distinctive affective tone, the primitive reaction to success. Fear and Anger, as previously observed, may be regarded as corresponding developments of the responses evoked by difficulty. Of these too Sorrow would seem to be a further special case, being in the extremer form a tendency not only to desist from any given line of action but to abandon the pursuit of the end by further variation of means. It is seen in its purest form in the ultimate defeats of the primary trend.

Theoretically, any conative tendency of primary and independent order, so far as it is enduring and concerned with a central object to which a permanent "attachment" can be formed, may provide the basis of a sentiment. It is rare, however, in normal development for tendencies to be found in such isolation. In so far as there is approximation to such simplicity the disposition is more appropriately described as an obsession, monomania, or "complex," all of which terms involve a reference to some degree of dissociation which alone can produce such isolation. The typical sentiment is complex and more or less controlled by the character as a whole.

The parental sentiment involves a tendency to seek the presence of the child, to foster its development and to anticipate all that a mature and enlightened self regard might lead it to desire.

As the simple tendency occurs only in a more complex system so the sentiment forms part of a larger whole. The parental sentiment is usually bound up with what would otherwise be regarded as ego-centric ambition and both are modified in proportion to the extent to which they blend and interact.

In general the structure of character as a whole may be interpreted as a resultant of such modes of synthesis.

GENERAL SURVEY OF THE SCIENCE

General Psychology.—In the foregoing exposition an attempt has been made to present the central problem of the science, and to indicate certain representative lines along which its topics may be treated. It need scarcely be said, however, that the subject is controversial, and that even fundamental issues are still matters of dispute. In particular, we have noted two sharply opposed tendencies which have contended for priority throughout the history of the science. On the one hand the distinctive nature of conscious life has given encouragement to the project of constructing a pure Psychology, a science of mind treated in absolute separation from its physical and physiological connections. This conception of the science has been fostered not so much perhaps by psychologists themselves as by the development of the physical science through which Nature has come to be treated as a system "closed to mind," a doctrine inevitably suggesting that Mind is equally closed to Nature. On the other hand, mental life has a bodily counterpart and in a variety of ways appears to be bound up with the more elementary functions of the organism. Hence the tendency to approach the problem of mind from a biological point of view.

On each side of this broad division subsidiary schools are aligned. It is important to avoid each of these extremes, and more particularly important to avoid the assumptions upon which the antithesis is based. What is revealed to "introspection" is not wholly exclusive of the world revealed to external observation. Without assuming two separate and independent fields of investigation, Psychology may be comprehensively treated as the science of individual experience, its conditions and its expressions in behaviour. In practice it is generally so treated whatever the view professed. Primarily it is concerned with the analysis of experience, and with the laws of psychical process. Herein its most distinctive concepts emerge, and for the conduct of the inquiry introspective observation is essential. In determining the bodily processes with which mental life is connected it is in the main committed to the procedure of the biological sciences. These studies are psychological so far as the facts revealed are related to mental life. The two methods are systematically combined in the use of experiment. The distinctive feature of the psychological experiment is that it involves a two-fold process of observation: external observation by the experimenter who arranges the physical setting, and introspection on the part of the subject of the experiment.

More specifically, Psychology is concerned with mental process in relation to a certain cycle of events in which five phases may be conveniently distinguished:

1. A process of stimulation commencing externally to the body,

II. Receptive physiological processes,
III. Central processes,
IV. Responsive physiological processes,
V. Physical products and other changes, again external to the body.

The fundamental relations between body and mind call for formulation primarily with regard to mental process and the third phase of the cycle. It is doubtful if these be causal in tbe ordinary sense of the term. But there is a considerable mass of evidence that a close parallelism holds between mental and central physiological process. How close it is as yet impossible to say; but the further we pass from central to peripheral events the less exact it becomes. Nevertheless it is possible to establish certain correlations between stimuli and experiences and between experiences and expressions In fact upon such relations depends in very large measure our knowledge of minds other than our own.

Traditional Psycho-physics is concerned with the precise relations which hold between experience and the phase of the process, though a complete solution to the problems raised involves some reference to phases II. and III. In this connection there arose the first important attempts at mental measurement. (*Cf* EXPERIMENTAL PSYCHOLOGY and PSYCHOLOGY, HISTORY OF.) The central problem here is to determine the quantitative relations between stimulus and sensation.

The psycho-physics of perception is paralleled by a psychophysics of expression. Mental process finds expression in movement and in the activity of the glands; and the form of expression, either in itself or in its products admits of precise determination. Though little advance has been made in the direct measurement of the mental state expressed, much has been done in the measurement of the expression, and the results obtained admit of important application. Under this head falls the subject of Mental Tests, and the study of the conditions of efficiency in work. (*Cf.* INTELLIGENCE TESTS.)

The study of mental life in relation to the last phase of the cycle provides Psychology with many points of contact with the anthropological sciences. The mind of primitive man is known only by the products of his work and thought; and extending the concept of mental product to embrace spoken and written language an enormous field of research is opened up. In this way, for example, Philology and Folklore bring grist to the psychological mill.

Genetic, Comparative, Individual and Abnormal Psychology. — General Psychology is concerned with what is true of all experiments alike. But experiments differ, and there are many branches of the science concerned with their differences. Some differences are the product of development, and so far as interest is directed to tracing the course of growth, the study is said to be genetic. In one sense all Psychology is genetic, since development is a universal property of mind, and with its development we have been concerned throughout, so far, at any rate, as its course can be reconstructed from the general laws of mental process. But the term "Genetic Psychology" tends to be restricted to certain special studies; that of the development of mind in general, and the inquiry into the course of growth in the individual life. The former has lent a special interest to the study of the animal mind; the latter has fostered the growth of a child Psychology.

Not only do races and species differ, individuals differ too. "Differential" Psychology, or the study of individual differences is one of the fruits of measurement. For one person differs from another not so much in the presence or absence of fundamental characteristics, as in the relative degree to which various common functions may be operative.

Applications of Psychology. — After a long period of slow development the science has reached the stage at which it may be profitably applied. For the purposes of a general survey it will suffice to distinguish formative, directive and curative applications. Prominent under the first head are the applications of Psychology to education. In general, educational practice aims at the formation of cognitive, affective and conative dispositions which are likely to be serviceable in later life and in the pursuit of some career; in other words, to develop knowledge and ability, taste and character. Educational Psychology attempts to formulate the theory relevant to this process. In many respects, no doubt, the unsystematized "wisdom of the ages" and the genius of the teacher counts for much more than does psychological theory. This is notably the case in the training of taste and character. But in regard to the acquisition of knowledge and to the cultivation of ability, Psychology can offer a more effective contribution. Even here, however, the contributions are largely negative. Theoretical consideration and experimentat findings have largely succeeded in dislodging many deeply rooted practices based on mistaken doctrines concerning the growth of the mind. The discovery, for example, that training in one direction is not necessarily transferred to others apparently similar has exerted considerable influence upon educational procedure. So, too, has the development of mental tests, the utility of which is by no means limited to the definition of the natural course of development and the limits of educability. If positive and constructive contribution to the training of character are less obvious one can at least point to a promising ferment of ideas in relation to these problems. This has largely been directed and inspired by psychological theory.

Given minds equipped with appropriate dispositions, there is still scope for guidance, for directing energy and ability into appropriate channels and for controlling its economic use. What we have called the directive applications of Psychology are notably illustrated in vocational guidance (*q.v.*) and by the study of the conditions of efficiency in work. This field of application is rapidly expanding. It largely depends upon the close co-operation of psychologists and physiologists. The distinctive contribution of the former, however, lies not so much in detailed application of psychological theory as in providing a new approach to problems hitherto conceived — when conceived at all — in purely physical terms.

The treatment of mental disorder provides another example of the intrusion of the psychological point of view. Mental like bodily function may become deranged, but so-called treatment for both alike had for centuries been conceived in a purely physiological way. In the later years of the nineteenth century a reaction set in against this conception, and methods more psychological began to be employed for the treatment of "nervous" disorders. It is too early, perhaps, to pronounce with assurance upon the results of modern psycho-therapy, or to adjudicate between its rival schools, but here, too, there is great promise in the change of standpoint and undoubted value in the ferment of ideas. Not less important than the changes in treatment for mental disorder and the connected preventive and educational applications which advance to this field may be expected to provide. (See PSYCHOANALYSIS.)

Psychology **and Philosophy.**—As yet it is not possible to treat Psychology simply as a special science. In view of its distinctive concepts it cannot be wholly divorced from philosophical thought. The analysis of these concepts raises fundamental questions as to the nature of mind, its causal and other relations to the material world. Special topics may be treated in the empirical way of the natural sciences without raising metaphysical issues. This is the case, for instance, in the study of the details of sensory experience and of its physical conditions, in the investigation of the laws of learning and of forgetting, and in the quantitative treatment of individual differences. But outside such special inquiries, and more particularly in the attempt to give an account of this science as a whole the Psychologist is continually on the verge of metaphysical issues. To a great extent the successes achieved in the sciences of the material world have had to be paid for by the science of mind. This success has in part been attained by regarding as purely mental all phenomena which fail to fit into the purely physical theory. In this way, for example, the secondary qualities of material things were presented to the Psychologist as examples of what is distinctively "mental" to the consequent confusion of his field. Hypotheses and methods employed in the natural sciences have tended to be regarded as essential to science in general, and to these psychological data are supposed to conform. There has been no purely psychological hypothesis, generally acceptable, which has done for Psychology what the atomic theory, for instance, has been able to do for Chemistry. Such very wide hypotheses have often been proposed, but following physical and chemical models, each sooner or later has become the victim of a reaction. There is thus much to suggest that Psychology must employ hypotheses and methods which are peculiar to itself. In any case the psychologist must be critically occupied with a variety of questions which for other sciences are mainly predetermined. He can escape controversy only by restricting himself to co-operation within the narrow limit of a "school." In the later phases of the history of Psychology, new schools of thought have arisen in almost every decade, each proclaiming a Copernican revolution. Whilst this, no doubt, is evidence of vitality and progress, the multiplicity of claims suggests that the Copernican revolution is yet perhaps to come.

BIBLIOGRAPHY.—General Psychology: G. F. Stout, *Manual of Psychology* (4th ed. 1929) and *Analytic Psychology* (1896); W. McDougall, *An Outline of Psychology* (3rd ed. 1928); J. Ward, *Psychological Principles* (2nd ed. 1920); W. James, *Principles of Psychology* (1890) and *Text-book of Psychology* (1892); R. S. Woodworth, *Psychology—a Study of Mental Life* (1922); *Psychologies of 1925* by various authors (1926); *Traité de Psychologie*, ed. by G. Dumas (Paris, 1923). Special Departments: For the more important works on the particular branches of the subject *see* the bibliographies to the special articles. (G. F. St.; C. A. Ma.)

PSYCHOLOGY, COMPARATIVE. This article deals with Comparative Psychology in its biological aspects. The aspect of the subject from the pure psychologist's point of view will be found under COMPARATIVE PSYCHOLOGY. In everyday life we are accustomed to look upon the behaviour of animals in the same way as we judge the actions and conduct of our fellow men. We do this as if the actions of animals were dictated by a consciousness such as we know from our own experience. In this way we attribute to animals sensations, perceptions, ideas, feelings and impulses, dictated by will. We suppose that these faculties control the behaviour of animals as they do our own actions. The driver talks to his horse, the sportsman to his dog. We say that the worm writhes with pain, the moth flies into the flame out of curiosity, the dog is faithful, the serpent false. The hen which has acted as foster-mother to ducklings looks on with anxious feelings as the young take to the water. And the aquarium naturalist maintains that mussels, sea-snails, starfishes or sea-anemones, feel happy when they move or expand in the fresh water he has given them. This common-sense view, which represents the natural attitude of unprejudiced man to animals, has been usual from the earliest days. Savages and primitive peoples to-day feel themselves closely related to animals. On such a conception of the relationship of the minds of animals to those of men reposes the widespread belief in a transmutation of souls with intermediate stations in animals, the so-called metempsychosis.

Since ancient times, however, there have always been investigators who opposed this anthropomorphic conception of animal behaviour. Descartes maintained that animals are mere machines, moving purely as automata in response to stimuli received. But above all it is modern advances in science which have caused men to study the behaviour of animals more closely and more critically. The nervous system and the sense organs have become better known. The rising science of physiology, concerned with the functions of living organisms, has been able to show that many actions of animals can be submitted to a scientific study and to a causal explanation. Thus it came about that at the end of the 19th and beginning of the 20th century, a number of workers, such as Beer, Bethe, von Uexküll, maintained that the behaviour of animals is solely a subject for physiological research. According to these and other more recent workers, the concern of science in studying animal behaviour should be strictly limited to the investigation of visible movements and of their causation. One of the principal reasons why these researchers disagree with the anthropomorphic view-point sketched above is that *objectively we can never obtain information about the inner life of animals, i.e., about the phenomena of consciousness going on in their minds.* Indeed, the same thing is really true for the conscious life of our fellow men. For from direct experience we only know our own conscious self. But since our fellow men in like situations behave as we do, therefore we conclude by analogy that they think and feel just like ourselves. Further, they tell us the same thing in speech, so that the conclusion by analogy seems all the more sure. The science of human psychology is founded on these facts. But the behaviour of animals leads to a similar analogy, especially the behaviour of those animals most nearly related to man and of those in whose ways man has most confidence, since they surround him as his household animals. For this reason comparative psychology, which is concerned with the origin of human conscious phenomena in children and lower human races, is led to deal with such analogies in animals when it is seeking, in the animal, phylogenetic antecedents of the human mind. And so, with the coming in of the present century, a new science has arisen, the goal of which is to study animal behaviour, in particular such phenomena as resemble those connected, in man, with particular mental occurrences.

A further circumstance must be taken into account. The behaviour of animals in their natural environments tends throughout to be purposive and concerned with preservation of life. Now, we are accustomed to derive the purposefulness of human conduct from the action of will, which reasons and has an aim. And so we incline, on superficial reflection, to ascribe purposive animal conduct to the action of a similar will. Only a closer inspection of the nature of many actions of animals shows that the matter is not so simple as to justify such an analogy. We find a remarkable purposefulness not only in the behaviour of the animals but also in their bodily structure. The development and functions of organs are purposeful throughout. This shows that not all purposefulness need be the result of the conscious workings of will. At the same time, this fact is a further ground why science should concern itself with the causes of animal behaviour. This new science, whether called the science of animal behaviour or animal psychology, is concerned not only with the behaviour of animals under normal circumstances, but it attempts, by experiment, to penetrate more deeply into the connections between cause and effect in animal conduct.

REACTION TYPES

Animal reactions can be divided into four groups, according to the degree of complication of the physiological processes which accompany them. These types of behaviour represent to a certain extent four different levels at which the reactions of animals proceed. The behaviour of animals may take the form of tropisms or taxis, which are not very common; reflex movements or reflexes, which are universal; instinctive reactions; and lastly intelligent actions, found only in the highest animals. Although reflexes and instincts occur both in animals which, as regards their performances, stand at the very summit of the animal series, and also in the lower animals, nevertheless within the animal kingdom a gradual increase is recognizable in the degree of accomplishment of reactions. Instinctive behaviour assumes a higher degree of complexity and at the same time a greater plasticity as we ascend the animal series. This is correlated with the higher development of bodily structure and the greater efficiency of the nervous system which goes with this.

Tropisms.—Many animals exhibit a particular response to stimuli affecting particular regions of their bodies. They turn either towards or away from the source of the stimulus. When a turning of the body alone is concerned the reaction is called a *tropism* (Gr. τρέφειν, to turn). If the animal moves in the direction which the body has assumed we speak of the behaviour as a *taxis*. According to the kind of stimulus concerned, the reactions are named *thigmo-*, *stereo-*, *geo-*, *thermo-*, *chemo-*, *photo-*, *helio-*, or *tropho-taxis* or *tropism*. The names refer to the stimuli due to pressure, touch of a solid body, gravity, temperature, chemical substances, light, sunlight or food. The tropism or the taxis is positive when the animal turns towards the source of stimulation, negative when it turns or moves away. Sessile animals attached to the substratum can only perform bending movements with their free anterior ends or organs. These animals, then, exhibit chiefly tropistic movements. Thus the hydroid polyps in the sea turn their hydranths towards the light. New branches of the colonies grow naturally towards the light falling on them from above. If a branch of such a polyp stock is suspended in an aquarium lighted from above, so that the end normally uppermost hangs lowest, then the newly budded branches grow upwards once more. This is a result of a negative geotropism and a positive phototropism inherent in the animal. Most lower animals, especially worms, but also many small mammals, exhibit a positive stereotropism. They come to rest only when the greatest possible extent of their body-surface is in contact with solid objects. This is one of the reasons why, in an aquarium or cage, the inmates seek out the angles and corners. The bottom-dwelling catfish *Amiurus* takes up these positions owing, on the one hand, to thigmotaxis — its feelers seek to touch solid objects — and on the other, to phototropism. When the two types of stimuli do not coincide in the directions they tend to impose on the animal, the latter takes up a position which is the resultant of the two directions. Many lower animals show a definite phototaxis. Thus, not only small crustacea but also fishes and amphibian larvae swim towards light; though this does not occur unconditionally. If, for instance, a number of tadpoles are placed in a round glass vessel filled with water, and the vessel is allowed to float on the surface of an aquarium in which other tadpoles are present, then the individuals in the aquarium itself are uninfluenced by the light. They swim about in all directions. But the tadpoles in the small dish all turn toward the source of light (fig. 1). Numerous small fishes and crustaceans behave in the same manner under like circumstances. It is the confined space which in this case calls forth or awakes the positive phototaxis.

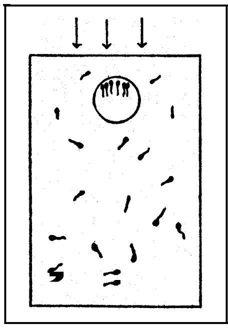


FIG. 1.—TADPOLES NOT INFLUENCED BY LIGHT IN LARGE VESSEL; ARE POSITIVELY PHOTOTACTIC IN GLASS

Although tropisms and taxis such as we have already described are widely spread throughout the animal kingdom, yet the conception of a tropism was originally much less wide. Jacques Loeb used the term in a much narrower sense, maintaining that the position assumed by an animal as a result of the direction of the stimuli affecting it is assumed in a purely automatic manner. The reaction he considered to be just as purely mechanical as the movement of a floating needle towards a magnet. It was, in particular, the way in which many animals react to light stimuli that caused Loeb to formulate his Tropism Theory. When a bilaterally symmetrical animal receives a stimulus, for example a ray of light, on one side, the stimulation of that part of the body, or of the sense organs affected, results automatically, through the intermediary of the nervous system. in setting into activity the locomotor organs of that side. By this means the body is turned and the rotation continues until the long axis of the animal is brought into the direction of the light rays. In other words, the animal turns until the two symmetrical sides of the body each receive an equal amount of stimulation. Then the locomotor organs of the other side commence to function and the whole animal moves forwards. Numerous investigations have shown, however, that such a regulation of behaviour purely through symmetrical stimulation, *i.e.,* where the stimulus — in our instance light — directly causes the movement, is extremely rare in the animal kingdom. It is found particularly in such animals as harbour symbiotic algae in their bodies and therefore seek out the light. Examples are the flagellate protozoan *Euglena* and the flat-worm *Convoluta roscoffensis.* In most other cases the circumstances are not so simple. In particular, the processes are complicated by the interaction of the central nervous system, which so largely controls behaviour. Through this the reactions lose their apparently automatic character. It is true that many animals place themselves symmetrically to the stimuli. Examples have been given above. Indeed, we frequently make use of the fact by allowing animals to carry out their tropisms and so to collect together in a certain spot when we wish to catch a considerable number of individuals quickly and easily. In this general sense we may continue to use the expression tropism, which of late has been so hotly attacked. We must realize, however, that it is not a simple mechanism that we have before us. If we scatter a number of young caterpillars of certain species of butterflies on the surface of a table standing at a window most of them will certainly crawl towards the light. But it is probable that one or two will move in another direction. This depends upon other stimuli which influence the central nervous system. The effect of these stimuli may then conflict with the tropism which would otherwise manifest itself.

We have seen already, from the example of the tadpoles and other animals in small vessels, that there is no necessity for a tropism to be present in an animal equally under all circumstances. Rather, it is called forth by certain definite stimuli. Conversely, the tropisms which are present are frequently *reversible.* When a stimulus becomes too strong, a positive may be converted into a negative tropism. Thus, many lower crustaceans such as *Daphnia,* become positively phototactic when the temperature is lowered, negatively when it is raised. *Daphnia* which has become adapted to a light of medium intensity swims towards the source of light when the intensity of the light is diminished and away from the light when it is increased. The previous *milieu* is an optimum which the animals seek to re-attain after it has been altered.

Reflexes.—We have seen that animal tropisms are automatic in appearance only. Reflexes, on the other hand, are stimulation effects which are really purely mechanical. Reflexes are invariably dependent upon the presence and interaction of a nervous system. The morphological basis of every reflex consists, in the first place, of a *receptor,* or *sensory neurone.* This is a ganglion cell with definite processes which take up the stimulus and conduct the excitation to the cell-body and to other processes which transmit the excitation further on. The second component of the reflex path is another ganglion cell, an *effector,* or *motor neurone.* One outgrowth of this is in connection with the last-mentioned process of the sensory neurone, which conducts the excitation received to the cell-body of the motor neurone. The excitation is then sent on by other processes of the motor neurone and conducted to a muscle or gland, which is thereby activated. The sum total of these nerve conduction paths is called a *simple reflex arc.* The connection between the sensory and the motor neurone constitutes a simple nerve centre, or reflex centre. But in the animal kingdom *composite reflex arcs* are most usually found. This comes about by further ganglion cells, called *association* or *internuncial neurones,* being intercalated between the sensory and the effector neurones of the arc. These association neurones are in communication with yet other centres. Further, the reception of a stimulus usually takes place through particular sense-cells, which are normally found as parts of sense-organs having complicated structures. Yet the essential physiological elements of a reflex are invariably reception of stimulus, conduction of stimulus, and final result. Reflexes were so named by Descartes (Lat. *reflexus,* reflection). The stimulus coming from the sensory neurone is conceived as being reflected on to the motor neurone. Such reflexes are widespread in the animal kingdom wherever a nervous system has been developed. It can truly be said that by far the greater number of movements of animals, or of their organs, depend upon reflexes. These can be observed in numberless cases from the coelenterates upwards, to the highest mammals, and in man himself. Quite apart from the purely reflex movements of inner organs, a number of reflexes can be observed in the external actions of human beings. The contraction of skin in the cold and the reddening or turning pale of the face are examples.

Among animals sea-urchins show most clearly to what an extent the whole behaviour can be dominated by such reflexes. Von Uexküll rightly says of these creatures that they are purely reflex animals. All their reactions can be explained by reflexes. If a mechanical stimulus affects a spot on the skin of a sea-urchin, the neighbouring spines incline towards the spot in question. This occurs because the excitation is conducted by nerve paths towards those muscles surrounding the bases of the spines, which lie nearest to the stimulated spot. Von Uexküll was able to show that the movement of a sea-urchin along the ground, following such stimulation, depends upon these reflex movements of the spines. The same is true of the so-called "turning-over reaction" of the sea-urchin, in which an animal that has accidentally fallen on to its back rights itself again by purposeful movements of the spines. Between the spines of the sea-urchin are found so-called *pedicellariae.* These are small three-clawed pincers, each on a long stalk. At rest, the slender stems lie on the body of the animal. There are four kinds of these pincers, each of which is erected and brought into action only by quite specific stimuli. Long, thin, motile *snap pedicellariae* shut to the light touch of any small animal which may serve as prey and happens to be swimming by. The short strong *biting pedicellariae* rise to a stronger mechanical stimulus and then open, closing again on further touch. They will bite, for example, slowly but strongly into the leg of a small crustacean. Quite weak mechanical stimuli, such as those produced by small foreign bodies falling on to the surface of the sea-urchin, excite the small *cleansing pedicellariae* which serve to clean the surface. The disposition of the reflex arcs is such that when a stronger stimulus occurs, suitable pincers are held ready while the type which is too weak stands back. Thus a chemical stimulus repels the biting pincers and causes the spines to bend away from one another, so that room is made for the fourth set, the *poison pedicellariae.* This type, which possesses poison glands, now enters into activity. For if a mechanical stimulation of a region of the body-surface now occurs, the stalks of these *pedicellariae,* together with the spines, all bend towards the stimulus. The jaws of the pincers close together as soon as they come into contact with the object. The erection of the stalks as a result of the chemical stimulation is an essential preliminary to the functioning of the snap-reflex. The weapon may be said thereby to be loaded and put into a state of tension. Thus for the poison-pincers to act a coupling of two small stimuli is essential.

Similar reflexes are found in the other groups of echinoderms, particularly among the starfishes and brittle-stars. These are able, by reflexes, to free themselves from all sorts of difficult situations. Preyer fastened *Asterias* by sticking five nails with big heads into a board close to the angles between the five arms of the starfish, but without injuring the latter. The confined animals, which could not escape upwards owing to the large heads of the nails, freed themselves in various manners by squeezing, bending and turning the body now in this, now in that way (fig. 2). This they did, not according to any definite plan, nor from any insight into their position or of the necessary steps to be taken to attain freedom, but solely as a result of their physiological constitution and of the various possibilities of movement at their disposition. Brittle stars, when an india-rubber tube has been passed over one of the five arms, escape very quickly by propping the neighbouring arms against the rubber and so pushing it off. A starfish turned on its back first extends all its tube-feet which then feel around as if seeking for a solid object on which to attach themselves. Then several of the tips of the arms turn the right way up. So far all this takes place in no definite order. Apparently each part works independently of the others. Only after a period of indecision, a co-ordination of the movements is brought about through the radial nerves. The tube-feet of one or two of the arms which have turned over (the directive arms) attach themselves to the sub-stratum, whereupon the body with the remaining arms turns over. This *directive influence* assumed by one or two of the arms consists in the inhibition by impulses from the directives of the independence of the remaining arms. Something similar occurs when the starfish frees itself from the pentagon of nails. Now, it is both interesting and important that an amputated arm of a starfish, or indeed any isolated part of an echinoderm, behaves to stimuli as if it were still connected to the whole animal. It does this so long as its nervous reflex paths are uninjured. This is the real proof of the purely reflex character of the different reactions observed in the normal animal.

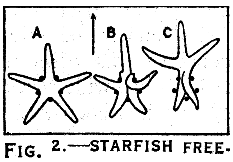


FIG. 2.—STARFISH FREEING ITSELF AFTER BEING HELD BETWEEN FIVE PINS

Hermit-crabs hide their unprotected naked abdomen in the shells of sea-snails which, as occasion offers, they exchange for more comfortable shells. Before slipping into such a new shell, they first put their claws inside, as though they wished to begin by investigating the new abode. Conical snail-shells are held in such a manner that the crab's telson to a certain extent holds the tip of the house and the crab, standing almost on its head, turns the shell round. This appears eminently purposeful, for by this means small stones and grains of sand which may happen to be inside the shell fall out. If these were not removed they might injure the soft hind-parts of the crab. If a number of empty shells of sea-snails are placed in an aquarium, containing hermit-crabs, the animals change their habitations continuously. As soon as a crab happens upon an empty shell, it feels it over and then steps in. The fact that frequently in this pursuit a shell which suits the crab admirably is exchanged for another obviously smaller and less suitable, shows plainly that a purely reflex action is involved. Bohn expresses himself thus:

> "The animal carries out a quite definite series of movements, from the moment when it touches the shell until the instant when it hides its abdomen in it. Each movement causes the next one to follow on. Hence it is possible, to a certain extent, to cheat the crabs. If one places them upon a round stone or wooden ball, then they turn this round in all directions, press their bodies against it and seek for the mouth, which of course does not exist. They look for the opening likewise in an unusually convex oyster shell."

Thus the hermit-crabs, too, behave in this respect like automata. The stimulus supplied by the snail-shell, acting through the appropriate reflex paths, mechanically causes the movements just described. And this seems just the same when the movements are unnecessary or even quite meaningless.

A peculiar type of reflex is found in many animals, which under certain circumstances serves as a defence when the animals are seized by an enemy. This is the *autotomy* or *self-mutilation reflex,* By it animals are able to throw off the parts of the body or limbs which have been caught, so that with this loss they can still escape. In this way many annelid worms throw off certain parts of the body, starfishes and brittle-stars reject their arms. Crustacea, especially shore-crabs and lobsters, break off legs and claws which are caught and held. Spiders and many insects behave in a like manner. Since the place at which the limbs break off is usually suited morphologically to this purpose, a definite adaptation is involved.

A good example of behaviour made up almost wholly of reflexes is afforded by the ant-lion, the larva of *Myrmeleo formicarius.* These animals construct funnel-shaped hollows in sandy soil and dig themselves in up to their heads at the bottom of the funnel. Then they lie in wait for passing ants. When an ant approaches the margin of the funnel, the ant-lion, in response to the stimulus supplied by the sand-grains rolling down the walls of the funnel, performs the *jerk-reflex; i.e.,* it throws its head upwards and backwards with a mighty jerk. Consequently the surrounding fine sand is thrown up and causes the ant, already advancing with difficulty in the heavy soil, to slip completely down. The jerk-reflex may be repeated a couple of times if further sand particles continue to fall down. If the ant chances to touch the inner side of the widely-open mandibles of its enemy, the *snap-reflex* follows. This involves the closing of the sharp jaws to seize the prey. This snap-reflex can be induced artificially by the touch of a fine needle. The construction of the funnel, too, is said to be performed reflexly. Such reflexes are very widespread among insects. The larvae of dragon-flies, for example, live in water as predaceous animals. They catch their prey with their so-called mask. This is the modified underlip, consisting of pincers which can be projected rapidly for a considerable distance in front of the head. Since in this case optical stimuli bring the mechanism of snapping into action, the movement to and fro of any small object about the size of the normal prey is sufficient to cause these larvae to snap at them. If one lightly strokes the wing of a fly, *Eristalis tenax,* once or twice with a thread, the insect raises the hind-leg of that side and wipes the wing-surface with it. The numerous cleaning movements of insects come about, too, in a purely reflex way. As in echinoderms, amputated portions of the body behave just as when they still formed a part of the whole animal, provided that the necessary nervous connections are still present. The stinging apparatus of the honey-bee, which remains fixed in the human skin after stinging owing to its backturned hooks, and is thus torn out of the abdomen of the bee, continues to bore even deeper into the wound. And it is common knowledge that one must beware of the hinder portion of a freshly killed wasp, even when this part of the body is cut off, for it continues for quite a time to execute stinging movements. The trunk portions of ants, after the head and hind part of the body have been cut, off, continue for a half hour or an hour to walk around haltingly with short steps and rise up again if they fall over.

Fishes and amphibians supply examples proving that among vertebrates, too, such essential movements in the life of the animals as are concerned with the catching of prey still take place in a purely reflex manner. Many fishes and most amphibians react only to moving prey. Thus they make no distinction if instead of real food one waves other objects of corresponding size to and fro before them Sharks seize all small objects thrown overboard from a ship, even when these are empty tins. The possibility of angling for many kinds of fish with artificial bait is due to automatic response of the animals to stimuli. A frog would starve before snapping at a motionless earthworm. It seizes it only when the worm moves. The frog reacts to a fly only when the latter cleans itself or moves from the spot in which it was standing. Indeed, for the frog as for other animals a *summation* of stimuli is often necessary. On the first movement of the prey on coming into the field of vision, usually a mere turning of the head results. More movement causes farther turning, the body also participating. Additional stimuli then result in a raising or a lowering of the head in the direction of the prey, and finally snapping or extension of the tongue follows. If the prey is missed, as not infrequently happens, the frog only snaps again when the animal moves anew.

INSTINCTIVE BEHAVIOUR

The Nature of Instincts. — Whereas generally speaking reflexes are made up of single movements of an animal or of its organs in response to a stimulus, instincts are those reactions which are composed of numerous movements (Lat. *instinctus*, impulse). A requisite condition is that the responses in question be shown by all normal individuals of the species in an almost identical manner. This type of behaviour is inherited from the ancestors of the animals in exactly the same way as any visible morphological character. Since this mode of behaviour is inborn, it has not to be learnt by the individuals of the species. Instincts are always adapted to the normal mode of life of the animals and for this reason they appear to be essentially purposeful in character. But, like reflexes, they are quite automatic and give a certain stamp to each different species of animal. We are concerned, then, with all behaviour and modes of action of which it can be said that the animals are impelled by a motive from within. Physiology rightly regards instincts as series of reflexes or so-called *chain-reflexes* (Loeb). This means that they can be analysed into a greater or lesser number of individual reflexes of which the occurrence of one is always the cause of the initiation of the next. Thus an animal disturbed during one instinctive action, so that the series of reactions is interrupted, is often incapable of continuing the action where it has left off, but must restart the whole series from the beginning. This, however, is frequently impossible, since often the first stimulus, which set the series going, is no longer present, or the physiological conditions of the body of the animal have become altered. An instinct, then, is a sum of reflexes, whose connection with one another is rigid and immutable like the reflexes themselves. Formerly all those complicated and purposeful actions which take place as inborn impulses, without any realization on the part of the animals as to their significance or object, were classed as instinctive behaviour. As just explained, however, the modern view is unconcerned with the presence or absence of consciousness or of purpose in the behaviour under consideration. In a later section, we shall return to this question. But it may be stated here that in most cases of instinctive behaviour no realization exists on the part of the animals as to the purpose of their conduct. From the nature of the case, no such realization could exist. Ziegler *(1920)* has given a comprehensive account of the historical development of the concept of instinct. The often amazing purposefulness of instincts has given rise to numerous explanatory hypotheses, none of which has supplied a satisfactory solution of the problem involved. Nothing therefore remains but to attribute the purposeful character of the conduct of the animals to the same factors which are responsible for the adaptive structure and functioning of their organs. Selection co-operates as a secondary but very important factor.

Instincts can be subdivided according to their objects into those of nutrition, migration, cleansing, protection, defence, metamorphosis, pairing, egg-laying, care of young, nest construction and social life. To the last-mentioned belong all the complex social instincts. We meet with instinctive actions in all divisions of the animal kingdom in which a central nervous system has been developed. Instincts are present from worms up to mammals, and many human actions are purely instinctive. Instinctively the newborn seek the mother's breast and the drowning man clutches instinctively to any solid object which offers. In point of fact, by far the greater number of the actions of invertebrate animals depend upon such inherited inflexible instincts, as also do those of many lower vertebrates. Just as reflexes are found to be particularly characteristic of echinoderms, so the higher arthropods, in particular certain crustaceans and above all the insects, are instinctive animals *par excellence.* A few examples only of the instinctive actions of animals will be cited here.

Earthworms have the habit of dragging into their tubes leaves, pine-needles, bits of straw and other small objects, in order that the decaying plant-remains may serve them as nourishment. As early as 1881 Charles Darwin, who devoted a comprehensive work to the activities of worms, drew attention to the fact that the dragging down into the earth of these objects is done in a remarkably purposeful way. The worms tend to catch broad-based leaves, such as those of limes or cherry trees, by the top, so that the leaf rolls itself up on being drawn into the narrow worm-tube. It would have been useless to catch hold of the leaf by the stalk, for the broad base would have offered an almost insurmountable obstacle. The worms behave in an opposite manner with pine-needles, which are attached in pairs to a short basal piece. The worms take hold of them at the point where the two needles are joined together. Had one needle been dragged by its tip, the other would have been prevented from entering the hole. Mangold (1924) lately showed that there is a difference in the chemical make-up of leaf-blade and stalk, of needle-tip and basal piece. The worms scorn the taste of the leaf-stalks or of the needle-tips. In addition, further help is afforded by the fact that the leaf usually turns round on being drawn along on the ground, so that the point goes foremost while the stalk acts as a rudder.

The strange marine crab *Dromia* possesses the instinct of holding a sponge or an anemone, as if for protection or as a concealment from view, with its last pair of legs which are bent up towards the back. On strong stimulation however, and when fleeing from enemies, the crabs drop these foreign bodies and scamper away hastily. In the aquarium they just as readily take up living or dead companions, heads of fishes, or even transparent pieces of glass which naturally could not conceal them from the gaze of their enemies. The spider-crab, *Maia,* conceals itself from its enemies by tearing off with its claws pieces of seaweed growing in the neighbourhood and sticking these on to the spines and hairs growing on its back. These spines are provided with back-turned hooks. A well-known habit of hermit-crabs is to plant the surface of their shelly dwelling with actinians, and indeed with particular species of anemones. Many of these crabs transfer their companion to their new dwelling when they move. Violent fights often take place between the inhabitants of an aquarium for possession of the anemones. Lloyd Morgan (1908) describes a very specialized adaptation to the circumstances of life in the yucca moth *(Pronuba yuccasella)* of tropical America. The instinct involves the most minute details of the creature's life-history. The caterpillars of this species pupate a fortnight before the commencement of the flowering season of the yucca plants (*q.v.*). Each of the large, yellowish-white, bell-shaped flowers, opens for a single night only. This occurs at the same time as the straw-coloured yucca moths with their silvery sheen, hatch out. A female of this moth fetches the sticky pollen from the flowers, kneads it together and holds the big ball so formed with her strong, hairy labial palps. She then visits another flower and with her ovipositor lays an egg in the rudiment of the seed in between the egg cells of the plant. Then she betakes herself to the stigma on the pistil and there sticks the pollen she has brought with her. It is asserted that the same individual several times repeats the alternate egg-laying and pollen-seeking in the same flower. Four or five days afterwards, the larvae creep out and begin to devour the seed-rudiments, of which about 200 are present in the flower. Three or four larvae are found in one flower and each needs about 20 eggs for its food. Thus, about 100 eggs are left for the yucca for its own reproduction. As soon as the larvae have grown to full size, they creep through a hole they have gnawed in the wall of the fruit and let themselves down on a thread to the ground. Here they spin an egg-shaped cocoon in the earth. They remain there until the following summer, when they pupate. The yucca plants can be pollinated by no other kind of moth. Conversely, the caterpillars of the yucca moth require the seed-rudiments of their own particular species of yucca as nourishment. Each species of yucca has a special species of moth adapted to itself alone. The yucca moth brings her business to completion without seeing or hearing what happens, without knowing the result, the fate of her eggs or the necessity for plant-pollination.

Even the most complicated behaviour of the social insects (*q.v.*) turns out in most instances to consist of inborn instinctive actions. Thus bees and wasps have been isolated as soon as they hatch, so that they could learn nothing of the life and activities in the hives or nests whence they came. Nevertheless, these animals occupied themselves in exactly the same way as all workers of the particular species, as soon as the necessary material was placed at their disposal. They built, collected food, and fed larvae which were given them. Ants and termites, too, afford an excellent example of the fact that instincts may be purposeless. Quite a number of definite species of lower animals, particularly beetles of the family Staphylinidae, habitually steal into the nests of social insects. These ant guests and termite guests are not only tolerated but often even cared for and fed. Ants, indeed, care for the brood of many of these guests. They are induced to do this by certain secretions furnished to them by special glands of their guests in compensation for the trouble they have taken. This tolerance of and caring for definite guests has become with them a definite instinct, the so-called *symphily instinct.* And this is essentially harmful to the success of the ants' or termites' own colony. For the ants are often so intensely occupied by their guests and offspring of these, that they go so far as to neglect the proper care of their own brood and thus jeopardise the continued existence of their colony.

Capacity **for** Learning. — Although we have so far represented instincts as unalterable and inflexible inherited modes of action, this does not apply to all instincts. There exist numerous cases in which animals are able more or less to modify their inborn types of conduct in relation to prevailing circumstances, *i.e.,* to adapt their behaviour to the given situation. This applies to such cases as web-construction by spiders or nest-building by birds. It is true that each species of spider makes its web according to a definite plan, which may be considered as a specific character. It is equally true that each kind of bird builds its nest in a very definite manner, easily recognizable by the ornithologist. But in each different case the locality in which the web or nest is constructed is a different one. Moreover, the available material for making the bird's nest often varies, for instance, as regards the shape and length of the twigs collected, etc. The spider, too, in spinning its web must adapt itself to the space at its disposal, and the bird must suit its behaviour to the conditions of the locality in which it is working, to the fork of the branch, the hollow in the trunk of a tree in which it makes the nest. And in other ways we see that animals, particularly those which as regards their conduct stand high in the animal series, break away from the inborn inflexibility of instincts and behave in this or that manner according to the circumstances. Thus instincts are frequently plastic and can be adapted to conditions. The experiences which the particular animal has had during its lifetime here play a definite part. For this reason we must next describe two faculties on which the power to accumulate experiences depends.

Memory. — First comes the power of memory. This is present in all branches of the animal kingdom, even in the Protozoa. But this fact is not very astonishing, since one can consider "memory" in a certain sense as a general characteristic of matter. The properties of a colloid can depend upon the way in which it reached its present state, that is on previous history, age, temperature, duration of physical processes, and so on. Hysteresis of metals is somewhat similar. In animals, memory consists in the fact that a stimulus, when it acts on an animal causing a certain excitation in the body, leaves behind itself a residuum or trace. In consequence of this the organism is to a certain extent physiologically different when later on the same stimulus acts upon it again. And so the possibility arises of an animal reacting first in one way and later in another, to the same stimulus. When a certain stimulus is repeated a number of times in a short interval, an animal may accustom itself to the stimulus. That is, on the first occasion the animal will answer the stimulus by the reaction which normally follows it. But later, the reactions become weaker and in the end the animal no longer reacts at all to this stimulus. This is not due to fatigue of the organs of motion, the muscles, but it is the result of becoming accustomed to the stimulus. Only after a period of rest does the animal once more react normally to the stimulus. On the other hand, an animal which is reacting in a certain way to a stimulus repeated at frequent definite intervals can "exercise" the movement in question. The animal gradually executes the movements more promptly and more rapidly than it did without the practice. Human beings find a similar gain in performance through frequent repetition or exercise. The paths of the nervous system which conduct the excitations become better and better "trodden," better suited to take up and transmit this excitation. In the end, through repetition, a given action can become a habit.

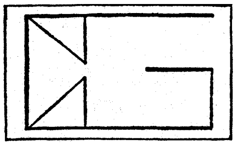
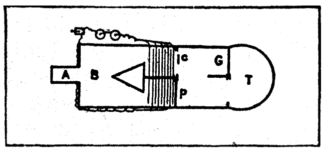


FIG. 3.—YERKE'S EXPERIMENT TO MAKE A CRAYFISH FAMILIAR WITH AN EXIT FROM A BOX

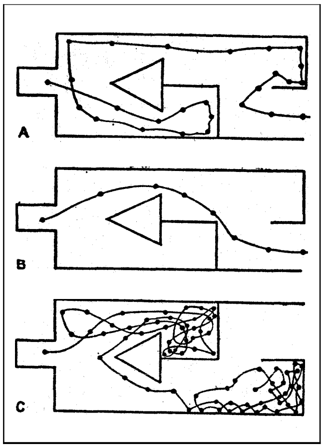
Association. — In so far as animals possess a true central nervous system with higher, dominant centres, we find in them a further and more important faculty, that of forming associations If, at the same time as a stimulus which has a definite resulting reaction acts, another stimulus occurs which in itself would cause no change in the conduct of the animal, then, provided the two stimuli always act together, after a certain number of repetitions the reaction follows on the indifferent stimulus alone, whereas in the beginning it results only from the first stimulus. In the nerve paths, a *coupling* of the courses of excitation has occurred An association of the two stimulation and excitation phenomena has been formed. The number of repetitions necessary for such an association to be established differs both with the species of animal and with the nature of the stimulus. One or two examples will make this clearer. An earth-worm was placed in the middle limb of a T-shaped tube system so that it was possible for the animal to creep into the right-hand or into the left-hand portion of the cross-piece of the T. In one of the arms of the cross-piece, the electrodes of an induction coil were placed, so that when the worm touched these it received an electric shock. Five or six experiments were made daily with each animal tested. Whereas in the beginning the animals went as often to the left as to the right, it became apparent that after about 80 or 100 experiments, the side with the



AFTER YERKE

FIG. 4.—LABYRINTH TO TEACH A FROG TO FIND THE EXIT TO WATER IN VESSEL

A. Entrance: B. Intermediate space; C. Wire grid connected to electric battery; P and G. Glass partitions electrodes was visited less often. After about 120 to 180 trials, in every 20 experiments there were at most 1–3 errors. The animals, then, had learnt to avoid the place associated with an "unpleasant" stimulus. In other words, they had been "trained" to go to a certain side. This habit of turning always to the right side, acquired by training, could be reversed by a further training. This was done by placing the electrodes on the side which previously had been the right one for the worms to turn into. Not only could normal earthworms be trained in this manner, but also animals from which the brain had been removed, and even worms lacking the whole portion of the central nervous system contained in the first six segments.



AFTER YERKES FROM K.C. SCHNEIDER

FIG. 5.—LABYRINTH EXPERIMENT WITH A FROG
A. Path after 6 experiments; B. after 100 experiments; C. Confusion of trained frog after sides were interchanged. Dots represent separate jumps

Yerkes instituted experiments with *Cambarus affinis,* a relative of the fresh-water crayfish. He placed these crustaceans in a specially shut-off portion of a box, from which they could get out into the main portion of the box through an opening in the middle. From the main portion two outlets, separated from one another by a partition, led into a vessel of water (fig. 3). The animals as often made use of the right as of the left exit. Next, the right hand outlet was closed by a glass plate. During a period of 30 days each crayfish underwent 60 experiments, in which the boxes were always carefully cleansed to exclude the presence of possible smell stimuli. The average results of the performances showed in the first ten trials 50% of correct solutions, in the second ten 60%, in the third 75·8% and in the sixth 90%. By a correct solution is meant that the experimental animal immediately chose the correct exit. One of the crayfishes, after 450 experiments, made only one mistake in 50 trials. It is plain that such a method permits the investigator to test how long the lesson is retained by the experimental animal when no practice takes place in the interim. After a *Cambarus* had progressed so far in its lessons that it made one error only in ten trials, the experiments were interrupted for a fortnight. When, on the fourteenth day, the experiments were recommenced, it was evident that the animal still remembered what it had learnt. But now three errors were made per ten trials.

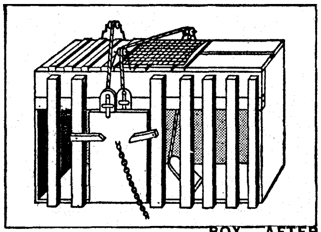


FIG. 6.—PROBLEM BOX AFTER THORNDIKE

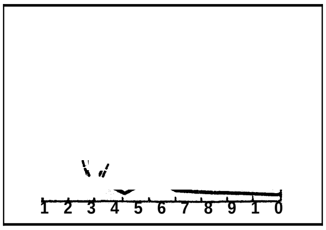


FIG. 7.—CURVES SHOWING RATES OF LEARNING BY APES (HEAVY LINE), IN THE LABYRINTH (LIGHT LINE), IN THE PROBLEM-BOX (DOTTED)

Yerkes carried out experiments on frogs similar to those already described with *Cambarus.* He used a box like that mentioned above, except that the two exits were contrived in a rather more complicated manner. The outlets led to a tank of water but the direct path was closed by a transparent glass plate, so that the animals were obliged to make a *détour* (fig. 4). Daily series of ten experiments were made. After 100–120 trials the frogs no longer made mistakes. They made for the water by the shortest path. The effect of the training was measured by the number of correct and incorrect attempts at the two critical spots, the entrance and exit of the labyrinth (fig. 5). After the experiments had been discontinued for one month, it was found that the frogs had not yet forgotten their lesson.

It is generally known that birds and mammals can learn or be trained. But in addition we see everywhere in nature how the most varied types of animals turn their acquired experiences to account. It is the faculties just described, the plasticity of instincts, the capacity for memory, and the ability to form associations, which permit of such conduct. But the foundation for the behaviour resulting from these faculties, which is frequently complicated, is always provided by inborn reflexes and instincts. With the object of analysing animal conduct more closely, numerous experiments have been made, particularly by American workers, utilizing apes, dogs, cats, hedgehogs, rabbits, rats, mice, various birds and even reptiles, such as tortoises. The object of these experiments is to discover the capacity for learning, the ability to acquire experience. The outlet from more or less complicated labyrinths or mazes has to be found and learnt, or problem boxes are used, in which the animal must open a door to get out by latches which are more or less complicated according to the nature of the animal studied. These fastenings consist of levers, hooks, bolts, wires, that must be pulled, levers to be pressed down with the foot, and so on (fig. 6). The animal is obliged to discover the mechanism of opening the door for itself by chance trial in the course of its planless efforts. The duration of the learning, or here of the formation of a habit (the dropping of useless movements), is judged by registering the failures (figs. 7 and 8). Companions are sometimes placed in the company of animals which have already learnt the solution of such a task, to see whether they will themselves learn more rapidly by imitating the movements of their fellows. It has been proved that this rarely occurs. Even when the animals are shown the necessary manipulations by the experimenter putting the limbs of the animals through the movements, this does not help. Each animal is obliged to learn everything through its own experience. A mass of results has been accumulated by these American "behaviourists," the value of which will only become apparent when they have been co-ordinated.

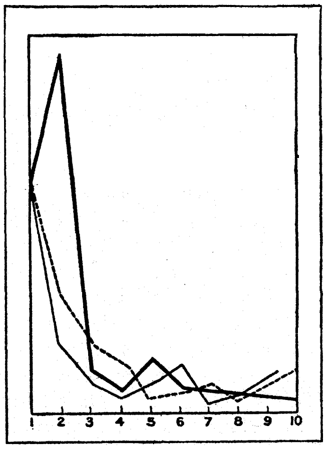


FIG. 8.—CURVES SHOWING RATES OF LEARNING THE WAY OUT. FOR APES (HEAVY LINE); A WHITE RAT (LIGHT LINE); A SPARROW (DOTTED LINE)

In conclusion of this section it must be pointed out that in experiments with animals it can easily happen that the subject trains itself to small occurrences unnoticed by the experimenter and not taken into account by him. Slight noises, movements, for instance the reversal of an electric switch, and so forth may unwittingly be the cause of the establishment of a habit. Then the results obtained from the experiments do not give a picture of the capabilities of the animals which it was attempted to test, but of their capacity of turning experiences to account. Many animals are able to take note of movements so small that they are hardly or not at all observable by men. The so-called "thinking" and "calculating" horses and dogs owe their fame to this ability. Naturally they really know neither how to calculate nor how to read. Often unknown to their owners they have trained themselves to very slight signs given by the trainer on the accomplishment of the right solution of the task, without his

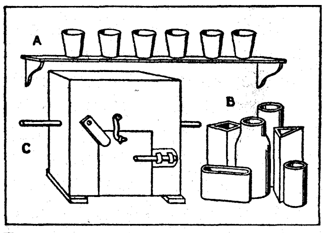


FIG. 9.—EXPERIMENT FOR TRAINING APES TO OPEN LATCHES: (A) COLOURED VESSELS, (B) VARIOUS VESSELS, (C) PROBLEM-BOX CONTAINING FOOD

own knowledge. The animals have learnt by experience that they receive a tasty morsel when they cease to tap with paw or hoof as soon as the sign in question appears. Their master, however, thinks he is rewarding them for having correctly solved their problem. But the real signs consist of very slight movements of the body, of the head or even only of the features of the questioner. These signs are the expression of the conclusion of a state of tension on the part of the questioner, which occurs as soon as the correct number of beats has been reached,

INTELLIGENT ACTIONS

The highest type of action is represented by intelligent action, that is, conduct which depends upon an insight into the connection of things and events and upon their causal relationships. Intelligent actions, above all, distinguish men from animals. Formerly it was said that animals act on instinct, man on reason. And in truth this insight is lacking in most animals. It is only recently that it has been shown that in a small group of animals there is a mode of conduct which recalls reasoned actions of men and is certainly a precursor of such. These animals are the anthropoid apes, man's nearest relatives. From observations on anthropoids in zoological gardens the conclusion had long been reached that as regards their conduct these creatures are to be placed far above all other animals. The way they handle objects at their disposition, and employ the most diverse means of attaining their end, whether it be a fruit or other desired object, makes their whole conduct appear highly human. Our knowledge has been very considerably advanced by the carefully planned experiments made by W. Kohler (1917), with chimpanzees in the German Anthropoid Station on Teneriffe, under conditions which were as natural as possible and in a climate similar to that of their home. The work of Yerkes, S. J. Holmes and Miss Kohts is also of great value.

Kohler's experiments were of quite a simple nature. They resembled those now employed with quite small children. For the experimental animal it was always a question of attaining some object, such as a fruit, which could not be reached directly by grasping it with the hand. A banana with a string attached to it, which lay out of reach of the arm, was at once pulled in by the chimpanzees with the aid of the string. Hungry dogs, cats or horses in a similar situation would simply have starved. Experiments have demonstrated that dogs will not of their own accord drag meat from a table, even if they have been trained to gain possession of the meat on a word of command by pulling at a string attached to the meat and hanging down from the table. In other words, although they are physically capable of accomplishing the task, it is too difficult for them. If a loose fruit lay out of reach of the chimpanzees, in front of the bars of their cage, they soon succeeded in pulling it in with the aid of some object such as a stick, a wire, a loop of cord or a stone. Thus they interposed between themselves and the thing desired a material intermediary object which was not a portion of their own body. We can therefore speak here of the use of tools. Probably something similar was involved when the animals fetched packing cases which were placed at their disposal and climbed on to them in order to reach fruit hanging from the roof of the room in which they were confined. Or again when, in order to attain the same object, they placed a bamboo stem vertically, quickly climbed up it and seized the banana whilst jumping off. One of the apes used pieces of bamboo four metres long for this purpose. The chimpanzees accustomed themselves to use the sticks for all possible other purposes, such as for levers to force open packing cases, tools to dig up roots, for touching a mouse or lizard held out to them, and finally even as a weapon, although not for hitting but for throwing. The animals learnt all this on their own account without its having been shown to them by men. A curious use, of straws became the fashion with them for a time. They used these for catching ants, which they waylaid and licked up whenever they could gain possession of them, doubtless on account of the taste of formic acid in the insects. In the present instance an ant pathway led over the outside of a cross-beam of the wire-netting enclosure. Kohler describes how first one of the chimpanzees, then another, and finally the whole company, held out straws and spikes through the netting on the beam so that in a short time the straws were covered with ants. Then the prey was quickly drawn in and licked off in the apes' mouths. All the animals in the station could be seen squatting next to one another along the ant pathway, each with a straw, looking like a row of anglers along a stream. Such a use of tools, which is evidently intentional, is found in no other animals. It is true that certain sand-wasps pound the sand at the entrance to their nests with a small stone held between the jaws. This, however, is a purely instinctive action. The blood-red weaver ants, *Oecophylla smaragdinea,* found especially in Ceylon, stick together the leaves out of which they form their nests with spun thread. In the preparation of this they use their larvae, somewhat like living distaffs. The worker ants take hold of the larvae with their, jaws and force them by a gentle pressure to extrude the secretion from the large spinning glands. In so doing they move the larvae to and fro, pressing them now against one now against the other of the two leaves which are gradually being stuck together, so that eventually a dense and strong fabric results. This behaviour, too, in contrast to the real use of tools, is an instinctive action.

When one packing-case did not suffice as a foothold for reaching a banana which was hanging particularly high up, the apes placed one or more cases on top of the first. They managed to erect tower-like constructions of four cases. It is true that the boxes were placed on top of one another in such an inexact manner that it was only the inborn gymnastic dexterity of the apes that prevented the dangerous construction from collapsing in use. The problem of fetching food which had been thrown down behind a trellis out of reach, by circumventing the trellis, was solved by the chimpanzees without more ado. Dogs often and fowls always fail at the same task because they are so attracted by the sight of the near-by food that they take no notice of the round-about way leading to it, although they may know this route already. On the other hand, it was extremely difficult for the chimpanzees to shove away a box which prevented them from seizing a fruit lying in front of the bars of their cage. It was always apparently considerably easier for them to make a détour with their own body, *i.e.,* to run or climb by a roundabout way to the object of their desires, than to achieve their purpose by means of a tool. This was the case when a small-meshed wire net was placed before the fruit and the net had to be pushed aside with a stick. The most difficult case was when it was necessary to push the fruit away first of all to drag it in afterwards. A complete solution of this problem was only arrived at by the two most intelligent of the apes. For the different chimpanzees showed a definite gradation in their capabilities. Such individual differences in the ability to adapt themselves to a given situation are found everywhere in the animal kingdom. These differences are present, too, when pure but modifiable instinctive actions are concerned. Probably the highest accomplishment attained in the Teneriffe experiments was the case of an animal which itself manufactured a tool. Only one chimpanzee did this. The sticks at its disposal proved all to be too short to drag in a fruit lying in front of the netting of the cage. After many efforts, the animal eventually succeeded in sticking a narrow tube inside a wider one and so lengthening the stick. After this had succeeded once, the animal used the same method every time there was a necessity for it. In doing this he always held the wider tube in the left hand and pushed the end of the narrower tube into it with the right. Eventually, he perfected it to an instrument composed of three tubes, the narrowest being in the middle between the two wider ones.

An important element in the manner in which the chimpanzees mastered all of these tasks was the fact that the solution frequently occurred suddenly, the animal as it were giving itself a jolt. In this respect the manner of solution differs notably from the solutions discovered by other trained animals purely by chance. Lower apes have been presented with the same problems and it has been found that these animal's too can work with intermediary tools and intermediary actions. But the action is always towards the animal. A preliminary movement of the tool away from the animal is never carried out. Whereas it occurs to the anthropoids to push a rake behind a banana to drag it towards them, or to move a bolt which closed a case in the direction away from themselves, the lower apes abandon such tasks. Thus the actions of the anthropoids are actually the highest attained in the behaviour of animals. In this respect, their conduct is a real intermediary between animal and human behaviour.

THE BEHAVIOUR OF THE PROTOZOA

Reflexes, instincts and intelligent actions are bound up with the presence of a nervous system. In consequence of this, out of the various existing types of behaviour, tropisms alone would seem applicable to the Protozoa. But this in no way covers the facts. The behaviour of the Protozoa is to a certain extent of a special nature and may be contrasted with that of the Metazoa. In spite of an outward simplicity of organs of locomotion, the behaviour of these unicellular animals can nevertheless be very varied. The cause of the movements of the pseudopodia of rhizopods, *e.g. Amoeba,* has been ascribed to surface-tension. When, in spite of this, under apparently identical external conditions one individual behaves differently from another, the difference depends upon the varying physiological states in which the two animals happen to be. The apparently arbitrary spontaneous movements are accounted for by inner causes, which depend upon the alteration in the chemical reactions going on inside the cell, caused chiefly by metabolic processes. Not only pseudopodial movement, but also the intake of food by these animals, and the construction of the shells of shelled amoebae, have been imitated by artificial models. In this way it has been demonstrated that all. these phenomena can be explained by chemical and physical laws equally applicable in inorganic nature. Yet it has up to now been impossible to construct a model which unites in itself all the life processes. Many questions remain still to be answered. The living organism possesses such a complex organization, having a definite structure made up out of numerous spatial parts, that we are still far removed from being able to unveil all its secrets.

The infusorians and flagellates, which, owing to the possession of cilia or flagella, are much more motile than the rhizopods, tend, so long as they are swimming freely in the water, to move forwards in a spiral path, rotating continuously on their long axis. The sessile forms produce currents with their motile organs, bringing food towards them from the neighbouring water. These animals almost invariably respond to external stimuli—touch by a solid object, chemical substances in solution, etc.—with one and the same definite reaction. This is the *"flight movement"* or avoiding reaction (Jennings). The cilia of a swimming infusorian, which, to take an example, has hit against a solid object, reverse the direction of their beat, so that the animal is driven backwards for a short distance. Then the animal slows down its rotation on the long axis. The beating of the cilia of the mouth region diverts the front end towards the aboral side so that the body of the animal now describes a conical figure. Finally, the infusorian again swims forwards as in the beginning, but owing to the previous swinging round of the long axis, the movement forwards is now in a different direction. If the infusorian again hits against the solid object, the action is repeated until, in the end, the obstacle is avoided. It is noteworthy that it is immaterial from which direction the stimulus comes and on which part of the body it impinges. The infusorian invariably responds by the same avoiding reaction, the different phases of which are merely carried out with different intensities according to the strength of the stimulus. Since such a flight-movement is the reaction of infusorians and flagellates to almost all stimuli (indeed it occurs in corresponding circumstances in many of the smaller Metazoa), the response of these animals is fundamentally always negative. The final result may, nevertheless, often be positive. Thus *Paramaecia* collect in a drop of water rich in oxygen because they swim into this drop from the surrounding water without any reaction but on arriving at the boundary of the drop they are stimulated to execute the avoiding reaction so that they can no longer get out of the drop. Since they hardly possess any positive reactions these Protozoa do not pursue their prey but only happen by chance upon their food. On this behaviour Jennings based his theory of the *"method of trial and error"* which he supposes applies to the whole animal kingdom. In point of fact the behaviour of many Metazoa, right up to the mammals, frequently gives the impression that the animals attain their goal through methodless trials and final chance success. In spite of this, the theory has turned out not to be of general application. It is in contradiction to Loeb's *tropism theory* which assumes forced movements, since chance plays a considerale rôle in Jennings's theory. Our description of the different types of behaviour has shown that in reality more complex factors intervene.

Among the Protozoa, particularly among many of the larger infusorians, other reactions in addition to that just described are possible. Thus *Stentor roeseli,* attached inside its tube of mucus, first bends to the aboral side when carmine particles are dropped into the water which it whirls past its body. Since, in spite of this, the particles continue to reach its surface, it next reverses the direction of beat of its cilia and then once more moves them in the normal sense. After this has been repeated several times without result, the animal withdraws into its tube, at first for a short, then for a longer, period. If the carmine particles are still there, a fourth type of reaction eventually supervenes. The *Stentor* contracts forcibly, loosens its foot and swims away. The series of reactions employed by *Stentor* is graduated according to degree of effectiveness. In a certain measure the animal makes a purposeful choice out of its different reaction possibilities. The term "action system" has been used to designate the totality of the possible reactions which an animal possesses in consequence of its bodily structure and which characterize its various reactions under different circumstances. The action systems of the Protozoa only include a relatively small number of definite movements. Animals are able to respond to the stimuli they encounter only with one or other of these movements, or with a combination of them.

THE SENSORY FACULTIES

As we have seen already, very frequently the behaviour of animals has led to a mentality being ascribed to them similar to that of human beings. We have seen, too, that a mind, *i.e.* the phenomena of consciousness, cannot be experienced objectively. Nevertheless, we can attempt to form at least some idea of how the surrounding world in which animals live would appear to them if they possessed a consciousness analogous to our own. For human beings the sense-organs are the gates through which we receive the impressions of our surroundings. They constitute the only path through which what we know of the outside world reaches us. The totality of all the things and processes in our surroundings, among which our own bodies must be included, is the *Umwelt* or "surrounding world." In this surrounding-world animals too are comprised. The question now arises as to how much the animals themselves can take in through their sense-organs of these surroundings in which we see them. Since the type and structure of the sense-organs in animals is often quite different from what it is in ourselves, it follows that the *Umwelt* of an animal must generally appear quite different from what it does to man. By documenting ourselves concerning the sensory capabilities of animals we can obtain a conception of how their *Umwelt* must appear, assuming that they possess a consciousness similar to our own.

Sense of Time.—A sense of time, which exists in a number of animals, is the result of complex stimuli, affecting various sense-organs. Often animals which are regularly fed, brought into their stalls, or put into the open at stated times, show by their behaviour as the moment approaches that there exists in them some feeling of what is about to happen. This may have various causes. Frequently it is the preparatory actions or other behaviour of men themselves that the animals know from experience to be the precursors of the event. Then again, certain physiological processes go on in the animal's body with a definite rhythm, which, in consequence of a long-standing connection with the event in question, have acquired for the animal a time-relationship with it. Such physiological processes are hunger, fatigue, etc. We find, too, in a number of the lower animals a definite rhythm due to regular repetition of recurring external stimuli. Sea anemones open and close with the rhythm of the tides and retain this same rhythm for some time in an aquarium. But a real conception of time is lacking in all animals, even those which are mentally the most gifted, namely the anthropoids. Animals, then, live solely in the present. They know no past and no future. They are unable to survey the span of life, youth and old age, as we do.

Influence of the Central Nervous System.—In the Protozoa the whole protoplasm of the animal body is irritable. In Metazoa the sense-organs take over the task of receiving stimuli. These sense-organs exercise a certain selection among the innumerable changes going on in the environment, all of which might act as stimuli. Each sense-organ responds only to those stimuli to which it is adapted. These are the so-called adequate *stimuli* of the particular sense-organ. This is very expedient, for if all the changes going on all the time in the environment were able to act upon an animal as stimuli, animals would never be at rest. Nevertheless the number of stimuli sent on as nerve impulses by the sense-organs to the nervous system is very large. But we may often observe how the behaviour of an animal does not alter at all although certainly one or several of its sense-organs are receiving stimuli. The explanation is found in the activity of the central nervous system. In general, reflex movements take place as a consequence of stimuli acting on the organism. But we have seen above that the morphological basis of reflexes is formed by the reflex arc, which is usually composite. Association neurones interposed in the reflex path are connected with other nerve cells, and by the massing together of such ganglion-cells centres are constituted. The centres of the separate senses are in communication with one another through numerous nerve fibres. This permits of the working-up of the stimuli received by the different sense-organs. Other nerve centres are interposed between the principal ones. These are, in a sense, subordinate, having the function of co-ordination and purposeful conduction of the impulses coming from the sensory centres. Finally a ganglionic mass, the brain (*q.v.*), has been developed in the course of evolution, to which the whole of the nervous system is subordinate. The brain takes over the regulation of the highest functions, those involved in purposeful behaviour. This brain development commences in flat-worms and in annelids. It attains its greatest development, on the one hand, in the supra-oesophageal or cerebral ganglion of certain invertebrates, and, on the other, in the vertebrate brain with its five divisions and far greater complexity. With the brain, that very important part of the central nervous system, the ventral nerve cord of annelids and arthropods, and the spinal cord of vertebrates, is in closest connection. The brain merits our particular attention above all because in man it is rightly considered to be the organ or seat of the mind.

The Highest Centres.—The brain, using this term generally to include the highest centres of the nervous system, has the function of co-ordinating movements. Here the decision is made as to which impulses shall be conducted further on, when the results of stimuli arrive simultaneously from several sense-organs. In addition the brain decides into which nerve-paths these impulses shall be switched for conduction to the effector organs. This highest connecting centre is at the same time the most important inhibition centre. It intervenes as the highest court of appeal in the course of reflex and instinctive activities. The brain, just like the lower centres, can stop or inhibit these actions. An example will make this clear. When the mouth-parts of a normal crab come into contact with a piece of food, the chemical stimuli derived from the food cause the appendages, in a reflex manner, to tear up the food and to put it into the mouth. The action stops when the stomach is full, when the animal's hunger is satisfied. If, now, the commissures which unite the crab's brain to its ventral nerve-cord are cut through, the mouth appendages continue to work as long as food is presented to them. The result is that the stomach and the gut of the animal are eventually so crammed with food that they burst. This shows clearly that the brain, which is normally kept informed of the state of repletion of the stomach through special nerves, exercises an inhibitory influence on the reflexes concerned in feeding. Whereas it is impossible to persuade a normal frog to croak by any stimulus whatsoever, this croaking invariably follows when a frog whose forebrain has been removed is stroked down the back with the finger. Here, too, the inhibitory function of the highest centres is apparent.

Further, the brain functions as an organ of summation. It is a sort of reservoir for separate impulses, in themselves perhaps too small to result in action. The nervous energy thus stored up in the brain is from time to time liberated into motor paths in response to further incoming impulses, which can be due to internal causes. In this manner, so-called *spontaneous actions* arise, that is to say actions which take place without external cause, apparently in an arbitrary manner. Together with its functions as centres for the voluntary distribution and switching of impulses, the brain also includes the centres concerned in the formation of associations. It brings about the inter-connections between nerve impulses due to different but simultaneous stimuli. Upon this the faculty of association depends. Finally, the centres are also situated here through the activity of which a certain continuous tension of the body muscles, the so-called muscular tone, is brought about.

The more an animal is endowed with highly developed instincts, the less does it stand in need of a large number of individually acquired experiences, memory-images, and associative faculties, to be able to behave in the most adaptive manner possible. Thus we find that in insects in spite of the complexity of their instinctive lives, the brain remains relatively small. Added to this, the whole bodily design of these creatures, particularly the presence of an external skeleton, prevents the volume of the body from exceeding a certain size. Thereby absolute limits are further set to the size of the brain, and hence, also, to the further development of mental qualities, the beginnings of which are actually present. In vertebrates there are no such special limits set to the growth of the brain. Hence we find in the different classes of vertebrate animals a progressive development of the mental faculties. This reaches a high point in the birds, but the highest pinnacle is attained among the mammals. It is true that in the latter the lower groups are inferior to birds. It is only in the monkeys, and finally in the anthropoids, that the highest level is attained, forming an intermediate step to the intellect of man. The highest centres, particularly the association centres, lie in birds and mammals in the cortex of the fore-brain, the surface of which increases proportionately to the mental faculties.

Deficiency Phenomena.—When the hemispheres of the fore-brain are removed from an animal, a number of deficiency phenomena are evident in the animal's behaviour. These become the more apparent the higher the animal in question stands in the evolutionary series. Thus fishes or frogs without these fore-brains show no noticeable difference in their behaviour from normal individuals. Such frogs catch flies as usual. They avoid obstacles, dig themselves into the mud in winter, and betake themselves to water during the warmer months. They even possess memory, although it lasts but a short time. All this is accomplished by the centres situated in the intact parts of the brain. Reptiles and birds without fore-brains are no longer capable of spontaneous movements. A few days after the operation, when shock effects have disappeared, a pigeon thrown up into the air flies with co-ordinated movements. It alights in the ordinary way on a perch and avoids obstacles. It can still see and hear well. But all memory has vanished. It does not recognize its food and consequently does not eat or drink of its own accord. It recognizes neither friend nor enemy and if it has young it does not care for them. In mammals, the deficiency phenomena vary according to the mental capacities of the particular animals. Dogs without their fore-brains have been kept alive for years. They appear completely blind and they take no food of their own accord. For the most part they lie quietly sleeping. Such a dog no longer shows any signs of joy. Rather it exhibits fear. It goes without saying that the dog is incapable of learning anything new.

If the whole brain is removed from a vertebrate animal, the effect is always fatal. But whereas in man section of the spinal cord is followed by instantaneous death, the decapitated trunk no longer showing any reflex movements whatever, brainless animals (spinal animals) are well able to carry out such movements. This is the more true the lower the animal stands in the vertebrate series. In apes there are indications only of such movements. A spinal dog makes running movements when the under-surface of the paws is pressed. Its tail can be caused to wag. A decapitated rabbit makes one or two last jumping movements. Fowls and pigeons with their heads cut off run around with wings beating. In these spinal animals all complicated faculties have disappeared owing to the loss of all the higher centres and of the main sensory centres. But the co-ordination of normal locomotory movements persists because this depends on centres in the spinal cord. Lower vertebrates can be kept alive even longer after being deprived of their fore-brain. A spinal frog still plainly exhibits all reflexes. If the skin of such a frog is moistened with dilute acetic acid, the animal makes movements with the foot of the side touched, as if to remove the stimulus. If this extremity is prevented from moving, the frog uses the other leg in an apparently purposeful manner. This experiment proves that biologically useful actions can take place without the presence of consciousness. Such experiments have the further value of showing which actions of animals can take place in an apparently purposeful fashion, but without any intervention of the highest centres, that is without conscious intention.

Reactions to Form-stimuli. — A question to which physiology for long supplied no satisfactory answer arises whenever animals react to form-stimuli (fig. g B). This is the case when the image of a definitely shaped object thrown on the retinal cells calls forth a reaction. And it is equally the case when any other stimuli having a spatial combination are followed by a definite reaction. This is particularly so with the sense of touch and the topo-chemical sense. Von Uexkiill has attempted to supply an explanation of the phenomenon. According to him, each combination of important stimuli corresponds to a model or schema in the brain. The effects of such a stimulus-complex upon a particular group of sensory cells, for example the retinal elements upon which the separate points of the image of an object fall, are conducted by definite appropriate groups of nerve fibres, past the association neurones and the lower centres, until they arrive finally at the highest centres. There the sensory nerve paths reach their end-points. But these end-points must from the nature of things have some spatial arrangement. Von Uexkull assumes that the impulses conveyed to these end-groups are transferred to the corresponding schema somewhat after the manner of electrical induction. The stimulation of the schema then causes a particular reaction of the animal in a relatively simpler manner. The discrimination of spatial boundaries of objects by the most highly organized central nervous systems and brains thus requires a fixed spatial arrangement of nerve paths. The higher brains, as it were, reflect a portion of reality in their schemata through the spatial interrelationship of their parts. In this way there arises in the central nervous systems of the higher animals a new individual universe. Von Uexkull calls this the counter-world (Gegenwelt). Although the things in the outside world which are important to the animal may correspond to definite schemata, the spatial arrangement of the elements of the schema need not be identical with the spatial structure of these objects. And it certainly is not identical. The immense complication of structure of the highest centres which this discussion implies to be necessary must be the reason why reactions to form-stimuli only occur in animals possessed of well-developed and highly complex brains. But that this faculty may exist in relatively low animals is shown by the fact that hermit-crabs have been trained to use as dwellings snail-shells of a particular shape only, and to shun other shells. It is evident, therefore, that these animals, through responses to stimuli in their nerve centres, must be able, then, to distinguish the shapes of these objects from one another.

THE CONCEPTION OF THE ANIMAL MIND

The opinions as to what is meant by the conception of mind are very divergent. Many investigators (Häckel, Famynzin, Bechterew, Claparède, and others) are of the opinion that animal psychology must assume a mind in all animals, even the lowest. According to the view of many modern authors, animal psychology is the science of animal reflexes, instincts, plastic behaviour, and the co-ordination of these actions. Others again consider the capacity for learning, associative memory, as a proof of the presence of mental phenomena. At the root of many of these views lies the thought that the mind is a factor regulating the organic being, that it intervenes in the causal connections between material physiological phenomena. The mind is supposed to be super-added to organisms, and hence to be super-imposed on the laws of physics and chemistry applicable in lifeless nature. The mind is supposed to intervene as a factor directing events towards the attainment of definite ends and purposes, a finalist, teleological principle added to the causal laws of nature. It is especially the purposefulness of animal behaviour, observable everywhere, which is the reason for this assumption. Frequently the name of "consciousness" is given to a mind so conceived, or to the sum total of the phenomena corresponding to such a mind. It leads to misunderstandings when some authors identify the object of animal psychology with the study of consciousness, while others use the conception of consciousness in the sense explained above as a "psychic factor." We here use mind as identical with consciousness or the totality of inner experience. Everyone knows this changing play of conscious phenomena arising out of his own personal experiences. For this reason there can be no definition of the conception. With all phenomena of consciousness, physiological processes occur in the central nervous system which are indissolubly bound up with them. The physiological processes in question cannot take place without the accompaniment of mental phenomena. And mental phenomena never appear without corresponding physiological changes going with them. The course of the physiological processes is continuous. The phenomena of consciousness are discontinuous, being interrupted by unconsciousness, sleep, or fainting. On this view an intervention of the mind in the course of physiological occurrences is impossible. Further the psyche, soul or mind, is not a substance, as has sometimes been supposed, but it is a course of mental events. From all this it follows, as already indicated, that the mind cannot be objectively experienced. No other course remains open to us, then, but to see in animals a mind analogous to our own consciousness, and to attempt to picture to ourselves what sort of knowledge animals can obtain through the functioning of their sense organs of the things and happenings in their environment and how in consequence the world may appear to them.

The Surrounding-world and Inner-world of Animals. — For the lowest animals stimuli alone exist. The whole manifold environment surrounding us does not exist for them. Hence they are ignorant of enemies or dangers. The capacity to choose between different reactions is almost wholly lacking to these animals. Their reactions to external stimuli are fixed reflexes. In many instances this is so striking, as for example with the echinoderms, that the animals might rightly be called reflex automata. It is in just these animals that a unified central nervous system is absent. Hence their bodies cannot receive any directed stimuli. In the worms the development of a brain commences, and in higher groups this more and more takes over the co-ordination and direction of movements. The spontaneous movements likewise derive from this brain. The sense-organs become more and more complex. In the most highly developed molluscs, the cephalopods, the structure of the nerve centres and with them the behaviour, is so complicated that one can credit them with a counter-world (Gegenwelt), with schemata. The brain of the arthropods is the highest switch-centre and the organ of inhibition. In the higher Crustacea associative memory appears clearly for the first time. Behaviour based on reflexes and instincts can now be modified, for the instincts are plastic up to a certain point. The surrounding-world (*Umwelt*), although certainly not yet objectively perceived, becomes nevertheless ever more and more manifold. In insects these faculties become even further enhanced. Reactions to colours and to shapes exist. Nevertheless instincts still heavily outweigh plastic actions.

It is only in the vertebrates that plastic behaviour steps gradually into the foreground, although the lower groups of vertebrates are little in advance of the highest invertebrates. Since memory replaces intellect in the animal, we frequently find quite amazing instances of memory, particularly in relation to the sense of locality and of finding the way home. It is remarkable that the types of animal which exhibit a complex faculty of association and capacity for learning from experiences composed of numerous details, are phylogenetically young forms which developed only a little before the Chalk age. These are the social insects, dragonflies, robber-flies, birds, and higher mammals. But the faculty of association is not in itself sufficient to build up higher psychic functions by the summation of simpler psychic elements. The so-called psychology of association, which held the field for some time, came to grief in the attempt to maintain this view. The capacity for highly compiex performances and in the end for single-purposed actions depends upon the fact that the method of trial and error, which is exhibited by most animals as a testing of various reaction possibilities, is now moved up into the brain, where it intervenes in the various physiological processes due to experience.

Reflexes and **Consciousness.**—We have seen that reflexes are the basis of most animal movements. It is therefore natural to enquire into the relationship of reflex movements to psychic happenings and all the more so since in man there can be a connection between reflexes and the phenomena of consciousness. There is a whole series of reflexes which take place without our being conscious of them. Thus the pupil of the eye enlarges or contracts according to the intensity of the light falling on the retina quite without our knowledge. Nor are we able to alter the size of the pupil aperture at will. In other cases at least the end result is known and often the stimulus also. If one sits with one leg crossed over the other and hanging down loosely, a light tap with the edge of the palm on the front of the shin just beneath the knee-cap causes a jerking up of the leg. The movement and the touch-stimulus are felt. But we are not able to suppress or alter the course of this reflex by an effort of will. There are other reflexes which we can inhibit at will. Such are the closing of the eye-lids when the lashes are lightly touched or when an object comes rapidly towards the eye. Since in ourselves some reflex phenomena take place with, others without, consciousness, and some can be suppressed by the will, while others cannot be so influenced, we can draw no conclusions as to whether consciousness accompanies reflex behaviour seen in animals.

Even though many instinctive actions appear to be accomplished with conscious intention owing to their remarkable adaptiveness, yet we can often convınce ourselves by appropriate experiments that the animal has no consciousness of the purposeful nature of its actions. When the conditions are so altered that the actions of the animal are turned into nonsensical, non-adaptive ones, they still continue to run their course, which corresponds to an inborn plan. From this it becomes evident that the animal acts in reality merely by instinct, that is without knowledge of the object and meaning of its behaviour. We see that instinct is really only a concatenation of reflexes. The burying beetle, *Necrophorus vespillo,* attracted by the smell of the corpse of a small animal, commonly buries the latter beneath the soil by undermining the ground. Then it lays its eggs in the corpse, thus providing for its brood when it hatches out. It has been observed that the animals are able to gain possession of a corpse, hung purposely on a small gibbet, by digging around the posts and so making it fall. H. Fabre had proved by a series of extremely ingenious experiments that this bringing down of the gibbet is in no way the result of a special cleverness on the part of the beetles, but that it happens by mere chance. For if the suspended corpse just touches the ground next to the posts of the gibbet, the beetles commence to dig there. As a result, the gibbet often falls down owing to a loosening of the soil. But if the spot at which the corpse touched the ground happened to be some little distance from the posts of the gibbet, the beetles never dug close to the posts. Hens in the open scrape at the ground in a purposeful manner to unearth worms, insects, and so forth. Yet the following experiment shows that they have no knowledge of the intention nor the meaning of their behaviour. A hen climbed into the earthenware plate in which grains of corn were brought to her and, once inside the plate, continued the scraping movements which were now completely purposeless. The only effect of tbe movements was that the corn flew out and was scattered. Next the hen was given her corn in a small box with sides 15cm. high, which was firmly fixed to the floor of the chicken-run. The hen walked up to the box, began to peck at the seeds inside it, and in so doing made powerful scraping movements on the bare wooden floor of the box, which movements were of course completely senseless. Such observations must warn us to examine very critically actions of animals which appear to us purposeful, and not to interpret them straight away in an anthropomorphic manner. If consciousness exists in the hen which behaves as we have observed, it is certainly quite another kind of consciousness than that which we should feel in the animal's position.

Nigher **Mental** Faculties. — The grasping of the objective inner relationship between two things is a performance superior to instinctive action. Such a capacity has been proved for anthropoids, lower apes, dogs, white rats and fowls. We may accordingly assume that the faculty is present generally in higher mammals and in birds. Fowls were trained to pick corn grains from one of two grey papers of different tints, for instance from the lighter of the two. Then the two papers were replaced by another pair. Of these the grey paper to which the birds had previously been trained was now the darker of the two. The fowls went by preference to the now lighter paper. They behaved in the same way with any other arrangement of pairs of papers chosen out of the four used. There is then a relative but no absolute knowledge. The same kind of relative appreciation regarding pairs of grey papers has been shown to exist in lower apes and in a pointer dog. In the case of the rats two spaces were lit to different intensities. One of these two was the place in which they were fed. Köhler's chimpanzees were offered two boxes distinguished by having front boards of different sizes. One of these, for instance that with the larger front board, contained food. After the animals had learnt to go to the right box, other pairs of front boards were put in. The animals always chose that which was the bigger at the moment, without regard to the absolute size. In all these cases, a comprehension of relation, a transposition, occurs just as when we recognize a tune even when it is transposed into another key.

Until lately no psychological explanation had been suggested for this faculty. The *Kohler-Wertheim theory of Gestalt (form)* which has been developed in the last decade and was first applied in human psychology appears to fill this gap. For it relates as much to the physiological as to the psychological side of the phenomenon. Our perceptions are not simple summations or additive configurations of sensations, composed of separate elementary sensations. Rather the sensory impressions make themselves felt to us as specific, rigid, unified impressions of the whole situation. These are more than the sum of the parts. Rather they are spatial forms, meiodies or intellectual associations *(Gestalten).* According to the theory in question these *Gestalten* can be transposed. The physiological processes which form the basis of the phenomena or experiences of *Gestalten* themselves participate in the character of these phenomena. And Kohler has actually attempted to show that in physics there exists a non-additive, super-geometrical form arrangement which may have a real meaning. The physiological occurrences, according to the *Gestalt* theory, have themselves the properties of a *Gestalt.*

Finally the highest accomplishment of animals, the capacity *to abstract,* has been demonstrated in anthropoids. Nadie Kohts first showed a chimpanzee a number of bone disks of various colours and shapes. Then she succeeded in getting the animal to choose these particular disks out of a heap containing others as well. The chimpanzee succeeded further in solving an even more difficult problem. A hemispherical bowl of a certain colour was shown to it and then the ape chose out of the collection of variously coloured bone disks a disk having the identical colour of the bowl. The animal abstracted the idea of the colour from the very different shapes of the two coloured objects. It considered the colour alone. It was due likewise to such a faculty of abstracting that the Teneriffe chimpanzees were able to drag in a fruit lying out of arm's reach by using all sorts of objects without regard to their shapes, as if they were sticks. Possibly the *Gestalt* theory might provide a physiological explanation, at least in principle, for this most complex behaviour. Yerkes has corroborated the presence of this faculty by quite other methods.

Whether or not animals have ideas or conception is still most debatable. If a dog or a cat makes no effort to reach its food from the moment when the food is removed from its sight, it may well be concluded that these animals have no memory-image of what they have just seen. In spite of the highly perfected training performances of many higher animals, there is no reason why independent ideas should necessarily be associated with the accompanying memory processes. The observed behaviour can well be explained by the associated coupling of the sensory impressions with inborn instincts, or body movements which have become habit through practice. Up to now, it is impossible to decide whether in animals, as in ourselves, a conscious separation of immediate and reproduced sensory impressions exists, or if such is at least foreshadowed. The anthropoid apes form an exception once more. Their "insight," the fact that they make "discoveries," would appear to be explicable only on the assumption that they are gifted with objective conceptions. Kohler is of the opinion that the higher animals know "separate things," and not only diffuse "experience complexes." He points to the enormous importance of the "comprehension of meaning" for the formation of concepts, for an insight into the "meaning" of the connection between events. "To be able to see things in the surrounding world, it is necessary for an animal to have experience of the meaning, of the structure, of that part of its surroundings." (Koffka.)

THE EMOTIONS

The mental life of human beings has both an objective and a subjective side. The objective side of consciousness includes perception, sensation and conception, or in short all that is connected with the outside world surrounding us. The subjective side, on the other hand, concerns that part of our inner lives which belongs to us alone, our real interior world, or in other words emotions and the phenomena of will. The importance of the emotions in the whole mental life is so great that many psychologists see in them the basis of all mental phenomena. But what is the state of affairs in animals? S. J. Holmes regards pleasure and displeasure as the most powerful factors regulating the conduct of animals. Whilst in dealing with the objective side of the animal mind we were obliged to resort to analogies with our own mental experiences in order to attempt to form a picture of this part of a possible inner life of animals, we are even worse off in regard to their fkelings. Objectively the mind cannot be experienced. How then is it possible to arrive at the innermost emotions of animals? Here, too, we are obliged to depend on our only means of study of the animal mind, namely analogy, which unfortunately is very uncertain. In the animals most nearly related to ourselves we observe behaviour which coincides closely with certain expressions of our own inner life. This is so convincing that the objection that the mode of procedure is questionable might easily be overridden. It becomes difficult for our emotions to refuse to accept these connecting links. Yet even with the mammals our confidence in the analogy is shaken. In the remaining vertebrates, and more particularly in the invertebrates, which are so differently constituted from ourselves, this convenient tool must be foregone.

It is the "expressive movements" visible to the eye which permit of the argument by analogy. There are the gestures of animals nearest related to ourselves, and added to these there are finer changes which can be shown physiologically. These agree fully with those changes in ourselves accompanying our sensations. If there is any mental correlative to the expressive movements of animals, it must be represented by the so-called emotional side of our own mind. Our sensations are those of pleasure or displeasure, of excitement or calm, of tension or relaxation. The rise and fall of our feelings are accompanied by definite changes in the rhythm and in the intensity of respiration and pulse. Exactly similar changes can be observed in animals either directly or with the help of special apparatus. All small animals, such as rabbits, rats or birds, show this when seized or even when approached by the hand in their cage. Changes in the rate of respiration, on stimulation, have been found to occur not only in fishes but even in arthropods, particularly in insects. Are these purely physiological processes, or may we argue from analogy and attribute to these animals feelings such as we ourselves know? In men these respiratory and vasomotor phenomena occur when particularly strong and lasting emotions are concerned. It is just these, for example joy, sorrow, care, fear, anger, fury and others, which are normally accompanied by typical expressive movements. In us these movements consist of mimicry, the expression of the eyes, particular movements of the limbs, the whole attitude of the body. They are involuntary and take place in a reflex manner. We find a number of these expressions repeated by our nearest animal relations.

Of greatest interest to us are the expressions of the emotions in apes, which in many ways resemble our own to a remarkable degree. Nevertheless, differences exist, as Kohler points out as a result of his experiences with the Teneriffe chimpanzees. A shake of the hand was a sign of displeasure. Greater discontent was expressed by striking the ground rapidly with the hand. Indignation was made known by a forceful beating with both fists on the ground and an excited jumping up and down. Animated nodding of the head was the sign of joyous expectation. Fits of anger in anthropoids, as has long been known from experience in zoological gardens, are wont to be of uncommon intensity and long duration. Travellers relate how the hunted gorilla makes the most enraged assaults on its enemies, accompanied by roaring and beating of the chest with its hands. Just as men do in similar circumstances, chimpanzees scratch their head or the side of their body as a sign of uncertainty, indecision or embarrassment. When very astonished they leave their mouth wide open. They are even capable of a sort of weeping, although without tears, when afflicted with grief. And so, too, they laugh in a certain measure, as an expression of pleasure or joy. When tickled in the palm of the hand their face is drawn into a sort of grin, while they titter or squeal with apparent pleasure. In common with human beings apes can blush and grow pale in the face.

In birds, too, movements exist which may be interpreted as the expression of feelings. These animals seem likewise to be subject to moods and humours corresponding to physiological conditions. On the other hand, the interpretation of particular movements of invertebrates is most uncertain, although they too have been regarded as expressive movements. The bee-keeper believes he hears the moods and feelings of his wards from the note given out by the inhabitants of a hive. In cephalopods a lively play of colours of the chromatophores is observable which makes the whole body or separate parts of it appear now light, now dark. At the same time, particularly in *Sepia,* the arms are held in a peculiar manner. It appears certain that these changes reflect definite excitations in the nervous system. But whether or not they are the expressions of definite feelings can only be guessed at.

One of the most emphatic feelings in human beings is that of pain. It is usually accompanied by particularly marked expressive movements. The most characteristic signs are violent withdrawal, warding off of the stimulus which causes the pain, and other movements, the use of the voice being a common accompaniment, rising on occasions to a shout. In the vertebrates we find quite similar expressive movements and sounds, following on stimuli which we can suppose, on the analogy of their effects on ourselves, to give rise to perceptions and feelings of pain. It is true that these expressions are much less intense in herbivores than in the more agile carnivores and more especially in the apes. In the lower vertebrates, and even in birds, these signs of a sensation of pain are even less apparent. Must we then suppose that these animals have a duller sense of pain than the higher vertebrates? In invertebrates, the existence of a sense of pain becomes very questionable indeed. Certainly here too we often find violent defensive and other movements following on corresponding stimuli. But we have no means of testing whether these are the expression of a sensation of pain or merely the consequence of a very strong excitation of the nervous system'. The following experiment is suggestive. If an earthworm is suddenly cut into two pieces with a spade, the front half creeps on apparently unaffected while the hinder end writhes violently. Yet the latter contains only the ventral nerve-cord, with its lower centres, whereas the cerebral ganglion or brain is in the front portion. But the brain being the seat of the highest centres must be regarded as the bearer of consciousness, including the feeling of pain. It is worthy of remark, too, that in the highest organized invertebrates, the insects, injuries and mutilations tend usually to have no externally apparent effects. These animals usually behave in a quite unconcerned manner in response to extremely powerful stimuli, from which we would, from our own experience, be inclined to assume a violent feeling of pain. An ant continued quietly to suck honey after first the antennae and then the whole abdomen had been cut off. When the whole lower portion of the head, including the mouth, was cut off in bees and wasps (leaving the antennae intact), the animals went back again to some honey which they had found. When a caterpillar is wounded in the posterior part of the body and the head is turned round to the wound, the animal will eat its own flesh. It is possible to place the hinder end of a dragon-fly's abdomen between its jaws, upon which it begins at once to consume its own body. This seems to indicate that a sensation of pain is lacking in arthropods. We conclude that to all appearances a pain sensation is present in the higher vertebrates and that the lower we descend in the animal scale, the more doubtful it becomes whether or not pain exists, until in the lowest animals it is almost certainly absent.

In many of the higher animals, mammals and birds, expressive movements are to be observed which by comparison with similar movements in ourselves may be taken as signs of fear. In addition to the changes in respiration and pulse-rate referred to already, trembling of the body is seen, together with timid withdrawal or, in the case of animals living in herds, panic-stricken flight. Numerous analogies are found, too, in the animal kingdom, again particularly in the higher mammals, for the outward and visible expressions of our own feelings of pleasure. And while we cannot be certain in the lower animals that there are any expressions of pain, almost all animals, right down to the worms, show a violent excitement during pairing and in other actions connected with sexual life. One might be inclined to interpret these as the expression of greatly heightened feelings of pleasure, of the same nature as our sensations of sexual satisfaction.

THE LANGUAGE OF ANIMALS

By animal language we understand not only the various productions of sound but we must also include in the conception all those movements and modes of behaviour by which animals influence their fellows from a lesser or greater distance away. Hence, animal language may consist of sound language or of sign and gesture language. Naturally we find animal language developed principally where the conditions of life are such that animals are in close relationship with their fellows. This is more particularly so in the mutual quest of the opposite sexes for one another for the purpose of pairing. Since it is usually the males which are the active partners in seeking out the females or in enticing them to come to them, they are possessed of the most expressive speech, or it may even be the males alone that have the power of speech. Of insects the males alone are capable of sound-production. For the enticement of the opposite sex the language of gestures plays at least as great a part as that of speech. Frequently certain bodily positions serve as signals. The calls and warning notes of parent animals have a great importance, particularly of mother animals that keep their young with them for a time. But such calls are always found, in addition, where animals live in close contact with one another, when they possess a social life as a family or a herd. Finally, a kind of battle language is to be observed in animals, both in the form of expressions on the part of the attacker and on that of the attacked. Naturally the necessary conditions for the development of such a language are only present where not only the animal expressing itself is capable of producing the requisite sounds or signs, but where also the other individual is equally capable of receiving and interpreting the signs produced. A sound language, for example, can only exist when the individuals for which it is of import possess ears. Consequently, every observed production of sound or noise, every apparent gesture, must not immediately be interpreted as a form of language.

In one respect all animal languages are fundamentally different from human language. Whilst we speak or make gestures to explain our thoughts or wishes to others, in the language of animals something far more primitive is concerned. For there is never any conscious intention involved. It is never anything but the instinctive expression of a definite physiological condition, under certain circumstances also of a particular sensation. Nor is the second animal, to which the first addresses itself, ever capable of giving a definite meaning to the sign or sound emanating from its companion, nor of understanding it as a conscious message. An utterance in the language of animals means nothing more than a certain stimulus, sign or signal, the reception of which is answered by certain reactions. It is true that in this way animal speech to a certain extent attains the meaning of a communication. And this is all the more so since once more we can observe here how a purposeful adaptation co-operates. Normally the language signs are answered correctly, that is purposefully, in accordance with their meanings. Further, the words or definite sounds used even by the highest animals refer always to their feelings, and never designate objects,

Insects.—In addition to the sound-language of certain insects, other modes of communication are found in this group. More particularly among social insects the capacity of inter-communication has reached a high pitch. The mode of expression to be observed here is spoken of as antennal or feeler-speech. Ants induce their companions to regurgitate food from the crop by gentle tapping or stroking of the head with the antennae. The ant guests have adapted themselves to these conditions and imitate the speech-signs of their hosts. But the feeler-speech of ants is much more comprehensive than this, so that the celebrated myrmecologist Wasmann was able to compile a sort of dictionary of the ant language. The strength and rhythm of the antennal tappings are concerned and the parts of the body to which they are applied. An ant which has found an object too heavy to be carried alone fetches companions to help in the work. The termites possess a similar highly developed language. They do not, however, use the feelers, but the whole head, with which they rain rapid blows on the head of a companion.

Von Frisch has made exact studies on the mode of communication of honey-bees. The worker bees, on returning to the hive from a productive food-source which they have found, dance a recruiting dance. During this the scent organs, situated between the fifth and sixth abdominal segments, are extruded. The dance moves in a quite definite and peculiar manner in and out between other workers that happen to be in the hive, inducing them now to fly out to work. The type of dance varies according to whether a source of nectar or of pollen has been discovered.

Birds.—The sounds and speech of birds are extremely varied. Sounds are produced by the lower larynx, or syrinx. In true song-birds the sounds can become songs which charm the human ear. Yet even these sounds are the mere outlet of a state of excitement. The birds have no intentional purpose in mind. According to the most recent view the song of birds is not necessarily connected with pairing, but it bursts forth whenever the bird is labouring under strong excitement. This occurs, of course, most frequently in the pairing season. No song is given when a bird is unwell. The calls, warning notes, etc., of song-birds must be distinguished as inborn instinctive impulses, distinct from the sexually differentiated song of the males. This is a secondary instinct and is in many species not entirely inborn, but it must be acquired by the young males through imitation of older birds. Quite a number of birds have the desire and the capacity of imitating strange noises. Such, for example, are the jay, the butcher-bird, the starling, the mocking-bird and others. Ravens and their relatives and parrots, especially grey parrots, are best able to imitate the human voice. But even in these cases, nothing ever exists beyond the satisfaction of this curious imitative impulse. There is never any real speech, in the sense of any meaning being attached by the animal to the sounds which it makes. In the majority of cases the speech of parrots is merely an automatic reaction to external stimuli. In the case of those very rare parrots which apparently speak in a purposeful manner, as for instance by crying "Come in" when a knock is heard at the door, or by demanding food, training has undoubtedly taken place, although this training need not have been given intentionally by the owner of the bird. The parrot in question may very well, without any intention on the part of the owner, have associated, in its impulse for phonetic imitation, the words with the consequential arrival of food or other reward. It goes without saying that an "understanding" of the words on the part of the bird is completely excluded, since even the best instructed parrots can never say any other words or sentences than those which they have learnt.

Mammals. — These produce sounds with the larynx. In their language also there are cries of appeal, cries for warning and mating calls. Horses neigh, snort, whinny and mares squeal in addition. Dogs bark. growl. whine or howl and they can modify these sounds in loudness, pitch and duration. The sound-language of apes has been investigated on more than one occasion. Garner (1900) was the first to use the phonograph in studying the language of apes. With capuchin monkeys he succeeded in establishing 30 different sounds having different meanings. Mammals in general have at their disposal a more or less well-developed gesture-speech in addition to sound-speech and this is particularly evident in apes. Every species of ape and each group of nearly related species has its own inborn sounds, lip-signs, bodily postures and movements, by which the animals make known to one another their feelings and intentions. The means of imparting information are particularly numerous in the anthropoids. The Teneriffe chimpanzees, when pleasurably excited, gave vent to a repeated sound of "och" (as in "loch"), their tears were accompanied by a deep "oo," and grief was expressed by a high "ee" sound.

Possibly the reason why animal sound-language has undergone no further progress is that animal speech is always an expression of the prevailing feeling of excitement, humour and perhaps also emotion. The sound-expressions of animals never represent facts. They are not names for things. Hence animals have no vocabulary. Animal language is concerned wholly with feelings, giving no expression at all to intellectual events. Even those animals which have at their command a multiform sound-language are never able to carry on a "conversation." The same statement is true of gesture-speech.

CHILDHOOD AND PLAY OF ANIMALS

Real childhood and youth are found only in birds and mammals. It is the period of life in which young animals, while moving around and forming impressions more or less independently, still enjoy the protection of their parents. It is true that young mammals and birds are equipped from birth onwards with the necessary inborn reflexes and instincts to enable them to maintain their lives and to conform to the habits peculiar to their species. Nevertheless, in these animals, numerous faculties require practice. The young have to learn the use of their limbs by experience. At birth chicks and ducklings are endowed to different degrees. Both possess the inborn reaction of standing on one leg and scratching the head with the other. A chick succeeds from the very beginning, but a duckling loses its balance in its first efforts. It learns by experience how to balance its body while carrying out the movements. Through practice the co-ordination of the instinctive movements is improved. In the chick the instinct to drink and the co-ordination of the necessary movements is inborn. But to set the train of movements in action a releasing stimulus is necessary. Normally this is supplied by the sight of the hen drinking. But the mere sight of water, or the feeling of standing in water, in no wise acts as a stimulus. If, however, grains of corn are thrown into the water, the chick pecks at them at once, and the drinking reflex is immediately set in action by the wetting of the beak. Next time, the stimulus of water on the feet is sufficient. Sucking of the mother's milk by a young deer is an inborn instinct, just as is the action of following the parents through a wood. But the commencement of the act of sucking is a reflex depending on its own adequate stimulus, which is normally supplied by the mother's teats. A fawn in captivity will only suck at a feeding-bottle after the teat has been moistened with milk. The voice of many birds can be heard after they hatch out of the egg. But when, for instance, the mother bird makes it known by a warning call that a bird of prey is flying by, a young moorhen immediately ceases to hammer at its egg-shell and to tweet. It keeps still until informed by a different call from the mother that the danger is past. This is a further example of the purposeful nature of instincts, although the animal has not the faintest conception of the significance, object or result of its behaviour.

In species of animals where the struggle for existence makes particular demands on the abilities, parents usually "instruct their young." (See EDUCATION IN ANIMALS.) Normally there is again no question of any intentional, conscious, systematic instruction. Young birds are obliged to learn how to fly correctly. Under the protection of their parents, young storks and birds of prey copy their movements, and young swifts practice fly-catching. Young water-birds have often to learn to swim and to dive. Whereas young ducks go at once to water, young swans and gulls must be taken there by the mother. Male and female falcons together teach their young to hunt. They let captured prey drop do n on to the young which have followed them up into the air.

Play (see also PLAY IN ANIMALS) affords a means of practising the use of the limbs, of gaining the skill requisite for independent life and of acquiring strength. Hence play is principally found in young animals, but it is seen too in the adult. This is particularly the case with predaceous animals, where it has the same significance as in young animals, being a sort of gymnastics or sport. This conception of play, first brought forward by Groos (1907), is now generally accepted. It has replaced the earlier opinion of Herbert Spencer that play is the expression of an overflow of energy. Types of play may be subdivided into movement, hunting and fighting games. The so-called "love-play" of adult animals is of quite a different nature. .4s an instinctive activity for the heightening of sexual excitement love-play is an aid to sexual reproduction.

A few examples of the play of young animals may be given. Young predaceous animals and some ungulates have the instinct of running in pursuit of a moving object. They jump after one another or after the parent animal, often stimulated by the sight of the tip of the tail or the brush of the mother. Young ungulates carry out amusing leaps and capers. Young climbing animals practise climbing and jumping from branches. Predaceous animals push stones, tufts of grass, or pieces of wood with their paws and then jump after them as if at a living prey. When they fight together they seize each other with teeth and claws, but without using their weapons in earnest. The young of animals which have horns or antlers frequently butt at one another before the horns have grown out. The play of apes is particularly lively, consisting usually of movement-games. In the play of chimpanzees something manifests itself which might well be termed joy in performance. The games of the anthropoids kept at Teneriffe often took the form of a sort of sport or fashion. Thus, for some time, they took pleasure in breaking open the cover of the drain in the animal-house. On another occasion they occupied themselves in offering bread to fowls which were outside the bars of their cage. When the fowls pecked at the bread the chimpanzees would draw it back quickly, or would hit at the birds with a stick or a piece of wire.

ETHICS AND AESTHETICS

Ethics. — Man is wont to ascribe all manner of moral sentiments to those animals with which he is most familiar. But it must be borne in mind that morality in the strict sense is impossible in animals for the reason that they are incapable of abstract thought. On the other hand it is quite certain that many moral actions of human beings have their roots in animal behaviour. Whenever the mode of life of animals involves a number of individuals remaining together temporarily or permanently, we find the beginnings of morality. Of course, the actions in question are always purely instinctive. First of all the numerous instincts for the care of offspring by parent animals must be mentioned. Social life in larger or smaller groups requires a mutual consideration of the individuals for one another. Often a special impulse for companionship exists. This is, no doubt, the reason why many animals attach themselves so easily to men. Among birds we find the highest and fullest development of conjugal life. Lifelong mating is known in the stork, the partridge, the swallow and the dove. It is true that we must not exaggerate our interpretation here. In these animal marriages, if they may so be called, there is no question of a relation of friendship or love between the partners. They are rather brought together again and again because instinct always drives them back to the same place where they first built their nest. The reason for conjugal fidelity in these cases is a fidelity to locality or nest. To be sure, in certain birds, the pairs cleave together with a measure of tenderness. The love of monkeys for their young is well known, not only for their own, but for the offspring of others or even the young of different species of animals. Yet observations in zoological gardens have shown that the mother ape in captivity, in spite of her tenderness, allows no food to get to her young when little food is available. It is noticeable, on the other hand, with what care carnivore mother animals bring food to their young, and can even be persuaded in zoological gardens to suckle strange young.

Aesthetic Feelings.—These have also been ascribed to the higher animals. Thus the decorative colours of male animals play an important part in Darwin's theory of sexual selection (*q.v.*). It appears to be certain that the capacity possessed by birds of distinguishing between colours will, in most cases, certainly not permit of the female taking note of all the details of the decorative feathering of the male, though for the purpose of Darwin's theory, the stimulatory effect of the general impression is all that is required. Many birds, such as magpies, undoubtedly are stimulated by bright objects and colours (see C. G. Levick, Antarctic Penguins). The ornamental bowers of the bower-birds of Australia and New Guinea undoubtedly impress the females merely by the quantity and brightness of the heaped-up leaves, fruits, berries, bones, shells and so forth. For these collections are for the most part quite disorderly. In general it is characteristic that regular houses or constructions which appeal to our sense of beauty are found only in those animals which certainly build them by instinct alone. As soon as the building activity, owing to a greater plasticity of the instincts, is no longer restricted so exactly to quite definite materials, we notice at once a deviation from the forms appealing to our own aesthetic sense. Animals have no true sense of beauty. Yet the roots of such a sense lie in the animal kingdom. Among the anthropoids it appears timorously in a singularly engaging form. Thus the Teneriffe chimpanzees were wont to deck their bodies with all sorts of objects, such as twigs, plants, cord, rags. It would appear as if these objects, hanging on the body, had a decorative function in the widest sense. On occasions the chimpanzees, when left to themselves, ran around in a circle after one another in a peculiar manner, stamping their feet. Indeed, an attempt at a certain rhythm could be noticed in their movements. Kohler is of the opinion that these games are comparable with the play of children, and, in their extreme forms, with the primitive dances of aborigines.

ANALOGIES WITH PARTICULAR HUMAN MENTAL STATES

Sleep and Dreams of Animals.—A condition corresponding to our sleep exists in vertebrates, particularly in mammals and birds. All sensory activities are then reduced. The capacity of executing voluntary muscular movements is interrupted,-while the automatic movements and activities continue as usual. The eyes are generally protected against optical stimuli by the lids or nictitating membranes. At the same time many animals assume a characteristic sleep-position. A distinction between diurnal and nocturnal animals can be made according to the time of day at which the animals rest in this way. But not infrequently animals go through several phases of rest and activity during the 24 hours. In the mouse the number of these periods is particularly great. Sleep is more especially a necessity for animals high up in the scale as regards their mental capacities. Thus it is comprehensible that guinea-pigs spend only 11% of the whole 24 hours in resting and their longest periods of rest are only 10 minutes' duration. They feed continuously so long as food is offered to them.

Many reptiles and amphibians likewise assume typical sleeping postures. Snakes, lizards and urodele amphibians frequently curl themselves up, while tortoises withdraw their head, tail and extremities beneath their protective shield. But whether or not this outward rest is really accompanied by an internal recuperation as in our own sleep must remain questionable. The opinion has also been advanced that sleep appeared first in the animal series with the development of the forebrain. Against this is the fact that numerous fishes exhibit a state of rest with reduced sensory activity and cessation of movement. Both in nature and in aquaria fishes may not infrequently be observed to rest motionless on the bottom or against a stone with scarcely a movement of the gill-covers or fins. Others float right up against the surface of the water as if lifeless. This resting condition is known in the big shark of the North Atlantic, in the moon-fish *Orthagoriscus,* and in bream, all of which are met with in calm water drifting motionless at the surface. Their sensory activity is so much reduced that they may be approached unperceived. Finally, in various invertebrates temporary motionless states are known. Particularly is this to be observed in insects. According to the time of day at which they are active insects can also be divided into day and night animals. The males of many species of bees "sleep" in bell-shaped flowers which protect them from rain and dew. The position assumed by resting insects is generally that of the normal motionless state. Certain South African Hymenoptera of the genus Ammophila rest at night in a very peculiar fashion. They hold on to twigs with their jaws, and, letting go with the legs, allow the body to hang down freely. Among the higher Crustacea, too, and also in the flat-worms (planarians) resting states are known, with diminished sensitiveness to stimuli. In general, it may be stated that a condition of sleep comparable with our own exists in the higher vertebrates, but that the lower down we descend in the animal series the more we encounter resting states which differ from sleep. Among the lower invertebrates sleep is certainly absent.

During the sleep of higher mammals, particularly apes and carnivores, sounds and spontaneous movements may be observed which suggest a comparison with what can be seen to occur when our fellow men dream. During sleep a dog may bark, growl, wag its tail and jerk its limbs, while a cat will spit. Ungulates also frequently make movements in their sleep. Presumably phenomena take place in the central nervous system of these animals similar to those occurring in ourselves when we experience a dream. But we must be clear that the content of the animal's dream can never overstep the picture of the world with which the waking animal is endowed. A number of investigators prefer to deny the existence of animal dreams altogether and to see in the sleep-movements nothing but the effects of internal nerve stimuli. But if we concede any conscious life to the animals in question there is no reason for denying dreams to them. By analogy with our own dreams we are then obliged to suppose that in animals likewise the dream content is more confused and poorer than the waking consciousness.

Animal Hypnosis.—Many animals, in response to particular stimuli, fall into a remarkable state which has frequently been compared to the physiological phenomenon of human hypnosis. A so-called "fear-rigor" is known in the brittle-stars. In higher Crustacea a "cramp-reflex" can easily be called forth. As early as the middle of the last century the so-called "magnetism" of river crayfishes was known. By stroking the animals in a direction from head to tail they can be rendered motionless. But holding them on the back will suffice, or making them stand on their head with the claws bent outwards. The "feigning death" of many insects, particularly beetles, comes into the same category. The "cataleptic rigor" of the stick-insect, *Dixippus morosus,* is particularly remarkable. Vertebrates, too, can be put into a state of rigor. It usually suffices to place the animal on its back and to hold it there for a while, at the same time preventing all movement. Not only fishes, frogs, snakes, crocodiles, but also all sorts of birds, rodents, goats, pigs and dogs can be rendered temporarily motionless.

As to the meaning of these phenomena, in the invertebrates inborn, mostly useful, reflexes are involved, by which the animals are able on occasion to escape from their enemies. In the vertebrates the state of rigor is probably the result of peculiar inhibitions in the central nervous system which are brought into action by the cessation of all movement. Whereas the duration of the state of rigor may in the lower animals be considerable, in vertebrates it is the shorter as the brain of the particular animal is more highly developed. The lengths of time during which certain animals remain in a state of rigor are as follows: a stick insect, up to $4\frac{1}{2}$ hours; a crayfish, $\frac{1}{2}$ to 4 minutes; a frog, several hours; a goose or a hen, about $\frac{1}{2}$ hour; a rabbit up to 6 minutes; a dog, usually only $\frac{1}{2}$ minute. At the end of this interval, or of a shorter one, the animal wakes up spontaneously. But this can be brought about at an earlier time by weak external stimuli. From the physiological phenomena occurring during rigor, which have been noted in numerous investigations, it is certain that this state is something quite different from human hypnosis. It is only lately that hens and dogs have been put into a condition of true hypnosis, *i.e.,* into a state of rigor exactly corresponding to that assumed in human hypnosis. The means employed to induce this state were the same as those customary for human beings. A shining object is held before a hen, or when sitting on the experimenter's hand the bird is moved slowly up and down. Forthwith the animal sinks into sleep. The state of hypnosis is so profound that the bird can be lifted up by one leg and set down again, without being wakened up.

There exist analogies in animals, too, for the mass-psychosis observable in human beings under certain circumstances. Usually it is an aimless wild flight of a group of animals without any reasonable cause. Travellers describe such stampedes of immense troops of ungulates such as antelopes, zebras and so forth, in the tropical steppe country. Stampedes of the half-wild horses which live in huge herds on the South American pampas are highly undesirable happenings for the owners of the animals. The cause of these occurrences is the action of a purposeful instinct by which a warning signal from a leader or other member of the company causes all the animals to take to flight. As soon, however, as the resulting general excitement and flight movement increases out of all proportion to the cause, we have a definite case of mass-psychosis.

Mental Diseases of Animals. — Individuals occur, particularly in higher animals, exhibiting a behaviour which varies in greater or lesser degree from that which is characteristic of the species in question. This is due to disturbances caused usually by diseases or pathological changes in the nerves or brain. Parasites are frequently responsible for the abnormal behaviour. Spirochaetosis of fowls is due to a blood parasite which causes the animals to fall into a state resembling a deep sleep. Rabies in dogs changes the behaviour of the animals so that they become capricious, bite at the air without reason, and eventually become extremely excited and may finally pass into a state of frenzy. The cyst of a tape-worm, *Taenia* coenurus, in the brain of sheep causes the disease known as staggers. Dogs in the brains of which tumours were found by sectioning after death were, during their lives, in full possession of all their sensory faculties, but exhibited a continual desire for restless movement. Endemic cretinism in dogs is due to faulty development of the brain. The animals in question are good-natured but extremely apathetic. Staggers in horses is caused by a chronic enlargement of the ventricle of the brain, known as internal hydrocephaly, and a resulting inflammation of the brain. The animals are apathetic, sleepy, and stand for the greater part of the day with closed eyes, hanging head and ears down. A whole series of other nerve and brain diseases of animals, harmfully influencing their behaviour, is known to veterinary science. The true mental diseases of human beings have their counterpart in animals in cases perhaps best described as inborn weakmindedness, hereditary mental deficiency and cretinism.

THE HISTORY OF ANIMAL PSYCEIOLOGY

According to the conception of primitive peoples, man is in some way related to the animal world which surrounds him. Every person has his symbolic animal, his totem, into which he believes he is changed at death. This animal represents the-embodiment of the soul, either of individuals or of the whole race. For this reason it is sacred and may not be hunted. Gods in ancient Egypt and in India had human bodies of gigantic proportions with the heads of animals. Apes and other animals kept in the temples were considered holy. The belief in a migration of souls through different animals has always been widespread. All of these points of view are based upon the assumption that the animal soul is closely related to the human soul, that there exists no essential difference between the two. The ancient Greek philosophers, too, who engaged in detailed discussions of the animal soul were dominated by the belief in an essential relationship to men. It is true that the belief that the animal soul is on a lower level than the human soul makes itself gradually more and more felt. The Pythagoreans and Empedocles, on the contrary, believed in a transmigration of souls with intermediate stages in animals. The natural philosophers, the Epicureans, and later Lucretius Carus and Plutarch, ascribe more or less human attributes to animals. Particularly in Plutarch do we find many examples, in the nature of anecdotes, purporting to demonstrate the intellect, memory, deliberation and reason of animals. Quite a number of really good observations are included in these tales. This purely anthropomorphic mode of thought was maintained by individual thinkers for a long period. The neo-platonist Porphyrius subscribed to this view and even as late as the 16th century Montaigne used it to humble the pride of man. In the 18th century, Condillac and Leroy were influenced by the same idea.

Parallel to this humanizing conception another point of view made itself felt quite early in Greek philosophy, maintaining that there is a great and unbridgeable gap between human and animal souls. The great exponents of idealistic philosophy, Socrates, Plato and Aristotle, insisted on the distinction between man and beast, as did the Stoics. They denied the faculty of thought to animals. According to Aristotle, man possesses a reasoning soul (*anima intellectualis*), and, in addition, a purely sensory soul (*anima sensitiva*), whereas animals possess the latter alone. An animal is gifted only with the faculties of sensation and movement, while man has, in addition, the power of thought and understanding. He alone has an immortal soul. This great cleft in the modes of conception of the animal soul continued until long after the middle ages. The middle ages were dominated by the teaching of the Church which was strongly influenced by Aristotle. In the same way as the Greek philosopher, the Scholastics differentiated between a sensory and a reasoning soul, the latter being present in man alone. Instinct was considered to be a contrivance of nature permitting the animal to perform purposeful actions without understanding the reason for its behaviour. Further, sense-perception and sense-memory were ascribed to animals, while man had, in addition to this, intellectual perception and true memory. Descartes (Cartesius, 1596–1650), too, thought that animals had no share in the intellectual substance. They ranked as mere machines.

As early as the 16th and 17th centuries a number of thinkers, such as Montaigne, Rotarius, Thomasius, Jenkin, opposed themselves to this conception of rigid instincts. They conceded memory and comprehension to animals and thus pointed the way to a new animal psychology. The view taken during the English and French period of enlightenment of the 17th and 18th centuries was also in sharp opposition to the mediaeval idea of instinct, although it had been arrived at in quite another manner. The sense-impressions and perceptions were here considered to be the basis of thought. The distinction between a thinking and a perceptive soul no longer held. According to Hume animals are able to store up sensory impressions and make experiences. But, in addition, they possess numerous inborn instincts. The differences between animal and human modes of thought are gradual only. In the 19th century the tendency made itself felt, under the influence of the free-thinkers, to avoid the word *instinct* altogether for there was once more a movement towards an anthropomorphism which soon became unbounded and conceded thought and feeling to animals in the same way as to man. This was the period in which Alfred Brehm, Karl Voigt and others attempted to bring animals and man together.

The teaching of Charles Darwin had great influence on the conception of the animal mind. He sought to explain the purposefulness of instincts by natural selection. The mental faculties of man have developed out of those of animals. The desires of human beings derive from the instincts of animals. Romanes and Lloyd Morgan subscribe in a general way to the Darwinian view of the animal mind. Commencing with the 19th century the "modern animal psychology" began. According to this, many physiologists, as a reaction against the previous grossly anthropomorphic standpoint, were led to abandon all treatment of the mental life of animals and to investigate nothing but outwardly recognizable movements and actions of animals. The young science received its first imprint from the fact, brought to light particularly by the foremost investigators of social insects, that animals are not rigid machines but that their inborn modes of behaviour too are plastic. The fashions in which workers in different countries attacked the main problems were to a certain extent different from one another. In France, G. Bohn and his pupils laid stress on the faculty of associative memory as being the most important phenomenon in animal behaviour. In North America, particularly, stress was laid on the exact determination of the various aspects and phases of learning or habit formation in animals. J. B. Watson is one of the most prominent representatives of this "behaviourism," as the whole tendency is termed. In addition to admirable special lines of investigation in animal behaviour, H. S. Jennings, L. T. Hobhouse, Ll. Morgan, E. L. Thorndike, M. F. Washburn and others have supplied important theoretical contributions to the study of the animal mind. S. J. Holmes lays emphasis on the feelings of like and dislike as factors regulating behaviour. During the last few decades in Germany it is principally our knowledge of the sensory faculties of numerous different animals that has been investigated, often in great detail. We will mention only the work of von Frisch on the olfactory sense, the power of distinguishing colours and the language of bees. To this must be added the investigation of the intelligence of apes carried out by W. Köhler, which has been so fruitful of conclusions. Here, too, numerous theoretical contributions have been published. The comprehensive work of H. Ziegler on the concept of instinct should be mentioned, as being the only comprehensive summary of the history of animal psychology.

During the last decade, however, the influence of novel trains of thought has made itself felt, taking possession of comparative psychology in a revolutionary manner. We refer to the recognition of the importance, for understanding the behaviour of animals, of the qualities of form and totality. No longer, as hitherto, are separate and isolated stimuli regarded as the dominant factors, but it has been recognized that the separate actions of animals arise usually from the totality of the situation at the moment. Undoubtedly this mode of dealing with animal psychology is destined to produce numerous important conclusions. The most outstanding result of modern animal psychology is the proof that the first steps towards numerous phenomena of the human mind are to be found in animals. Through this, comparative psychology, which is concerned with the development of the mind in children and in primitive man, has acquired much valuable material. Just as man has long been known to be linked to the animal kingdom by his bodily origin, so now the gap is bridged which up to the present has separated him from the animals on the mental side.
(*See* also ANIMAL BEHAVIOUR.)

BIBLIOGRAPHY.—A recent comprehensive survey of the whole subject is contained in F. Hempelmann's *Tierpsychologie* (Leipzig, 1926), which has a full bibliography; other books of note include:—L. T. Hobhouse, *Mind in Evolution* (1901); H. S. Jennings, *Behaviour of the Lower Organisms* (1906); C. Lloyd Morgan, *Habit and Instinct* (Leipzig, 1896), *Animal Behaviour* (2nd ed., 1908), *Instinct and Experience* (Berlin, 1912); G. Bohn, *La Naissance de l'intelligence* (1909), *La nouvelle psychologie animale* (1910); E. Claparède, *Die methoden der tierpsychologie Beobachtungen und Versuche* (Leipzig, 1909); S. J. Holmes, *The Evolution of Animal Intelligence* (New York, 1911); E. L. Thorndike, *Animal Intelligence* (New York, 1911); W. S. Hunter, *The Delayed Reaction in Animals and Children* (Behaviour Monographs, No. 2, 1912); G. Kafka, *Einführung in die Tierpsychologie, I. Die Sinne der Wirbellasen* (Leipzig, 1914); *Tierpsychologie* (Munchen, 1922); J. Loeb, *Forced Movements and Tropisms* (1918); J. B. Watson, *Psychology from the Standpoint of a Behaviorist* (1919); H. Ziegler, *Der Begriff des Instinktes einst und jetzt* (Jena, 1920); N. Checchia, *La psicologia degli animali* (Turin, 1922); M. F. Washburn, *Animal Mind* (1923); R. M. Yerkes, *Almost Human* (1925); Marie Goldsmith, *La psychologie comparée* (1927); I. Pavlov, *Conditioned Reflexes* (1927). (F. HE.)

PSYCHOLOGY, HISTORY OF. In the earliest times psychology is a part of the general description of human conduct. Though the details are no longer valuable, the general classifications originally used are historically interesting on account of the way in which they have persisted.

Greek Psychology.—The oldest records which are sufficiently elaborate to be important belong to the sixth and fifth centuries B.C. and constitute part of the natural philosophy of the Greeks. Earlier traces are found in Homer and the Greek tradition represents a growth of opinion from the tenth century before Christ or even earlier. The medical schools of the sixth century B.C. seem to have advanced far enough to establish the common distinction between sense and reason on anatomical grounds: the importance of the brain was recognized and an attempt made to connect the sense-organs with the brain. The physiology was very crude but the important principle established was the necessity of integration so that the different sense impressions could be unified. The clear assertion that the mind sees and hears (not the external organs separately) is the beginning of psychological investigation. At the same period the original doctrine of temperaments appeared. A temperament was regarded as a peculiar disposition, both physical and mental, which owed its character to the ratio in which the humours were mixed in the body. These humours were four substances which, by analogy with the four elements (earth, air, fire and water) were regarded as composing the body. They were called blood, phlegm, black bile and yellow bile. The terms for the different temperaments (sanguine, phlegmatic, melancholic, choleric) were introduced in the Middle Ages by an Arab physician: though not actually Greek they represent faithfully the original idea. The work done at this period (600–400 B.C.) is part of the development of medicine. While common observation referred to the "wits" of men or to their senses as different kinds of ability, there is throughout this period complete lack of any idea of a soul as the distinct agent in any activities either of sense or reason. The origin of Western Psychology was in the study of the organism and not in speculations about a supernatural "soul." This is so far the case that Aristotle considers the thinkers before Socrates were exclusively concerned with physical nature, and for that reason unphilosophical.

The idea of a soul as something distinct from the body and capable of existence apart from the body, seems to have become definite at the close of the fifth century B.C. The Pythagoreans are credited with the view that the body is the tomb of the soul and that life on earth is a period of time during which the soul uses the body as its instrument. This leads naturally to a doctrine of release by purification and a theory of immortality. Such matters do not belong to the sphere of psychology. But they need to be mentioned because the first elaborate synthesis of doctrine was deeply affected by this type of thought. Plato was responsible for this synthesis and his work was destined to persist for many centuries as the kind of psychology most acceptable to western Christianity. Its most obvious characteristic was the dualism of soul and body which satisfied ethical and religious demands. But while the dualism can be admitted as a characteristic of the Platonic philosophy, there has been a tendency to exaggerate its significance for the actual teaching of Plato as to the functions of the soul. In harmony with the trend of Greek thought Plato emphasizes first the idea of activity: the soul is the origin of all movement, it is self-moving, in other words it is the dynamic factor as opposed to matter. The functions ascribed to the soul fall into three classes. These functions are nutritive, sensitive and rational. They may be regarded as the kinds of activity which are found at different levels of development in the scale of nature. They are seen distinctly in the plant, the animal and the human forms of organization. Of these the higher includes the lower and man may be regarded as a complex nature in which are included the capacities for assimilation of food, reception of sense-impressions and ideation. Though Plato was chiefly interested in the problems of moral conduct he was well acquainted with the natural science of his day and employs it to formulate his general psychology. The basis for this is the concept of Eros, the fundamental drive or conation which fulfils itself in all the forms of life. This appears at different levels in the forms of desire or natural appetite, courage or aggressiveness and reason or the love of truth and beauty. The idea of development is introduced as a progress from the first random impulses to fully co-ordinated and purposive action. In the course of this development there is a stage at which desire and reason are in conflict. The recognition and the analysis of this moral conflict is one of the most significant points in Platonic psychology. The argument is based on the sound principle that character implies definite aims. co-ordination of efforr and selection of impulses. This requires the acts of deliberation and reason, the full waking consciousness of principles. In dreams Plato sees the tendency of desire to satisfy itself in imagery when the higher faculties no longer inhibit the passions.

In the localization of functions Plato adopts the current doctrine that the liver, the heart and the brain are the seat of desire, courage and reason. Democritus was probably responsible for this, and he was the leader of the scientific school which cultivated anatomy and favoured a materialistic doctrine based on the theory of atoms. From Democritus comes the long-lived theory that sensation is produced by the action on the body of atomic forms (eidola) which are given off by objects, travel through the air and enter the body through appropriate channels of the five sense-organs. Plato had very little interest in the detail of sense-perception. He concentrates attention on the experience rather than its physical or physiological basis and is content to take sensation as the beginning of knowledge. He treats knowledge as a growing sense of meaning, a form of reaction rather than a reception of impressions. This idea of activity as the most fundamental element in experience is the peculiarly Platonic element in all the schools which are opposed to a pure empiricism. The whole development from sense to reason is an inner development, a gradual evolution of the power of the soul to interpret events as they are given in the field of sensation. With a shrewd insight that has been justified by modern tests of intelligence, Plato considered that the distinctive mark of intellectual capacity was the understanding of relations. The synoptic mind, capable of seeing all things in their relations and therefore concerned primarily with meaning, is the highest product of human development. In this connection Plato elaborated his famous scheme of education. It is the first great example of applied psychology and also presents the germs of a social psychology. For education is regarded by Plato as a process in which the powers of the soul develop through the interaction between the individual and the environment. The first stage is the formation of a disposition as a result of influences unconsciously assimilated. The social environment is like an atmosphere: it furnishes the subtle influences which the mind feeds upon, analogous to the healthy or unhealthy air which imperceptibly produces health or disease in the body. This unconscious assimilation of influences is called imitation. It is not conscious mimicry but the tendency to form ideals of action under the influence of the patterns which are ever before the eyes of the young. The later stage of education is comprised in definite forms of instruction of which the psychological character is that they develop the power of abstract thought.

Plato wrote no separate treatise on psychology: the subject appears at different points in his work whenever the questions of knowledge or conduct are under consideration. Aristotle is therefore usually considered the first teacher of a scientific psychology in the western schools. This title is well deserved, for the *De Anima* in particular and the other minor works associated with it in subject-matter are the sources from which have been drawn most of the psychology taught in Europe down to the close of the eighteenth century.

The main points of Aristotle's theory may be stated as follows: The animal organism begins its independent life with an endowment of heat and motion. The material body has a connate pneuma: something corresponding to what a modern writer would call nervous energy is distributed throughout the body and makes possible the first functions. Aristotle knew nothing about nerves: he accepted in general the medical view that life is dependent on the presence of air in the blood vessels. This organic air was called pneuma, a word which means breath or wind, equivalent to the Latin aninta or *spiritus*. The animal spirits were accepted almost without question to the end of the eighteenth century. They fulfilled in a confused manner all the functions of the breath as basis of life, of the nerves as conductors of sensation and of the more refined substance which was the assumed agent of rational thought. In a sense, therefore. the pneuma is the material soul, a phrase which is not self-contradictory before the time when the soul as immaterial is opposed to the hody as material But Aristotle does not identify the soul with the pneuma. With considerable subtlety he defines the soul as the entelechy of a natural body capable of life. The word entelechy means the final state of development, natural completeness: and Aristotle really defines the soul as the functions of an organism when all its parts are united and active. The importance of this definition lies in its complete rejection of any attempt to make the soul a thing or an entity. The definition indicates a class of functions to be studied, snd Aristotle proceeds to deal with them. All functions come under the general head of motion, so we are now really studying a particular class of motions. The body is a material structure subject to impact from the outer world: the genesis of sensations is found in the action of outer forces or stimuli on the organs of sense. Aristotle paid careful attention to the characteristics of touch, taste, smell, hearing and vision. In general all sense-affection is a form of touch: the differences are in the medium and the sense-organ. In the case of vision a motion is transmitted from the source through a particular medium called the diaphanous and continued along the pneuma of the optic passage to the sensorium. The form of this explanation is perfect: but the medium would now be defined as luminiferous ether (if any) and the optic passage with its pneuma as optic nerve. After the separate senses comes the problem of unity. This requires a common sensorium, a meeting place for all the special senses and also the centre for the perception of the common qualities of all objects, such as shape and size. Aristotle considered that the heart was the seat of all psychic functions, an unfortunate aberration from the earlier and Platonic view that the brain was the organ of the soul. Probably Aristotle was led to this view by the fact that very little was known about the brain, nothing about nerves, and most emphasis was laid on the blood as the seat of life and of the pneuma. The error seems to have had little effect on the general description of functions. Aristotle saw the futility of defining sensation as the reception of any material image of the object or even as an impression: he evaded the difficulty by saying that sensation receives the form of its object without the matter: in other words sensation is a significant change of the mind corresponding to the physical motion in the sense-organ. As the original motion dies away a variety of different phenomena occur. After-images are motions continued in the organ of vision and are the most obvious example of the way in which motions persist. Imagination is a "decaying sense" and can be described as analogous to after-images. But here we have really begun to move away from any positive and perceptible motion: the words become metaphorical. If we admit a certain permanence in sense-affections we can suppose that some sensations persist and that this is the origin of memory. The word in Greek conveys the idea of remaining or abiding (Mneme) and that is nearly all that can be said about memory. The accumulation of memories makes what men call experience. This is passive reason: but the passive must not be confused with the active. In spite of the strong empiricism of his method Aristotle does not confuse the mind with its physical basis or its acquired contents. Reason as the act of the soul is underived: whether the soul is or is not immortal Aristotle refuses to say.

Parallel with the range of functions from sensation to reason there is a similar sequence from desire to will. All living creatures have some degree of conation, some innate will to live, which Aristotle calls *orexis*. This is the dynamic aspect of behaviour. It coexists with the different degrees of knowledge and so acquires different values. When the object which gives satisfaction is presented to the senses the tendency to possess it is the simplest form of *orexis*, called by the Latin writers *appetitus* and in English appetite. If the want or striving is correlated with an image of the object desired or the object is the work of imagination, the psychological state is called wish. If finally the object is one about which it is possible to deliberate, the outcome of deliberation is called will. Here we find Aristotle using his principle of development to state in simple terms a naturalistic theory of will. There is no suggestion that will is a separate faculty and no discussion of freedom of the will. Aristotle defines will simply as that desire which embodies the results of deliberation and discusses individual responsibility, but not freedom of the will. He considers also the difference between those who do not stop to deliberate and those who tend to paralyse action by excessive deliberation. These are the types known to modern writers as impulsive and obstructive. These topics were regarded by Aristotle as belonging to the science of conduct and are discussed in his Ethics. The word ethics is derived from the word meaning character (*ēthos*) and this is a variation of the word for habit (*ĕthos*). The Greek sense for individual qualities made their ethics primarily a study of character and therefore a branch of psychology. The keynote of individual development is habit-formation and Aristotle's ethics has for its centre a doctrine of character as the product of habits. The habit is not mechanical: it is a disciplined attitude of mind which makes the act of judgment an expression of principles: morality is dependent on reason and reason can only act efficiently when impulses are properly organized.

This brief and summary statement will serve to indicate how far Aristotle covered the whole field of psychology. His treatment of knowing and willing as the main classes of functions remained with little alteration for many centuries. Such subjects as sleep and dreams he treated in a scientific manner, and showed an interest in abnormal phenomena. His successors in the Peripatetic school tended more and more towards purely scientific work. The first head of the school after Aristotle was Theophrastus whose fame rests chiefly on his work in botany but is supported also by the fragments of a work on the senses. This is exclusively concerned with questions that belong to empirical psychology and seems to show an increasing tendency to separate this subject from the sphere of speculative philosophy or religion.

HELLENISTIC AGE

With the death of Alexander in the year 323 B.C. the Hellenistic Age began and with it there came a period of speculative thinking more Oriental than Greek in its character. On the other hand at Alexandria itself the sciences began a triumphant progress which soon eclipsed all previous efforts. The greatest scientific achievements of antiquity belong to the third century before Christ and show that religion was by no means the only interest of that age. In addition to the work done in geometry, astronomy, mechanics and other sciences, special mention should be made of the work of the medical men Herophilus and Erasistratus. Though these men were not the first to discover the nerves, they so far enlarged and established the knowledge of their structure and function that they deserve to be called the discoverers of the nervous system. This was a great contribution to the knowledge of animal organisms and one which in the end could not fail to affect psychological theory. At the time it produced no revolution. The Stoic philosophers used the pneuma of their predecessors and showed considerable skill in the analysis and classification of functions. Though their interests were mainly ethical the earlier Stoics (c. 300 B.C.) took pains to elaborate their psychological basis. They seem to have realized more clearly than their predecessors that psychologically a sensation is only an event in consciousness, a mere awareness of an inner state: they emphasized the relation between imagination (fantasy) and hallucination (phantasm) with the associated problem of the relation between subjective conviction (illusion) and objective truth. The Stoics delighted in extravagances and talked about universal Reason or Logos: but out of much speculation they evolved some important ideas. Because reason was to some degree innate in all creatures they attributed to animals an unreflective wisdom which was known to the Roman Stoics as instinct. Similarly from the belief that all men were endowed by nature with a knowledge of natural laws and rights they derived the concept of conscience (syneidēsis), the inner sense of conformity or lack of conformity with this innate reason.

The extraordinary brilliance of the classical period of Greek thought was neglected for nearly five centuries after its decline. The Stoics carried on the work when Greece became a Roman province, but their power was soon exhausted and their history became a record of mere repetitions. The only factors that had any significance in the Hellenistic Age were the various religious movements which tended to create a division between the natural and supernatural elements in the description of man. The Jews of Alexandria in the last century before Christ adopted the language and ideas of the Greeks but recognized the sphere of scientific investigation as relevant only to the corporeal nature: the spiritual life was not to be studied by such methods. As the Hebrew tradition always distinguished between the vital principle and the supernatural spirit (*neshem* and *ruah*) this method of adopting Greek psychology to explain the facts of sense-experience was easily adapted to the general body of their thought. Philo Judaeus (c. A.D. 40) was the most effective author of this Jewish-Alexandrian School. The same principles were followed by the Christian Platonists of Alexandria (about A.D. 180) and in this way a large amount of pagan teaching became established as part of the tradition of the Christian schools. In the third century of the Christian era the pagan philosophy was revived by Plotinus. While this was definitely intended to be a return to Platonism it was so far affected by the spirit of the age that it emphasized primarily the inner experience and made its psychology a description of those activities of the soul which seemed to be independent of bodily processes. A pure psychology built on introspective study of such phenomena as attention and memory was the result. The influence of Plotinus was continued in the work of Augustine; and through the position of authority which Augustine retained in the Middle Ages, this type of introspective thought was never wholly forgotten. The development of ancient psychology may be said to have concluded in a separation between the physiological and the religious interests. Galen (A.D. 200) was the last great physician. He added to the knowledge of the nerves by distinguishing sensory from motor nerves and made some acute observations on the relation between mind and body. Galen was sufficiently interested in philosophy to discuss many questions which belong to the field of physiological psychology, but always from the point of view of the medical man. Augustine (d. A.D. 430) studies the problems of psychology from the standpoint of an observer who can describe the actual experiences. The passages in the *Confessions* which describe memory and spiritual exaltation are permanent contributions to the literature of psychology.

The general decline of western culture brought to an end all progress in the natural sciences and philosophy. From the fifth to the twelfth century nothing important is achieved. The revival of learning in the twelfth century and its more complete restoration in the thirteenth was due in large part to the rise and progress of the Arab empire. When the victorious progress of Islam in the seventh century made the Arab master of the Persian empire, the Greek culture which survived in Syria and elsewhere was eagerly absorbed by the conquerors. From Baghdad in the East it travelled to Spain in the West, and, with additions from Constantinople and Sicily, it reappeared in the thirteenth century as the new learning of Christendom. So far as concerns any material that is important the psychology taught in the thirteenth century is simply the Greek psychology so far as it was recovered and understood. Aristotle and Augustine together account for all the available material.

EARLY MODERN THEORIES

Progress in psychology depends mainly on two kinds of interest. One is the interest in the structure and functions of the body which provides new material in the fields of anatomy and physiology. The other is the interest in the variety of human behaviour as it is observed in personal or social relations. During the period from the thirteenth to the sixteenth century there was a slow accumulation of efforts in both these directions and the result was seen in a great revival of activity which must be regarded as a subsidiary effect of the main progress in the sciences and in humanism. The work of Vesalius in human anatomy (1543) is the principal landmark in the study of the structure of the body: its ultimate significance was the tendency to abandon the view that a number of faculties were located in the body (such as the faculty of digestion or excretion) and to reduce all processes to the terms of physiological mechanism. By successive attacks on the idea of the soul as something reciding in the body and distinct from its material organization, the writers of the Renaissance built up a new science of man which had for its main principle the idea of natural functions entirely distinct from the activity of a supernatural soul. This movement was part of the whole development by which science became separated from theology.

The first part of the movement was quite unsystematic and was achieved as the expression of new values in the estimate of human conduct. The real beginnings are found in the work of such writers as Machiavelli who sweep away the formal descriptions of conduct as uniformly rational and openly declare that man is ruled by elementary passions. This example was followed by many others. Whether they accepted the idea that man is by nature evil or preferred to describe human nature more generously, they all agreed that conduct depends on natural impulses, that desire is more important than reason, and behaviour expresses temperament. As temperament could be explained in physiological language and related to the humours, it is evident that this kind of theory ceased to have any connection with the traditional doctrine that man was made in the likeness of God. A powerful movement toward reform in education assisted the progress of these views. A good example of the relation between psychology and education at this period is the work of Juan Luis Vives, a Spaniard who travelled widely and produced a marked effect on English thought after his lectures in Oxford (1523–28). The interest felt at that time in the study of personality was shown by the great popularity of a book called *The Examination of Men's Wits,* translated from the original Spanish work of Juan Huarte. A flood of writings too numerous to mention followed the fashion of this age. Discussion of individual differences as due to age, sex, climate or other causes filled many volumes and anticipated the better known works of the late eighteenth century. The programme carried out by later investigators was outlined by Francis Bacon in his *Advancement of Learning* (1605). Bacon appreciated fully the new attitude in psychology and advocated research along lines which have only been adequately treated in modern times. Among Bacon's suggestions are such topics as the use of aids to memory, the importance of connecting concepts with impressions on the senses, and the whole range of studies by which the foundations of character can be discovered in the constitution of the body and the social environment. In this way Bacon directed attention to the kind of material which now belongs to social psychology.

Thomas Hobbes (1588–1679) is often described as the father of modern psychology. The phrase is justified by the fact that Hobbes produced a concise summary of psychology which included both the individual and the social aspects. Taking as his guiding principle the idea of motion, Hobbes explicitly rejected the scholastic phrases and developed a mechanistic scheme. Sensation is defined as a mode of motion excited in the physiological organism: imagination is a continuation of this motion after the object ceases to act on the senses: dreams are imagery caused by external conditions, such as a sensation of cold, which produce internal motions equivalent to imagination: reason is the adding and subtracting of ideas derived from experience. The method used by Hobbes was derived from the physical sciences and particularly from the mechanics of Galileo. It was deductive and arbitrary in character but it influenced the whole trend of thought by showing the possibility of a psychology which conformed to the new ideas of scientific procedure. In general Hobbes drew upon Aristotle for much of his material and some of his most striking phrases owe their origin to his knowledge of the original Aristotelian language. In a famous passage of the *Leviathan* (Ch. 3) Hobbes explains the connection between ideas as due to the "trayne of imaginations" and gives an example of the way in which one idea may draw another after it. Hobbes deserves credit for the way in which he treats the will. As sensation is a movement inward, due to the action of objects, so volition is a movement outward and a kind of reaction which is primarily a form of vital movement. Hobbes thus begins the account of will from the basis of a natural striving or activity which was called at that time appetite. This elementary striving is connected with pleasure or pain; and is accordingly a movement toward or away from the exciting cause. As the creature develops, this activity is associated with images, becomes modified by deliberation, and so finally appears as will. Will is therefore defined simply as "the last appetite." This again is really a version of Aristotle's doctrine in the Ethics, but it was restated in a style unsurpassed for virility and may be accepted as original on account of the new value which the ideas received from the form in which they were presented. The ultimate aim of Hobbes was to give an account of human conduct in social relations and to explain the necessity of political order to control natural passions. His views are those of a sociologist who requires to begin with a scientific description of the human species. Hobbes was essentially a behaviourist who lacked the necessary knowledge of biology and was compelled to employ the methods of a mechanistic age.

The scientific work of the seventeenth century was brought to its highest level by Galileo and Newton. The brilliance of these men set a fashion which extended to all branches of science and created the belief that the science of organisms could be reduced to the terms of a mechanical explanation. Descartes led the way by making a sharp distinction between mind and matter, with the intention of treating the organic activities by the method of the physical sciences. On this basis he was able to describe bodily movements as due to impressions on the sense-organ which set in motion the animal spirits: when this motion arrives at the brain it causes the opening of a valve through which the current then flows down the motor nerve. To this total motion, inward and outward, Descartes gives the name *undulatio reflexa.* As at that time the animal spirits were supposed to perform the operation of conduction along the nerves, this theory may be recognized as a laudable attempt to state the principles of reflex action, not unlike the modern scheme of afferent and efferent currents with connection at a synapse. Descartes grasped very clearly the possibility of purely mechanical action, as it is actually seen in reflex movement. He decided that animals act always in this manner and stated the view that animals are machines. As he admitted a soul in human beings, they were not described as machines: the soul could direct the movement of the animal spirits by its action on the pineal gland in the brain, and this action constituted voluntary motion as superior to reflex action. The general idea of animal spirits and their motions was also used to explain emotions. Descartes saw the difficulty of explaining emotions as consisting only in perceptions or ideas. He grasped the point that in emotions the peculiar element is the bodily disturbance, and that the state of emotion is due to the combination of a perception with some tendency to motion, *e.g.,* flight in the case of fear. This theory was further elaborated by Malebranche who adopted the Cartesian doctrine and through Malebranche it was handed on finally to modern times when it was more adequately stated by Lange (1887). What is called the James-Lange theory of the emotions is the modern version of the views expressed by Malebranche. In the eighteenth century La Mettrie drew the further conclusion that man is a machine. His work, *L'Homme Machine* (1748), was resented at the time as atheistic, but in fact it was little more than a conscientious attempt to construct a complete physiological psychology.

Meanwhile in England the Cartesian principles inspired John Locke to attempt a fresh analysis of the mental powers. Locke's *Essay concerning the Human Understanding* (1690) was not strictly a work on psychology but it suggested a method of analysing experience which led others to adopt views that were more distinctly psychological. Locke himself was interested in the analysis of knowledge and proposed to show that all human knowledge is acquired during life by the use of natural faculties. Dispensing with innate ideas and obscure "powers" of the soul, Locke employed only sensation and reflection. Sensation accounts for knowledge of the outer world: reflection enables us to perceive the inner events and attain ideas of such objects as memory. The problem which Locke created by this analysis, which is only partly genetic and never purely psychological, was that of finding a principle of unity which would hold together the separate ideas got by experience. The soul was no longer invoked as the principle of unity. In its place was put the process of association. Locke barely mentions this and only recognized it as a form of connection when no rational union between ideas was evident. But his successors created what is known historically as the doctrine of association of ideas. David Hume (1711–1776) reduced experience to its lowest terms, impressions and ideas. He revived Aristotle's doctrine of connection by similarity and contiguity, adding for reasons connected with his own philosophy the form of connection called cause and effect. In this way a completely empirical plan was evolved. Nothing was required except the phenomena of consciousness and the bonds between them established by habitual coexistence or succession. In the question of method Hume established the guiding principles of modern psychology. From Hume through James Mill to Bain, this standpoint was retained as a practical method of psychological investigation. Its great merit was the emphasis laid on primary data and actual experience, with no metaphysical principles to confuse the issues. Its defects could only be seen when biological principles showed its limitations.

The psychologists of the eighteenth century in England were dominated by their ideals of scientific method. To make the mind intelligible they were ready to break it into atomic parts and invent ways of putting it together again. From England this idea spread to France. Already in France the spirit of Descartes had developed into a rationalism which tolerated nothing but the most sharply defined objects. The age of La Rochefoucauld's epigrams, La Bruyère's characters and all the wit of the salon, was a period when the psychological mood triumphed. The last phase was presented by Étienne Bonnot, Abbé de Condillac, chiefly in his *Traité des Sensations* (1754). Condillac's way of using the analytic method was to imagine a statue and endow it with one sense only, the sense of smell. In this way Locke's method is simplified: for while Locke began with sensation and reflection, Condillac starts with an isolated sensation and gradually builds up the mind by adding other sensations, the functions of attention and memory emerging in the process. If this procedure had the virtue of avoiding all mysticism and requiring no such hypothesis as a soul, it demonstrated all the vices that ruin the attempt to build a psychology out of logical abstractions. The successors of Condillac, the Ideologists of the Napoleonic period, were conscious of the failure but unable to remedy the situation. For a time psychology in France ceased to be important.

The German historians date the beginning of their historical achievements in psychology from the work of Leibniz who died in 1716. Though Leibniz wrote no separate work on psychology he made a number of suggestions which gradually acquired importance as the basis of a reaction against the tradition derived from Locke. Leibniz struck at the root of Locke's influence by insisting that the activity of the intellect must be assumed from the first. This doctrine was characteristic of the German way of thinking and was partly due to the religious mysticism which persisted in that country from the 14th century onwards. Leibniz united his faith in the original activity of the intellect with the idea that all perceptible quantities can be divided into infinitesimal parts. Assisted by the new ideas of the calculus in mathematics, Leibniz evolved the theory that perception and will could be traced back to elementary forms which were too undeveloped to be presented in consciousness. He argued that the sound produced by a wave of the sea must be compounded out of the sounds made by each drop, and therefore that a perceptible sound would be the sum of a number of imperceptible causes. These were called "petites perceptions" and the level at which they enter consciousness was called apperception. Similarly a fully conscious act of will is the complete form of minute unnoticed tendencies to action. In this way Leibniz opposed the view that mental processes must either be clearly apprehended or not exist at all. He asserted the reality of obscure and confused states of mind, and thus introduced views which were to be developed later into the theory of the threshold and the Unconscious.

The work in which Leibniz made clear his opposition to Locke (*Nouveaux essais sur l'entendement humain,* 1704) was not published until 1765. This explains the appearance in Germany of a vigorous but brief period of purely empirical work. Taken directly from English sources and constructed largely by translating the works of Locke and other British writers, this empiricism for a time changed the current of German thought. But experience was interpreted in terms of feeling rather than sensation. The German writers were most interested in recording their inner states: the diary with its intimate introspective entries became fashionable. The Berlin Academy became a centre of psychological activity and the ultimate product of much tentative discussion was the recognition of the "three-faculty" doctrine. Henceforth sensation, feeling and will were regarded as the three classes of mental states. Before this time only cognition and volition were recognized: the feelings came in as obscure ideas. Several minor writers contributed to produce this result, but the most authoritative work was due to Tetens. Johann Nicolas Tetens (1736–1807) wrote his *Philosophische Versuche über die menschliche Natur und ihre Entwickelung* in 1777. This book has considerable historical significance. The speculative psychology of the period did not attract Tetens. Bonnet, the Swiss naturalist, had brought into vogue a "fibre psychology," in other words, a premature attempt to explain mental processes by associating each activity with a neural fibre and describing it in terms of the motion excited in the fibres. Tetens more correctly relied on the observation of experiences and his treatment of the subject is on the whole well-balanced and sound in its principles. Kant was well acquainted with the work of Tetens and derived from that source the psychological groundwork of his philosophy. The critical philosophy of Kant does not enter into a history of psychology, though its principles have had great influence on later theories, chiefly in the direction of eliminating from psychology the idea of the soul and confining attention to mental phenomena. The successors of Kant followed lines of thought that moved further away from the experimental basis, and consequently added nothing of importance to psychology as a natural science. German idealism from Kant to Hegel (1830) was not concerned with the mind as understood by the empiricists but with the concept of a universal mind. In spite of the sterility of this doctrine so far as concerns the data of individual psychology, its tendency to look beyond the individual to the race and to the historical evolution of thought was the incentive which impelled the next generation to begin enquiries into folk-psychology and social psychology. But before this could become a distinctive field of work the spirit of the exact sciences had to be revived.

At the close of the eighteenth century the French were admittedly supreme in the sciences of anatomy and physiology. Their influence tended to restore psychology to its place among the sciences of the organism. The treatment of mental derangements as natural conditions and not as possession by evil spirits was greatly advanced by the attitude of Pinel, a doctor in Paris. About the same time (1798) the treatment of defectives was put on a more rational basis. The idea of the mind as a mysterious occupant of the body was discarded: empirical philosophy and medical science combined to establish the idea that it was the product of the experiences which were supplied through the senses. This theory was responsible for the work of men like Itard (1774–1838) who definitely formulated the principles of re-education for defectives, and others who began to study methods for training the deaf and dumb. A growing tendency to regard the mind as a group of functions dependent on the brain and indirectly on the whole physical organism was given explicit form in the writing of Pierre Jean George Cabanis. Adopting the medical profession and training his mind not only on the modern literature but also on the works of Hippocrates, Cabanis became in effect the advocate of physiological psychology. The famous expression attributed to him, that the brain secretes thought as the liver secretes bile, was not a piece of materialistic cynicism but a vigorous way of declaring that mental functions were always brain functions. Cabanis wrote a work entitled *Rapports du physique et du moral de l'homme* (1789 and 1802) which is one of the modern classics on the relation of mind and body. In this field Cabanis was soon surpassed by Franz Josef Gall (1758–1828) an Austrian surgeon who deserved more recognition than he obtained. Religious fanaticism and political intrigue combined to suppress his efforts, but Gall established his reputation in Europe for unequalled knowledge of cerebral anatomy and his own work was the foundation of the doctrine of cerebral localization. Gall was unfortunate in having a pupil, Spurzheim, who was a charlatan. Spurzheim found an ally in George Combe of Edinburgh and their misguided zeal produced the literature of Phrenology, a fantastic combination of bad anatomy with an absurd theory of faculties. In spite of the ill repute which this foolish theory of "bumps" brought on the excellent work of Gall, it is necessary to recognize that Gall's own work was very important and was known to the best anatomists of Europe. Gall knew the difference between the sensory and motor nerves and that they had different points of origin in the spinal cord. This important discovery, which ultimately made clear the nature of reflex action, was announced in England by Sir Charles Bell (1811), and was presumably the result of independent research.

THE NINETEENTH CENTURY

In the first quarter of the nineteenth century psychology was not making much progress. In England the associationism of David Hartley was regarded as orthodox doctrine. Hartley came under the spell of Newton's work and proposed to explain all mental phenomena by assuming that they were due to vibrations of the nerves and that these vibrations could be communicated by one nerve to another if the other had at any time been excited together with the first. This was obviously a theory of association stated in the language of Newtonian mechanics. Hartley's work, *Observations on Man, His Frame, His Duty and His Expectations,* was completed in 1746. It was a diffuse production and included the theory of vibrations, the theory of association and a considerable amount of comment on the Christian religion. Priestley, interested in all kinds of scientific work and inclined to atheism, saw the advantages of this associationism and produced in 1775 an edition which omitted everything else. In 1801 a complete edition appeared in England and this gave the theory a new lease of life. The development of British psychology was affected for a time by attempts to break away from the strict principles of empiricism. Thomas Brown (died 1820) was inclined to lay emphasis on the activity of the mind. His use of the term "suggestion" indicated a desire to escape from the narrower limits of association and give the mind a creative activity. Sir William Hamilton (d. 1856) also provided a new term, redintegration, which denoted the tendency of one experience to return as a whole when any part of it was given independently. But the masterpiece of the period was James Mill's *Analysis of the Phenomena of the Human Mind* (1829). This work was strong in its consistency and was constructed on the most uncompromising use of associationism, the doctrine which British readers accepted as being simple, practical and devoid of any tendency toward metaphysics. James Mill wavered occasionally but there were no serious lapses. The work was well done and everyone felt that the school had found its final exposition. When John Stuart Mill edited his father's work in collaboration with Bain it was already possible for him to see that the complete absence of any kind of spontaneous activity was a defect which before long would make the *Analysis* interesting only to the historian. The French School had found the same defect in Condillac and for a time Maine de Biran's *Essai sur les Fondements de la Psychologie* (1822) seemed likely to initiate a new kind of activism. But the new light was extinguished in mysticism and Maine de Biran was almost forgotten until the followers of Bergson revived him as a forerunner of their master. In Germany after the decline of the idealistic philosophy there was a strong revulsion in favour of the material sciences and out of this interest grew a new crop of psychological data and theories.

Herbart. — Before the physiological school began to dominate the field, a very influential system of psychology was produced by Johann Friedrich Herbart (1776–1841). Reacting from the fashionable idealism of the day, Herbart made an attempt to construct a realistic doctrine which so far imitated the natural sciences as to be presented in the language of statics and dynamics. The original and most elaborate statement of the theory was cumbered with numerous mathematical formulae which had no real significance and were ignored even by the most faithful disciples. The fundamental thesis is that the soul is a real quantity of energy, an idea which comes directly from Leibniz. Every experience demands expenditure of this energy, a perpetual effort of the soul to maintain its unity against the force of impressions. Since the total energy is always the same, formulae for the distribution of energy can be devised. As any one impression gains strength, others lose it. Thus there is a continual rise and fall of presentations. When an idea first claims attention it has least energy and is said to be below the threshold of consciousness: if it acquires energy it rises and is apperceived: it may then be reduced again to the subconscious region. The picturesque language of summits, arches and wavecrests doubtless assisted to make Herbart popular. The fusion and complication of the elements served to explain the variety of mental states. Above all the Herbartian scheme gave new meaning to the ideas of attention and learning. Like his contemporary Beneke, Herbart had a sense for the pragmatic value of psychology. They both took a direct interest in the processes of education and Herbart became almost a gospel for generations of teachers. The principle of connecting ideas so that new material could derive strength from ideas already present in the mind and the use of existing knowledge as the instrument by which to assimilate and "apperceive" new information were sources of inspiration to teachers. Among Herbart's numerous works the most important were the *Lehrbuch der Psychologie* (1816), the essay *De Attentionis Mensura* (1822) and *Psychologie als Wissenschaft neu gegründet auf Erfahrung, Metaphysik und Mathematik* (1824). Some of the best known writers of the Herbartian school were M. W. Drobisch, Theodor Waitz and W. F. Volkmann. Waitz in his *Anthropologie der Naturvolker* (1859) initiated a new development and directed attention to the field of racial psychology which occupies an important place in the literature of psychology after 1860.

NEW METHODS

In spite of its many good qualities the work of Herbart definitely belongs to the old tradition which had its chief affinities with the philosophical doctrines of the soul. A new departure required a point of view which was radically different and this was supplied by the progress of physiology. The work of Sir Charles Bell in England *(An Idea of a New Anatomy of the Brain,* 1811), of Magendie (1822) and others culminated in the general physiology of Johannes Müller (1835) and changed the whole direction of thought. The new interest centred upon the structure of the nervous system and the demonstration of reflex action. To appreciate the importance of these topics it is necessary to remember that general psychology was at that time still essentially a study of the spirit of man rather than his organization. In spite of the Cartesian tendency to animal automatism and the mechanistic character of some later theories, there was no body of scientific facts which could be used to build up an adequate account of the conscious life. The Hegelian introspective methods were losing support. In France Comte openly rejected the whole procedure and was one of the first to adopt the standpoint of behaviourism. There was little or no conception of the end to which their scattered impulses were leading, but the movement gathered strength. The more speculative minds saw the importance of classifying many human actions as reflex: for this meant that a large part of a man's life was put beyond the boundaries of reason. About 1851 Claude Bernard, Brown-Séquard and Ludwig contributed in different ways to the doctrine that the constriction and dilatation of the blood vessels is governed by the action of the nerves belonging to the sympathetic system. The sympathetic system has some connection with the brain but is partly independent and cannot be regarded as under the control of reason: it is to a large degree self-regulating and for that reason is also called autonomic. The bodily changes which take place in the regions where the sympathetic nerves operate affect the whole condition of the organism, and, since they are not a part of the voluntary *activities,* must be regarded as destroying the idea that *psychic* life is limited to the field of rational conduct. A speculative interpretation of these facts was given by Schopenhauer who taught that reason was secondary to will and that the dominant factor in life was to be found in the unconscious impulses which belong to the organism before the cerebral growth makes it possible to have ideas. This philosophy of the Unconscious was a premature attempt, but it served to make popular the view that outside the sphere of ideas there is a wide range of activities, and that impulse is more dynamic than thinking.

The group of experimentalists who gathered round Johannes Muller were responsible for the creation of a definite physiological psychology. Muller himself made important experiments on the phenomena of vision, on the action of the vocal chords and on colour contrast. He taught the doctrine of specific energies of the nervous system, believing that each class of nerves was limited to one kind of action. This view has been modified as it seems more likely that the nerve-terminals are the important factors in determining the nature of the sensation. But though not wholly accurate Muller's view was important in making clearer the fact that every experience is conditioned partly by the stimulus and partly by the structure of the nervous system. It was necessary, therefore, to study these as correlated events and physiological psychology became the science of these correlations. Miiller was the first to give a satisfactory explanation of binocular vision. He demonstrated the fact that there are points on the retina of each eye which correspond in such a way that an object stimulating two corresponding points is seen as one visual object. Contemporary with Miiller was E. H. Weber who studied experimentally the sense of touch and of temperature. Weber's Law, one of the landmarks of modern psychology, was first stated in 1834. In 1846 the article on *Der Tastsinn und das Gemeingefühl* appeared in Wagner's *Handworterbuch der Physiologie.* The formula known as Weber's law was derived from experiments which showed that if a stimulus increased by definite quantities the differences could only be perceived when the increase was a certain proportion of the previous quantity. In the case of hearing, for example, to obtain equal increases in the sounds as perceived it is necessary for the stimuli to increase by $\frac{4}{3}$ (1, $\frac{4}{3}$, $\frac{16}{9}$, etc.). The original statement of the law has been modified in details but Weber established the general principle and was the author of that branch of psychology which is called psychophysics. Weber's own work was a modest report of experiments. The notice which the facts and methods ultimately attracted was due to writings of Gustav Theodor Fechner. Fechner had considerable knowledge of science and was able to reduce his general theory of psychophysics to the forms of experimental research. He soon realized that the main points had already been stated by Weber. In fact it seems probable that he did little more than revise and co-ordinate a number of existing formulae. The methods he used were (1) that of just noticeable differences, (2) of right and wrong cases, (3) of average error. The first had been used by Delezenne in 1826 and Weber in 1831: the third by Steinheil in 1837: the second by Vierordt in 1852. The particular merit of Fechner lay in the industry with which he investigated the working of these principles. He gave direction and inspiration to a large number of workers who found in his methods a basis for exact experiments in the laboratory. His main work, *Elemente der Psychophysik,* was completed in 1860. G. E. Müller's work *Zur Grundlegung der Psychophysik* caused Fechner to write in 1882 a *Revision* which was to supersede the *Elemente.* Fechner also made researches in the field of aesthetics and was a pioneer in the study of aesthetic proportions.

While the physiologists were progressing in the study of sensation a new attempt was made to adjust the old traditions to fresh circumstances. This was undertaken by Rudolph Hermann Lotze, a man peculiarly fitted for the task because he combined with his knowledge of the philosophical doctrines a grasp of the developments in general science and especially in physiology. Lotze's *Medicinische Psychologie oder Physiologie der Seele* (1852) deserves to be remembered as a powerful influence in directing the thoughts of its readers toward a new valuation of the psychological problems. Lotze's study of medicine convinced him that the approach to psychology must be through the study of the organism and that all psychic functions were dependent on neural processes. The significant feature of Lotze's psychology is its concreteness. The reader feels that even the more speculative parts are written in a spirit of critical caution and that the independent status of the soul is not asserted as an abstract dogma but as a necessity due to the fact that physiological explanations are so often inadequate. Before 1852 Lotze had written a work on general pathology (1842) and on physiology (1851). He moved gradually from the study of the body to the study of mind. Among the many suggestive ideas which Lotze expresses in his work the theory of local signs is best remembered. The problem of space-perception is peculiarly difficult because it involves relating the actual extension of the outer world to an inner consciousness which has no such extension. In other words the quantity of space must be stated in terms of a qualitative order. To do this Lotze assumed that the sensations reaching the mind from different parts of the body had different values and were in this way capable of suggesting to the mind their relations to each other in space. The term "local sign" was the name given to this quality of the bodily states by which we get not only the sensation itself but also a recognition of its position. The theory has many difficulties and is by no means generally accepted, but it remains as a possible solution of the problem.

Wundt.—In the work of Fechner and Lotze it is easy to see the process by which modern psychology was created. The metaphysical tendencies gradually died away and attention was concentrated on the facts which lay nearest to the border-line of the natural sciences. The whole period from Miiller and Lotze to the close of the century was covered by the life and work of Wilhelm Wundt. Born in 1832, Wundt was trained in the medical sciences and became assistant in physiology to Helmholtz (1857). Between the years 1852 and 1862 he composed his first work, *Beiträge zur Theorie der Sinneswahrnehmungen.* Living in the atmosphere of German philosophy, Wundt was faced with the question of the soul, which became for a time the storm centre of German thought. Wundt decided that the soul was to be defined not as a separate agent but as a particular class of actions. Henceforth he was free to work on the nature and classification of these actions. The merits of Wundt's achievement depend very largely on the attitude which he adopted toward the problems of method. He conceived scientific method as a universal term which became specialized by the nature of the field in which it was employed. He accepted the idea of experience as a distinct object of study and proposed to apply to experience all the methods which would help to explain it. With his own training in physiology and his knowledge of the work done in psychophysics, he attacked the field of experience along both lines. His monumental work, *Grundzüge der Physiologischen Psychologie* (1872), shows in its title the emphasis which is thrown on the relation between anatomy, neurology and psychology. The facts which were to be studied were not taken as abstract movements of the mind but as functions of the organism to be explained in terms of physiological processes correlated with psychological events. The distinction between mind and body was thus subordinated to the view of experience as the actual events which could be analyzed partly in terms of the neural action and partly by a purely psychological analysis. The *Grundriss der Psychologie* (1897) presented the main outline of the system in a form useful as a text-book; which has been widely used and has influenced the teaching of psychology in every country.

To Wundt must be given the credit of two great achievements. He created the modern type of experimental psychology and he devised a method of analysis. Previously the idea of experimental psychology had been confused with the indefinite kind of appeal to experience which was occasionally opposed to the more exaggerated types of metaphysics. Experiment in Wundt's sense means the isolation of a particular problem and the employment of methods for exact observation under conditions which were properly controlled. Work of this kind demanded all the facilities of a well-equipped laboratory and Wundt was a pioneer in this direction. His laboratory was opened in 1879 and was the first of its kind The method of analysis, which determined the greater part of the work done in the laboratory, was based on the view that psychical states as experienced are compounded out of simple elements. The mind can be analysed into three main classes of activities, ideas, feelings and volitions. The ideas are the ways in which we become aware of objects: they are presentations which are immediately known. But the earlier psychologists had considered chiefly the relation between the awareness and its object: they had in fact considered the logical significance of the idea rather than its psychological structure. Wundt turned his attention to the processes which constitute the act itself and distinguished the elements which enter into the complex experience. These elements are the sensations, which are themselves complex in so far as they have both quantity and quality. Though these are inseparable they can be varied under experimental conditions and the quantity or intensity can be measured. A great part of the work done by Wundt, and the numerous workers who gathered around him or copied his methods, was in this field of exact measurement of sensations. It is obvious that the programme could be most easily carried out in the field of sensations and some time elapsed before any similar attack was made on the higher functions. As sensation corresponds to the action of afferent nerves, so volition or willing corresponds to efferent neural currents. Here the simplest pattern is that of the reflex arc. The reception of sensation is followed by the reflex muscular action and in this way a system of responses is established. These responses from the first have a purposive character, and it is therefore possible to explain the whole range of voluntary action as the complex or developed form of elementary reflex acts. It is not possible here to enter into the details of Wundt's experiments. The point which is to be emphasized is the general plan of analysis by which all complex states or activities are broken up into their constituent parts. The psychology which results is described as structural because it works with factors which in themselves are abstract and proceeds by ideas of fusion and complication to build up the total mental states.

Wundt also attempted to apply his methods to the field of anthropology. His *Völkerpsychologie* was a monumental work. Language, religion and custom were the three aspects of primitive tribal life which he studied. To these three he applied the method of analysis, tracing the concrete forms to their origins in gesture and vocal sounds, imagery and habit. But Wundt's excursion into this field was less fruitful than it would have been if he had possessed a direct knowledge of anthropology.

Helmholtz. — The middle of the nineteenth century was a time when a variety of new movements began to influence the course of psychological thought. Before considering them it is necessary to mention the important contributions made by Hermann Helmholtz (1821–94). Helmholtz was professor of physiology in the earlier part of his career and later (1871) became professor of physics. From his early days he was in contact with the idealistic philosophy of Germany and this remained throughout his life an influence which drew him toward the problems of perception. As Helmholtz had a gift for making instruments, he was equipped in a most extraordinary way for the particular work which he undertook. His main contributions were contained in two great works. The work entitled *Die Lehre von den Tonempfindungen: Physiologische Grundlage fur die Theorie der Musik* (1873), was a complete study of sound, both as regards its production, the physiological mechanism of hearing and the character of perceptions. The other work, *Handbuch der physiologischen Optik* (1859), was equally comprehensive in its treatment of vision. In the analysis of sound Helmholtz explained the nature of overtones and the consequent "colour" or distinctive character which different instruments give to the same tone. Physics, physiology and psychology were brought together in the treatment of this subject and the result remains one of the great examples of experimental analysis. In the field of vision Helmholtz was the first to appreciate the work done by Thomas Young. In 1801 Young suggested that sensations of different colours depend on different frequencies of the vibrations and that there were three primary colours, red, yellow and blue. Experiments by Wollaston caused him to change this list, putting violet for blue. The subject seems to have attracted little attention till Helmholtz took it up. A rival theory existed which goes back to the time of Aristotle and rests on the actual description of visual experiences. It had been revived by Goethe in his *Farbenlehre* and was distinguished by the fact that black and white were included in the list of colours. Goethe was interested in the work of J. E. Purkinje (1819) on subjective visual experiences, and also entertained a peculiar dislike for the work of Newton. Purkinje is remembered as the observer of the "Purkinje phenomenon," which is the fact that as the intensity of light decreases the colours with short wave lengths (green, blue) are more visible than the others. The Young-Helmholtz theory was based on the physical analysis of light rather than the immediate experiences and therefore omitted black and white, which may be regarded as degrees of brightness. Since the days of Helmholtz the theories of hearing and vision have been developed in many different directions. In 1879 James expressed doubts about the finality of the explanation of hearing, and work done by Rutherford, Rayleigh, Ewald and others must be taken into consideration in judging its merits. In the case of vision new factors have been introduced. Hering (1874) proposed an explanation which involved the idea of chemical changes in the retina and four primary colours related to four substances in which the changes take place. The explanation of after-images has been a complicating factor and the possibility that the rods and cones of the retina are the most important factors gives the whole question another aspect. The work of Max Schultze (1866), Parinaud (*La Vision,* 1898) and von Kries (1894), together with the suggestions of Wundt, McDougall and the more radical views of Ladd-Franklin, would claim attention in a complete history of this subject. The original work of Helmholtz has been reissued in 3 vols. (Eng. trans. 1924) and this edition contains accounts of later work. But whatever changes may be necessitated by the progress of science, the achievements of Helmholtz will remain immensely significant for the historical development of psychology.

Evolutionism. — The establishment of laboratory methods and experimental ideals was one of the great achievements of the nineteenth century. But viewed in retrospect it is seen to be inadequate by itself to cope with the demands of life. It needs to be supplemented by methods and materials which have a different value. These were supplied by the rise of evolutionary biology which dates from Charles Darwin's *Origin of Species* (1859). Darwin himself made valuable contributions to the literature of psychology, though at the time they were not recognized as belonging in that class. In the *Origin of Species* he discussed the nature of instincts: in the *Descent of Man and Selection in Relation to Sex* he raised the whole question of the development of mental powers in man and animals, with further extension to the more startling probability that moral qualities might have a natural history: still more definitely psychological was the treatment of *The Expression of the Emotions in Man and Animals* (1873). This last work will serve to illustrate the enormous importance of Darwin's work. The first characteristic is the habit and power of observation which makes the theory arise directly out of personal experiences: next comes the belief that every event has an explanation, that an expression is equivalent to the operation of definite muscles, and that the use of the muscles is not a matter of chance but intimately related to the life of the individual. The results of Darwin's work were only partly adequate and the laws he formulated do not go much beyond the limits of works on physiognomy. But the ideas were suggestive and could be applied in other directions: they were destined to leaven the whole mass of psychology. British psychology was already beginning to move in new channels. The man who understood the situation was Alexander Bain and his work forms a bridge between the age of Mill and the rise of evolutionary thought. Bain was a Scotchman, trained in Aberdeen, who at different times lectured on moral philosophy, natural philosophy and logic. He took a practical interest in the problems of education and was well acquainted with the development of physiology at the time when the German School was flourishing under Müller. This factor in Bain's outlook mainly accounts for the character of his work. He was prepared to accept the idea of an innate activity but not to treat it as in any sense a mysterious or spiritual force. In his view it was equivalent to cerebral energy and was a physiological process. Though he was not prepared to deny the reality of the soul, Bain considered that psychology should not go beyond the limits of the natural sciences. His theories are empirical in character and the solidity of his work is largely due to the amount of positive scientific material which he collected: he was a believer in the value of the inductive methods. Bain's chief publications were *The Senses and the Intellect* (1855), *The Emotions and the Will* (1859), *The Study of Character* (1861), *Relation of Mind and Body* (1873) and *Education as a Science* (1881). In scope and importance no one equalled Bain during the days of his productive activity, and the works are still consulted and quoted. But it is significant that Bain's system of the human mind, as he called it, was finished in the year which saw the beginning of Darwin's influence. In this respect Bain was unfortunate. His energy and industry achieved great results, but he remained rooted in the Associationism which could no longer be stretched to cover the whole life of the mind. The age of Alexander Bain passed away in his own lifetime. He belonged to the age of transition which was rounded off by Lewes and ended by Spencer.

Herbert Spencer (1820–1903) was the first writer to make general use of the principle of evolution. At first this was not a form of Darwinism. As Darwin owed something to Malthus, so Spencer was indebted to Lamarck and the Positivists. The idea of development in social life came first and then in 1855 appeared the first edition of the *Principles of Psychology.*

In pure psychology Spencer achieved very little: when he came to the place in the system which should have been filled by that subject, he did no more than adopt the current ideas of the Associationists. But the real service rendered by Spencer was in progressing by gradual steps from the description of organic structure, through neurological specialization of function into the origins of mental life. In this descriptive work he kept constantly in mind the guiding principle of adaptation, which implies that the inner development is controlled by the necessity of responding to the external environment. The term biology is thus given a concrete meaning. As the nervous system develops the inner development takes the form of psychic action. Next to general physiology Spencer proposed to put aesthophysiology. In other words there is a development from purely somatic or bodily action (as in reflex motion) to sense-perception and thence by degrees of refinement and complication to the higher mental functions. This plan contains all the essential elements of a purely objective approach to psychology and is in fact a form of psychobiology. The importance of Spencer was due to the way in which he established the idea of objective psychology and stimulated work in comparative psychology. His article on "The Comparative Psychology of Man" *(Mind,* 1876) may be described as the foundation-stone of that science.

In British psychology the tendency between 1850 and 1880 was toward emphasis on the relation between body and mind, with considerable attention to the abnormal and pathological states. The books most widely known were such as the *Psychological Enquiries* of Sir Benjamin Brodie (1855–62), *Chapters on Mental Physiology* by Sir Henry Holland (1858), *Mind and Brain* by T. Laycock (1860), *Body and Mind* by H. Maudsley (1871), *Principles of Mental Physiology* by W. B. Carpenter (1852 and 1874). George Henry Lewes, Professor of Physiology in London University, wrote a series of volumes on *Problems of Life and Mind.* The third volume, published after his death in 1879, was entitled *The Study of Psychology, Its Object, Scope and Method.* In this work Lewes defined psychology as "the analysis and classification of the sentient functions and faculties, revealed to observation and induction, completed by the reduction of them to their conditions of existence, biological and sociological." This definition represents the view created by the writers of the preceding quarter of a century. It is notable for the fact that it states clearly the necessity of extending the biological treatment to include the activities which are peculiar to man as related to a social environment. This aspect of the subject was soon to have its day.

French School.—While British psychology was passing through its enlightenment, France was beginning to emerge from a period of lethargy. The undisputed leadership in science which France held at the close of the eighteenth century, gradually slipped from its grasp. There was a period of confused and scattered efforts which seemed to show that France had abandoned the methods of Condillac without finding any new inspiration. The only line of thought which was not broken was the medical which, from Pinel onward, seemed to be peculiarly suited to the French genius. Esquirol, Baillarger (1842) and Brierre de Boismont (1845) kept alive a psychology which was more concerned with abnormal than normal states. A special line of investigation which occasioned a long controversy beginning in 1825 was concluded by Broca in 1861. This was the question of a special centre for speech, which Broca declared to be the third frontal convolution of the left hemisphere. The study of aphasia has developed since Broca's time into a much more complex question involving motor aphasia, word-blindness, word-deafness and agraphia (loss of power to write a word otherwise comprehended). Broca's problem was part of the general question of localisation. The pioneer work had been done by Gall and was carried on in a desultory manner until about 1870. Then new methods were employed in experiments on animals and the brain began to be mapped out according to results which showed how the destruction of a particular part of the cortex affected muscular action or sense-perception. The names of Fritzsch, Hitzig, Munk, Goltz, Ferrier, Horsley, Schaefer and many others indicate the activity shown in this branch of research. Though Broca's view has been modified by subsequent research it is historically important. The more general advance of psychology was initiated by Taine's book *De l'Intelligence* (1870). Taine used his literary gifts to interest the French in the empirical English methods. His book was important as an influence in establishing new ideas of method, and in 1888 a professorship of Experimental and Comparative Psychology was created at the Collège de France. The first occupant of the chair was Theodule Ribot (1839–1916). In 1873 Ribot published a book on *L'Hérédité Psyclzologique* which Taine and his party regarded as the beginning of a scientific study of mind. In 1876 Ribot founded the *Revue Philosophique,* rivalling Bain who began the publication of *Mind* in the same year. In 1879 Ribot produced two small but valuable books on the historical development of English and German psychology. In 1888 he published a study of *Attention* and this was followed by other monographs. By his writings Ribot did much to set psychology on the right road, partly by emphasising positive experimental work and partly by suggesting new points of view, such as the relation between emotion and memory. In 1889 a laboratory for psychological work was established at the Sorbonne. Its first director was Henri Beaunis who published in that year his book on *Les Sensations Internes.* Beaunis was a physiologist and his appointment was significant as indicating that psychology was to rank among the sciences. From this time onward there was rapid growth and expansion over the whole field. Richet, Grasset and others followed the more physiological lines. Pierre Janet opened a new era in pathological psychology. The study of character occupied a prominent place and was promoted by Perez (1892) Paulhan (1894) and Fouillée (1895). The psychology of society was treated by Gabriel Tarde in his work Lois de *l'Imitation* with a brilliance which attracted attention beyond the limits of France, and Gustav Le Bon secured an even more extensive reputation by his work on the psychology of crowds. The psychology of religion received attention in 1896 through the work of Recejac, followed by special studies in mysticism (1908, Delacroix), in primitive beliefs (Lévy-Bruhl) and in the psychology of primitive societies (Durkheim). Every topic and every point of view now has a representative in France.

While French psychology is made famous by many brilliant names, the most famous product of the French school is the method of the intelligence tests known as the Binet-Simon test. Alfred Binet (1857–1911) began his active life when psychology had already passed out of the philosophical schools. In 1886 he collaborated with Féré to study animal magnetism and in 1887 he wrote on The Psychic Life of Micro-organisms. The *Psychol-ogie du Raisonnement* (1886) initiated a series of studies on the functions of thought and will, and in 1892 a work on Alterations of Personality showed the tendency to abandon associationism for a more adequate view of mental activity. In 1894 Binet became director of the Laboratory of the Sorbonne. In 1895 he began to develop work in individual psychology. The importance of this event lies in the fact that it involved a new conception of experimental work: the object was not so much to study isolated phenomena in the manner of Wundt as to correlate one aspect of mental life with others. This kind of work was specially useful in the problems of the schoolroom and the factory. In 1900 Binet published the results of long research in a work entitled La *Suggestibilité:* an earlier work (La fatigue *intellectuelle,* 1898) had been produced in collaboration with Victor Henri and these works showed the possibilities latent in the field of education. A laboratory for the study of pedagogical problems was founded in 1905. By good fortune the Government in 1904 decided to investigate the condition oi mentally defective children in the schools. But there was no exact way of determining the status of a child: there was no exact formula by which to define the relations between the normal and the subnormal. The metric scale of intelligence was devised. As a first attempt it was, naturally, imperfect. Various "revisions" have appeared from time to time and variations have been introduced to suit different conditions. But the merit of being the original creator of tests belongs to Binet.

Italian Writers.—In Italy the course of development was similar to that in France. Positivism was influential in Italy before 1870 and found a champion in Roberto Ardigo. Though more a philosopher than a psychologist, Ardigo had a point of view which allied him with Spencer and he used his influence to promote what he regarded as the positive science of the soul. A more experimental line of work was initiated by Giuseppe Sergi at Rome. This type of psychology is predominantly physiological, has reference particularly to problems of physical and mental education, and has become widely known on account of its application in schools under the name of the Montessori method. Important work in the study of the bodily changes in fear and fatigue was done by Angelo Mosso, professor of physiology at Turin (La Paura, 1896; La Fatica, 1903). Francesco de Sarlo represents the influence of Wundt. He founded an Institute for Experimental Psychology at Florence and published among other works I dati *dell'esperienza psichica* (1903). Sancte de Sanctis has made many valuable contributions to psychology beginning with a study of dreams (I *sogni,* 1899). The subject of criminal psychology was made the centre of extensive interest by the work of Lcmbroso (*L'uomo delinquente,* 1876). The idea of criminal types as used by Lombroso has not stood the test of later investigations, but this branch of psychology owes its active progress to the beginning made by Lombroso.

British Writers.—Returning to the situation in England after 1880, we find a distinct type of psychology developed by James Ward (1843–1925). Ward represents a movement sufficiently influenced by German philosophy to reject associationism, but not drawn by that influence into either physiological or experimental psychology. Ward's teaching was developed in a number of articles written between 1875 and 1886, but the first complete statement was presented in the article *Psychology* contributed to the ninth edition of the Encyclopedia *Britannica* in 1886. It is a singular tribute to the worth and vitality of this article that it was reproduced, with no fundamental changes in 1918 as a book entitled Psychological Principles. Ward considered that the task of psychology is "to analyze and trace the development of individual experience as it is for the experiencing individual." Influenced largely by such writers as Leibniz and Lotze, with adequate knowledge of Wundt and the contemporary biologists, Ward developed a psychology which was based on the concepts of a self and the continuity of development. The self as the subject of all experiences accounts for the unity of psychic life: it is active in the form of attention. The gradual development of the sense-organs and the nervous system is accompanied by a development of the primary mental acts, the sensori-motor experiences. There is a succession of higher levels of activity as this original material becomes more complex; perception, memory and thought emerging as products of development. The interaction between subject and object is the general character of the process, but fresh possibilities are created by the forms of interaction between selves. The social factor in psychology was given a particular significance by Ward as the medium by which the process of mental development reaches its highest level. The school to which Ward belongs is known as the "self-psychologists," because the distinctive feature of their method is the assertion of a "self" as subject and the use of introspection as the chief source of information. The origin of this school was in the work of Brentano (Psychologie *vom empirischen Standpunkte,* 1874). Brentano, a neo-scholastic writer, opposed all tendencies toward either physiological theories or the idea of the subconscious. He accepted the view that the "soul" is the same as the acts called psychic phenomena and that these phenomena can be directly observed: observation of others, of children, animals and abnormal types can also be used. The influence of Brentano (and Herbart) is seen in the works of G. F. Stout. namely *Analytic* Psychology (1896), *Manual* of *Psychology* (1898) and Groundwork of Psycltology (1903). As a study of the structure and processes of the mind the *Analytic* Psychology has taken rank among the classics of modern British psychology. The other works have been among the most influential text-books of recent times. There is a strong likeness between the work of Stout and Ward's standpoint. Both present a pure psychology supported chiefly by direct inspection of mental processes, rich in fine distinctions and acute observations. The value of this work is not disparaged by admitting that modern psychology has passed beyond its limitations. In some respects there is a more modern quality in the works of James Sully. In 1874 he published a work on Sensation *and* Intuition: in 1884 the *Outlines* of Psycltology appeared: the Teacher's Handbook (1886) reached a fifth edition in 1909: the most complete exposition was given in The Human *Mind* in 1892. Sully was more like Bain than Ward. He had a gift for accumulating data without much inclination to give them the form of a philosophical system. Separate studies on *Illusions* (1881) and *Laughter* (1902) showed the author's tendency toward the experimental method and the viewpoint of the natural sciences. Sully also felt the importance of making psychology applicable to practice. He followed the example of Herbart and Bain in making psychology a part of the education of teachers. He wrote Studies of Childhood (1895) and founded the British Association for Child Study.

American Writers.—Among the first group of workers in Wundt's laboratory was James McKeen Cattell, whose reports on the work being done were published in *Mind* (1881) and were the first announcements of the new methods to reach English and American readers. The first laboratory for experimental psychology in America was opened in 1883 by Stanley Hall, at that time Professor of Psychology and Pedagogy in the Johns Hopkins University, Cattell was the first professor to occupy a chair exclusively assigned to psychology: this was at the University of Pennsylvania in 1888, where a laboratory was also established. America took the lead in developing experimental psychology, though not without opposition and delays. The progress was in a large measure due to William James (1842–1910), the only man who can be compared with Wundt for the range and influence of his work. James had the interests, abilities and training without which no one could make exactly the contribution which the times demanded. Born in 1842, James graduated in Medicine at Harvard in 1870, became instructor in physiology and later Assistant Professor of Comparative Anatomy and Physiology. From 1879–1889 James was accredited to philosophy, but in 1889 he became Professor of Psychology. In 1899 he became Professor of Philosophy and retained that title until he retired from teaching in 1907. This record is extremely significant, both as showing the variety of interests in the life of James and the complex sources from which his doctrine evolved. *The Principles of Psychology,* published in 1890, stands alone as a monument of scientific skill, comprehensive knowledge and attractive writing. It presented at one and the same time the physiological, the psychophysical, the analytic and the pathological aspects of the subject. James did not allow physiology to obscure the main issues. He did not sympathize with the extremists who treated consciousness as a by-product, the "epiphenomenon" of Huxley. He was inclined to be sceptical about the work of Fechner and to be more interested in the mental pathology studied in France. He had a keen sense for the dynamic aspect and by his famous phrase, "the stream of consciousness," made popular the idea that psychology was more concerned with processes than with static forms or faculties. The chapters on instinct and habit showed an appreciation of the genetic attitude, soon to become developed into a distinct branch of psychology. With the scientific element in the mind of James was united a strain of mysticism, revealed partly in the belief that the powers of the mind were not exhausted in the ordinary phenomena of experience, partly in the interest which led him to study the forms of religious consciousness. James revolutionized thought on the nature of religion by his characteristic treatment of that subject in his *Varieties of Religious Experience* (1902). In this also he was a seminal thinker and the psychology of religion owes an immense debt to the effect produced by this book.

The presence of James and Miinsterberg at Harvard gave that university for a time the first place in American psychology. Hugo Miinsterberg (1863–1916) was an able experimentalist and made valuable contributions reported in his *Beiträge zur experimentellen Psychologie* (1889–1892), and the *Harvard Psychological Studies* (1903–1906). In 1900 he published *Grundzüge der Psychologie,* a discussion of principles. In his later period Munsterberg broadened the field of his work. In 1908 he published a book on *Psychology and Crime.* In 1912 he produced a study of *Psychology and Industrial Efficiency.* In this work he reports a number of investigations, partly made in the laboratory, on such subjects as the qualifications for success in driving street cars. The application of psychological tests to discover the aptitudes of men employed in different industries was then a new departure and this was pioneer work in a field which has since become recognized as a distinct part of psychology.

Edward Bradford Titchener (1867–1927) at Cornell University represented for many years a well-defined type of structural psychology which relied almost exclusively on the experimental laboratory and the principles of Wundt. Granville Stanley Hall (1846–1924) represented a different attitude. Though he had been one of the first students who went from America to Wundt's laboratory, he afterwards became critical of that school and considered its outlook too narrow. The influence of Darwin then became the source of Hall's conception of psychology which was primarily genetic. The evolution of mind in the individual and the race was taken as the focus of a study which had more affinitywith biology than physiology. This programme necessitated a study of child life, for it was based on the "law of recapitulation," that the individual reproduces in the stages of mental growth the mental evolution of the race. This "law" was nothing more than an unprovable dogma, but it did good work as a regulative principle and led to careful studies of individual development. Articles written in 1882–3 on such subjects as "The Contents of Children's Minds on Entering School" are regarded as the beginning of the scientific child-study which now flourishes in America. A work entitled *Adolescence* (2 vols., 1904) was the chief contribution which Hall made to the literature of the subject. James Mark Baldwin was also influenced by the biological doctrine of evolution. His works on *Mental Development in the Child and the Race, Social and Ethical Interpretations in Mental Development* and *The Individual and Society,* were notable contributions to the study of the individual in the social environment, more systematic and logical than Hall's work but also more dialectical and less wide in scope and application.

THE TWENTIETH CENTURY

In Germany another attitude toward the problems of psychology became prominent in 1900. This was due to the influence of Oswald Külpe and the so-called Wiirzburg School. The tradition of the Wundtian school tended to limit individual psychology to the technique of physiological or psychophysical experiments. Kiilpe attacked the problems of judgment and volition with the intention of discovering how far the experience at a given time was influenced by the whole set of the person's mind. The higher mental processes were treated not so much as combinations of elements but as variable functions of the whole mental attitude. The method required the use of introspection and aimed to make an analysis of the higher thought processes in a way which was more concrete and natural than any of the existing methods. The workers in this school included Karl Marbe, H. J. Watt, N. Ach, A. Messer and K. Biihler. Their writings served to shift the emphasis from the concept of psychological elements to the idea of total reactions dependent on such broad conditions as temperament, personality and interests. This effort coincided with a growing interest in the science of the individual as a living unity and materially assisted the development of psychology in this direction. The logical result of this tendency would be a complex method which could produce a complete picture of the mental life of an individual. A programme for this kind of work was outlined by W. Stern who founded an Institute for Applied Psychology in Berlin, and wrote, among other works, a *Psychologie der Individualitat* (1911). The object in view was to make for each individual a complete record of all data, such as environment, education, physical condition and intellectual attainments. In effect this was an attempt to organize ail methods of psychology in a comprehensive scientific survey of the individual. *(See* DIFFERENTIAL PSYCHOLOGY.)

The expansion of psychology in the 20th century has been so rapid and complex that it is impossible to do more than describe its tendencies.

Behaviourism.—In its most extreme form behaviourism excludes everything which cannot be stated in the terms of organic response. This would still be ambiguous if the term organic were not taken to mean exclusively nerves, muscles and glands. In its most general terms the psychology of the behaviourists may be called the study of the stimulus-response situation. But while the terms stimulus and response define the field of observation, they must be limited in their application if behaviourism is to be given its exact significance. In the earlier period, before the theory reached its most extreme form, the main dispute was between the structural and functional views of psychology. The structuralist worked with elements and mental states which were described as complexes of elements. The functionalist did away with elements and substituted processes as forms of organic adjustment to the environment. One party was concerned with saying what the mind is: the other considered only what it does. The functionalist was influenced by the growth of biology and so came to use the term behaviour as the most convenient way of suggesting that the subject of his study was the life of the mind. By these gradual transitions a large number of psychologists became virtually behaviourists even before the school was conscious of its own standing. For example William McDougall in 1912 published a book with the title *Psychology: the study of Behaviour,* and defined psychology "as the positive science of the behaviour of living things." But the mark of this kind of behaviour is "the manifestation of purpose or the striving to achieve an end." In other works McDougall has defended animism *(Body and Mind: A History and Defence of Animism)* and continued to uphold a psychology based on the idea of purposive striving *(Outline of Psychology* 1923). Although the terms soul and mind and consciousness are rejected as unsatisfactory, there is nothing in this form of psychology to offend supporters of the older tradition. But in the year 1913 John B. Watson put out the first statement of a more radical doctrine of which the essential feature was that all reference to consciousness should be condemned as unscientific. In 1914 Watson published the book called *Behavior* and in 1919 another book called *Psychology from the standpoint of a Behaviorist.* These works constituted the manifesto of the new school. It will be useful to note some of the tendencies which explain its appearance. As early as 1887 Carl Georg Lange produced a famous monograph on the emotions *(Über Gemüthsbewegungen).* In 1890 James restated a similar theory of emotions which he had partly outlined in 1884. The peculiarity of the theory consisted in resolving the emotion into the perception of the bodily changes which take place at the same time as the perception of the object said to cause the emotion. The real emotion is the motor and other processes which occur in the body, as in flight or weeping, and qualify the state of cognition. Physiologists had already established the fact that the vasomotor disturbances (dilatation and contraction of blood vessels) were controlled by the sympathetic system and, though not voluntary, were functionally connected with the cerebral centres. The increasing recognition of this involuntary system and its activities encouraged those who were already inclined to write psychology in purely objective language. The most influential work came from Russia where Setschenow began as early as 1863 to say that psychology must take simple reflexes as its basis. The simple reflex would not have enabled psychologists to advance very far, but after the publication of the work of Pavlov on the salivary glands the idea of conditioned reflexes became an important supplement. A reflex is said to be conditioned if a reflex action normally excited by a stimulus of one kind can be excited by another stimulus through association. For example, if the flow of saliva due to the presence of food comes to be produced by ringing a bell, the reflex action of the salivary gland is said to be conditioned, After 1909 this became the stock example of mechanistic theories and supported the doctrine that behaviour is never more than a very complex set of conditioned reflexes. The knowledge of glandular action and particularly the ductless glands (endocrinology) was the new element in physiology and was also accepted as a new chapter in psychology. One of the most influential books of this period was W. M. Cannon's *Bodily Changes in Pain, Hunger, Fear and Rage* (1915), which supplied more detailed facts about the physiological element in emotional behaviour, especially the automatic increase in the production of adrenalin under conditions of emotional excitement. The results seemed so much more scientific and exact than the other views on mental states that Behaviourism was advocated as the only scientific form of psychology. Carried out on rigidly theoretical lines, the principles of Behaviourism require the psychologist to avoid all such terms as sensation, emotion, memory or thought. Sensation is neural response: emotion is glandular or visceral response: memory is neural habit: thought is verbalized response or language behaviour. This theory has the advantage of being apparently simple and using only objective terms. It has the disadvantage of being paradoxical and failing to do more than state the bodily functions in which mental states are objectified. *(See* BEHAVIOURISM.)

Animal Psychology.—The attitude of the behaviourist has been due in large part to the progress of Animal Psychology. This has been compelled to rely on objective data and either ignore or deny any factor called consciousness. Animal behaviour is an ancient study which belongs primarily to zoology. It became a part of psychology after the work of Darwin had shown the importance of studying human and animal behaviour comparatively. A large amount of material had been collected by various writers from Aristotle and Pliny to C. G. Leroy and Reimarus in the eighteenth century. Leroy especially was a good observer and earned commendations from Darwin. Some, like Descartes, classified animals as machines; a view revived and supported by T. H. Huxley. Others retained a more generous view with an inclination to be sentimental and anthropomorphic. The idea of continuity in human and animal life was deeply resented by orthodox thinkers, and the shock of this resentment was largely borne by G. J. Romanes. He wrote on *Mental Evolution* (1878), *Animal Intelligence* (1882), *Mental Evolution in Animals* (1883), *Mental Evolution in Man* (1883). This epoch was mainly descriptive: it passed away when the problems of animal behaviour were taken into the laboratory. In 1890 Jacques Loeb published a work on *Der Heliotropismus der Tiere,* followed by another *Über die Bedeutung der Tropismen fur die Tierpsychologie* and *Studies of General Physiology* (1905). This work was primarilyphysiological. Loeb made popular the term tropism, a form of behaviour which consists in "turning" from one position to another as a result of unequal stimulation. The term was in use in the case of plants (heliotrope) which "turn" to the light in the sense that light stimulates the kind of cell growth which results in that position. Loeb was prepared to explain the behaviour of the moth when it flies into the flame by a similar analysis. The physico-chemical changes would then be the only factors needed to explain animal behaviour. The truth of Loeb's thesis is not open to dispute in particular cases, but it is not possible to make it adequate for all cases without too free use of the imagination. The physiological method requires to be supplemented by the biological. In this direction very important work was done by Lloyd Morgan, *Introduction to Comparative Psychology* (1893), *Instinct and Habit* (1896) and other works. The mechanistic school was represented by Bethe, Uexkiill, Ziegler and others in Germany. In 1904 H. S. Jennings published the results of his experimental work in a volume entitled *Contributions to the study of the Behavior of Lower Organisms.* The phrase "trial and error" was made current by its use in this connection. The experimental work begun by Jennings on lower organisms has been. carried on in a great variety of forms by many workers, especially in America. A pioneer in the work was E. L. Thorndike (*Animal Intelligence,* 1898), followed by Yerkes, Parker, Holmes and others. In France G. Bohn published *La Naissance de l'Intelligence* (1909) and *La Nouvelle Psychologie Animale* (1910). These are only samples of a great variety of contributions which range from the amoeba and ants to the chimpanzee. One of the most important points for the psychologist is the question of learning. The experimental work has largely been devoted to the problems of the learning process. The maze has been most extensively used for this purpose, and other contrivances such as the box with the closed door which the animal must open to get its food. While the progress has been cumulative and valuable, the methods have not been very original or satisfactory. A new possibility was introduced by Wolfgang Kohler when he studied the apes in the German zoological station at Tenerife. Kohler devised problems which could not be solved by the blundering tactics of trial and error: the apes were compelled by the circumstances to use methods which involved more intricate mental processes. Kohler contends that the solution of the problem is reached by an act of insight, a grasp of the logical significance of the whole situation. If this is true the trial and error doctrine needs revision, at least in the case of the higher animals. *(See* PSYCHOLOGY, COMPARATIVE.)

Child Psychology.—Child psychology is the most modern of all departments of the subject. Though animal psychology has a long history, human psychology was consistently limited to the reason of the adult man instead of being treated genetically. It is a curious fact that no distinctive treatise on child-psychology appeared before Dieterich Tiedemann (1748–1803) wrote his *Bookachtungen uber die Entwickelung der Seelenfähigkeiten bei Kinder* (1786). This work was translated for the *Journal Général de l'Instruction* in 1863, quoted by Perez in a book on

Tiedemann in *1881* and translated into English in *1877* as *A Record of an Infant's Life*. In France Perez, Egger and Compayré produced works of some importance. In America F. Tracy's book, *The Psychology of Childhood* (1893), had a wide influence and was later translated into several languages. Other works in the earlier period were produced by Lobisch (*Entwickelungsgeschichte der Seele des Kindes*, 1851), by Sigismund (*Kind und Welt*, 1856) and by Kussmaul (*Untersuchungen ueber das Seelenleben des neugeborenen Menschen (1859)*. The date of the last work coincides with the rise of Darwinism. Here as elsewhere Darwin was a pioneer, setting the example of keeping a daily record of a child's development. Taine imitated this example, but both essays were relatively small contributions, appearing as articles in *Mind, 1877*. A more ambitious attempt was made by Wilhelm Preyer, *Die Seele des Kindes* (1882), which reached a seventh edition in 1908. In *1895* Sully published his *Studies of Childhood.* Stanley I-Iall and Mark Baldwin also made notable contributions. The subject has since expanded into a large literature which is partly child-study, partly a division of genetic psychology and partly a product of educational psychology. In Germany W. Stern published in 1914 a comprehensive work translated into English under the title *Psychology of Early Childhood* (1924). In its latest stage of development child-psychology has become practically a study of human behaviour from birth onwards. The behaviourist is interested in the reactions of the infant, whether they can be defined as mental or not. Behaviour in this sense begins with the earliest reflexes, is observed and described according to the correlation with chronological age, and is explained chiefly in terms of conditioning. In this work John B. Watson has set an example and data are being continually supplied by other students. Educational psychology is concerned with children at the school age and aims to establish norms of achievement with a view to improved methods of training. Here the intelligence-tests play a large part and much experimental work is being done on subjects of instruction, such as reading, writing and arithmetic. The work of E. L. Thorndike in America (*Educational Psychology*, 1903) represents the historical basis of the work belonging to this branch of applied psychology. Among other contributions those of E. Meumann and E. Claparède deserve special mention.

SOCIAL PSYCHOLOGY

Social psychology was the product of the Romantic Age which was initiated by Herder and completed by Hegel (d. 1831). There is nothing before this period which has power and continuity. It is true that Aristotle used the idea of a sense of kinship, that Hobbes made fear dominant in human relations and that Adam Smith partly evaded the individualism of the eighteenth century by a doctrine of sympathy as a primary instinctive response to the actions of other persons. But the justification of a social psychology was lacking so long as there was no conception of a total life in which the individual was merged by the very conditions of his existence. This conception was provided by the historical school which began at the close of the eighteenth century to challenge the individualism of that age. Herder created a new sense for the continuity of racial life and began the movement which was destined to become the science of anthropology. The development of this science was deeply affected by the Hegelian concept of universal mind and of culture as the manifestation of that mind. This interpretation, though wholly speculative in character, had the effect of concentrating attention on the psychic anthropology which the German philosophers first attempted to construct and they called their science by that name. But the defect of the method they employed was its lack of empirical investigation, and the conscipusness of this defect led to different attempts at reconstruction. Auguste Comte's sociology was one of these attempts and, though it does not belong exclusively to the field of psychology, the idea of social forces which it established must be noted as a significant contribution. In Germany at the same time Herbart was leading a reaction from idealism to realism and the Herbartians were responsible for the first attempt to translate the idea of the social mind into definite theories of a psychological type. The work of T. Waitz, *Anthropologie der Naturvolker*, belongs to this school *(1859)*. In *1856* Moritz Lazarus published a work entitled *Das Leben der Seele;* Hermann Steinthal published *Der Ursprung der Sprache* in the same year. In *1860* Lazarus and Steinthal founded the journal called *Zeitung fur Volker-Psychologie und Sprach-Wissenschaft.* This is usually regarded as the historical basis of modern social psychology. In England Comte's influence affected Herbert Spencer who emphasised the relation of psychology to sociology. G. H. Lewes, under the same influences, first defined psychology as including, over and above the functions of the organism, those interactions between individuals which constitute the social nature of man. A further stimulus to the subject was given by the rise of evolutionary biology which gave the required definiteness to the earlier doctrines of progress and development. An original and striking attempt to indicate the positive evolution of the social mind was made by Walter Bagehot *(Physics and Politics, 1873)*. Bagehot was fully conscious of the method which he proposed to use, namely "the applications of the principles of natural selection andinheritance to political society." In carrying out his programme he employed the language of dynamic psychology. The first age of man was called by him the custom-making age, a period in which the ruling force was imitation and of which the product was a "cake of custom." Next follows the period of conflict between customs, a period of disruption and mental agitation, which leads to "the age of discussion" and produces toleration and a respect for intellectual independence. Bagehot gives many acute examples of the spread of customs, as for example the adoption of a particular literary style by writers of a given period. Very little was left for later writers to do in this particular class of work. Gabriel Tarde (1843–1904) achieved a great reputation for a theory which was in essence another statement of Bagehot's theme. Tarde's works, of which the best known is *Les lois de l'Imitation,* were temporarily important. Time has shown that they were not sufficiently emancipated from the historical and sociological romanticism which Comte's ideas of social evolution made popular in France. A similar criticism can be applied to Taine who exploited the suggestive but misleading doctrine of the "milieu." Taine was influenced by the growth in France of psychopathology and the emphasis laid on suggestion. This influence was even stronger in the case of Gustave Le Bon who has popularized a rather uncritical doctrine of the Crowd and its mentality *(La Psychologie des Foules, 1895)*. There is an element of truth in Le Bon's chief contention that crowd-mentality is inferior to the mental level of the same individuals acting separately: there is also undoubted truth in the view that emotional states are in some sense contagious: but Le Bon's method is too purely descriptive to be permanently valuable as psychology. The wide generalizations of Tarde and Le Bon have been in part responsible for a reaction toward a narrowly analytic view of social reactions.

Before stating the principles of this later school it is necessary to trace some other movements. The German school produced a monumental work in the *Volkerpsychologie* of Wilhelm Wundt. The French school which follows Durkheim approaches the psychological questions from the basis of social organization. Durkheim felt that mental contents are not strictly individual. What a man thinks or wills is not merely the product of his neuro-cerebral system: it is equally the product of the social life which he shares. There are collective representations and collective volitions, states and activities of the tribal mind, which owe their character and particularly their compulsive force as beliefs to what can only be described as their super-personal reality. This type of theory is perhaps biassed by excessive pre-occupation with primitive mentality. The difficulties of understanding the nature of primitive thought are very great, and credit is due to Durkheim and his school for the vigorous attack made on the problem. Important work has been done on the psychological aspects of primitive life under the impulse of this movement, for example by Lévy-Bruhl (*Les Fonctions Mentales dans les Sociétés Inférieures,* 1912; and other works). While this type of work was predominantly sociological, there was another line of development which could be regarded as conforming more closely to the definition of social psychology. This was rooted in Darwinism and was an attempt to analyse the whole life of the individual as it developed in a social environment. In this class must be reckoned G. S. Hall and J. M. Baldwin. Hall became dissatisfied with the narrow limits of the psychology which he first expounded and sought to make the science more concrete, vital and comprehensive. His work was mainly descriptive, registering the information obtained from questionnaires and other sources. Such topics as "The Contents of Children's Minds on Entering School" (1882–3) and the major work on *Adolescence* indicate sufficiently the interests which dominated Hall's work. Baldwin aimed to show that individual development was achieved through interaction between the person and the society, the two being at all times coexisting aspects of an organic unity. The growth of animal psychology gave a new direction to thought by bringing into prominence the question of the relation between the native endowment of the human animal and its acquired characters. E. L. Thorndike undertook to define the "original nature of man" and to discover what instinctive tendencies determine human behaviour. A similar aim inspired the work of William McDougall, *An Introduction to Social Psychology* (1908). McDougall's work in experimental and physiological psychology made him a leader among psychologists before he attacked the special questions of social psychology: his work in this field has had exceptional influence among British and American students of the subject. McDougall adopts an attitude which is defined by the concept of purpose. All life and all mental activity has the striving, conative or purposive characteristic: it is not merely response to a stimulus. The elements of social psychology are found in the natural instincts and emotions. A list of instincts is made and to the majority of them a corresponding emotion is assigned. Examples of these pairs are flight and fear, repulsion and disgust, pugnacity and anger, self-assertion and elation. The value of this catalogue of instincts has been disputed by some critics and vigorously denied by others. But the wide acceptance given to McDougall's views is good proof that they harmonized with some general trend of opinion. The popularity of reason was already waning and everyone was ready to turn over the page and begin another story. For the learned reader there was already a model provided by Galton's essay on *Gregarious and Slavish Instincts,* in which he endeavoured "to prove that the slavish aptitudes in man are a direct consequence of his gregarious nature, which itself is a result of the conditions both of his primaeval barbarism and of the forms of subsequent civilization." Galton based his generalizations on the observation of cattle in South Africa and his real topic was the nature of herd instincts. The significance of the gregarious instinct did not at the time receive much attention: the average man was not prepared to see in social institutions the working of impulses which were operative below the levels of reflective thought. But the study of animal societies and the popularity of theories about the Unconscious have united to make attractive any interpretation of human life which throws emphasis on primitive instincts. A further result has emerged from the distinction between natural impulses and social organization. In so far as the impulses must exist in order to maintain the structure and continuity of society. while society at the same time requires their restriction, there will necessarily be forms of conflict both in the life of the individual and in the society. Here psychoanalysis steps in to corroborate the general principles of this social state of transition which involves repression of the most dynamic forces, especially sex-instincts and pugnacity. An adequate treatment of this topic demands an equal knowledge of the medical, psychological and anthropological aspects. Very few men combine these studies in a way that would qualify them to succeed in the task, but W. H. R. Rivers was one of the few and his contributions were exceedingly valuable *(Instinct and the Unconscious,* 1920; *Psychology and Politics,* 1923). The extension of social psychology into the analysis of political organization and the nature of the modern state carries the subject beyond the outlook of this article, and studies of the group-mind must be regarded as belonging to the almost unlimited field of applied psychology.

A reaction in the field of social psychology was produced by the attitude of the behaviourists. With an excess of revolutionary zeal the behaviourists adopted the principle of reducing all mental life to the stimulus-response formula and were led to challenge the traditional views of instinct and emotion. Some rejected instincts entirely, accusing the instinct-psychologists of defending the old faculties under new names. Such lists as that which McDougall created have been specially attacked by adherents of this latest school. In the language of these reformers these are only action-patterns, laid down in the organism as physiological structures, and the stimulus brings into play one or other of these patterns. As modes of action these ara reflexes and the total action can be analysed into component parts which are reflex in character. Language, for example, is acquired by the combination of an auditory stimulus with a vocal response (at first accidental): when the connection is once established the utterances of the parent or teacher operate as an extension of the original "circular reflex," that is, the process in which the child hears the sound which it makes and then imitates the sound which it hears. As a descriptive analysis of elementary behaviour explanations of this kind are valid. The difficulties begin at the later stages when the responses are more varied and their selection seems to depend on such factors as interpretation of meaning. It is then necessary to introduce hypotheses and take refuge in the complexity of brain-structure with the possibility of innumerable cells carrying on activities which as yet cannot be observed.

Present Tendencies.—The dynamic attitude predominates among psychologists who have entered the field since 1900. The majority find the biological approach most congenial: they link up animal and human psychology by this way of regarding them, include child-psychology as a genetic science, and treat the more difficult problems of the nature of intelligence by regarding it as a capacity for the variation of responses in varying situations. But these titles do not apply to all psychologists. Many would disclaim any particular designation and say that for the present psychology is simply concerned with methods and results, not with theories. Specific problems exist in bewildering numbers and it is enough for the worker to solve his chosen problem without attempting to build a system. This agnostic attitude is justifiable, but it is difficult for its exponent to escape from the pre-suppositions of his own technique. This has been shown by two movements which have earned important places in the recent history of the subject. These are the *Gestalt* psychology and the Freudian doctrine. The term *Gestalt* has come into general use for want of an equivalent in the Anglo-Saxon vocabulary. It may be translated "configuration," though the German writers do not consider that this word is exactly adequate. An early tendency in the same direction may be found in the work of Külpe and the Wurzburg School, but the specific origin is found in the writings of Ehrenfels (*Über Gestaltqualitäten, Vierteljahrschr. f. wiss. Philosophie,* xiv. 1890) and Wertheimer (articles in *Zeitschrift fur Psychologie,* 1911–12, reprinted as *Drei Abhandlungen zur Gestalt-theorie,* 1925). The essential feature of the *Gestalt* theory is that it employs "configurations" instead of elements, or it may be said to take as its elements significant groups rather than abstract parts. For example, a tone in a musical sequence is not heard as a tone simply: it is merged in the configuration of the musical phrase in which it occurs. In vision a similar fact is demonstrable either in the grouping of the objects or in the form of movement from one position to another. Five dots arranged in a row have a different "form-quality" from the same dots arranged like the five of hearts. A line presented in the vertical position and then again in the horizontal position will, if the rate of motion is not too slow, produce the impression of one line rotating through an angle. There seems to be a process in these cases which is more than the reception of impressions (peripheral) and may be a reaction originated centrally. The most important work in the development of this theory has been done by W. Kohler. The full significance of the viewpoint can hardly be estimated yet. One of the implications seems to be that in the actual mental experience a relation may be as significant as the data between which the relation holds. Thus an animal may learn to respond to a change from one colour to another though the colours used may be quite different. If this is true, it would imply that the total character of the situation is more significant than the (supposed) elements; in fact the elements as such would exist only for the experimenter who arbitrarily analyzes the situation into those elements. Kurt Koffka has shown how this new outlook would affect problems of education (The *Growth* of the *Mind,* Tr. 1924). Kohler's observations on apes suggested to him that the apes arrived at a solution of a problem when they saw all the factors in the situation as a whole: this he regarded as an intuition, a real comprehension, rather than the trial-and-error process usually attributed to animals. If this line of enquiry leads to more complete results and the Gestalt theory becomes an established doctrine, recent ideas about the learning process will require to be revised in accordance with the new discoveries.

The new psychology of 1880 was the psychology of the laboratory and the experimental method of Wundt. The new psychology of 1900 was the dynamic psychology of Freud. (See PSYCHO-ANALYSIS.) The most significant contribution which Freud has made to general psychology is to demonstrate the sense in which the affective or emotional life of the individual may control the entire psychic life. The keyword of the theory is repression. Though other writers had suggested that forgetting might be as great a problem as memory and that in fact there might be no such thing as complete forgetting, Freud first expounded the processes by which an experience may be thrust into oblivion and kept there as an active but unconscious psychic force. The term "unconscious" thus acquires a positive meaning and the unconscious is the underworld of the mind where the repressed memories live and act. This unconscious area cannot be reached by the normal memory: it is not equivalent to a lapse of memory or a failure of attention, for in those cases the lost idea or impression might return to consciousness through later recollection. The unconscious of which Freud speaks is only to be reached through the technique of psychoanalysis. The reality of the unconscious for the individual consists in the conflict which it creates and in the unrecognized symptoms of that conflict, such as irrational dislikes and fears, inhibitions and peculiar physical disabilities. The particular theory has been generalized in such a way as to become a possible element in general psychology. This is due to the interpretation of the individual's relation to society. It is held that natural instincts (especially those connected with sex) are never perfectly harmonized with the requirements of the social order. Conflict at some stage of life is inevitable and this conflict may lead to repression with consequent harm to the psychic development of the person concerned. It is accordingly probable that every person has some degree of emotional disturbance, if only in the form of mild prejudices. The doctrines of Freud have penetrated into modern psychology and become one of the chief reasons why the emotions are now so much emphasized. The behaviourists, however, are disinclined to give any place to the unconscious and claim that the only distinction necessary is between verbalized and unverbalized behaviour. The Behaviourist would accept most of the facts, particularly the presence of sex-interests in the early life of the child, and explain the subsequent development entirely in terms of conditioning. For the practical psychologist, concerned only with the normal mind, the process of conditioning and reconditioning may be a satisfactory explanation of the personal characteristics which he is called upon to study. If mental pathology demands a different technique, the psychologist may claim that it does not fall within his province. But the psychology of the future will in any case be increasingly concerned with the problems of personality, with the early stages of development and with the growth of the mind, laying stress on the methods of training which will prevent abnormality and promote the development of well-balanced minds.

BIBLIOGRAPHY.—J. M. Baldwin, *History of Psychology,* a Vols. (1913); G. S. Brett, *A History of Psychology,* vol. i., Ancient and Patristic (1912); vols. ii. and iii., Mediaeval and Modern (1921); E. Chaignet, *Histoire de la Psychologie des Grecs,* 5 Vols. (1887–93); M. Dessoir, *Abriss einer Geschichte der Psychologie* (Eng. Tr., 1912); G. S. Hall, *Founders of Modern Psychology* (1912); Janet and Séailles, *History of the Problems of Philosophy* (Vol. *1,* Psychology, 1902); O. Klemm, *Geschichte der Psychologie* (1911); (Eng. Tr. 1914); H. Siebeck, *Geschichte der Psychologie* (1884) (Greek theories only); G. Villa, *Contemporary Psychology* (1903); *H.* C. Warren, *A History of the Association Psychology* (1921). (G. S. B.)

PSYCHOPHYSICS, the science that deals with the determination of the relation between the mental and physical worlds, or, more specifically, of the relation between sensation and its stimulus. The word is generally used with reference to the quantitative determination of the latter relationship.

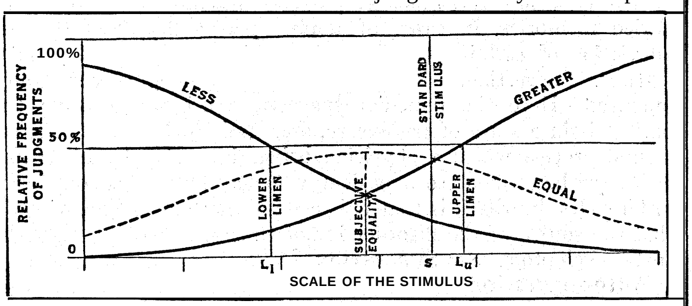
History.—Psychophysics was established by Gustav Theodor Fechner (1801–1887), who coined the word, invented the three fundamental methods, conducted elaborate psychophysical experiments, and began a line of investigation that still persists in experimental psychology to-day. Fechner's classical book, Die *Elemente* der *Psychophysik* (1860), may be looked upon as the beginning, not only of psychophysics, but also of experimental psychology (*q.v.*) itself. Fechner, trained in physics, became interested in his later life in metaphysics, and cast about for a way of relating the spiritual to the material world. He hit upon the notion of measuring sensation in relation to its stimulus. Ernst Heinrich Weber (1795–1878), the physiologist, had discovered that the just noticeable differences between the intensities of sensation always bore, when stated in the increment of stimulus necessary to produce such differences, an approximately constant ratio to the total magnitude of the stimulus. This fact, properly speaking, is Weber's Law: if two weights differ by a just noticeable amount when separated by a given increment, then, when the weights are increased, the increment must be proportionally increased for the difference to remain just noticeable. Fechner chanced upon Weber's Law and undertook to use it for the measurement of sensation. If R be the stimulus (*Reiz*), and S be the resultant sensation, and A signify an increment of either, then Weber's Law becomes $\Delta R/R =$ a constant, for the just noticeable difference. Fechner went further and assumed that all equal increments of sensation must be proportional to the same ratio, $\Delta R/R$, that is to say $AS = c\Delta R/R$, where c is a constant of proportionality. If this equation is integrated, if R be measured in terms of the threshold stimulus (the value of stimulus at which S is zero or just ready to appear), and if the constant be changed to k for common logarithms, we have $S = k \log R$.

This particular formula Fechner named Weber's Law, although it is really Fechner's Law and is thus sometimes called the Fechner-Weber law. It expresses the simple relation that the magnitude of a stimulus must be increased geometrically if the magnitude of sensation is to increase arithmetically. For Fechner it meant that the relation between the spiritual and material worlds is statable, and that there is therefore only one world, the spiritual; but for physiologists and for many philosophers it meant the measuring of sensation in relation to a measured stimulus, and thus the possibility of a scientific quantitative psychology. Fechner got his conception of psychological measurement from Herbart, but he was really refuting Herbart in demonstrating that psychology can be experimental.

Fechner's original work stimulated much research and much controversy. It was argued against him that it is introspectively obvious that sensations do not have magnitude (the quantity objection), that "a scarlet is not just so many pinks." This difficulty was met by the Belgian, J. L. R. Delboeuf (1831–1896), who developed the concept of the sense-distance, holding that sensations, although not complex magnitudes, are separated by variable distances which can be compared as "greater," "equal," or "less," the three categories of judgment which the psychophysical methods require. In Germany, Georg Elias Müller (1850—) undertook an elaborate criticism of Fechner and an extension of his work. In America, E. B. Titchener (1867–1927) made a historical and practical exposition of psychophysics in the second volume of his Experimental Psychology (1905). More recently F. M. Urban, then also in America, improved one of the methods and developed the concept of the psychometric function. Other well known psychophysicists are W. Wirth in Leipzig, and William Brown and G. H. Thomson in England.

Limens.—Psychophysics makes extensive use of the concept of the threshold or limen, of which there are two kinds. (i.) The *stimulus* limen is that value of stimulus which terminates a sensory continuum. The visible spectrum is limited by a stimulus limen in the reds (ca. 800$\mu\mu$ wave-length of light) and another in the violets *(ca.* 400$\mu\mu$). Tones range between the limen for the lowest audible tone (ca. 16 vibrations per sec.) and the limen for the highest audible tone (ca. 20,000 vs./sec.). The stimulus limens for intensities of weights, sounds, brightnesses, and other sense-qualities have been determined, but depend upon so many factors that no simple statement of their values is possible. Stimulus limens have also been determined for size and for duration. In the case of illumination, the size, duration and intensity of the stimulus are interrelated; a very small stimulus has to be more intense to be perceived. (ii.) The *differential* limen is that difference between two stimuli which marks the boundary between sensed difierence and sensed equality. It is often confused with the just noticeable difference, although in fact it is a statistical quantity for the theoretical point between what is just noticeable and what is just not noticeable. In fact both limens are statistical values, for the variability of the conditions of excitation can not be controlled and what is sensed at one time may not be sensed at another. Hence the limens are averages or mathematically determined points where the sensation is as often sensed as it is not.

Methods. — There are three fundamental methods of psychophysics, all of which Fechner invented. (i.) In the method of limits (method of minimal changes, of least perceptible differences) the stimulus is varied serially (usually by discrete steps) until a change is noticed. For example, to determine the stimulus limen of intensity, imperceptible intensities are presented in increasing order until the stimulus is first sensed; then a descending series from perceptible to imperceptible is observed; and finally the results of many such series are averaged. For the differential limen there are always two stimuli, of which one, the standard, is kept constant, and the other, the variable, is altered until a difference between the two appears or disappears, according to the direction of change. Here the limen is the distance from the standard to the average point of change, and there are always both an upper differential limen and a lower, since change can be noticed on either side of the standard. (ii.) In the method of average error (method of production) the experimental subject himself changes, by means of appropriate apparatus, the stimulus continuously, usually until subjective equality with a standard has been reached. Since subjective equality is not physical equality, the results yield an average or constant error for the subject and also a variable error about this average. (iii.) In the constant method the subject is presented at random with a predetermined set of stimuli for which he judges in every case the presence or absence of sensation or of the difference between the sensations. Because of the variability in the conditions of excitation his judgments are not always the same for the same stimulus, but it is found that, as a difference increases, the frequency with which the differenceisperceived increases. When enough judgments have been taken, these relative frequencies can be plotted in a psycho*metric* function. The figure shows the case of the differential limen. Reading from left to right, the frequency with which the variable is judged "less" than the standard decreases, the frequency of the judgments "greater" increases, whereas the remaining cases, the equality judgments, are maximal at the centre. The liminal values of the stimulus are taken as those values where the probability of the judgment "less" or "greater" is as likely as it is not, *i.e.,* the points on the scale of the stimulus corresponding to the points where the abscissa for 50% crosses the psychometric functions. The limens are the distances of these values from the standard stimulus (the distances L_l to S and L_u to S) and one of them may even be negative when subjective equality deviates widely from the standard. Subjective equality is usually taken as the point where the judgments "less" and "greater" are equally likely, *i* e., the intersection of the two psychometric functions. It is customary (as in the figure) to fit to the observed frequencies for the psychometric functions smooth ogives of the normal probability integral, sometimes called the phi-function of gamma; but this curve is only an empirical approximation and has no theoretical significance.



Weber's Law. — The Fechner-Weber Law implies that all differential limens of intensity should bear a constant ratio to the standard stimulus, whatever its value, and for this reason the psychophysical methods have been used most extensively to test the law and to determine these ratios. In general it may be said that the experiments indicate that the law holds approximately, although not exactly, within the middle ranges of intensity, but not for very small or very large intensities. Thus it appears that the liminal ratio for visual brightness is about 1/100, that is to say, illumination must be increased by 1/100 of its amount for a change to be perceived. The liminal ratio for lifting weights with the hand is about 1/40 and for pressure on the skin about 1/20. For tone the value is about 1/10; and for smell it ranges as a rule between 1/4 and 1/3. See DISCRIMINATION, SENSIBLE.

Results. — There is a very large body of quantitative results on liminal determinations. For theoretical purposes the constant method with weights, lifted by the hand, has been most used. The psychophysical methods, however, lie at the basis of nearly all quantitative methods of experimental psychology, especially those that deal with sensation. In its mathematical theory psychophysics is identical with the statistical methods that psychology uses in social measurements and with mental tests, and the boundary between the psychophysical and the statistical methods is thus quite properly becoming dim.

BIBLIOGRAPHY.—See G. Th. Fechner, *Elemente* der Psychophysik (Leipzig, 1860, 1889); J. L. R. Delboeuf, *Éléments* de *psychophysique,* and *Examen* critique de *la loi* psychophysique (both, Paris, 1883); G. E. Müller, *Zur Grundlegung* der Psychophysik (Berlin, 1878), *Gesichtspunkte* und Tatsachen der psychophysischen Methodik (Wiesbaden, 1904); E. B. Titchener, Experimental Psychology, II., pts. i. and ii. (New York, 1905); F. M. Urban, Application of Statistical Methods to the Problems of *Psychophysics* (Philadelphia, 1908); W. Wirth, Psychophysik (Leipzig, 1912); W. Brown and G. H. Thomson, Essentials of Mental Measurement (Cambridge, 1921). (E. G. BOR.)

PSYCHOSIS. Strictly speaking, the term psychosis means a state of mind, a concrete psychical process or a mental act; but is now generally used to signify an abnormal state of mind. This definition needs qualification, however, since the technical use of the term in psychiatry is confined to certain forms of mental disorder which can be distinguished from states of congenital mental deficiency on the one hand, and from "borderland" conditions or neuroses on the other. A distinction should be made between "psychosis" and "insanity," which in popular and legal language signifies that an individual, owing to his state of mind, is unable to manage himself or his affairs, is in need of care and control and is not to be held accountable to society for his actions.

Psychosis, on the contrary, is a strictly medical term; it refers to a type of mental illness with certain intrinsic characteristics, assuming various forms, and due to a variety of causes. It does not necessarily lead to serious disturbances of behaviour, and there are many individuals who though not insane in a legal sense are nevertheless the subjects of a psychosis.

Psychological Considerations. — Though it is convenient to divide mental disorders into different categories based upon their causation, clinical characteristics or course and outcome, so many transformations of the clinical syndromes occur that no hard and fast division into separate disease entities is possible.

One broad division is that made between the psychoses proper and the neuroses, a term embracing such morbid conditions as hysteria and obsessional neurosis. One of the essential features of a neurosis is the retention of what may be called the "herd-sense," and a psychosis is marked by its diminution or loss. In a neurosis the patient is oriented to realities and has an intelligence alive to his own needs; his symptoms tend to be provoked by external circumstances, and he is sensitive to changes in the social atmosphere; he sees facts as they are but meets them in a faulty way. He does not seriously offend against the conventions, and however exacting his conduct may be his *entourage* still regard him as akin to themselves—as, indeed, he is, since all persons are apt to exhibit mild neurotic symptoms when life becomes too complex and difficult.

In a psychosis, however, the irruption of images, feelings and cravings into consciousness leads to distorted, views of reality and to falsification of facts; the sentiments and habits of the patient undergo a change, and his conduct becomes inexplicable and (apparently) unmotivated; he becomes indifferent to public opinion and impervious to solicitations from without; briefly, he loses touch with common life and lives in a world of his own.

Two Groups of Psychosis.—The differentiation by Kraepelin of the psychoses into two broad groups—manic-depressive insanity and dementia praecox—has been of inestimable service to psychiatry, though his view that these should be regarded as distinct disease entities has not been established. It is more in accordance with clinical facts to regard them as two reaction types which sometimes occur in pure form but more often as mixed. The manic-depressive reaction is characterized by severe and irregular fluctuations of mood in the directions of excitement and depression with intervals of normality. Dementia praecox tends to pursue an unfavourable course, and is characterized by a peculiar and often complete disorganization of personality with predominant changes in the affective life and will.

As the disease does not always proceed to dementia, and may develop at any age, Bleuler prefers to apply to it the term *schizophrenia* (splitting of mind). Jung has stated that the essence of dementia praecox consists in the fact that the unconscious to a large extent replaces the conscious, and the validity of this formulation is clearly exemplified in those schizophrenics to whom the term *paraphrenia* is given. This psychosis is marked by the exuberant development of fantastic delusions and hallucinations, which appear all the more extraordinary as the personality is so preserved as to enable the patient to make a normal reaction to social life on occasions. The morbid mental products in these cases can properly be regarded as an echo of the ultimate realities of organic life.

Causation and Treatment of Psychoses.—A psychosis is a disorder of behaviour, and represents a failure of function at the psychological level. Psychiatry (*q.v.*) thus differs in its subject-matter from general medicine; the former deals with disturbances in the reactions of the organism as an integrated whole, and the latter with disorders of special systems of organs. Since the behaviour of an individual, whether normal or abnormal, depends upon an infinity of factors—the nature of his life situations, the state of his organism, and the whole of his past history, both personal and ancestral—it is impossible to select one factor as explanatory of the total reaction. The problem of causation in the psychoses is thus dissolved in relativity, and in each case an endeavour is made to seek out, and remove where possible, any factors, either physical or mental, which seem to be exerting an unfavourable influence upon the behaviour.

There is now a general tendency to approach the problems of mental disorder from the standpoints of biology, pathology and general medicine, as it is recognized that the psychoses must be the outcome of a malfunctioning organism. Many psychoses, indeed, have definite relationships to diseases of the nervous system and of the bodily organs, as well as to general disturbances due to infections, exhaustion and drug intoxications. The causal significance of foci of chronic infections from the nose, throat, teeth, uterus or intestines has recently been emphasized and investigations along these lines make it evident that the whole resources of medicine should be utilized in the treatment of mental disorder. Mind cannot be regarded as an entity and detached from the body, and the secrets of disordered personality cannot be discovered by confining researches to the brain. The mind is not merely a function of the brain; it is a function of the whole organism having its roots in the viscera, the endocrine glands, the vegetative nervous system and the musculature.

In contrast to the toxic-exhaustive group of psychoses or an organic psychosis such as general paralysis, which are accidental episodes in the life of normal people, the biogenetic psychoses are the outcome of an hereditary or constitutional predisposition to mental disease. The psychotic episodes may be excited by mental or physical stresses, but the tendency already exists. The different forms assumed by these psychoses are independent of any specific pathogenic agent and dependent upon the personality make-up or inborn psychic constitution. Thus a manic-depressive psychosis is considered to exhibit an exaggeration of a pre-existing cyclothymic or extraverted temperament, and dementia praecox of a pre-existing schizophrenic or introverted temperament. Kretschmer has noted a relationship between certain forms of physique and these psychic types. His work sheds light on the organic foundations of temperament, and has an intimate bearing on the problem of the biogenetic psychoses.

The psychoses do not offer a fertile field for the application of formal psychotherapeutic procedures, such as hypnotism and psychoanalysis; their subjects lack insight and sense of illness, and tend to be non-co-operative and impenetrable. Indirectly, however, psychological treatment plays a large part in the prevention, cure and amelioration of psychoses and psychogenetic factors largely influence for better or worse the reactions of a psychotic.

BIBLIOGRAPHY.—C. C. Jung, *Collected Papers on Analytical Psychology* (1917); *W.* A. White, *Foundations of Psychiatry* (1921); *W.* H. R. Rivers, *Instinct and the Unconscious* (1922); H. Devine, "The Reality Feeling in Phantasies of the Insane," *Brit. Jour. Psych.* (1923); *A.* Hesnard, *L'inconscient* (1923); *E.* Kretschmer, *Physique and Character* (1925); *P.* Janet, *Psychological Healing*, 2 vol. (1925).

(H. DEV.; C. S. R.)

PSYCHOTHERAPY, the treatment of disease by psychological means. Throughout the ages the attempted cure of ills through mental influences has been in vogue, but it is only of late that psychotherapy has been placed on a scientific basis and become a recognized branch of medicine. It is in the main employed in the treatment of so-called functional nervous disorders which are now regarded as mental in origin. One of various methods may be used according to the special faith of the physician or the type of case he is dealing with.

Hypnotism and Suggestion.—During hypnosis, suggestions towards the removal of symptoms are made. The common aversion to this means, its unreliability, and the supervention of more satisfactory methods, have led to its progressive disuse in recent years. In treating neurotically disabled soldiers during the World War it was, however, much employed. And for the recovery of buried memories, in cases of double personality, and for the alleviation of certain symptoms, it is of some value. *See* HYPNOTISM. Suggestion, without any hypnotic sleep is commonly practised. Here the remedial suggestions are made while the patient is in a state of passive repose. It is in essence the same mental process which a physician brings into play by his assurances for betterment to a patient who has faith and confidence in him. Its drawback is that it is a blind method of treatment in that the source of the disorder is not thus attacked but only the surface symptom. *See* SUGGESTION.

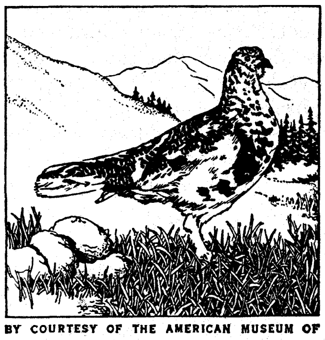
Auto-suggestion and Persuasion.—In the case of auto-suggestion the suggestions are given by the self and not by another. Its great advocates, Coué and Baudouin, believed that all suggestion was of this type and that a second individual was not necessary. It is probable, however, that emotional forces, directly or indirectly, between two persons are needed in most cases.

Persuasion is that method especially associated with Dubois of Berne, in which the patient takes an active share in modifying his mental state. His reason is appealed to, and from the explanations given him he is led to see that there is no logical basis for his symptoms. Though persuasion may benefit certain mild forms of nervous symptoms, it has to be borne in mind that an exaggerated value is given to the reasoning process and that many sufferers are painfully conscious of the absurdity of their fears which reason can in no way modify. The element of suggestion, too, must be a factor in the mental process.

Psychological Analysis endeavours to trace out the root origin of the nervous disorder, and in this respect is therapeutically more scientific than other methods. It involves a frank dissection of all the neurotic symptoms, taking a longitudinal survey of the emotional life history of the patient, noting the circumstances and situations which produced the neurotic reaction, interpreting dreams, giving the individual insight into cause and effect, as well as re-educating him towards a more normal attitude of mind as regards his instinctive desires and impulses. As in all psychotherapy, the personality of the physician counts for much. Unconscious suggestive influence is of course present also to some extent. Such analysis may be carried out by a special technique known as *psycho-analysis* which involves the adoption and application of the psychological theories of Sigmund Freud. In a few types of cases this method is valuable, but the expense and length of time it usually necessitates render its use extremely limited. *See* PSYCHIATRY and PSYCHOANALYSIS Occupational therapy has in late years been developed much for certain types of patients in conjunction with psychotherapeutic treatment. Organized occupational work tends to give an opportunity for the expression of the personality, forms an outlet for energy, and diverts attention from the self. Moral and religious influences, though of no small import, hardly enter into the sphere of scientific medicine.

(C. S. R.)

PTARMIGAN (*Lagopus mutus*), a gallinaceous bird akin to the grouse (*q.v.*). The word in Gaelic is *tarmachan.* It is not found in Scotland below 2,500 ft. and haunts the open moors, where there is no cover. It is the only British bird which turns white in winter. The American form, L. *rupestris,* is scarcely distinguishable. These birds show perhaps better than any of the group the protective coloration of the plumage so characteristic of the grouse.



BY COURTESY OF THE AMERICAN MUSEUM OF NATURAL HISTORY

WHITE-TAILED PTARMIGAN. OR MOUNTAIN GROUSE (LAGOPUS LEUCURUS), SHOWING SUMMER PLUMAGE

PTERIA (mod. *Boghaz Keui),* the ancient capital of the "White Syrians" of Cappadocia, which Croesus of Lydia is stated by Herodotus to have taken, enslaved and ruined, after he had declared war on the rising power of Persia and crossed the Halys (after the middle of the 6th century B.C.). Thereafter he fought a battle near the city, and retired again across the river to his ultimate defeat and doom. Pteria is mentioned by no other ancient authority, but it is of great interest if, as seems highly probable, (1) its "White Syrian" inhabitants were what we call "Hittites" (*q.v.*), or at least, participants in the "Hittite civilization"; (2) its remains are to be seen in the prehistoric city and remarkable rock-sculptures near Boghaz Keui (*q.v.*) in Cappadocia, about 100 m. east of Angora and beyond the Kizil Irmak *(Halys)*. This is the chief "Hittite" site in Asia Minor.

The remains of Boghaz Keui are indubitably pre-Persian and pre-Greek. They consist of a large fortified city on a steep slope enclosed by two deep ravines, and falling to northward over 800 ft. from summit to base. The acropolis was strengthened with a circle of stone redoubts, between which led very narrow gateways, and with internal redoubts as well. Just inside what seems to have been its principal entrance is a rock face inscribed with nine lines of "Hittite" characters, greatly defaced (Nishan Tash), and a similar inscription, equally illegible, can be detected on a neighbouring rock. Below the acropolis on the north-east is a residential quarter, containing large ruins of what seems to have been a palace or temple built round a central court. The whole site is surrounded by a wall, 14 ft. thick, with towers about 100 ft. apart. The monument, however, which earliest rendered Boghaz Keui famous is the sculptured rock grotto, 1 m. to the east, called Yasili Kaya. Here two hypaethral galleries are adorned with reliefs in panels, the larger gallery showing two processions, which, starting on both walls from the entrance, meet at the head of the grotto. On the left wall are 45 figures, headed by a gigantic male figure, erect on the bent necks of two men. On the right wall he is opposed by a female of almost equal stature standing on a leopard or lioness, and followed by a young male with battle-axe, erect on a similar beast. Behind these are some 20 figures of mitred priests, etc. There can be no doubt that the female is the great Nature goddess of western Asia, attended by her spontaneously-generated son, with whose help she creates the world. *(See* GREAT MOTHER OF THE GODS.) Priests or minor divinities follow them. The other procession, according to the analogy of other monuments, should be composed of mortals bearing *sacra* and headed by their king, who makes offering or dedicates his city to, or engages in some mystic union with, the goddess. The figure following him seems to be that of his high priest. "Hittite" symbols are carved above many of the figures. Besides the processions there are five independent reliefs in the small gallery and its approach, one repeating the figure of the high priest.

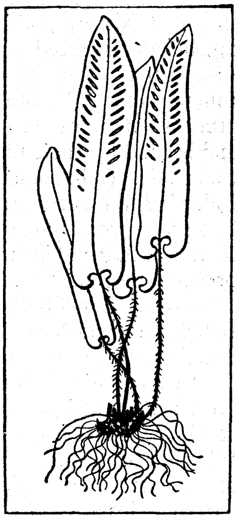
In 1906, Winckler found a number of tablets in two languages, Babylonian and local, the latter being that of the Arzawa letters found at Tell el-Amarna. Among them was a cuneiform copy of the treaty made by Rameses II. in his 20th year with the king of the Kheta, and inscribed on a wall at Karnak. In 1907 Winckler continued his excavations. From tablets written in Babylonian Winckler has established the fact that Boghaz Keui was the capital of a powerful Hatti dynasty from the middle of the 16th century B.C. to at least 1200 B.C. He claims further that its ancient name was Hatti. At the height of its power it ruled all Asia Minor down to the Aegean and northern Syria to the headwaters of the Orontes, and was also overlord of the Mitanni and the Amurri (Amarru) in hfesopotamia. It had relations with Egypt and Babylonia. The four kings of the Kheta, alluded to by name in Egyptian texts, have been identified with kings of Boghaz Keui. The decline of Hatti power began with the expansion of Assyria after 1100 B.C. and Cappadocia seems to have been inferior to Phrygia after the rise of the Midaean dynasty in the 9th and 8th centuries. It should be added that the identification of Boghaz Keui with the Pteria of Herodotus has not yet been confirmed.

BIBLIOGRAPHY.—C. Ritter, *Erdkunde,* xviii.; C. Texier, *Descr. de l'Asie Mineure* (i., 1843); J. Hamilton, *Researches,* etc. (1842); H. Barth, *Reise von Trapezunt,* etc. *(Erganz. Petermann's Geog. Mith.;* 1860); G. Perrot and E. Guillaume, *Expl. arch. de la Galatie* (1862–72); K. Humann and O. Puchstein, *Reisen in Kleinasien u. Nordsyrien* (1890); Murray's *Guide to Asia Minor* (1894); G. Perrot and C. Chipiez, *Hist. de l'art* (1886) vol. iv.; Lord Warkworth, *Notes of a Diary,* etc. (1898); E. Chantre, *Mission en Cappadocie* (1898).

PTERIDOPHYTA, one of the groups comprising the ferns and their allies, of the second great division of plants, the Archegoniatae, the other being the Bryophyta (*q.v.*). The Pteridophyta thus share with the Bryophyta a middle position between the essentially aquatic Thallophytes and the essentially terrestrial Spermatophytes. Much of their special interest centres round that fact. They include plants well represented at the present day; but many already existed in the early land-vegetation of the Devonian period, now known only as fossils; they appeared in greater profusion as fossils of the coal, and many of these early types continued on into the Mesozoic age while their correlatives are included in the flora of the present day. Thus their geological history supports the conclusion that they take a middle position in the evolutionary progression of plant-life, in which a transition from life in water to life on land was a striking incident.

Hofmeister first showed that there is essential similarity underlying the life-histories of mosses and ferns, and that the same scheme, in modified form, extends to the seed-plants also. Since this is so, an account of the Pteridophyta may fitly be introduced by a brief record of the life-history of a fern, as an example of the Archegoniatae generally, and of the Pteridophyta in particular. There are two periods in each normally completed life-cycle of these plants when the individual is represented by a single cell; and these punctuate the limits between two distinct bodily phases, or generations as they are called. One of these is the leafy *fern plant* which every one knows; the other is a small green scale-like body, delicate in texture, called the *prothallus,* which escapes the observation of most people, though actually common enough. The former is sexless, but bears *spores* in large numbers; it is the *sporophyte* generation. The latter is the sexual generation, and, since it produces *gametes,* it is called the *gametophyte.*

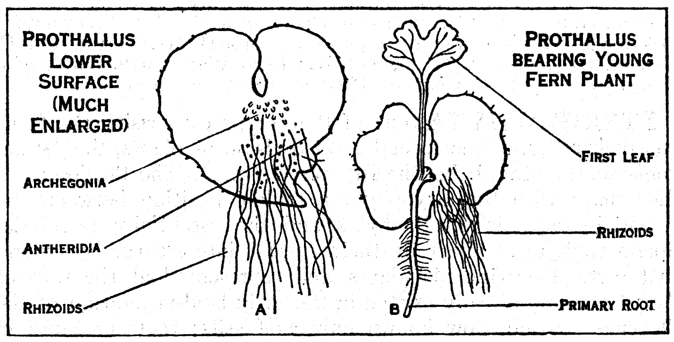
Life-history of a Fern.—The fern plant varies in size from a minute herb to a tree-like body, 60 or even 80ft. in height. It consists of a stem bearing characteristic leaves, usually of large size and delicate outline; the shoot thus constituted is attached by roots to the soil, the whole being traversed by conducting tracts. Since the green leaves serve a nutritional function, the plant is able to subsist as a perennial land-plant (fig. 1). On the leaves the *sori* are borne, of various form and position. In the hart's tongue or the common shield fern they appear as dense groups of brown *sporangia* seated on the lower surface, and covered while young by a membranous indusium. Each sporangium is a stalked capsule containing numerous minute, dry and dusty spores, which are violently ejected when ripe, and each is then liable to be carried away individually by the breeze. The spores are unicellular propagative organs.



FROM STRASBURGER, "LEHRBUCH DER BOTANIK" (GUSTAV FISCHER)

FIG. 1.—HART'S TONGUE (PHYLLITIS SCOLOPENDRIUM)

Each spore germinating on moist soil may grow into a prothallus or gametophyte (fig. 2), which never grows large, though being green it is physiologically independent. It bears the *sexual organs* or *gametangia,* usually on its lower surface (fig. 2, A). Near its base are the male gametangia or *antheridia,* which when ripe consist each of a protective wall of cells surrounding numerous spermatocytes. When bathed by external water (rain or dew) the wall ruptures, and each spermatocyte emits a single spiral *spermatozoid,* which moves in the water by lashing cilia (fig. 3). Near the indented apex of the prothallus the female gametangia or *archegonia* are formed (fig. 2). They are flask-shaped organs, also protected by an external wall; each contains a row of three

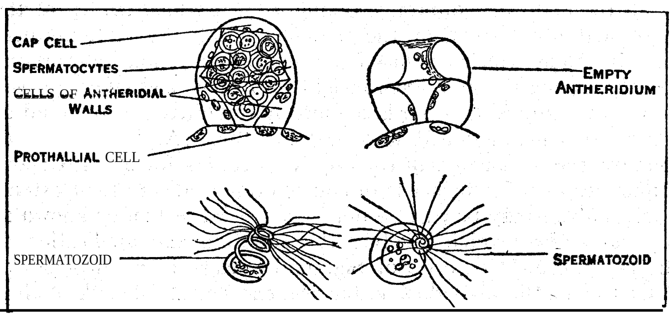


FROM STRASBURGER, "LEHRBUCH DER BOTANIK" (GUSTAV FISCHER)

FIG. 2.—PROTHALLUS OF SHIELD FERN (DRYOPTERIS FILIX-MAS)

cells, of which the lowest and largest is the ovum or egg, sunk in the tissue of the parent (fig. 4). When ripe the archegonium also ruptures on access to external water, the distal cells of the wall parting so that an open channel filled with mucilage leads down to the rounded egg. *Fertilization (syngamy)* consists in the fusion of the spermatozoid with the egg to which it is attracted by soluble substance diffusing from it into the water that bathes the open archegonium. The result of that fusion is the *zygote,* which is the starting point for the development of a new fern plant. This new individual appears first as a spherical mass of delicate cells, nursed in the cavity of the archegonium; but it soon bursts out with its first leaf and root, and its apical bud ready to grow into a new fern, while the prothallus rots away (fig. 2, B).

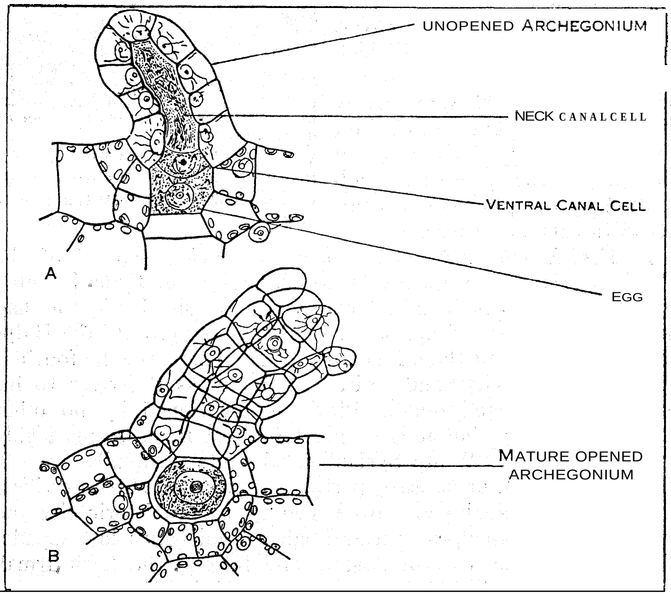
The central feature in syngamy is the *coalescence of the male and female nuclei;* the resulting fusion-nucleus is then *diploid,* with the $2n$ number of chromosomes (*see* CYTOLOGY). That character is then maintained throughout the tissues of the sporophyte. On the other hand, when the fern-plant comes to maturity and forms sporangia, the cells that are to form the spores undergo



FROM STRASBURGER, "LEHRBUCH DER BOTANIK" (GUSTAV FISCHER)

FIG. 3.— ANTHERIDIUM OF POLYPODY (POLYPODIUM VULGARE)

a nuclear change, called *reduction* or *meiosis,* by which they resume that simpler, constitution possessed by the nuclei of the prothallus, and described as *haploid* (n). These events normally alternate in regular succession, and they constitute that *nuclear cycle* which underlies all normal life-histories of the Archegoniatae. They stamp structurally the distinction of the two alternating generations. Such alternation, in one form or another, appears in all plants that show sexuality. The Pteridophyta illustrate the cytological cycle with unusual clearness, since the two somatic phases (viz., the haploid prothallus and the diploid fern plant) are so unlike, and so markedly independent the one of the other during their adult existence. It seems probable that in the course of evolution some simple form of alternation present in an algal



FROM STRASBURGER, "LEHRBUCH DER BOTANIK" (GUSTAV FISCHER)

FIG. 4—ARCHEGONIUM OF POLYPODY (*POLYPODIUM* VULGARE)

ancestry has been regularized and standardized in the Archegoniatae in accordance with a passage from the relative uniformity of aquatic life to the more varied vicissitudes of life on land. In the Bryophyta the gametophyte was more adaptive, and became the dominant generation; on the other hand, in the Pteridophytes, as also in all the higher land-plants, the sporophyte became specialized as the dominant land-living organism. But the Archegoniatae themselves were never wholly emancipated from dependence on external liquid water. They show their amphibious character by their zoidiogamic fertilization; and this confirms their position as primitive land-plants.

For the most part the Pteridophyta are like the Bryophyta in possessing only one type of spore (*homosporous*); but they produce these in enormous numbers. A common shield fern may ripen over 50,000,000 of them in a season. This is a primitive mode of propagation characteristic of early vegetation.

On the other hand, some few Pteridophyte-types such as Selaginella and Isoetes, and those curious little fern-derivatives styled collectively the Hydropterideae, possess sexually-differentiated spores, and are described as *heterosporous;* numerous smaller spores (*microspores*) bear each a rudimentary male prothallus, while a few larger spores (*megaspores*), or only a single one, produce each a massive female prothallus. In this they show a state of specialized advance along lines that have led to the final success of the flowering plants. The Pteridophytes as a whole present the paradox of a great division of the vegetable kingdom that has achieved success by force of numbers, rather than by the more refined methods of physiological adjustment and of propagation even in the higher plants. These paragraphs, of necessity rather technical, will suffice to introduce the Pteridophyta, Vascular Cryptogams, or fern-allies as they are sometimes called. They are represented by six natural groups or classes of organisms, of which four include forms both living and fossil, but two are known only as extinct and very early fossils. Such facts at once confirm their position as representing a primitive vegetation. They may be arranged in rough sequence according to their complexity of form and structure; but this must not be understood as conveying any definite view as to affinity.

CLASSIFICATION

I. PSILOPHYTALES, comprising only fossil types of simple conformation, from early Devonian rocks.

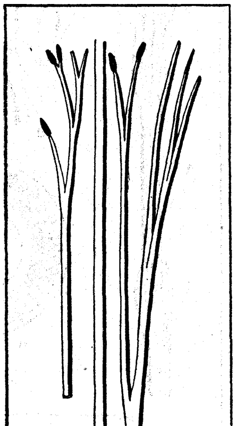
II. PSILOTALES, represented by two genera of living plants, Psilotunz which is intertropical, and *Tmesipteris* which is confined to Australia.

III. SPHENOPHYLLALES, containing extinct Palaeozoic fossils of small size, which hardly extended into the Mesozoic period.

IV. EQUISETALES, including only the single living genus of the horsetails (Equisetum), but largely represented also by Palaeozoic fossils often of dendroid form (Calamariaceae).

V. LYCOPODIALES, or so-called club-mosses, well represented at the present day by the large genera, *Lycopodium* and *Selaginella;* also by Phylloglossum and Isoetes. But in the Palaeozoic period there existed the giant Lepidodendroid trees, as well as allied plants of humbler dimensions.

VI. FILICALES, or ferns; these comprise not only the living ferns, with about 150 genera and over 6,000 species, but also a rich sequence of fossils, from the Palaeozoic Coenopteridaceae to the most recent strata.

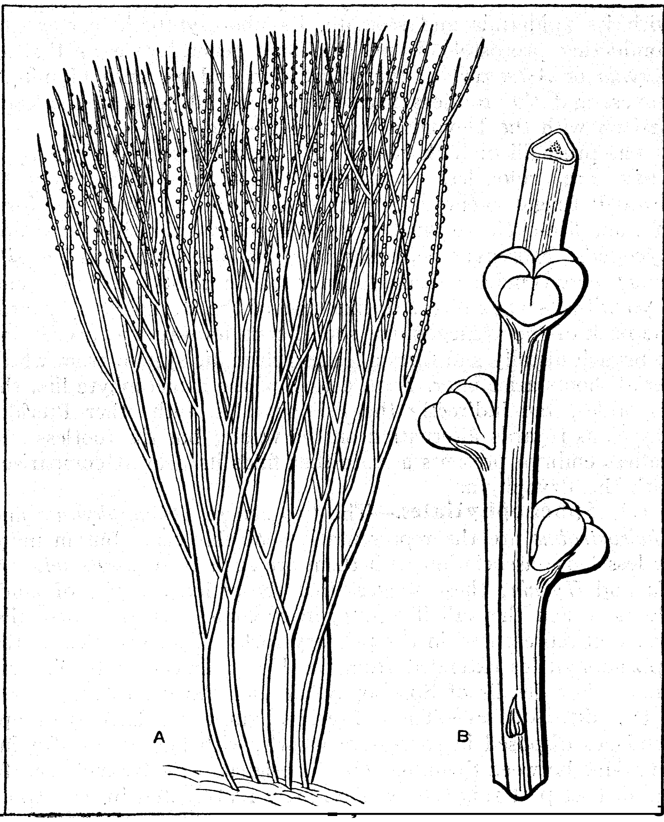


FROM KIDSTON & LANG IN BOWER, "FERNS" (CAMBRIDGE UNIVERSITY PRESS)

FIG. 5—HORNEA LIGNIERI

A newer scheme of classification treats the higher categoriee in a somewhat different manner. The phyla Pteridophyta and Spermatophyta (Seed Plants) are united into one group, the Vascular Plants or TRACHEOPHYTA. This includes four subdivisions: (1) the PSILOPSIDA, including the Psilophytales and Psilotales, (2) the LYCOPSIDA, including the Lycopodiales, (3) the SPHENOPSIDA, including the Equisetales and Sphenophyllales and (4) the PTEROPSIDA, including the Filiciniae, the Filicales of the above treatment, and also the Gymnospermae and Angiospermae, the two large groups of seed plants.

I. **Psilophytales.**—This new class of plants was constituted by Kidston and Lang to receive certain fossils of early Devonian time, discovered by Dr. Mackie at Rhynie in Aberdeenshire. Its name is taken from the old genus *Psilophyton* of Dawson, and the class now comprises a number of other genera of like age, more recently discovered, forming together a very distinctive flora. But of these only the sporophyte is known (fig. 5). The vegetative system consists of upward-growing, forked, aerial shoots that spring from a rhizome sometimes creeping, sometimes tuberous and mycorhizic; sometimes the underground branchlets are rootlike, forking in the substratum (Asteroxylon). The erect shoots are cylindrical, and were evidently green, covered by an epidermis, with stomata, and they are traversed by conducting strands of simple structure. Various superficial growths, often with the appearance of thorns or prickles, are borne upon the larger branches, as in Psilophyton and *Asteroxylon.* The plants



FROM ENGLER & PRANTL. "DIE NATURLICHEN PFLANZENFAMILIEN" (WILHELM ENGELMANN)

FIG. 6.—PSILOTUM TRIQUETRUM. (A) HABIT OF PLANT. SHOWING DICHOTOMOUS BRANCHING (B) PART OF A SHOOT

were of low stature, and growing gregariously"they must have looked rather like grass. The genera Hornea, Rhynia and *Aster*oxylon, described by Kidston and Lang were so well preserved that their structure is as well known as though they were modern plants. The class stands conspicuously apart as leafless and rootless vascular plants.

The most distinctive feature of the class for diagnosis is that the large sporangia, protected by a wall of many layers and containing numerous homosporous spores, are terminal on the vegetative twigs. The early existence thus demonstrated of leafless, and rootless and homosporous vascular plants, with distal sporangia of primitive construction is a fact of the first comparative importance. It is true it does not demonstrate any nearer connection with the Algae, but as regards other relations the new facts are highly suggestive. Long ago it was remarked that the widest gap in the sequence of plants was that between the Bryophytes and Pteridophytes. It is within this gap that the newly discovered fossils take their natural place, acting as synthetic links for the whole sequence of land-living, sporangium-bearing plants.

II. Psilotales.—The Psilotales are represented by two living genera, *Psilotum* and *Tmesipteris,* of which both generations are now known. They form a natural family of the Psilotaceae. By their features they appear remarkably isolated among living plants, and their nearest affinity is to be sought among the Psilophytales and Sphenophyllales, both being classes of plants long extinct. These two genera appear in fact as living fossils.

They live epiphytically, or in soil rich in humus, and are rootless. The green, more or less shrubby shoot is fixed in the substratum by much branched leafless rhizomes, which are infected by a mycorhizic fungus. The saprophytic nutrition by these is supplemented by photosynthesis in the green leafy shoots. In *Psilotum* the aerial stems bifurcate, bearing small and simple scaly leaves, which however pass upwards into bifid "sporophylls," and between the two teeth is seated a large trilocular synangium, containing numerous homosporous spores (fig. 6). *Tmesipteris* resembles it in general character, but branching is infrequent, the leaves and "sporophylls" are larger, and the synagium has only two large loculi. The anatomy of the green stem of *Psilotum,* with its epidermis and stomata, its photosynthetic cortex and conducting protostele, is on the same general plan as that of Rhynia or Asteroxylon; the bifurcation and presence of minute leaves, and the rootless mycorhizic base all support the comparison with the Devonian types of Rhynie.

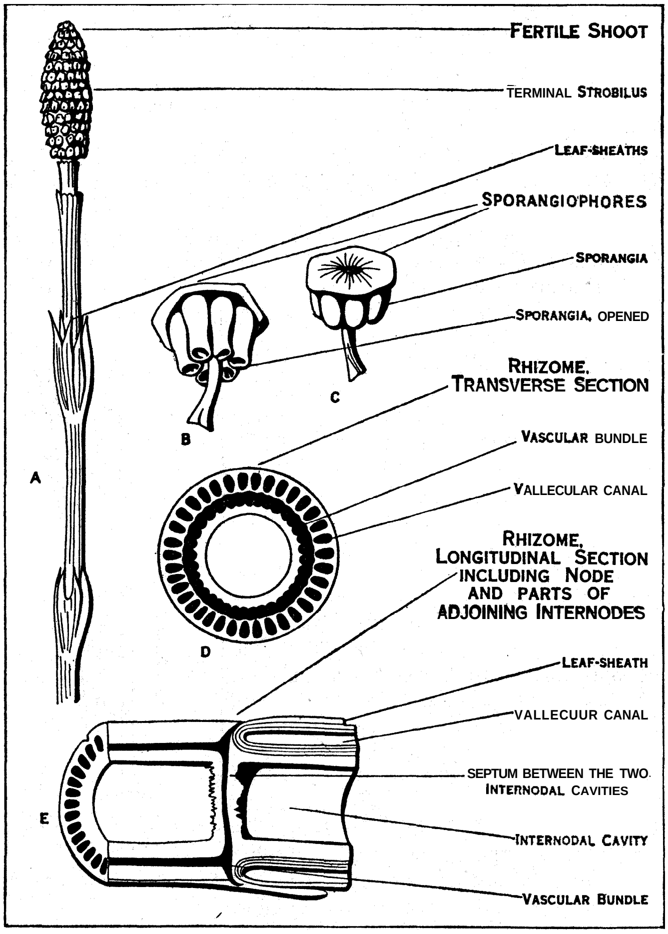
The prothalli of both genera have been discovered since 1914. They are colourless, nourishing themselves saprophytically through fungal agency. In fact these primitive plants conform in their life-cycle to what is seen in many primitive ferns and Lycopods. Moreover, the embryology has been traced in *Tmesipteris;* there is neither suspensor, nor root, nor cotyledon. The embryo with its apex directed, like that of the Bryophytes towards the neck of the archegonium, soon bursts its way out, proceeding to branch distally and form a leafless rhizomic system from which aerial shoots arise later. Such details of the gametophyte link the Psilotales, and indirectly the Psilophytales, with other Pteridophytes as regards alternation on the whole; but the rootless and leafless embryo presents a state that finds its nearest comparison with the Bryophyta.

III. **Sphenophyllales.**—The two genera *Sphenophyllum* and Cheirostrobus are the representatives of this class, but in more or less loose association with them are such types as *Pseudobornia* and Hyenia; these suggest that the articulate type of land-plants, which they all illustrate, in common with the horsetails, was well represented in the primary rocks. The existence of the Sphenophyllales extended from the Upper Devonian to Triassic time. (For details of Sphenophyllales see PALAEOBOTANY.)

IV. **Equisetales.**—Those Pteridophyta which have their appendages disposed in successive whorls, with long internodes intervening between them, have been designated the Articulatae. In the distant past this type was strongly represented by the Sphenophyllales, and by the Calamariaceae and others. But it is familiar to us to-day as it is seen in the horsetails, included in the cosmopolitan genus *Equisetum,* the only species of Equisetaceae, and the only living representatives of the Equisetales. These are semi-aquatic plants; they vary in height from a few inches to 30ft. or more, and are rhizomatous, with erect shoots arising from richly branched, subterranean stems, which are themselves rooted in the soil. The habit of the plants depends upon the method of branching of the shoot rather than upon the foliage, for the leaves are minute (microphyllous), and closely appressed to the stem that bears them. Each whorl of them forms a sheath closely investing the base of the next higher internode, while the teeth projecting upwards from it are all that represent the individual leaves. Their position alternates in successive nodes (fig. 7). The internodes are fluted, the ridges being continuous downwards from the next higher leaves; consequently those of successive internodes alternate. The number of the leaves in a whorl may vary according to the size of the stem, from three to 20 or 30. This is the scheme of the shoot in all species of *Equisetum,* and the shoot is constantly of radial construction. In some species the branching is sparse (E. *limosum*); in others it is profuse (E. *sylvaticum* and maximum), and the branches may themselves branch again repeatedly. Their number and the degree of secondary branching defines the habit, and justifies for the more bushy types the familiar name of horsetails. The branches arise in the axils of the leaf-sheaths, but they alternate with the leaves themselves. Many of those initiated remain dormant. A root is found at the base of each bud, but it also is frequently dormant, especially in aerial shoots. The structure of the underground rhizome is on the same plan as that of the aerial branches that it bears. Thus the whole plant consists of a succession of shoots, each with a dominant axis, whorls of subordinate leaves, and accessory roots.

In the transverse section of an aerial internode the sinuous outline shows the projecting ridges and depressed furrows of its fluted form, though this is less evident in the rhizomes (fig. 7, D). The centre of the section is occupied by a large air-cavity, surrounded by the remains of the pith. A circle of isolated vascular strands, corresponding in number to the leaves in the next whorl above, is in most species enclosed by a sinuous endodermis, which thus delimits the stele (E. arvense, etc.). Outside this lies the cortex, marked by an equal number of large air-cavities, which alternate with the vascular strands, and correspond to the furrows of the fluting. The vascular strands themselves are opposite the projecting ridges, and are extended upwards into the several leaf-teeth. Between the ridges are regions of green chlorophyll-parenchyma, while the whole is invested by a well-marked epidermis, with curiously elaborate stomata: these are ranged along the furrows, and so are opposite the photosynthetic tissue. The anatomy is clearly that of a semi-aquatic plant with its reduced vascular tissue and large air-spaces.

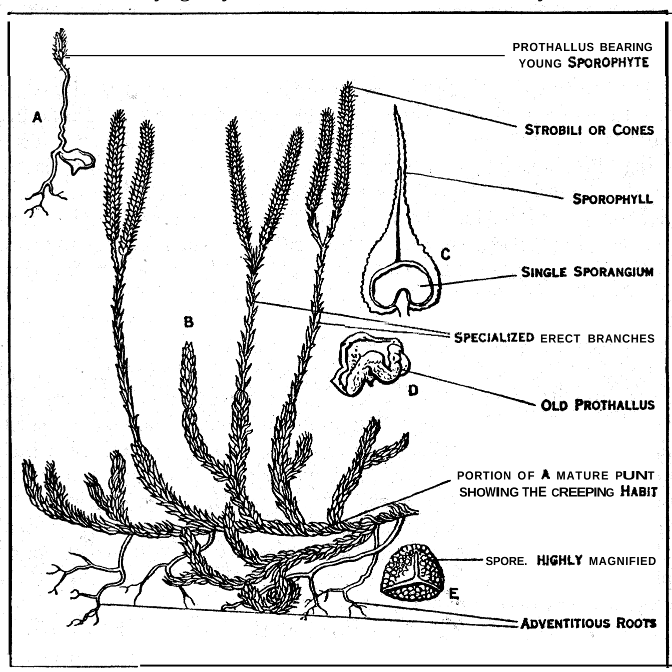
The sporangia of *Equisetum* are borne upon lateral appendages of the axis, sporangiophores, which are disposed in whorls, and are associated in definite strobili or cones, borne distally (fig. 7, A). Each sporangiophore consists of a stalk that expands into a peltate disc, from the inner surface of which some



FROM (A, B, C) STRASBURGER, "LEHRBUCH DER BOTANIK" (GUSTAV FISCHER)

FIG. 7.—LARGER HORSETAIL (EQUISETUM TELEMATEIA)

six to nine large sporangia hang parallel with the stalk (fig. 7, B, C). A single vascular strand passing through the stalk supplies a branchlet to each sporangium. These arise as massive growths from the first, and each produces a large output of homosporous spores (eu-sporangiate). The spores themselves are large; in ripening the outermost layer of the mall of each splits along spiral lines, giving rise to four elaters that straighten out when dry, and close round the spore in damp air. They are effective in forcing open the sporangium, which dehisces by a longitudinal slit: and those of different spores hooking together, the spores are grouped in germination, a matter of importance since the sexes are usually borne on separate prothalli. The spores germinate at once, producing each a green prothallus, which may be filamentous, flattened, or irregularly lobed. The smaller bear sunken antheridia, each with numerous spermatocytes, from which spermatozoids are liberated on access of water. The larger bear archegonia. The conditions of syngamy and formation of the embryo are essen-



FROM STRASBURGER, "LEHRBUCH DER BOTANIK" (GUSTAV FISCHER)

FIG. 8.—A CLUB-MOSS (LYCOPODIUM CLAVATUM)

tially as in ferns; but here the embryo has its apex directed to the archegonial neck (exoscopic), and it grows out directly into the apex of the young plant, successive whorls of leaves arising laterally upon it; a root derived from the basal region fixes the young plant in the soil. Notwithstanding the differences of detail, the life-cycle of a horsetail is comparable as a whole with that of a fern.

A greatly added interest in *Equisetum* arises from comparison with allied fossils; for not only were these numerous and of early occurrence, but they attained dendroid proportions, while some were heterosporous. They are grouped as the Calamariaceae, which will be specially treated elsewhere (see PALAEOBOTANY).

The Equisetales, thus comprising the Equisetaceae and the Calamariaceae, form a natural and closely related class, of which the nearest affinity was with the Sphenophyllales, but with some degree of relation also with the Psilotales; all of these being sporangiophoric Pteridophytes.

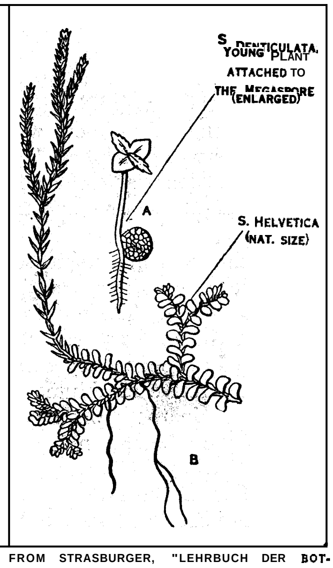
V. **Lycopodiales.**—This class comprises a considerable number of species now living widely distributed upon the earth, and known as *club-mosses;* though they are in fact vascular plants, and quite distinct from the true mosses. They are all relatively small, and indeed insignificant as features in the present flora, compared with the fossil types which, though they may have included a number of relatively small species, comprised also some of the largest plants of the forests of the coal period. It may be that among the lycopods no actual diminution in size took place as time went on, but rather that the types which were always small survived, while the giant members of the group became extinct.

The features which all club mosses have in common are that the leaves are relatively small and simple in form (*microphyllous*), while the sporangia are seated singly, one in the axil of each leaf of the fertile region, or spreading outwards on its base. This marks off the Lycopodiales clearly from the sporangiophoric Pteridophytes on the one hand, and from the Filicales on the other. As in the former, however, the axis is dominant in the adult shoot, and forks equally or unequally. According to the position assumed by the stem the habit of living club mosses is upright or pendent; but frequently, as in the stag's horn moss common on Scottish hills, with its creeping stem rooted in the soil, and bearing upright fruiting branches (fig. 8, B).

The class is divided systematically according to the presence or absence of a ligule, which is a small scale-like body borne on the upper surface of each leaf, near its base. Those in which no ligule is present, the ELIGULATAE, include *Lycopodium* and *Phylloglossum,* together with certain early fossils designated *Lycopodites;* those which possess a ligule, the LIGULATAE, include *Selaginella* and *Isoetes,* and with these are associated the fossil Lepidodendraceae and Sigillariaceae. The distinction is accentuated by the fact that the former are all homosporous, the latter heterosporous.

A, Lycopodiales *Eligulatae.* Lycopodium comprises about 100 species of small plants of varied habit, creeping, shrubby or epiphytic. The construction of the shoot is uniformly microphyllous, the bifurcating stem dominating the conformation of the whole plant. The leaves are simple and small, and in some species uniform throughout the plant. In others the sterile leaves are larger than the membranous sporophylls, the latter being associated in definite strobili, or cones (fig. 8, B). The former probably represent the more primitive type. Each of the isolated sporangia is seated at the base of its sporophyll; it is large, and kidney-shaped, with a short massive stalk, and it dehisces like an oyster-shell, in a plane parallel to that of the leaf. The arrangement of the leaves is sometimes in regular whorls, but frequently it is according to some more or less interrupted spiral scheme. The plant is fixed at its base by roots which spring endogenously from the stem, and show bifurcation.

The stem of *Lycopodium* is seen in transverse section to be surrounded by a bulky and often indurated cortex, and traversed by a stele continued to the apical cone itself, while from each leaf a minute vascular strand passes to its periphery. In the young stem there is a solid woody core, surrounded by phloem and ill-defined sheaths. But in fully-grown stems the core may be invaded by tracts of phloem, moulding it into a cruciform or stellate transverse section, or even separating it into distinct radiating plates, or permeating it to form a sort of woody sponge.



FROM STRASBURGER, "LEHRBUCH DER BOTANIK" (GUSTAV FISCHER)

FIG. 9.—A CLUB-MOSS (SELAGINELLA)

The sporangia are massive from the first, and vary slightly in spread along the leaf-surface, a point of interest for comparison with the ligulate types. Each produces after the usual tetrad-division a large number of homosporous spores, which germinate slowly. The prothalli produced from them, and the embryology that follows, vary more than is usual in a single genus. The prothallus sometimes grows at soil-level and is green (L. *cernuum*); but often it is underground and wholly saprophytic (*L. clavatum,* fig. 8, D, A). Whatever its form, the sex-organs are massive and deeply sunk, and both are present on the same prothallus. The antheridia produce numerous biciliate spermatozoids; the archegonia vary in length of neck, and sometimes have numerous canal-cells. But the egg is deeply seated, and produces an embryo with a suspensor. This thrusts the embryo deep into the prothallus, where it often develops juvenile characters of importance for comparison. The most striking of these is the swollen "protocorm," a tuberous growth seen in Hornea, and present also in *Phylloglossum.* Bursting out from the prothallus the embryo develops shoot and root, the former in the underground types finding its way upwards to the soil-level (fig. 8, A).

B. Lycopodiales Ligulatae. Selaginella comprises some 500 species, widely spread through the tropics, some native on temperate hill stations. The latter, chiefly of exposed habit, have radial symmetry, but most *Selaginellas* are dorsiventral, and live under shade. The genus shares the leading features of *Lycopodium,* but it differs in the presence of a ligule, and in the fact that all the species are heterosporous. Various *Selaginellas* are favourite greenhouse plants, and the fan-like spread of the delicate branches with their dimorphic leaves is well known (fig. 9, B); also the strange rhizophores springing from points of branching of the shoot, which turning downwards give rise to the true roots, being themselves organs of indeterminate morphological nature. It will be unnecessary to describe the vegetative organs or their anatomy in detail; the chief comparative interest lies in the propagative process

The sporangia are borne on radially-constructed distal cones. A smgle sporangium similar to that of *Lycopodium,* is borne just above the insertion of each sporophyll, with the ligule protecting it from without. The microsporangia are brownish when ripe and the megasporangia pale in colour, and both may be borne on a single cone. They appear all alike up to the stage when the numerous spore-mother-cells are formed. If all the spore-mother-cells undergo tetrad-division numerous microspores resembling those of *Lycopodium* result. But in a rnegasporangium only one, or at most a few of them form tetrads, and the resulting spores are large with a rugged wall; the number matured in a single sporangium may vary from one to four, or sorne multiple of four. On germination each microspore produces a small number of spermatozoids from a very reduced prothallus; but the large megaspore forms a more bulky prothalius, which, projecting from the disrupted wall, bears archegonia. One of these on fertilization develops an embryo with a suspensor The essentials of the process are as in *Lycopodium,* though the details are different. As the sporeiing develops its leafy shoot grows upwards, and its root downwards; with the megaspore attached laterally the whole has the appearance of a seedling of some flowering plant (fig. g, A). This is clearly an advance upon *Lycopodium.*

The other genus *Isoetes* is peculiar in habit and in habitat, yet shares many of the characteristics of *Selaginella* It contains about 50 species of tufted herbs, mostly living at the bottom of fresh-water lakes, though a few are amphibious or terrestrial. The plant consists of a short massive lobed stock, bearing crowded awl-shaped leaves of considerable length. Each bears a ligule on its upper surface, and when fertile as any one of them may be, a large cake-like sporangium lies between this and the axis. Roots with dichotomous branching arise from furrows between its lobes. The sporangia are heterosporous, and propagation is essentially similar to that in *Selaginella;* but there is no suspensor, and the spermatozoids are multi-ciliate.

A chief interest in these Ligulate types lies in their comparison with the Lepidodendraceae and Sigillariaceae, for these are also ligulate and heterosporous (*see* PALAEOBOTANY). These fossils attained dendroid dimensions, and though the primary vascular system was not unlike that of the modern Lycopods, they often differed in having secondary growth with an active cambium. In *Isoetes* there is a sluggish secondary growth in the short stock, which itself shows certain analogies with the Stigmarian rrunks of the gigantic fossils. Since any of the leaves of *Isoetes* may be fertile the whole plant appears as a strobilus of the same nature as *Lepidostrobus,* seated upon a Stigmarian base. In fact *Isoetes* is like a telescoped, but still living, fossil.

VI. **Filicales.**—The Filicales may be held as comprising all the living Megaphyllous Pteridophytes, together with such fossils as show essentially similar characters. But the mere fact that their leaves are relatively large in proportion to the stem that bears them is not a sufficient diagnosis. Some Lycopods (*Isoetes, Sigillaria*) share this character, and megaphylly is possible in any of Pteridophytes. But as a matter of fact, excepting *Isoetes,* none such are now living other than the Filicales. The most distinctive feature of ferns, however, is that *on the relatively large leaves many sporangia are borne, either singly or in groups (sori).*

Ferns are represented at the present day by about 150 genera, and 6,000 species. Some are minute, others attain considerable size as tree ferns; but none can be reckoned among the largest of living plants, nor is there fossil evidence that ferns ever attained extreme dimensions. Their geographical spread is general; some few are arctic, but ferns increase in numbers both of species and of individuals towards the Equator. Most are mesothermal hygrophytes, *i.e.,* they flourish under moist conditions with a moderate temperature; and the majority are shade-loving. Hence their headquarters are in the mountains of the tropics, where they form a considerable part of the undergrowth below the forest canopy. But their habitat is variable; some specialized types are actually aquatic, while others are able to withstand conditions of moderate, some even of extreme drought. Ferns are much richer in genera, species and individuals than any other living Pteridophytes. They present the climax of successful development in homosporous vascular plants. They show also a high degree of variety both in their vegetative and their propagative characters; these provide good diagnostic features for their classification. They have a full and long palaeontological history that stretches back to Palaeozoic times. The geological record can therefore be used as a valid check upon the conclusions drawn from the comparison of living types.

It has been said that the Palaeozoic period was the age of ferns, and it is true that "fern-like" leaves were then common. But it has now been shown that many of these belonged to seed-plants ranked as Pteridosperms, a class long since extinct, which also had fern-like leaves (*see* PALAEOBOTANY). It is not improbable that they represent a stock more distinct from ferns than the similarity of their foliage would suggest, for they had advanced early to seed-formation. It may be left as an open question whether or not both may have had far back in their evolution some common origin.

The life-history already described at the opening of this article holds for ferns generally, so that the grouping and natural classification of the class must depend upon differences of detail other than the life-history itself. A general comparison of them led long ago to the recognition of eight main families, which may here be placed in the reverse order to that first given by Mettenius (1856):—

I. Ophioglossaceae.	V. Gleicheniaceae.
II. Marattiaceae.	VI. Hymenophyllaceae.
III. Osmundaceae.	VII. Cyatheaceae.
IV Schizaeaceae	VIII. Polypodiaceae.

This grouping in linear sequence places the more robust types first, and the more delicate last, while the rest take middle positions. The former have been styled by Von Goebel the *Eusporangiate ferns,* in which the sporangium is from the first a massive body, in the formation of which many cells co-operate; in the latter each sporangium arises from a single cell, and those ferns in which this is so were styled *Leptosporangiate.* Intermediate states exist, and these suggest that the whole series constitutes an evolutionary progression. If this be true the question arises which is the more primitive, and which the more advanced state? The importance of this question is enhanced by the fact that the sporangium is a mere index of a general difference of organization of the two contrasted types. In point of fact *the Eusporangiate ferns are relatively robust in their general constitution, while the Leptosporangiate are relatively delzcate.* Thus the question is whether there has been in the course of evolution a progression from a robust to a delicate state, or the reverse Since the Eusporangiate ferns find their correlatives in the fossils of Palaeozoic time and are relatively few to-day, while the specialized Leptosporangiate ferns are absent from the Palaeozoic rocks and comprise the bulk of living ferns, it is concluded that the general progression has been from a more robust ancestry towards a more delicate and precise constitution.

Having perceived this general scheme of progressive refinement, it cannot be assumed that the 150 genera, and 6,000 species have formed a simple sequence. In testing the question of their relationships it will become necessary to revise the methods in use by systematists, whose aims were primarily classification They worked as a rule upon few criteria of comparison, drawn almost exclusively from the sporophyte generation. A more exact comparison will be necessary not only as regards external form, but also of internal structure and development, both of the vegetative and the propagative organs, and it must be extended to both generations. The larger the number of the criteria used in comparison the more trustworthy will be the conclusions drawn from them. The criteria currently used in the comparison of ferns are these:

1. The external morphology of the shoot.
2. The initial constitution of the plant-body as indicated by segmentation.
3. The architecture and venation of the leaf.
4. The vascular system of the shoot.
5. The dermal appendages.
6. The position and structure of the sorus.
7. The indusial protections.
8. The characters of the sporangium, and the form and markings of the spores.
9. The spore-output.
10. The morphology of the prothallus.
11. The position and structure of the sexual organs.
12. The embryology of the sporophyte.

By the combined use of these criteria it has been possible to revise the natural groupings of ferns, sometimes amending but more often upholding the decisions of the earlier systematists. The main conclusions may be stated as follows: The *Eusporangiatae* include the living Ophioglossaceae, Marattiaceae and Osmundaceae, together with the fossil Coenopteridaceae *(see* PALAEOBOTANY). All these are Palaeozoic types, though they overlapped into the Mesozoic, and some representatives have even survived to the present day. With them are to be associated also the Schizaeaceae, Gleicheniaceae and Matoniaceae, all of which figured prominently in the Mesozoic, and are well represented among living ferns. In addition to many archaic features of the vegetative system they all possess relatively massive sporangia, which originate simultaneously, being produced either singly or in small numbers in the sori. They are collectively styled *Simplices.* Each sporangium has a relatively large spore-output.

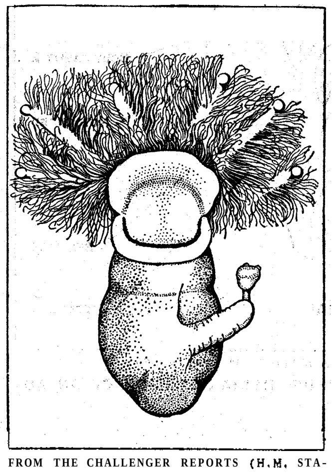
The Ophioglossaceae and Marattiaceae appear to have ended blindly and left no further derivatives. But derivative phyla may be traced by comparison from each of the Schizaeaceae, Osmundaceae, and Gleicheniaceae, while to the Matoniaceae so closely allied to the Dipterids, another phylum may be ascribed. The Schizaeaceae with their solitary marginal sporangia lead to the marginal Dicksoniaceae. The Osmundaceae have many features in common with *Plagiogyria,* while the superficial Gleicheniaceae link on to the Cyatheaceae, these being distinguished by their superficial sori from the marginal Dicksoniaceae. In both of these last-named families the sorus has become *"gradate," i.e.,* after the distal sporangia have been formed on the receptacle, a sequence of further sporangia follows *in basipetal sequence,* the effect of which is that the drain of nutrition is spread over a longer period of time. This may well have been a real factor in the success of these families.

A third state of the sorus, which has a like effect to the last, and may either be initiated independently or by transition from the gradate, is the *"mixed"* state, where sporangia of different ages are irregularly *interpolated between those already present.* This is the final condition seen in the evolution of the Leptosporangiate ferns, and is found in all the more advanced types.

From such intermediate stocks as those mentioned some *six derivative phyla of advanced Leptosporangiate ferns* may be distinguished, each centring round some well-known genus. Two of these comparison shows to have been derived from the Dicksoniaceae, viz., the Davallioid ferns centred round *Davallia,* and the Pteroids round *Pteris.* The Gymnogrammoid ferns are naturally grouped round *Gymnogramme,* and may probably be traced from the Osmundaceae, with *Plagiogyria* as a suggestive link. The Cyatheaceae probably gave rise on the other hand to the Blechnoid ferns, with *Blechnum* as a central type; and the Dryopteroids round *Dryopteris.* Lastly, a quite considerable number of genera may be traced as Dipteroid derivatives, from an ancestry suggested by *Matonia* and *Dipteris.* Thus at least six main evolutionary sequences of advanced Leptosporangiate ferns, with more or less pronouncedly "mixed" condition of their sori, may be referred in origin to types already distinct in Palaeozoic, or certainly in Mesozoic time. Each of these will have pursued its own phyletic advance independently of the others. Comparison reveals that most of them. or in some respects all, show parallel features of advance in form, vascular structure, soral characters, and sporangia, and particularly in the reduced spore-output from each sporangium. There is thus wide evidence of independent *homoplastic, and even convergent evolution* in the several phyla. In no respect is this clearer than in the distinctive feature of heterospory: for the Marsileaceae are referable in origin to a Schizaeoid source, while the Salviniaceae, whatever their actual relation, were of distinct origin from the Marsileaceae.

This brief abstract of the present position of the phyletic study of the Filicales can do no more than suggest how the matter stands to-day. Of all the Pteridophyta the ferns yield the most consecutive results. The living representatives of all the rest appear as isolated survivals, illuminated by fossil evidence, often as fragmentary and isolated as theirs. They raise as many evolutionary questions as they solve. It is only in the Filicales that it is possible, by placing together the evidence from palaeontology and that derived from the living flora, to reconstruct a story which, however incomplete, is sufficiently consecutive to serve as a basis for evolutionary opinion. The sum of it is for the ferns, as also for other Pteridophyta, that they have held their own to the present day as a class which has made the best of their amphibious existence by help of profuse production of homosporous spores. But from the point of view of descent, they have led on directly to no further type of land vegetation. The sources of this must be sought elsewhere.

BIBLIOGRAPHY.—J. Hooker and J. G. Baker, *Synopsis Filicum* (London, 1874), purely systematic; J. G. Baker, *Fern Allies* (London, 1887), purely systematic; Luerssen L. Rabenhorst, *Kryptogamen Flora,* vol. iii.; *Farnpflanzen* (Leipzig, 1889), a general treatise on European Pteridophytes; A. C. Seward, *Fossil Botany,* vol. i. (Cambridge, 1898); A. Engler and K. Prantl, *Natürl: Pflanzenfamilien* (Leipzig, 1892–1902), a general treatise, with copious references; F. O. Bower, *Origin of a Land Flora* (London, 1908), a general treatise; D. H. Campbell, *Mosses and Ferns* (1918), contains copious references; D. H. Scott, *Studies in Fossil Botany,* vol. i. (London, 1920); R. Kidston and W. H. Lang. "Old Red Sandstone Plants from the Rhynie Chert," *Trans. Roy. Soc. Edin.* (1917–1921); *F.* O. Bower, *Ferns,* vols. i.–iii. (Cambridge, 1923–28); D. H. Scott, *Extinct Plants and Problems* of *Evolution* (London, 1924); C. E. Von Goebel, *Organographie, Zweite Aufl.* (1913–24); *A.* J. Eames. *Morphology of Vascular Plants, Lower Groups* (New York, 1936). (F. O. B.; X.)

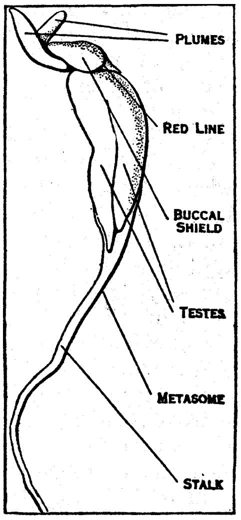


FROM THE CHALLENGER REPORTS (H.M. STATIONERY OFFICE)

FIG. 1A.—CEPHALODISCUS DODECALOPHUS AN ILLUSTRATION OF A FEMALE AS SEEN FROM IN FRONT. (AFTER McINTOSH)

PTEROBRANCHIA. The most strikingly novel discovery of the "Challenger" Expedition was a mysterious animal, dredged from 245 fathoms in the Straits of Magellan. It was described as *Cephalodiscus dodecalophus,* in 1882, and was at first placed in the Polyzoa. In 1903 it was announced that *Cephalodiscus* had been found by the Swedish Antarctic Expedition, from the original locality southwards to the Antarctic sea; and that it had been discovered off Borneo (near low-water mark), Celebes and Korea It was later recorded from new Antarctic or Sub-Antarctic localities, and off New Zealand, South Africa and Ceylon. Forgotten specimens were found in the British Museum from Kerguelen ("Challenger") and from the Antarctic (probably the Ross Expedition, 1839–1843). The study of the anatomy of this surprising animal revealed the unexpected fact that its affinities are with *Balanoglossus* (*q.v.*).

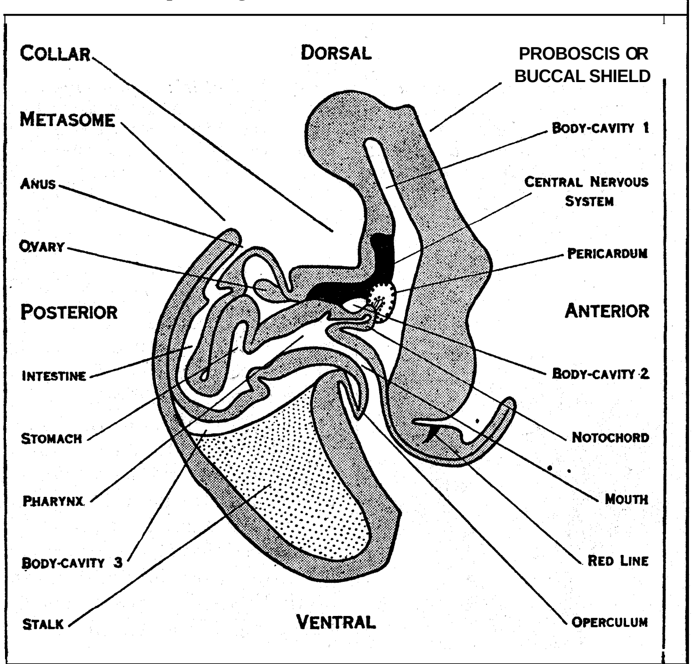
A colony of Cephalodiscus inhabits an orange, gelatinous dwelling (coenoecium), from a foot to half an inch long. The branches, from two inches to one tenth of an inch across, are composed of numerous laminae, including Foraminifera or other bodies, sometimes so numerous as to mask the gelatinous walls. The animals occur in large numbers, and are from 7 to 1mm. in length, without the stalk, which is very extensible. They can wander on the surface of their dwelling, the lower end of the stalk remaining attached to the wall of the tube, to facilitate retraction.



FROM S. F. HARMER, "MONOGRAPH ON THE SIBOGA EXPEDC TION" (MAX WEBER)

FIG. 1B.—A MALE (SIDE VIEW)

The body consists of the three regions characteristic of *Balanoglossus:*—(1) the "proboscis" or "buccal shield" (fig. 2), used as a crawling organ. A crescentic red line, near its lower edge, is distinctive of the genus; (2) the "collar," its front edge produced above into 3–9 pairs of plumes, each with two series of tentacles, and at the sides and below into a large "operculum"; (3) the third segment or "metasome," with the stalk. Each segment has its own body-cavity, unpaired in the proboscis, paired in the other two segments (figs. 2, 3). The first body-cavity opens externally by two "proboscis-pores," on the buccal shield, near its junction with the collar. The second cavities extend into the operculum and the plumes, each opening by a "collar-canal," immediately behind which is a "gill-slit," leading from the pharynx to the exterior (fig. 3). From the upper wall of the pharynx a "notochord" projects into the proboscis-cavity, where there is a "pericardium," corresponding with that of *Balanoglossus.* The central nervous system is in the dorsal region of the collar and of part of the proboscis.



FROM S. P. HARMER, "MONOGRAPH ON THE SIBOGA EXPEDITION" (MAX WEBER)

FIG. 2.— CEPHALODISCUS DODECALOPHUS, MEDIAN SECTION OF AN ADVANCED FEMALE BUD

The third body-cavities contain the alimentary canal and reproductive organs. The anus is on the upper side, the mouth being below, between the proboscis and the operculum. The young alimentary canal (fig. 2) is shortly U-shaped, but in the adult the U is much longer, passing ventrally down the body, the long axis of which is dorso-ventral. The two ovaries or testes open dorsally, in front of the anus, and the oviducts (at first mistaken for eyes) are highly pigmented. The eggs have much yolk, and development commences in the tubes. In certain species the colonies are either male or female, while in others both sexes occur, and an animal may have an ovary on one side and a testis on the other. The males resemble the females except in C. *sibogae* (fig. 1, B), in which they occur with neuter individuals without functional reproductive organs. These males have a single pair of plumes, with no tentacles, the alimentary canal is vestigial and the operculum has been lost. The three segments, their body-cavities, the collar-canals and the central nervous system are normal, but the third segment is mainly occupied by the two testes. The males are probably nourished by vascular connection with the neuters; and blood-vessels have been observed in this and other species. The buds, often in considerable number, remain connected by their stalks with the parent stalk until a late stage, but ultimately become free.

The species of Cephalodiscus are most easily recognized by the form of their coenoecium. The number of plumes is not always quite constant. but is a useful character. About 13 species are known, referable to three sub-genera: — Demiothecia, with a single cavity extending throughout the colony; and *Idiothecia* and *Orthoeczis*, in which each animal, with its system of buds, occupies a separate tube, nearly always isolated from its neighbours. The coenoecium is branched in *Idiothecia,* discoidal or plano-convex in Orthoecus. Rhabdopleura, the only other Pterobranch, resembles *Cephalodiscus* in form and structure, but is almost microscopic. It was first described from Norwegian and British seas (in rather deep water), but it occurs from Greenland to the Antarctic sea, including the Azores, the Malay archipelago, Ceylon, New Zealand, Australia and Tristan da Cunha. Several species have been described, but it is not at all certain how many are valid.

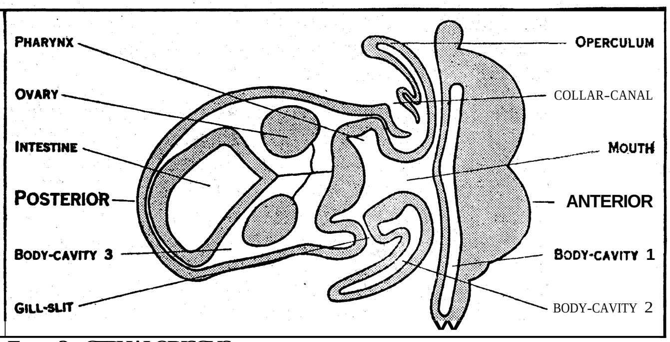


FIG. 3.—CEPHALODISCUS DODECALOPHUS, LONGITUDINAL (FRONTAL) SECTION OF THE FEMALE. SHOWING THE LEFT COLLAR-CANAL AND THE RIGHT GILL-SLIT (AFTER HARMER)

Rhabdopleura has no doubt been simplified, in correlation with its reduction in size. There is only one pair of plumes and gill-slits are not present. In most other respects it agrees with *Cephalodiscus*, to which it is clearly allied. The elongated, cylindrical tubes are about 2–3mm. long and a quarter of a millimetre in diameter. Each arises vertically from a tube closely attached to a solid object; and all the tubes are composed of laminae, which form distinct rings in the erect parts. The budded individuals do not become free, their stalks remaining connected by a cord. Its jet-black colour, in the adherent part, and the ringed tubes are features easily recognized.

BIBLIOGRAPHY.—(A) *Cephalodiscus:* W. C. McIntosh, and S. F. Harmer, Challenger *Rep.* xx., pt. lxii. (1887); S. F. Harmer, "Pterobranchia," Monogr. xxvi. *bis, Siboga* Rep. (Leyden, 1905); W. G. Ridewood, Brit. Antarct. ("Terra *Nova*") *Exp. 1910,* Zool. iv. pt. 2, 11 (History and list of known specimens) (1918); W. G. Ridewood, Ann. Mag. *Nat. Hist.* (9) v. 407 (key to species) (1920); (B) Rhabdopleura: A. Schepotieff, *Zool.* Jahrb. Abt. *Anat.* xxiii. 463; xxiv. 193 (Jena, 1906, 1907). (S. **F. H.**)

PTEROCLIDAE: see SAND-GROUSE.

PTERODACTYL, a term familiarly used for any member of the order Pterosauria, or winged reptiles. The pterodactyls are extinct flying reptiles found in rocks of all ages from the Lower Lias or perhaps the Rhaetic to the Upper Cretaceous. They fall into two great groups distinguished from one another by the presence of a long tail with a horizontal fin at its tip, in the one, and the lack of a tail in the other.

The best known form is *Rhamphorynchus* from the Solenhofen slate of Bavaria and probably the Kimmeridge clay of England. *Rhamphorynchus* has a head about $3\frac{1}{2}$ in. long, with a mouth opening very widely and armed with long, slender, sharp-pointed teeth. The eye, which is placed above the articulation of the lower jaw, is very large, and like that of many birds has a series of bony plates lying in its wall. The paired nostrils lie far back in front of the eyes. The neck, which is some 2 in. long, was flexible, and the head was carried at right angles to the neck. The body is small, about 4 in. in length by $1\frac{1}{4}$ in. in diameter. The tail is enormously long (15 in.) and although built of many joints, is stiffened by ossified tendons so that it must have moved as a whole. The wings are stretched membranes made by folds of skin held out by

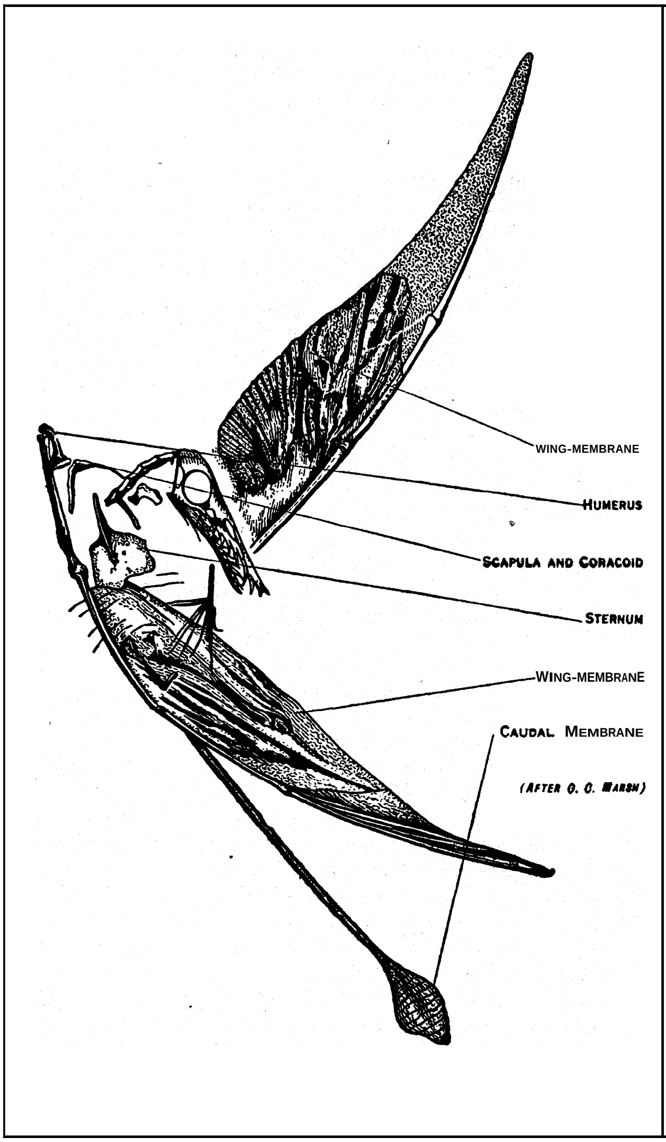


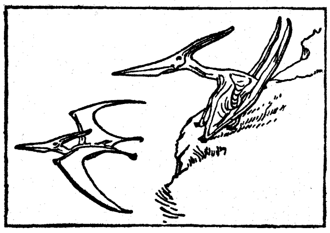
FIG. 1.—RHAMPHORHYNCHUS PHYLLURUS. FROM THE SOLENHOFEN LITHOGRAPHIC STONE, WITH THE GREATER PART OF THE WING MEMBRANE PRESERVED

the greatly elongated fore-limb, and especially by the enormously extended fourth finger, the width across the wings when fully spread is some 25 inches. The bony finger lies practically at the forward edge of the wing, the membrane which forms the rest of the structure being only some 2 in. from front to back, and passing backwards along the side of the body to the hind leg. The extremity of the tail bears a horizontal flap of membrane. The three first fingers of the hand are free and provided with large claws; they stand out in front of the wings and must have been used for holding food or for help in landing. The knees included in the wing membrane stand straight out from the side of the body, the lower leg is long and there are five slender toes, the first being always curiously bent inwards and downwards. The other four toes seem to have been connected by a web.

Rhamphorynchus was covered with a smooth skin usually without scales, but the top of the head bore a tuft of hair-like protuberances. The animal appears to have lived like a sea-gull on fish, and it is exceedingly difficult to understand how it could ever have risen from land or water after alighting.

FROM E. STRONER, "RECKONSTRUKTIONEN DES FLUGSAURIERS RHAMPHORHYNCHUS GEMMINGI" (SCHWEIZERBART, STUTTGART)
FIG. 2.— RECONSTRUCTION OF THE SKELETON AND WING MEMBRANE OF A PTERODACTYL, RHAMPHORYNCHUS, SEEN FROM BELOW

The group of tail-less pterodactyls is best represented by *Pteranodon* from the Kansas chalk. This creature had a wing-spread of 18 ft. and its head (measured from the tip of the snout to the summit of a great crest which rises from the occiput) is nearly 4 ft. in length. It was perhaps the largest flying animal of which we have any knowledge. Despite its great size it was extremely light, the wing-bones consisting of a bony layer no thicker than a visiting card, surrounding an air space which might be more than an inch in diameter; even the bone of an albatross is a crude and heavy structure in comparison. The remains of these giant animals are found in the Kansas and English chalk sufficiently commonly to show that they flew at a distance of some hundreds of miles from land. The brain of these large pterodactyls is extraordinarily like that of a bird, and its characters are such as to suggest that they practically lacked a sense of smell and depended on sight for the capture of their food.



FROM G. H. SHORT, "WING ADJUSTMENTS OF PTERODACTYLS" (ROYAL AERONAUTICAL SOCIETY)
FIG. 3.—PTERANODON GLIDING, AND ABOUT TO COMMENCE A FLIGHT

See REPTILES. (D.M.S.W.)

PTEROMA, in architecture, the colonnade at the side of a classic temple.

PTERON, in architecture, a term used by Pliny the Elder for the peristyle or colonnade of the tomb of Mausolos; loosely and rarely used for any surrounding colonnade or peristyle.

PTOLEMAEUS, of Alexandria, surnamed Chennus, Greek grammarian during the reigns of Trajan and Hadrian. According to Suïdas, he mas the author of an historical drama named *Sphinx*, of an epic, *Anthomeros*, in 24 books (both lost) and a *Strange History*. The last is probably identical with the work of which an abridgment has been preserved in Photius (*cod.* 190).

See editions of Photius's abridgment by J. Roulez (1834); and in A. Westermann, *Mythographi graeci* (1843); R. Hercher, *Über die Glaubwürdigkeit der neuen Geschichte des Ptolemaus Ckennus* (Leipzig, 1856); J. E. Sandys, *Hist. of Classical Scholarship* (2nd ed., 1906).

PTOLEMAIS, an ancient city on the coast of Cyrenaica, 70 m. N.E. of Bengasi, and 28 m. N.E. of Teuchira (Tocra). Its modern name is Tolmeita or Tolmetta. Of the city walls nothing is preserved, excepting a massive gate on the west, with two towers, at the end of the road from Barce (mod. El Merg). At the further extremity of the town is a fine Roman bridge. Little of the town remains but some very large cisterns.

See *Ministero delle Colonie, Notiziario Archeologico,* i. 114–154 (1915).

PTOLEMIES, a dynasty of Macedonian kings who ruled in Egypt from 323 to 30 B.C.

PTOLEMY I. (Πτολεμαῖος), the founder, son of Lagus, a Macedonian nobleman of Eordaea, was one of Alexander the Great's most trusted generals, and among the seven "body-guards" attached to his person. He plays a principal part in the later campaigns of Alexander in Afghanistan and India. At the Susa marriage festival in 324 Alexander caused him to marry the Persian princess Artacama; but there is no further mention of this Asiatic bride in the history of Ptolemy. When Alexander died in 323 the resettlement of the empire at Babylon is said to have been made at Ptolemy's instigation. At any rate he was now appointed satrap of Egypt under the nominal kings Philip Arrhidaeus and the young Alexander. He at once took a high hand in the province by killing Cleomenes, the financial controller appointed by Alexander the Great; he also subjugated Cyrenaïca. He contrived to get possession of Alexander's body which was to be interred with great pomp by the imperial government and placed it temporarily in Memphis. This act led to an open rupture between Ptolemy and the imperial regent Perdiccas. But Perdiccas perished in the attempt to invade Egypt (321). In the long wars between the different Macedonian chiefs which followed, Ptolemy's first object was to hold his position in Egypt securely, and secondly to possess the Cyrenaïca, Cyprus and Palestine (Coele-Syria). His first occupation of Palestine was in 318, and he established at the same time a protectorate over the petty kings of Cyprus. When Antigonus, master of Asia in 315, showed dangerous ambitions, Ptolemy joined the coalition against him, and, on the outbreak of war, evacuated Palestine. In Cyprus he fought the partisans of Antigonus and reconquered the island (313). A revolt of Cyrene was crushed in the same year. In 312 Ptolemy, with Seleucus, the fugitive satrap of Babylonia, invaded Palestine and beat Demetrius, the son of Antigonus, in the great battle of Gaza. Again he occupied Palestine, and again a few months later, after Demetrius had won a battle over his general and Antigonus entered Syria in force, he evacuated it.

In 311 a peace was concluded between the combatants, soon after which the surviving king Alexander was murdered in Macedonia, leaving the satrap of Egypt absolutely his own master. The peace did not last long, and in 309 Ptolemy commanded a fleet in person which detached the coast towns of Lycia and Caria from Antigonus and crossed to Greece, where Ptolemy took possession of Corinth, Sicyon and Megara (308). In 306 a great fleet under Demetrius attacked Cyprus, and Ptolemy's brother, Menelaus, was defeated and captured in the decisive battle of Salamis. The complete loss of Cyprus followed. Antigonus and Demetrius now assumed the title of kings; Ptolemy, as well as Cassander, Lysimachus and Seleucus, answered this challenge by doing the same. In the winter (306–5) Antigonus tried to follow up the victory of Cyprus by invading Egypt, but here Ptolemy was strong, and held the frontier successfully against him. Ptolemy led no further expedition against Antigonus overseas. To the Rhodians, besieged by Demetrius (305–4), he sent such help as won him divine honours in Rhodes and the surname of Soter ("saviour"). When the coalition was renewed against Antigonus in 302, Ptolemy joined it, and invaded Palestine a third time, whilst Antigonus was engaged with Lysimachus in Asia Minor. On a report that Antigonus had won a decisive victory, for a third time he evacuated the cduntry. But when news came that Antigonus had been defeated and slain at Ipsus (301) by Lysimachus and Seleucus, Ptolemy occupied Palestine for the fourth time. The other members of the coalition had assigned Palestine to Seleucus after what they regarded as Ptolemy's desertion, and for the next hundred years the question of its ownership becomes the standing ground of enmity between the Seleucid and Ptolemaïc dynasties. Henceforth, Ptolemy seems to have mingled as little as possible in the broils of Asia Minor and Greece; his possessions in Greece he did not retain, but Cyprus he reconquered in 295–4. Cyrene, after a series of rebellions, was finally subjugated about 300 and placed under his stepson Magas (Beloch, Griech. Gesch. III. [ii.], p. 134 seq.).

In 285 he abdicated in favour of one of his younger sons by Berenice (*q.v.*), who bore his father's name of Ptolemy; his eldest (legitimate) son, Ptolemy Ceraunus, whose mother, Eurydice, the daughter of Antipater, had been repudiated, fled to the court of Lysimachus. Ptolemy I. Soter died in 283 at the age of 84. Shrewd and cautious, he had a compact and well-ordered realm to show at the end of fifty years of wars. His name for bonhomie and liberality attached the floating soldier-class of Macedonians and Greeks to his service. Nor did he neglect conciliation of the natives. He was a ready patron of letters, and the great library, which was Alexandria's glory, owed to him its inception. He wrote himself a history of Alexander's campaigns, distinguished by its straightforward honesty and sobriety.

PTOLEMY II. PHILADELPHUS (309–246) was of a delicate constitution, no Macedonian warrior-chief of the old style. His brother Ptolemy Ceraunus found compensation by becoming king in Macedonia in 281, and perished in the Gallic invasion of 280–79. (See BRENNUS.) Ptolemy II. maintained a splendid court in Alexandria. Not that Egypt held aloof from wars. Magas of Cyrene opened war on his half-brother (274), and Antiochus I., the son of Seleucus, desiring Palestine, attacked soon after. Two or three years of war left Egypt the dominant naval power of the eastern Mediterranean; the Ptolemaïc sphere of power extended over the Cyclades to Samothrace, and the harbours and coast towns of Cilicia Trachea ("Rough Cilicia"), Pamphylia, Lycia and Caria were largely in Ptolemy's hands (Theoc. Idyll. xvii. 86 seq.). The victory won by Antigonus, king of Macedonia, over his fleet at Cos (between 258–56; see Beloch, III. [ii.], p. 428 seq.) did not long interrupt his command of the Aegean. In a second war with the Seleucid kingdom, under Antiochus II. (after 260), Ptolemy sustained losses on the seaboard of Asia Minor and agreed to a peace by which Antiochus married his daughter Berenice (250?). Ptolemy's first wife, Arsinoe (I.), daughter of Lysimachus, was the mother of his legitimate children. After her repudiation he married, probably for political reasons, his full-sister Arsinoe (II.), the widow of Lysimachus, by an Egyptian custom abhorrent to Greek morality. The material and literary splendour of the Alexandrian court was at its height under Ptolemy II. Pomps and gay religions flourished. Ptolemy deified his parents as the θεοὶ ἀδελθοί and his sister-wife, after her death (270), as *Philadelphus*. This surname was used in later generations to distinguish Ptolemy II. himself, but properly it belongs to Arsinoe only, not to the king. Callimachus, made keeper of the library, Theocritus, and a host of lesser poets, glorified the Ptolemaïc family. Ptolemy himself was eager to increase the library and to patronize scientific research. He had the strange beasts of far-off lands sent to Alexandria. But, an enthusiast for Hellenic culture, he seems to have shown but little interest in the native religion. The tradition which connects the Septuagint translation of the Old Testament into Greek with his name is not historical. Ptolemy had many brilliant mistresses, and his court, magnificent and dissolute, intellectual and artificial, has been justly compared with the Versailles of Louis XIV.

PTOLEMY III. EUERGETES I. (reigned 246–221), son of Ptolemy II. and Arsinoe I. At the beginning of his reign he reunited the Cyrenaïca to Egypt by marrying Berenice the daughter and successor of Magas (who had died about 250). At the same time he was obliged to open war on the Seleucid kingdom, where Antiochus II. was dead and his sister Berenice had been murdered, together with her infant son, by Antiochus's former wife, Laodice, who claimed the kingdom for her son Seleucus II. Ptolemy marched triumphantly into the heart of the Seleucid realm, as far at any rate as Babylonia, and received the formal submission of the provinces of Iran, while his fleets in the Aegean recovered what his father had lost upon the seaboard, and made fresh conquests as far as Thrace. This moment marks the zenith of the Ptolemaïc power. After Ptolemy returned home, indeed, Seleucus regained northern Syria and the eastern provinces, but the naval predominance of Egypt in the Aegean remained, although there are traces of its being replaced locally, towards the end of Euergetes' reign, by that of Macedonia—in Amorgos, Naxos, Syros, Nisyros, Cos and parts of Crete. (See Beloch, III. [ii.], p. 463.) After his final peace with Seleucus, Ptolemy no longer engaged actively in war.,

PTOLEMY IV. PHILOPATOR (reigned 221–204), son of the preceding, was a wretched debauchee under whom the decline of the Ptolemaïc kingdom began. His reign was inaugurated by the murder of his mother, and he was always under the dominion of *favourites, male and female, who indulged his vices and conducted the government as they pleased. Self-interest led his ministers to make serious preparations to meet the attacks of Antiochus* III. *(the Great) on Palestine, and the great Egyptian victory of Raphia* (217), at *which Ptolemy himself was present, secured the province till the next reign. The arming of Egyptians in this campaign had a disturbing effect upon the native population of Egypt, so that rebellions were continuous for the next thirty years. Philopator was devoted to orgiastic forms of religion and literary dilettantism. He built a temple to Homer and composed a tragedy, to which his vile favourite Agathocles added a commentary. He married (about* 215) *his sister Arsinoe (III.), but continued to be ruled by his mistress Agathoclea, sister of* Agathocles.

PTOLEMY *V.* EPIPHANES *(reigned* 204–181), *son of Philopator and Arsinoe, was not more than five years old when he came to the throne, and under a series of regents the* kingdom *was paralysed. Antiochus* III. *and Philip V. of Macedonia made a compact to divide the Ptolemai'c possessions overseas. Philip seized several islands and places in Caria and Thrace, whilst the battle of* Panium (198) *definitely* transferred *Palestine frurn* the *Ptolemies to the Seleucids. Antiochus after this concluded peace, giving his own daughter Cleopatra to Epiphanes to wife* (193–192). *Nevertheless, when war broke out between Antiochus and Rome Egypt ranged itself with the latter power. Epiphanes in manhood was chiefly remarkable as a passionate sportsman; he excelled in athletic exercises and the chase.*

PTOLEMY *VI.* PHILOMETOR (181–145), *the elder of his two sons, succeeded as an infant under the regency of his mother Cleopatra. Her death was followed by a rupture between the Ptolemai'c and Seleucid courts, on the old question of Palestine. Antiochus IV. Epiphanes invaded Egypt* (170) *and captured Philometor.*

The Alexandrians then put his younger brother PTOLEMY *VII.* EUERGETES II. *(afterwards nicknamed Physkon, on account of his bloated appearance) upon the throne. Antiochus professed to support Philometor, but, when he withdrew, the brothers agreed to be joint-kings with their sister Cleopatra as queen and wife of Philometor. Antiochus again invaded Egypt* (168), *but was compelled by the Roman intervention to retire. The double kingship led to quarrels between the two brothers in which fresh appeals were* continually *made to Rome. In 163 the Cyrenai'ca was assigned under Roman arbitration to Euergetes as a separate kingdom. As he coveted Cyprus as well, the feud still went on, Rome continuing to interfere diplomatically but not effectively. In* 154 *Euergetes invaded Cyprus but was defeated and captured by Philometor. He found his brother, however, willing to pardon and was allowed to return as king to Cyrene. In* 152 *Philometor joined the coalition against the Seleucid king Demetrius I. and was the main agent in his destruction. The* protégé *of the coalition, Alexander* Balas, *married Philometor's daughter Cleopatra (Thea), and reigned in Syria in practical subservience to him. But in* 147 *Philometor broke with him and transferred his support, together with the person of Cleopatra, to Demetrius II., the young son of Demetrius I. He himself at Antioch was entreated by the people to assume the Seleucid diadem, but he declined and installed Demetrius as king. In 145 in the battle on the* Oenoparas *near Antioch, in which Alexander Balas was finally defeated, Philometor received a mortal wound. Philometor was perhaps the best of the Ptolemies. Kindly* and *reasonable, his good nature seems sometimes to have verged on indolence, but he at any rate took personal part, and that bravely and successfully, in war. Philometor's infant son, Ptolemy Philopator Neos (?)*[1]*, was proclaimed king in Alexandria under the regency of his mother Cleopatra. Euergetes however, swooping from Cyrene, seized the throne and married Cleopatra, making away with his nephew. He has left an odious picture of himself in the historians—a man untouched by benefits or natural affection, delighting in deeds of blood, his body as loathsome in its blown corpulence as his soul. Something must be allowed for the rhetorical habit of our authorities, but that Euergetes was ready enough to shed blood when policy required seems true. He soon found a more agreeable wife than Cleopatra in her daughter Cleopatra, and thenceforth antagonism between the two queens, the "sister" and the "wife," was chronic. In* 130–1 *Cleopatra succeeded in driving Euergetes for a time to Cyprus, when he revenged himself by murdering the son whom she had borne him (surnamed Memphites). Massacres inflicted upon the Alexandrians and the expulsion of the representatives of Hellenic culture are laid to his charge. On the other hand, the monument and papyri show him a liberal patron of the native religion and a considerable administrator. In fact, while hated by the Greeks, he seems to have had the steady support of the native population. But there are also records which show him, not as an enemy, but a friend, like his ancestors, to Greek culture. He himself published the fruit of his studies and travels in a voluminous collection of notebooks, in which he showed a lively eye for the oddities of his fellow kings. The old Ptolemai'c realm was never again a unity after the death of Euergetes* II. *By his will he left the* Cyrenaïca *as a* separate *kingdom to his illegitimate son Ptolemy Apion* (116–96), *whilst Egypt and Cyprus were bequeathed to Cleopatra (Kokke) and whichever of his two sons by her,* PTOLEMY *VIII. Soter* II. *(nicknamed Lathyros) and* PTOLEMY *IX. Alexander I., she might choose as her associate. The result was, of course, a long period of domestic strife. From 116 to* 108 *Soter reigned with his mother, and at enmity with her, in Egypt, whilst her favourite son, Alexander, ruled Cyprus. Cleopatra compelled Soter to divorce his sister-wife Cleopatra and marry another sister, Selene. Cleopatra plunged into the broils of the Seleucid house in Syria and perished. In* 108 *Cleopatra Kokke called Alexander to Egypt, and Soter flying to Cyprus took his brother's place and held the island against his mother's forces. The attempts which Soter and Cleopatra respectively made in* 104–3 *to obtain a predominance in Palestine came to nothing. Alexander now shook off his mother's yoke and married Soter's daughter Berenice. Cleopatra Kokke died in* 101 *and from then till 89 Alexander reigned alone in Egypt. In 89 he was expelled by a popular uprising and perished the following year in a sea-fight with the Alexandrian ships off Cyprus. Soter was recalled (88) and reigned over Egypt and Cyprus, now reunited, in association with his daughter Berenice. This, his second, reign in Egypt* (88–80), *was marked by a native rebellion which issued in the destruction of Thebes.*

PTOLEMY *X.* ALEXANDER II.—*On his death* Berenice *assumed the government, but the son of Alexander I., Ptolemy X., entering Alexandria under Roman patronage, married, and within* 20 *days assassinated, his elderly cousin and stepmother. He was at once killed by the enraged people and with him the Ptolemai'c family in the legitimate male line became extinct. Ptolemy Apion meanwhile, dying in 96, had bequeathed the Cyrenai'ca to Rome.*

The Alexandrian people now chose an illegitimate son of Soter II. *to be their* king, PTOLEMY *XI. Philopator Philadelphus Neos Dionysus* (80–51), *nicknamed Auletes, the flute-player, setting his brother as king in Cyprus. The rights of these kings were doubtful, not only because of their illegitimate birth, but because it was claimed in Rome that Alexander* II. *had bequeathed his kingdom to the Roman people. Two Seleucid princes, children of Soter's sister Selene, appeared in Rome in 73 to urge their claim to the Ptolemai'c throne. Ptolemy Auletes was thus obliged to spend his reign in buying the support of the men in power in Rome. Cyprus was annexed by Rome in* 58, *its king committing suicide. From 58 to* 55 *Auletes was in exile, driven out by popular hatred, and* worked *by bribery and murder in Rome to get himself restored to Roman power. His daughter* Berenice *meanwhile reigned in Alexandria, a husband being found for her in the Pontic prince Archelaus. In 55 Auletes was restored by the proconsul of Syria, Aulus Gabinius. He killed* Berenice *and, dying in* 51, *bequeathed the kingdom to his eldest son, aged ten years, who was to take as wife his sister Cleopatra, aged seventeen.*

In the reign of PTOLEMY *XII. Philopator* (51–47) *and* Cleo*patra Philopator, Egyptian history coalesces with the general*

[1]Or according *to another* view, Eupator. *On the obscure questions* raised *by* these two *surnames. see* L. Pareti, ***Ricerche sui*** *Tolemei Eupatore e* ***Neo Filopatore*** *(Turin,*1908).

history of the Roman world, owing to the murder of Pompey off Pelusium in 48 and the Alexandrine War of Julius Caesar (48–47).

In that war the young king perished and a still younger brother, PTOLEMY XIII. Philopator, was associated with Cleopatra till 44, when he died, probably by Cleopatra's contriving. From then till her death in 30, her son, born in 47, and asserted by Cleopatra to be the child of Julius Caesar, was associated officially with her as PTOLEMY XIV. Philopator Philometor Caesar; he was known popularly as Caesarion. (For the incidents of Cleopatra's reign see CLEOPATRA, ARSINOË.) After her death in 30 and Caesarion's murder Egypt was made a Roman province. Cleopatra's daughter by Antony (Cleopatra Selene) was married in 25 to Juba II. of Mauretania. Their son Ptolemy, who succeeded his father (A.D. 23–40), left no issue[1].

See Mahaffy, *The Empire of the Ptolemies* (1895) and *Egypt under the Ptolemaïc Dynasty* (1899); Strack, *Die Dynastie der Ptolemäer* (1897); Bouché-Leclercq, *Histoire des Lagides* (1904, 1907); Meyer, *Das Heerwesen der Ptolemäer und Römer* (Leipzig, 1900).

(E. R. B.)

PTOLEMY (CLAUDIUS PTOLEMAEUS), of Alexandria, the celebrated mathematician, astronomer and geographer, was, according to the Byzantine Theodorus Meliteniota (*c.* 1361), born at Ptolemais Hermii, a Grecian city of the Thebaid. All that is known for certain about him is that he observed at Alexandria during the reigns of Hadrian and Antoninus Pius, between the years A.D. 127 and 141 or 151. Olympiodorus, a philosopher of the Neoplatonic school, who lived in the reign of the emperor Justinian, relates in his scholia on the *Phaedo* of Plato that Ptolemy devoted his life to astronomy and lived for 40 years in the so-called Πτερὰ τοῦ Κανώβου, probably elevated terraces of the temple of Serapis at Canopus, near Alexandria, where they raised pillars with the results of his astronomical discoveries engraved upon them. Arabian traditions say that Ptolemy lived to the age of 78 years, and give some details about his personal appearance, to which too much weight must not be attached.

His Work as a Mathematician.—Ptolemy's work as a geographer is discussed below, and an account of the discoveries in astronomy of Hipparchus and Ptolemy is given in the article ASTRONOMY: History. Their contributions to pure mathematics, however, require to be noticed here. Of these the chief is the foundation of trigonometry, plane and spherical, including the formation of a table of chords, which served the same purpose as our table of sines. This branch of mathematics was created by Hipparchus for the use of astronomers, and its exposition was given by Ptolemy in a form so perfect that for 1,400 years it was not surpassed. The doctrine as to the motion of the heavenly bodies known as the Ptolemaic system, was paramount for about the same period of time. The astronomical and trigonometrical systems are contained in the great work of Ptolemy, Ἡ μαθηματικὴ σύνταξις or The Mathematical Collection. Later it came to be known as the μεγάλη σύνταξις or alternatively as Ὁ μέγας ἀστρονόμος, the Great Astronomer, to distinguish it from another collection called Ὁ μικρὸς ἀστρονόμος or ἀστρονομούμενος, the Little Astronomer, comprising some works of Autolycus, Euclid, Aristarchus, Theodosius, Hypsicles and Menelaus. To designate the great work of Ptolemy, the Arabs used the superlative μεγίστη from which, the article *al* being prefixed, the hybrid name *Almagest*, by which it has ever since been known, is derived.

We proceed now to consider the trigonometrical work of Hipparchus and Ptolemy. In the ninth and tenth chapters of the first book of the Almagest Ptolemy shows how to form a table of chords. He supposes the circumference divided into 360 equal parts (τμήματα or degrees). Further, he divides the diameter into 120 equal parts. Then, for the subdivision both of the degrees and of the parts of the diameter, he uses sexagesimal fractions or, as we say, "minutes," "seconds," etc. It must not be supposed, however, that these sexagesimal divisions are due to Ptolemy; Babylonian in origin, they must already have been used by Hipparchus. Nor did the formation of the table of chords originate with Ptolemy; indeed, we know that Hipparchus wrote a treatise in 12 books on straight lines (chords) in a circle, while Menelaus (c. A.D. 100) wrote another in six books. Ptolemy shows how the calculation of chords is based on a few simple theorems in geometry (including the well-known "Ptolemy's theorem" relating to a quadrilateral inscribed in a circle), and these he gives in a form which for conciseness and elegance could not be surpassed; Hipparchus' method was no doubt the same, though his exposition would run to greater length.

As starting-point the values of certain chords in terms of the diameter were already known, or could be easily found by means of the Elements of Euclid. Thus the side of the hexagon, or the chord of 60°, is equal to the radius, and therefore contains 60 parts. The sides of the regular pentagon and decagon inscribed in a circle, which are the chords subtending arcs of 72" and 36" respectively, are found by means of propositions in Euclid's Book xiii.; expressed in terms of the "parts" of the diameter, they are found to be (nearly) $70^p\ 32'\ 3''$ and $37^p\ 4'\ 55''$ respectively. (It should be noted that the ratio of the chord subtending any angle to the diameter of the circle is the same as the ratio of half the chord to the radius; hence, expressed on this system, the chord of any angle is equivalent to the trigonometrical sine of half the angle.)

Now "Ptolemy's Theorem" enables us to deduce from the chords of two angles the chord of their sum or difference; the theorem is equivalent to the formulae $\mathrm{Sin}(A+B)=\mathrm{Sin}A\ \mathrm{Cos}\ B+\mathrm{Cos}\ A\mathrm{Sin}B$. Another proposition which Ptolemy gives, shows how to deduce from the chord of any angle the chord of half the angle; it is equivalent to the formula $\mathrm{Sin}^2\ \frac{1}{2}\theta=\frac{1}{2}(1-\mathrm{Cos}\theta)$. Yet another proposition gives the equivalent of $\mathrm{Sin}^2\theta+\mathrm{Cos}^2\theta=1$. As we know the lengths of (crd. 72°) and (crd. 60°), we deduce (crd. 12°); from this we deduce successively the chords of 6°, 3°, $1\frac{1}{2}°$ and $\frac{3}{4}°$, and again from these (by "Ptolemy's Theorem") the chords of $4\frac{1}{2}°$, $7\frac{1}{2}°$, 9°, $10\frac{1}{2}°$ etc.; we have therefore a table of chords going by gradations of $1\frac{1}{2}°$. It remains to find the chord of 1", and thence the chord of $\frac{1}{2}°$, in order to obtain a table going by gradations of $\frac{1}{2}°$. To find (crd. 1") Ptolemy uses a clever method of "interpolation" based on a proposition already assumed as known by Aristarchus of Samos (*fl.* 280 B.C.) and equivalent to the trigonometrical formula $\mathrm{Sin}\,\alpha/\mathrm{Sin}\beta<\alpha/\beta$ (where $\frac{1}{2}\pi>\alpha>\beta$). It follows from the proposition in question that (crd. 1") : (crd. $\frac{3}{4}°$) $<1 : \frac{3}{4}$ and (crd. $1\frac{1}{2}°$) : (crd. 1°) $<1\frac{1}{2} : 1$, whence $\frac{4}{3}$(crd. $\frac{3}{4}°$) $>$ (crd. 1") $>\frac{2}{3}$ (crd. $1\frac{1}{2}°$). Now Ptolemy has found (crd. $\frac{3}{4}°$) to be $0^p\ 47'\ 8''$ and (crd. $1\frac{1}{2}°$) to be $1^p\ 34'\ 15''$. Thus $\frac{4}{3}$ of the former is $1^p\ 2'\ 50''$ nearly (actually $1^p\ 2'\ 505''$) and $\frac{2}{3}$ of the latter is $1^p\ 2'\ 50''$. Thus (crd. 1"), being both greater and less than $1^p\ 2'\ 50''$, may be taken to be $1^p\ 2'\ 50''$ as nearly as possible. Ptolemy deduces that (crd. $\frac{1}{2}°$) is very nearly $0^p\ 31'\ 25''$; and he is therefore in a position to complete his table going by gradations of $\frac{1}{2}$ a degree. No wonder that De Morgan called this exposition "one of the most beautiful in the Greek writers." Ptolemy further uses the same method of proportional increase ("interpolation") to find the chords of angles containing a number of odd minutes between 0′ and 30′, inserting in the table opposite each chord, in a third column, $\frac{1}{30}$ of the excess of that chord over the one before. One particular result is worth quoting. Since (crd. 1") is found to be $1^p\ 2'\ 50''$, the whole circumference $=360\times(1^p\ 2'\ 50'')$ nearly, and, the length of the diameter being 120^p it follows that $\pi=3\times(1+\frac{2}{60}+\frac{50}{3600})$ or $(3+\frac{8}{60}+\frac{30}{3600})$, which is equivalent to $\pi=3{\cdot}14166$.

Trigonometry, as we have seen, was created by Hipparchus for the use of astronomers. Now, since spherical trigonometry is directly applicable to astronomy, it is not surprising that its development was prior to that of plane trigonometry.

Ptolemy obtains all that he wants in the shape of spherical trigonometry from the one fundamental proposition known as "Menelaus' Theorem" applied to the sphere, a theorem concerning the segments into which the sides of a spherical triangle are cut by a transversal. Menelaus gave the proof in his *Sphaerica*, iii. 1. Ptolemy gives it with two simple propositions on which it depends in the *Syntaxis* i. 13; the proof assumes as known the corre-

[1] The Ptolemies were not in antiquity distinguished by the ordinal numbers affixed to their names by modern scholars and represented according to the usual convention by Roman figures. This is merely done for our convenience. In the case of the later Ptolemies different systems of notation prevail according as the problematic Eupator and Philopator Neos are reckoned in or not.

sponding proposition for a plane triangle. The theorem for the sphere, though called by the name of Menelaus, must certainly have been known to Hipparchus, while the theorem for the plane triangle at least was probably known to Euclid. When Ptolemy requires the equivalent of one of our formulae in the solution of spherical triangles, he does not quote such propositions but proves them afresh each time by means of Menelaus' theorem. These various applications include the equivalent of such formulae for a right-angled spherical triangle as (1) $\text{Sin}\,a = \text{Sin}\,c\ \text{Sin}\,A$, (2) $\text{Tan}\,a = \text{Sin}\,b\ \text{Tan}\,A$, (3) $\text{Cos}\,c = \text{Cos}\,a\ \text{Cos}\,b$, and (4) $\text{Tan}\,b = \text{Tan}\,c\ \text{Cos}\,A$.

We are, above all, indebted to Ptolemy for very full particulars of observations and investigations by Hipparchus as well as of the earlier observations which Hipparchus recorded, *e.g.*, that of a lunar eclipse in 721 B.C. The work of Ptolemy is, in general, evidently based upon Hipparchus to a degree that makes it far from easy to identify Ptolemy's own contributions to the subject, except where he propounds a definite theory of the motions of the five planets, for which Hipparchus had only collected material in the shape of observations made before his time or by himself.

The **"Syntaxis."**—The contents of the *Syntaxis* can here be only very briefly indicated. Book i. contains the indispensable preliminaries to the study of the Ptolemaic system, treating of the earth, its spherical shape and its position in the centre of the universe, the circular movements of the heavenly bodies, the propositions required for the preparation of the Table of Chords, this table itself, the angle of obliquity of the ecliptic and Ptolemy's own method of determining it, and, lastly, so much of spherical geometry and trigonometry as is necessary for the determination of the connection between a star's right ascension, declination, latitude and longitude, and for the formulation of a table of declinations to each degree of longitude. Book ii. contains matter similar to that of Autolycus' On the Moving Sphere, *i.e.*, problems on the sphere, with special reference to the difference between various latitudes, the length of the longest day at any degree of latitude, and the like. Book iii. treats of the length of the year and the motion of the sun on the eccentric and epicycle hypothesis. Ptolemy observes that, to understand the difficulties of the question, we should read the treatises of the ancients, and especially those of Hipparchus, "that enthusiastic worker and lover of truth." He mentions here Hipparchus' discovery of the precession of the equinoxes (a subject to which he returns in viii. 2). In chapter 1, Ptolemy also lays down some general principles which are worth quoting, namely, (1) that, in seeking to explain phenomena, we should adopt the simplest possible hypothesis, provided that it is not contradicted in any important respect by the observations; (2) that in investigations depending on observations in which great delicacy is required, we should select those made at long intervals of time in order that the error due to the imperfection of our instruments may be lessened by being distributed over a large number of years. Book iv. deals with the length of the months and the motions of the moon, and Book v. with the same subject continued, the construction of the astrolabe, the diameters of the sun, the moon and the earth's shadow, the distance of the sun, and the dimensions of the sun, moon and earth. Book vi. is on the conjunctions and oppositions of the sun and moon, solar and lunar eclipses and the periods of their recurrence. Books vii. and viii. treat of the fixed stars, including precession. Book vii. ends with the catalogue (arranged under constellations) of the stars in the northern hemisphere, in which are entered the latitudes, longitudes and magnitudes; Book viii. begins with a similar catalogue for the southern hemisphere; the two catalogues include 1,022 separate stars as compared with the 850 or more included in Hipparchus' catalogue. Book viii. also describes the Milky Way and the construction of a celestial globe. Books ix. to xiii. are devoted to the planets. Book ix. begins with general remarks on the order of the planets, the difficulties in the way of framing a theory of the subject, the periods of revolution of the five planets, the different hypotheses that are possible; then (ch. 7) Ptolemy passes to the separate case of Mercury. Book x. treats of Venus; Book xi. of Jupiter and Saturn; Book xii. deals with the stationary points and retrogradations of each of the planets, and with the greatest elongations of Mercury and Venus; Book xiii. considers the motions of the planets in latitude, the inclination of their orbits and its magnitude.

The *Syntaxis* early became the subject of commentaries. For Book vi. and part of Book v. the commentary of Pappius is extant in Greek. Theon of Alexandria's commentary in 11 books was first published by Joachim Camerarius of Basle in 1538; the first two books were appended by Halma to his edition of Ptolemy. The *Syntaxis* was translated into Arabic for the Caliph al-Ma'mūn, himself an astronomer, by a translator unnamed, in 827; later it was translated by al-Hajjāj, the translator of Euclid, and again by Isḥāq b. Hunain (or perhaps his father Hunain b. Isḥāq), whose translation was revised by Thābit b. Qurra (d. 901). The first Latin translation was made from the Arabic by Gherard of Cremona; this translation, finished in 1175, was first published by P. Liechtenstein at Venice in 1515, but without the author's name. George of Trebizond made the first Latin translation from the Greek in 1451; this was revised and published by Lucas Gauricus at Venice in 1528. The editio *princeps* of the Greek text was brought out by Simon Grynaeus at Basle in 1538. The next complete edition was Halma's (1813–16). All former Greek texts are now superseded by Heiberg's edition of the astronomical works of Ptolemy (1899–1907) to which, so far as the *Syntaxis* is concerned, a German translation by Manitius has been added (1912–13).

Other Mathematical Works.—Of the other works of Ptolemy the following should be mentioned: (1) the Analemma, the object of which is to explain a method of representing on one plane the different points and arcs of the heavenly sphere by orthogonal projection on three planes mutually, at right angles, the meridian, the horizon and the "prime vertical." The problem is to find the position of the sun at a given hour of the day. Only a few fragments remain of the Greek text, but we have a Latin translation by William of Moerbeke from an Arabic version. This translation was edited with a valuable commentary by Commandinus (1562); and Heiberg has included it, with the Greek fragments alongside (where extant), in vol. ii. of his edition of the astronomical works. (2) The *Planisphaerium* survives in a Latin translation from the Arabic, which was edited by Commandinus in 1558 and is likewise included in Heiberg's vol. ii. The book is an explanation of a system of projection known as "stereographic," by which points on the heavenly sphere are represented in the plane of the equator by projection from one point, a pole. The pole taken by Ptolemy is the south pole. (3) *Φάσεις ἀπλανῶν ἀστέρων*. This is a calendar of the sort which the Greeks called *parapegma*, or a table of the risings and settings of stars in morning and evening twilight, with weather-indications (*ἐπισημασίαι*). (4) *Ὑποθέσεις τῶν πλανωμένων*, Planetary Hypotheses, in two books, the first of which is extant in Greek, the second in Arabic only. These works are also included in Heiberg's vol. ii.

Two separate geometrical works are mentioned by ancient commentators, (1) a single book *Περὶ διαστάσεως*, On Dimension, in which Ptolemy apparently tried to prove that there are only three dimensions in space; (2) a tract containing an attempt to prove Euclid's Parallel Postulate. The gist of the latter tract is given by Proclus in his Commentary on Euclid, Book i. (ed. Friedlein, 1873). Simplicius mentions a mechanical work *Περὶ ῥοπῶν*, On *Balancings*, while Suidas credits Ptolemy with three books on Mechanics.

The Optics of Ptolemy exists (save for Book i. and the end of Book v. which are lost) in a Latin translation made by a certain Admiral Eugenius Siculus from the Arabic in the 12th century. It was in five books, the last of which is interesting because it contains what is apparently the first recorded attempt at a theory of refraction of luminous rays through media of different densities; it deals also with astronomical refraction, of which it gives a better account than that of any astronomer before Cassini.

Lastly, Ptolemy wrote Harmonica in three books, a treatise on music. This was edited in Greek and Latin by John Wallis (1682); it appeared also with Porphyry's commentary, in *Johannis Wallis* Opera *Mathematica* (1699), vol. iii.

For further particulars the reader may refer to the article on Ptolemy in Smith's *Dictionary of Greek and Roman Biography*, vol. iii. (by De Morgan); Delambre's *Histoire de l'astronomie ancienne* (1817–21) vol. ii.; Rud-Wolf, *Geschichte der Astronomie* (1877); A. Berry, *A Short History of Astronomy* (1898); and for the mathematics to A. von Braunmühl, *Geschichte der Trigonometrie* (1900); Gino Loria, *Le scienze esatte nell' antica Grecia* (1914); and Sir T. L. Heath, *History of Greek Mathematics* (1921) vol. ii.

His **Work** as a Geographer.—Ptolemy is hardly less celebrated as a geographer than as an astronomer, and his **Γεωγραφικὴ ὑφήγησις** (or Guide to Geography) exercised as great an influence on geographical progress (especially during the period of the Classical Renaissance), as did his *Almagest* on astronomical. Its exceptional position was largely due to its scientific form, which rendered it convenient and easy of reference; but, apart from this, it was really the most considerable attempt of the ancient world to place the study of geography on a scientific basis. The astronomer Hipparchus had indeed pointed out, three centuries before Ptolemy, that the only way to construct a trustworthy map of the inhabited world would be by observations of the latitude and longitude of all the principal points on its surface. But the materials for such a map were almost wholly wanting, and, though Hipparchus made some approach to a correct division of the known world into zones of latitude, "climates" or *klimata,* as he termed them, trustworthy observations of latitude were then very few, while the means of determining longitudes hardly existed. Hence probably it arose that no attempt was made to follow up the suggestion of Hipparchus until Marinus of Tyre, who lived shortly before Ptolemy, and whose work is known to us only through the latter. Marinus' scientific materials being inadequate, he contented himself mostly with determinations derived from itineraries and other rough methods, such as are still employed where more accurate means of determination are not available. The greater part of Marinus' treatise was occupied with the discussion of his authorities, and it is impossible, in the absence of the original work, to decide how far his results attained a scientific form. But Ptolemy himself considered them, on the whole, so satisfactory that he made his predecessor's work the basis of his own in regard to all the Mediterranean countries, that is, in regard to almost all those regions of which he had definite knowledge. In the more remote regions of the world, Ptolemy availed himself of Marinus' information, but with reserve, and he explains the reasons that induced him sometimes to depart from his predecessor's conclusions. Among other things Ptolemy's work shows the increased knowledge of Asia and Africa acquired since Strabo and Pliny.

As an astronomer, Ptolemy was, of course, better qualified to explain the mathematical conditions of the earth and its relations to the celestial bodies than most preceding geographers. His general views had much in common with those of Eratosthenes and Strabo. He adopted from Hipparchus the division of the equatorial circle into 360 parts (our degrees), and supposed other circles (meridians) to be drawn through this, from the equator to the pole. Another set of circles was the series of parallels of latitude, and within the network of parallels of latitude and meridians of longitude it was Ptolemy's task to place the outline of the world, so far as known to him.

But at the very outset of his attempt he fell into an error vitiating all his conclusions. Eratosthenes (c. 276–196 B.C.) was the first who had attempted scientifically to determine the earth's circumference, and his result of 250,000 (or 252,000) stadia, *i.e.,* 25,000 (25,200) geographical miles, was generally adopted by subsequent geographers, including Strabo. Posidonius, however (*c.* 135–50 B.C.), reduced this to 180,000, and the latter computation was inexplicably adopted by Marinus and Ptolemy. This error made every degree of latitude or longitude (measured at the equator) equal to only 500 stadia (50 geographical miles), instead of its true equivalent of 600 stadia. The mistake would have been somewhat neutralized had there existed a sufficient number of points of which the position was fixed by observation; but we learn from Ptolemy himself that such observations for latitude were very few, while the means of determining longitudes were almost wholly wanting. Hence the positions laid down by him were, with few exceptions, the result of computations from itineraries and the statements of travellers, which, owing to the want of instruments, etc., were liable to much greater error in ancient times than at the present day. But, great as were the errors resulting from such imperfect means of calculation, they were increased by the permanent error arising from Ptolemy's system of graduation. Thus, if he concluded (from itineraries) that two places were 5,000 stadia distant, he would place them 10° apart, and thus in fact separate them by 6,000 stadia.

Ptolemy followed Marinus in taking, as his prime meridian from which to measure longitudes, a line drawn through the supposed position of the Fortunate islands (vaguely answering to the Canaries *plus* the Madeira group) which they placed $2\frac{1}{2}°$ (instead of 9° 20') west of the Sacred promontory (*i.e.,* Cape St. Vincent, regarded by Marinus and Ptolemy, as by previous geographers, as the westernmost point of Europe). Hence all Ptolemy's longitudes, reckoned eastwards, were about 7" less than they would have been if really measured from the meridian of Ferro, which continued so long in use.

The problem that had especially attracted the attention of geographers from Dicaearchus to Ptolemy was to determine the length and breadth of the inhabited world. This question had been fully discussed by Marinus, who had arrived at conclusions widely different from his predecessors. Towards the north, indeed, there was no great difference of opinion, the latitude of Thule being generally recognized as that of the highest northern land, and this was placed both by Marinus and Ptolemy in 63" N., not far beyond the true position of the Shetland islands, which had come to be generally identified with the mysterious Thule of Pytheas. The western extremity, as already mentioned, had been in like manner determined by the prime meridian drawn through the supposed position of the outermost of the Fortunate islands. But towards the south and east Marinus gave an enormous extension to Africa and Asia, beyond what had been known to or suspected to exist by earlier geographers, and, though Ptolemy reduced Marinus' calculations, he retained an exaggerated estimate of their results.

Contents **of the** "Guide to Geography."—In Book i., after general explanations (cc. 1–6), Ptolemy applies himself to a correction of Marinus' results, taking account (1) of the observed (astronomical) phenomena, (2) of the various recorded itineraries of travel (a) by land and (b) by sea. Marinus had assumed as the limit of knowledge to the south a region in Africa called Agisymba, inhabited by Ethiopians and abounding in rhinoceroses, which had been reached by Julius Maternus. Modifying the data regarding this journey, Marinus placed Agisymba on the southern tropic. This made the "breadth" of the inhabited world from Thule to Agisymba $63°+24°=87°$. Ptolemy, on the other hand, placed Agisymba and a certain promontory called Prason on a parallel as far south as Meroe is north of the equator; taking, then, the southern limit to be 16" 25' S., he finds the "breadth" of the inhabited earth to be $63°+16°\ 25'=79°\ 25'$, in round figures 80°, or 40,000 stades.

Marinus' estimate of the "length" of the inhabited earth overland (from west to east) may be stated in three parts, (1) from the "Fortunate islands" to Hierapolis on the Euphrates 28,800 stades, (2) from Hierapolis to the "Stone Tower" (near the Pamir?) 26,280, and (3) from the "Stone Tower" to Sera, the capital of the Serae (? inland China), 36,200 stades, making 91,280 stades in all. Ptolemy reduced the last two estimates to 24,000 and 18,100 respectively, thus arriving at a total of 70,900 stades. Reckoning 400 stades as the proper length of a degree of longitude measured at the latitude of Rhodes (36°), we have as the "length" according to Marinus 228°, which he rounded down to 225°, and as Ptolemy's estimate 177° 15', in round figures 180°. The measurement by Marinus of the distance by sea gave 125° from the Fortunate islands to Kory, a promontory in India opposite the northern point of Ceylon, and 61" more to the "Golden Chersonese"; the distances from the Golden Chersonese eastwards to Zaba and thence nearly south to Kattigara Marinus only gave in days of sailing. Ptolemy reduced the figure of 61° to 34° 48′, and the difference in longitude between the Golden Chersonese and Kattigara he made 17° 10′. Thus Ptolemy's total became 125° + 34° 48′ + 17° 10′ = 176° 58′ say 177°, to which he added 3° for the difference in longitude between Kattigara and the capital of the Sinae (sea-coast of China), making 180° as before.

But in thus estimating the length and breadth of the known world, Ptolemy attached a very different sense to these terms from that which they had generally borne. Most earlier Greek geographers and "cosmographers" supposed the inhabited world to be surrounded on all sides by sea, and to form a vast island in the midst of a circumfluous ocean. This notion (perhaps derived from the Homeric "ocean stream," and certainly not based upon direct observation) was nevertheless in accordance with truth, great as was the misconception involved of the continents included. But Ptolemy in this respect went back to Hipparchus, and assumed that the land extended indefinitely north in the case of eastern Europe, east, south-east and north in that of Asia, and south, south-west and south-east in that of Africa. His boundary line was in each of these cases an arbitrary limit, beyond which lay the Unknown Land, as he calls it. But in Africa he was not content with this extension southward; he also prolonged the continent eastward from its southernmost known point, so as to form a connection with south-east Asia. In Asia he took the line of coast from the Golden Chersonese as making a great bay towards the Sinae, and then proceeding southwards to Kattigara. The effect was to enclose the Indian ocean as one vast lake surrounded by Unknown Land. It must be noticed that Ptolemy's extension of Asia eastwards, so as to diminish by 50° of longitude the interval between easternmost Asia and westernmost Europe, fostered Columbus' belief that it was possible to reach the former from the latter by direct navigation, crossing the Atlantic.

Ptolemy proceeds (i. 19 sq.) to consider the question of maps and methods of constructing them. He first describes (i. 24) a method of conical projection in which the meridian circles are represented as straight lines all meeting in a certain point (a kind of north pole) and the parallels of latitude (in particular those passing through Thule, Rhodes, Meroe and Agisymba) as circles with that point as centre. (The fixed "pole," or centre of projection is as nearly as possible the vertex of the cone passing through the actual parallel circle of Thule and the equator.) A more elaborate system, in which the meridians are represented as actual arcs of circle and not straight lines, is then described (s. 10 sqq.).

Books ii. to vii. contain Ptolemy's systematic tabular location of places and features in terms of latitude and longitude for all countries. He deals in order with Europe and the Mediterranean, then Africa, then Asia, beginning with Asia Minor and passing to Palestine, Mesopotamia, Arabia, India, etc. Under Europe, the first countries dealt with are the "Britannic islands," Ireland and Albion; then comes Spain in three divisions, then Gaul in four divisions, then Germany, and so on. The arrangement of the subject-matter in tabular form, instead of being at once embodied in a map, suggests that Ptolemy's object was to enable the student to construct his maps for himself. Nevertheless, the work was from the time of its first publication accompanied by maps, which are regularly referred to in Book viii. How far the maps which are appended to the extant mss. represent the original series is a moot point. It is possible, however, that they have been transmitted by uninterrupted tradition from the time of Ptolemy.

In spite of the merits of Ptolemy's geographical work it cannot be regarded as a complete or satisfactory treatise upon the subject. It was the work of an astronomer rather than a geographer. Not only did its plan exclude all description of the countries with which it dealt, their climate, natural productions, inhabitants and peculiar features, but even its physical geography proper is treated in an irregular and perfunctory manner. While Strabo was fully alive to the importance of the rivers and mountain chains which (in his own phrase) "geographize" a country, Ptolemy deals with this part of his subject in so careless a manner as to be often worse than useless. In Gaul, for instance, the few notices he gives of the rivers that play so important a part in its geography are disfigured by some astounding errors; while he does not notice any of the great tributaries of the Rhine, though mentioning an obscure streamlet, otherwise unknown, because it happened to be the boundary between two Roman provinces.

Bibliography.—Ptolemy's Geographia was printed for the first time in a Latin translation, accompanied with maps, in 1462 (?), and numerous other editions followed in the latter part of the 15th and earlier half of the 16th centuries, but the Greek text did not make its appearance till 1533, when it was published at Basle in quarto, edited by Erasmus. All these early editions, however, swarm with textual errors, and are critically worthless. The same may be said of the edition of P. Bertius (Gr. and Lat., Leyden, 1618, typ. Elzevir), which was long the standard library edition. The first attempt at a really critical edition was made by F. G. Wilberg, and C. H. F. Grashof (Essen, 1838–45), but this only covered the first six books of the entire eight. The edition of C. F. A. Nobbe (3 vols., Leipzig, 1843), presents the best Greek text of the whole work, and has a useful index. The best edition, so far as completed, is that published in A. F. Didot's Bibliotheca graecorum scriptorum (Claudii Ptolemaei geographia; 2 vols., 1883 and 1901), originally edited by Carl Müller and continued by C. T. Fischer, with a Latin translation and a copious commentary, geographical as well as critical. See also H. Bradley, "Ptolemy's Geography of the British Isles," in *Archaeologia*, vol. xlviii. (1885); T. G. Rylands, Geography of Ptolemy Elucidated (1893); and a Polish study of Ptolemy's Germany and Sarmatia, in the Historical-Philosophical Series (2) of the Cracow University (1902), vol. xvi. (E. H. B.; C. R. B.; T. L. H.)

PTOMAINE POISONING, a phrase now popularized in the sense of a certain class of food-poisoning. The word "ptomaine" was invented by the Italian chemist Selmi for the basic substances produced in putrefaction. They belong to several classes of chemical compounds. (See Enteritis; Medical Jurisprudence.)

PUBLICAN: see Licensed Victualler.

PUBLICANI, the name given in ancient Rome to a body of men who either hired state property or monopolies to farm for their own profit or bought for a fixed sum the right to farm the taxes due to the treasury from the public land in Italy, or the land held by Roman subjects in the provinces. In early times the senate entrusted to officials the control of the sale of salt (Livy iii. 9), and it was a development from this that the state, instead of appointing officials to manage its monopolies, let out those monopolies to individuals. A regular system was established by which the censors who held office every fifth year, placed the sources of public revenue in the hands of individuals or companies, who on payment of a fixed sum into the treasury, or on giving adequate security for such payment, received the right to make what profit they could out of the revenues during the five years elapsing before the next censorship. The assignment was made to the highest bidder at a public auction. The same system was applied to the public works, the publicanus in this case being paid a certain sum, in return for which he took entire charge of a certain department of the public works. That this system was well established at the time of the Second Punic War is assumed in Livy's account of the various offers made by the wealthier class of citizens to relieve the exhausted treasury after the battle of Cannae (216 B.C.). On the one hand we have companies offering for branches of the revenue a price which was calculated rather to meet the needs of the state than to ensure any profit for themselves (Livy xxiii. 49). On the other hand individuals are represented as undertaking the management of public works on the understanding that they would expect no payment until the conclusion of the war (ibid. xxiv. 18).

Since wealth was a necessary qualification for the post, and wealth at Rome became more and more confined to the commercial class, the publicani became identical with the class of capitalists and traders. This was distinct at Rome from the senatorial class, which was excluded from it by definite enactment (see Senate), and, except in face of common danger, was often hostile to it. It was in their capacity of publicani in the wealthiest provinces that the capitalist or equestrian *iudices* (see Equites) became a menace to the provincial governors who represented the senatorial power. When the demands of the equestrian party determined the policy of the state we can trace the interests of the *publicani* as the motive of its action. Thus the fate of the Roman business men in Cirta led to the Jugurthine War in 112 B.C.; the disorganization of Asiatic commerce by the pirates led the *equites* to support the proposal to confer extraordinary powers on Pompey in 67 B.C.; and the quarrel over the contracts for the taxes of Asia in 60 B.C. led to the downfall of the senatorial party.

Under the empire the *publicani* were subject to close supervision. The name appears as "publicans" in the New Testament.

BIBLIOGRAPHY.—A. H. J. Greenidge, Roman Public Life (1901); J. E. Sandys, Companion to Latin Studies (1921).

PUBLIC AUTHORITIES PROTECTION ACT. This British statute was enacted in 1893 and represents, to some extent, a consolidation of previous statutes limiting the time within which actions may be brought against "public authorities," including thereunder local government authorities, justices of the peace and, it has recently been held, Crown servants also. It goes, however, far beyond the particular statutes which it proposed to "generalize and amend" in that it imposes new and most ihvidious restrictions on any plaintiff who seeks to sue a "public authority" for a wrongful act. These are dealt with in the article Petition of Right. The statute which requires all such actions to be brought within six months does not, however, extend to actions for breach of contract, as distinct from tort by public authorities. Such actions are subject to the ordinary period of limitation prevailing in actions between subject and subject, *i.e.,* private persons, namely six years. The Act has been described as "intended to protect public bodies from expense when they are unsuccessfully sued in respect of acts done or omitted to be done in the exercise of statutory powers or duties" (Lindley M.R. in Fielding v. Morley Corporation, 1899, 1 Ch. at. p. 4). The description is inadequate, however. As is shown elsewhere (see PETITION OF RIGHT), the statute operates in practice to deter persons wronged from suing at all, and penalizes them on technical grounds with special costs for suing even where they would have had an undoubted cause of action had the action been brought within the prescribed period of time. The "protection" afforded by the statute extends not only to any wrongful acts done "in pursuance or execution or intended execution" of a statutory duty but also in pursuance of any "public" duty or authority. All these terms, as also the question whether the act complained of arises out of a constructual relation or not, whether it occurred in the execution of a "duty" or merely in the exercise of a "power," as also the relation between a "continuing" act and "continuous" damage, have been the subject of endless litigation. The "protection," in other words the privilege, conferred by the statute extends not only to a public authority but also to all officers and servants acting under its orders. (J. H. Mo.)

PUBLIC HEALTH. The term as used in Great Britain connotes in the broad sense principles and measures which aim at promoting and safeguarding the health of the community in contra-distinction to those which are concerned in the main with the treatment of declared disease in the individual. For public health in the United States see Section II.

I. GREAT BRITAIN

The original conception of public health requirements in Great Britain was fairly simple—the improvement of drainage and sewerage, the provision of adequate and satisfactory water supplies, scavenging, the isolation of cases of infectious disease. Then came the supervision of housing conditions, the clearance of slum areas, the provision of open spaces and the efforts to provide a cleaner atmosphere. More attention is now paid to food supply as in provision for the analysis of food-stuffs, in the supervision of the production and distribution of milk, the elimination of tuberculosis from dairy cattle, the control of slaughtering and inspection of meat, the inspection of premises used for the preparation or storage of food. Action regarding infectious disease has passed beyond isolation of the individual attacked and disinfection of premises to the supervision of contacts and careful investigation of possible sources of infection, and the system of port sanitary control has been placed on a scientific basis and all these matters, as they develop, are referred to and accepted as public health measures.

The present century has witnessed public health development in other directions. There has been the growth of activities which aim at the conservation of young life, the early treatment of physical defects, the inculcation of healthy nurture with the object of ensuring healthy citizens. These have found expression in the Maternity and Infant Welfare (*q.v.*) and the School Medical Services. Public provision has been made for the treatment of certain diseases which, from their economic or social importance, can best be countered by organization on a communal rather than an individual basis, such as tuberculosis, venereal disease, and the crippling effects of infantile paralysis.

The statutory authority for this work is furnished by various Acts of Parliament. The charter of public health administration is the Public Health Act of 1875 which has been amended by the Acts of 1890, 1904, 1907 and 1925. Other important health enactments are the Public Health (Water) Act, 1878, the Infectious Disease (Notification) Act, 1889, the Infectious Disease (Prevention) Act, 1890, the Open Spaces Act, 1906, the Milk and Dairies (Consolidation) Act, 1915, the Public Health (Smoke Abatement) Act, 1926, and various provisions in the Housing Acts. The later developments of public health have their basis among other enactments, in the Education (Administrative Provisions) Act, 1907, the Education Act 1921, the National Insurance Act 1911, the Venereal Disease Act, 1917, the Maternity and Child Welfare Act, 1918, the Public Health (Tuberculosis) Act, 1921, and in various regulations framed by the Ministry of Health.

The foregoing refers to legislation for England and Wales. The Scottish and Irish Acts, though similar in objects and results are usually different in form and adjusted to the national conditions of those countries.

Central Authorities.—The authorities concerned in the administration of public health are central and local. In England and Wales the chief central authority is the Ministry of Health. This department had its origin in certain movements which can be traced back to the beginning of the 19th century. Interest of the State in the physical health of its citizens is a comparatively modern development, and may be traced broadly to four chief causes; first, to reaction against the anarchy of the Industrial Revolution; secondly, to the gradual development in the latter part of the 18th century of a humanitarian spirit, as evidenced by the work of John Howard in the reform of prison life, the movement for the abolition of the slave trade, and the efforts of Sir Samuel Romilly and others to infuse a spirit of humanity and common-sense into our penal laws; thirdly, and probably the most important, to the appearance for the first time of Asiatic cholera in Europe and the threat of its invasion of England; and fourthly, to the establishment of the central Poor Law Commission in 1834.

The first Secretary of this Commission was Mr. Edwin Chadwick, one of the great public health pioneers of the 19th century. He forced upon public notice the importance of sickness and ill-health in the production of poverty, and insisted that the prevention of disease was one of the first duties of the State. Largely as a result of his efforts the first Central Health Department, the General Board of Health, was established, prematurely as it afterwards proved, in 1848. Ten years later this board was dissolved and its duties distributed amongst other offices, but in 1871 they were gathered together again and, with those of the Poor Law Commission, transferred by Act of Parliament to a newly-created department, the Local Government Board. This board remained for nearly 50 years the principal central authority for public health, until in 1919 its functions, together with other health functions, such as health insurance and the medical inspection of school children, which had come to be entrusted to separate central authorities, were transferred to the Ministry of Health. The Ministry of Health Act, 1919, by which the Ministry of Health was established, had as its purpose the prevention of oveflapping and competition between certain of the central departments by bringing the health services which they administered into a single department under a Minister of Health.

Among other central authorities concerned with questions of public health are the Medical Research Council, a Committee of the Privy Council, which co-ordinates research on medical subjects, the Board of Trade, which is responsible for the health services of the mercantile marine under the Merchant Shipping Acts, the Ministry of Agriculture and Fisheries which has certain powers and duties relating to the production of food and milk, the Ministry of Pensions which has the care of disabled officers and men after they have left the naval, military and air services, and the Home Office, in respect of industrial hygiene control under the Dangerous Drugs Acts, etc.

Local Authorities. — The local authorities charged with the administration of public health services are the Rural and Urban District Councils, the latter including the Metropolitan, Municipal and County Borough Councils. These bodies are assisted in the discharge of their duties by a technical staff consisting of the Medical Officer of Health and the chief Sanitary Inspector, whom they are required by law to appoint, together with what additional assistance may be necessary. In the smaller districts the duties are sometimes performed by a part-time Medical Officer of Health who is also engaged in general practice, and by a whole-time Sanitary Inspector. In the larger cities the staff of the Public Health Department may number several hundred persons. The Poor Law Guardians have important health functions in relation to the medical care of the poor, and are also responsible for the administration of the Vaccination Acts.

County Councils other than County Borough Councils are not health authorities within the meaning of the Public Health Acts, but they have been given important duties under the Isolation Hospitals Act, under the Tuberculosis Regulations, the Maternity and Child Welfare Act, the Venereal Diseases Regulations, and also in regard to school medical inspection, and the tendency of present-day policy is gradually to shift much of the responsibility for these and similar personal health services from the smaller urban and rural authorities to the County Councils, and thus, by increasing the strength and efficiency of local administration, to diminish the need for detailed control and interference by the central departments.

Public Health Personnel. — The first local authority to appoint a salaried Medical Officer of Health in Great Britain was Liverpool in 1847. In 1848 the Corporation of the City of London appointed Dr. (afterwards Sir) John Simon to be its Medical Officer of Health. The larger cities followed and in 1872 the practice had become so general that the Public Health Act of that year made it obligatory on every urban sanitary authority to appoint a Medical Officer of Health. The Public Health Act of 1875 extended this obligation to all local authorities, both urban and rural.

At first no special qualification was prescribed, but in the Local Government Act of 1888 a clause was inserted requiring that after the 1st of January 1892 every Medical Officer of Health of a County or of a district containing a population of 50,000 or more inhabitants should be not only legally qualified in medicine, but also be the registered holder of a Diploma in Sanitary Science, Public Health or State Medicine. By an Order issued by the Ministry of Health in 1922, this requirement was extended to all Medical Officers of Health, so that to-day no candidate is eligible for such an appointment unless he holds a Diploma in Public Health, except by special dispensation of the Minister of Health. The Sanitary Officers Order of 1922 also laid it down that every Sanitary Inspector appointed by a local authority should possess a recognized qualification in Sanitary Science.

In the brief survey which follows reference is made to some of the more important matters dealt with by local public health authorities.

Vital Statistics. — Vital statistics furnish a measure of the influence of various conditions and occupations on the health of the population and a means by which the value and efficacy of the ameliorative and preventive action taken by local health authorities can be assessed. Every Medical Officer of Health is required to furnish each week to the Registrar General a return of all cases of infectio'us disease notified in his district. These returns, together with those supplied by the local registrars of births and deaths, are the material on which the Registrar General bases his Weekly Report, and also his Quarterly and Annual Statistical Surveys. This information is supplemented by Annual and special reports of Medical Officers of Health and from the results of investigations by Medical Officers of the Ministry of Health and by other departments and voluntary bodies interested in the physical, industrial and social welfare of the people.

Environmental Hygiene. — Long before the discovery of bacteria and their relation to disease, sanitarians recognized the close association of dirt and pestilence and the importance of cleanliness in the prevention of infection. It is difficult to believe that elementary health services such as the provision of a public water supply, drainage, sewerage and sewage disposal, the regular removal of house refuse and the cleansing of streets, which are to-day accepted as indispensable to civilized life, were practically unknown through the greater part of England and Wales less than a century ago. These services are now regularly undertaken by all local sanitary authorities. Control is exercised over building to ensure freedom from dampness, adequate lighting, ventilation, drainage, closet accommodation in houses intended for human habitation. Many of the larger towns have long since reached out beyond these elementary objectives, undertaking other services which have, directly or indirectly, a beneficial effect on the welfare of the community — the provision of cheap transport which has helped to overcome the housing difficulty, the provision of gas and electricity which has lessened labour in the homes and contributed to a cleaner and more wholesome atmosphere, the provision of parks and pleasure grounds where the people may recruit from their labour and the children play in safety.

Infectious Disease. — Local health authorities have been entrusted with important duties in regard to the prevention and control of infectious disease and have developed elaborate machinery for this purpose. The Infectious Diseases Notification Acts of 1889 and 1899 made certain of the commoner infectious diseases notifiable to the Medical Officer of Health and gave local authorities power to add to their number where it seemed necessary and expedient to do so. Since then other diseases have appeared in epidemic form, such as cerebrospinal fever, anterior poliomyelitis (infantile paralysis), encephalitis lethargica (sleepy sickness), and the central department, acting under authority of the Public Health Act 1875, has made these diseases notifiable by regulation and prescribed the measures which should be taken for their prevention and control.

The measures adopted by a local authority to control the spread of an epidemic disease are briefly, — isolation of the patient, either in the home or, where this is not practicable, in hospital; search for the source of infection; observation of the contacts; disinfection; and, where an efficacious vaccine is available, vaccination.

Under the authority either of the Public Health Act 1875 or of the Isolation Hospitals Act 1893, most local authorities have provided hospital accommodation for cases of infectious disease occurring in their districts.

Diphtheria, Tuberculosis, etc. — It is obvious that infectious diseases which are indirectly transmitted through the agency of some medium such as water, milk, food, flies, etc. are more easily prevented than those which are spread directly from person to person, and the measures that are applicable to the one do not always prove successful in the case of the other. For this reason typhoid, cholera, and other intestinal infections which formerly exacted such a heavy toll of life, no longer cause health authorities serious anxiety. In the same category one may place malaria, typhus and other insect-borne diseases. The diseases which are conveyed by personal infection, such as scarlet fever, diphtheria and the various epidemic nervous diseases, are much more difficult to control. The infection of many of these maladies is very widely spread throughout the community and many persons contract the disease in what may be called a sub-clinical form without being conscious of it. The occasional clinical cases are often merely the apex of a considerable pyramid of infection, the greater part of which is submerged and unrecognized. One of the great problems of preventive medicine is to elicit the factors which determine these periodic clinical or epidemic manifestations of an infectious disease. Various theories have been propounded, but none of them is entirely satisfactory. Other diseases, such as tuberculosis, have a dual character, *i.e.*, they may be transmitted directly from person to person or may be conveyed through the medium of some food such as milk or infected meat. Tuberculosis is a disease of great economic importance because the chief burden of mortality falls on the middle or productive years of life. It is for this reason that special measures have been taken to combat it in the form of notification, dispensaries, sanatoria and the other machinery established under the Tuberculosis Regulations. Somewhat similar measures, suitably modified, have been devised for the prevention and treatment of venereal diseases.

Food Inspection. — The most important measures dealing with food inspection are the various Sale of Food and Drugs Acts 1875–1907, the Public Health (Regulations as to Food) Act 1907 and the Milk and Dairies (Consolidation) Act 1915. Under these powers regulations have been made by the Central Authority dealing with such subjects as milk and cream, meat, shellfish, imported food, preservatives and the prevention of tuberculosis. To a country which imports a large proportion of its meat from abroad it is very important to have some means of supervising production at the source. Agreements have been entered into with the chief producing countries by which these countries undertake to inspect and stamp all meat intended for export to England. This reduces the inspection necessary on arrival. A certain amount of inspection is carried on both at the ports and at the chief distribution centres in order to ensure that the producing country fulfils its undertaking. The results of this method of control have been extremely satisfactory and every opportunity is taken to extend the system.

The local sanitary authority exercises supervision over the quality of the food distributed in its district and the conditions under which it is stored and sold to the public. For this purpose officers are appointed for the inspection of slaughterhouses and dairies, and samples of food are regularly submitted for analysis.

School Medical Service — The introduction of compulsory education made it apparent that many children were unable, through ill-health, to benefit from the education facilities provided. This led to the establishment of the medical inspection of school children in 1907 and the gradual evolution of the present School Medical Service. The most important statute dealing with this subject is the Education Act of 1921 which re-enacts and amplifies previous powers and imposes on local education authorities the duty of making adequate and suitable arrangements for the medical inspection and treatment of children attending public elementary schools and also the medical inspection of scholars attending secondary schools. Education authorities are also required to make special provision for blind, deaf, defective or epileptic children.

This systematic inspection has revealed a vast amount of unsuspected disease and minor defects which, if left uncorrected, lead in time to serious crippling. It is estimated that out of a total school population of some 7 millions, over a million children require medical treatment, apart from uncleanliness and dental diseases. The seeds of much of this ill-health are sown before the children enter school, a fact which emphasizes the importance of the pre-school welfare work which has already been referred to. On the other hand, the full fruition of school medical inspection can only be assured by continuation of the supervision during the critical transition years of early industrial life. Here the advantages secured by the National Health Insurance Acts of 1911–1924 are becoming apparent. With certain exceptions these provided for compulsory insurance against sickness of all employed persons between the ages of 16 and 70. (For further industrial welfare measures see INDUSTRIAL WELFARE AND MEDICINE and LABOUR LAW.)

Port Sanitary Administration. — Port sanitary authorities are constituted by order of the Ministry of Health. They carry out duties imposed by the regulations relating to cholera, plague and yellow fever and other "quarantine" work according to the system of International Sanitary Conventions to which this country is party; the Aliens Order 1920, the Port Sanitary Authorities (Infectious Diseases) Regulations 1920, and the Public Health (Imported Food) Regulations 1925. The sanitary staff of a port sanitary authority consists of the Port Medical Officer of Health and such assistants as the volume of work demands. In recognition of the national importance of this work, half the approved expenditure of a port sanitary authority is defrayed out of Central Governments funds.

International Health. — Many public health problems are international in character and there is evident need for some organization which will enable the nations to pool their experience and, where necessary, to co-operate in the application of such measures as are practicable for the prevention and control of disease. The first attempt to secure international uniformity in matters of quarantine was made in Paris in 1851 when a Convention embodying the precautions against infectious diseases which were then regarded as appropriate was signed by the participating countries. Modifications have been introduced into this Convention from time to time and in the Rome Agreement of 1907 an office or bureau called the International Office of Public Health was established in Paris to consider how best the convention could be amended and kept abreast with medical science. England, by reason of its vast international traffic, has been very directly interested in these conventions and has long been at pains to introduce a spirit of reasonableness into their requirements. The last convention, which was signed in Paris in 1926 by the representatives of 70 different nations, embodies most of the views that have long been held and practised in this country. This convention aims at securing what is necessary for the prevention of the introduction of disease with the minimum of interference to commerce and travel.

In the Peace Covenant a clause was introduced providing for the establishment of a health organisation at Geneva under the aegis of the League of Nations. The functions of this organisation cover practically the whole field of preventive medicine wherever co-operation between the nations is desirable or essential. By arrangements with the international office in Paris it undertakes the collection and dissemination of current information on epidemic disease: it gives assistance in times of national emergency as during the great epidemic of typhus in Russia in 1919, during the epidemic of malaria in Southern Russia, in Greece during the influx of refugees from Asia Minor and other parts of Turkey, and during the recent outbreak of dengue in Athens. It has done much to secure the standardization of various medical preparations, such as insulin, pituitrin and certain of the antitoxins. It has promoted inquiry into cancer, certain aspects of maternity and child welfare and tuberculosis.

Public Health Finance. — The expenses of the public health services are defrayed for the most part out of local rates (general district rate or special rate), but assistance is given by the Central Government in respect of what are known as the "grant aided services." Thus half the approved expenditure on school medical inspection, maternity and child welfare work, tuberculosis and port sanitary services, and three-quarters of the expenditure on venereal diseases is defrayed from funds provided by the Treasury. With the exception of certain of the larger boroughs, half the salaries of the medical officers of health and of the sanitary inspectors is refunded out of Exchequer contribution grant.

The question of the substitution of a block grant covering all health services for these special grants-in-aid is at present under consideration by Parliament. (G. BUC.)

II. THE UNITED STATES

A definition which expresses admirably the social and scientific conception of public health in America is that of Winslow, "Public health is the science and art of preventing disease and promoting physical health and efficiency through organized community efforts for the sanitation of the environment, the control of community infections, the education of the individual in principles of personal hygiene, the organization of medical and nursing services for the early diagnosis and preventive treatment of disease, and the development of social machinery which will ensure to every individual a standard of living adequate for the maintenance of

Mortality Trends in the United States. Death Rates per 100,000 Population, 1900–37 (United States Registration Area)*

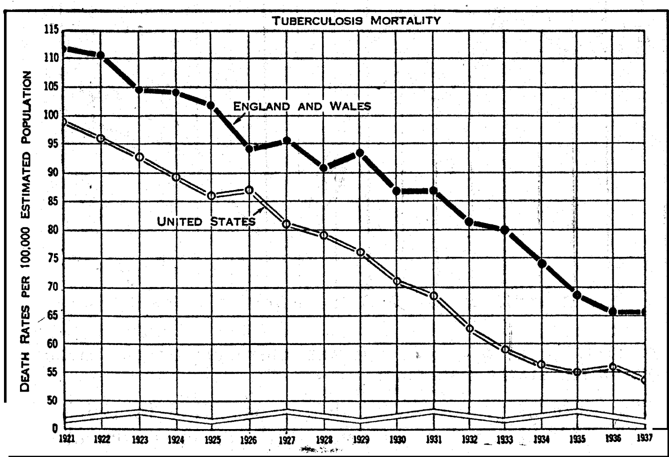
Year	Increasing						Decreasing							Other causes[8]	Total all causes
	Heart diseases[1]	Cancer[2]	Accidents[3]	Appendicitis	Diabetes mellitus	Cerebral haemorrhage[4]	Typhoid fever	Diphtheria	Diarrhoea, enteritis[5]	Influenza, pneumonia[6]	Tuberculosis[7]	Nephritis	Congenital malformations and diseases of early infancy		
1900	132·1	63·0	79·0	9·7	9·7	71·5	35'9	43'3	133·2	203·4	201·9	89·0	91·8	591·5	1,755·0
1901	132·6	64·3	88·1	10·0	10·2	72·2	32'3	34·0	113·5	193·6	196·9	89.3	80·7	534·2	1,651·9
1902	137·7	65·1	78·1	10·0	10·3	72·0	34.3	30·8	105·0	165·8	184·5	90·9	82·9	520·6	1,588·0
1903	143·0	68·3	87·2	11·0	11·3	72·0	34·1	31·7	101·0	173·6	188·5	97.3	86·2	498·5	1,603·7
1904	153·4	70·2	86·7	11·8	12·8	75·2	31·7	28.3	110·6	191·6	200·7	103·1	90·8	486·6	1,653·5
1905	152·2	71·4	84·0	11·9	12·9	74·7	27·8	23.6	115·7	167·7	192·3	103·4	89·3	475·1	1,602·0
1906	148·4	69·1	93·4	11·1	12·7	73·1	31·3	25·7	120.0	155·8	180·2	97.5	91·7	457·5	1,567·5
1907	159·7	70·9	94·4	10·9	13·5	76·1	29·5	23.6	113·3	179·9	178·5	102·4	92·7	451·7	1,597·1
1908	148·8	71·5	82·0	11·3	13·4	71·7	24·3	21·5	111·6	152·2	167·6	93.7	90·4	418·0	1,478·0
1909	151·4	73·8	81·4	11·3	13·8	73·9	21·1	20·4	103·2	150·7	161·1	95·2	87·5	395·2	1,440·0
1910	158·8	76·2	84·4	11·4	14·9	75·7	23.5	21·4	117·4	162·1	160·3	99·1	88·1	402·9	1,496·2
1911	157·1	74·4	84·6	11·7	14·9	76·5	21·0	18·9	91·2	149·6	159·2	97·7	93·2	368·1	1,418·1
1912	159·9	77·1	82·4	11·6	15·0	77·5	16·5	18·2	84·1	142·7	149·7	103·2	95·4	355·5	1,388·8
1913	155·8	79·0	85·5	12·1	15·3	76·5	17·9	18·9	90·3	144·8	147·8	103·0	98·5	364·2	1,409·6
1914	159·7	79·6	78·7	12·3	16·2	79·6	15·5	17·9	79·6	136·4	147·2	102·6	95·5	343·8	1,364·6
1915	165·7	81·4	76·6	12·5	17·5	81·2	12·4	15·7	72·1	149·1	146·3	105·1	92·1	327·3	1,355·0
1916	168·7	82·1	84·2	12·8	17·1	82·9	13·3	14·5	79'5	164·3	142·1	105·6	94·0	343·2	1,404·3
1917	171·7	82·0	88·2	12·6	17·0	84·5	13·5	16·6	79.3	167·8	147·1	107.9	91·9	345·4	1,425·5
1918	170·1	80·3	82·3	12·2	15·9	81·2	12·6	13·9	72·7	587·0	150·0	97.6	92·3	341·0	1,809·1
1919	146·7	80·5	71·9	11·8	14·9	78·6	9·2	14·7	55·2	222.3	125·6	88·1	79·9	288·0	1,287·4
1920	159·1	83·2	71·3	13·4	16·0	81·7	7·8	15.3	54·3	208·0	114·0	89.2	84·7	305·8	1,303·8
1921	156·3	85·6	68·3	14·4	16·8	80·6	9·0	17·6	51·4	99·3	98·9	85·0	83·9	291·1	1,158·2
1922	164·6	86·2	69·5	14·1	18·3	82·9	7·4	14·6	39·3	132·6	96·4	87.9	77·7	282·4	1,173·9
1923	173·8	88·7	75·8	14·7	17·7	86·9	6·8	12·0	39.6	152·4	92.8	89.3	77·3	291·9	1,219·7
1924	176·5	91·1	75·7	14·8	16·4	88·9	6·7	9·3	34·5	116·7	89.7	88.8	77·6	286·3	1,173·0
1925	185·7	92·8	78·5	15·2	16·9	81·0	8·0	7·8	39.4	123·4	86·7	96·5	74·0	278·2	1,184·1
1926	199·5	95·1	78·8	15·0	18·0	82·8	6·5	7·5	33·6	143·5	87·3	98·5	71·7	287·6	1,225·4
1927	196·0	95·7	78·5	15·0	17·5	80·4	5·5	7·8	27.6	103·2	80·9	92·6	67·8	274·9	1,143·4
1928	208·2	96·1	79·4	15·3	19·0	83·4	4.9	7·2	26·9	143·5	79.3	95·2	65·8	282·4	1,206·6
1929	210·8	95·9	80·9	15·2	18·8	82·1	4·2	6.6	23·5	147·2	76·0	91·2	62·4	277·1	1,191·9
1930	205·7	97·3	80·6	15·3	19·0	81·0	4·8	4.9	26.3	102.7	71·5	90·8	61·0	273·0	1,133·9
1931	201·8	98·9	78·5	15·2	20·4	79·0	4.5	4.8	20·7	107·7	68·1	87·1	56·4	263·9	1,107·0
1932	208·9	102·0	71·4	14·2	21·9	79·3	3·7	4·5	16·3	107·7	62.8	87·1	53·1	254·9	1,087·8
1933	205·8	102·2	72·4	14·1	21·3	75·8	3·6	3·9	17·2	95·5	59·5	82·9	50·5	262·4	1,067·1
1934	212·9	106·2	79·9	14·3	22·1	77·3	3·3	3·3	18·3	96·7	56·6	84·2	52·9	275·2	1,103·2
1935	213·1	107·9	78·3	12·7	22·2	76·6	2.8	3·1	14·1	104·0	55·0	81·2	49·4	271·8	1,092·2
1936	227·9	111·0	85·8	12·8	23·7	81·2	2.5	2.4	16·3	119·3	55.6	83·2	49·7	280·4	1,151·8
1937	222·3	112·0	81·4	11·9	23·7	77·0	2·1	2·0	14·6	114·5	53.6	79.6	49·0	278·4	1,122·1

*Vital Statistics, Special Reports, Jan. 16, 1939, Vol. 7, No. 14, pages 43–47, Department of Commerce, Bureau of the Census.

[1]Excludes diseases of the coronary arteries.
[2]Includes all malignant tumours.
[3]All external causes including automobile accidents of all types.
[4]Includes softening
[5]From 1900–20 includes ulcer of the duodenum.
[6]Includes capillary bronchitis.
[7]All forms.
[8]Includes deaths from all causes not otherwise indicated.

health." Progress in public health is shown by the following facts.

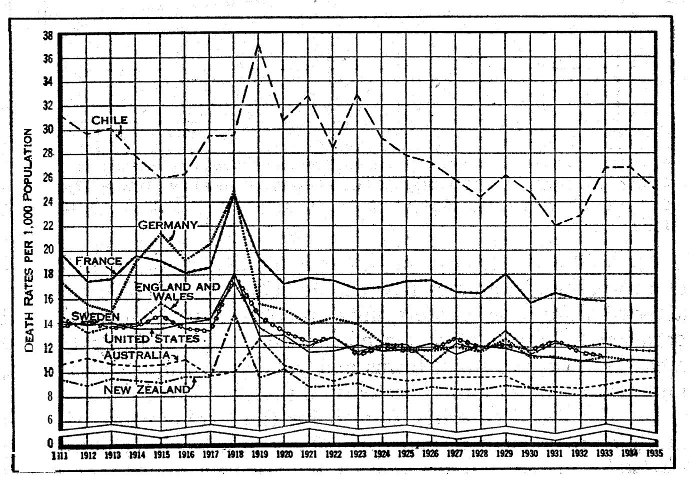
Increase in the Average Length of Life.—The health of the people of the United States has been improving consistently for the past 50 years as is revealed by the official morbidity and mortality rates and estimates of life expectancy. Even as late as 1880 the average length of life in the New England States and New York city probably did not exceed 40 years. By the beginning of the present century this had increased to 49 years for the original Registration States and in 1920 to 56 years for at least the 85% of the population in the registration area. Latest studies (1940) show the average duration of life for the white population is beyond 60 years. It is entirely possible, without any additions to the present knowledge of the causes and means of prevention of disease, that an average duration of life of 70 years may be attained by 1970.



BY COURTESY OF BUREAU OF MEDICAL ECONOMICS OF AMERICAN MEDICAL ASSOCIATION

FROM ANNUAL REPORT, CHIEF MEDICAL OFFICER. MINISTRY OF HEALTH, 1937: BUREAU OF THE CENSUS AND U.S.P.H.S. REPORTS, 1938

Decrease in Death Rate.—In 1870 there were 30 deaths from all causes for each 1,000 of the total population of New York city; in 1937 there were 11·4. Similar changes have occurred in other large cities and in the rural populations, although the city rates were higher in the beginning and have fallen at a more rapid rate than have those of rural communities. In some instances the city rates have been, for recent years, lower than the rural. Since 1900 the general death rate for the registration area of the United States has fallen from 17 to 11·4 per 1,000 of the population.



BY COURTESY OF BUREAU OF MEDICAL ECONOMICS OF AMERICAN MEDICAL ASSOCIATION

GENERAL DEATH RATES OF THE UNITED STATES REGISTRATION AREA AND CERTAIN FOREIGN COUNTRIES FOR EACH OF THE YEARS FROM 1911 TO 1935 — FROM MORTALITY STATISTICS, U.S. BUREAU OF THE CENSUS

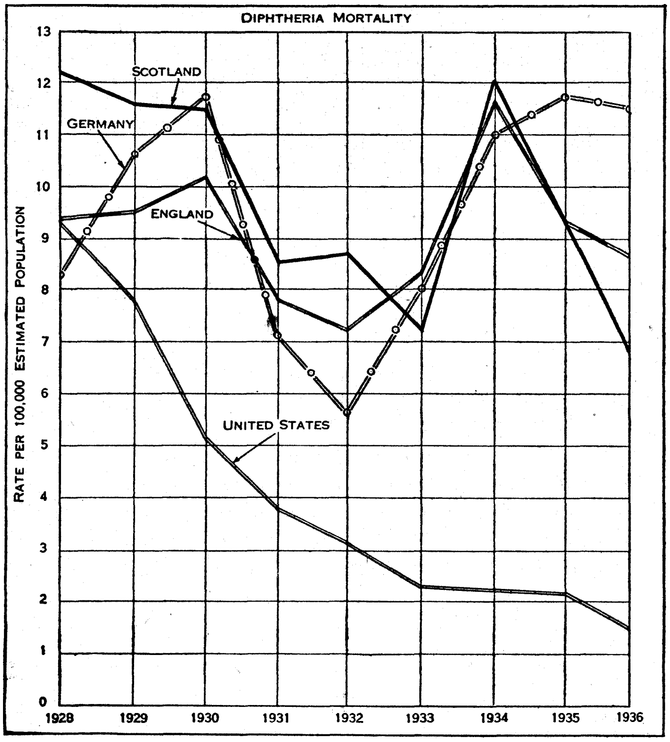
The past quarter century—1910–35—during which an increasing shift of the population took place from rural to urban residence (55% urban in 1927), was characterized by a greater improvement in general health conditions in both city and rural regions than in any previous similar period of time.

The advantage of the rural dweller over the city dweller is found in each decade of life. at least up to the age of 50, and this applies to both sexes.

Changes in Specific Death Rates.—More indicative than are general death rates, of the success of sanitation, personal hygiene and the application of administrative government and social resources for disease prevention, are the changes in the death rates from tuberculosis, typhoid fever, diarrhoea and enteritis among children, diphtheria and the infant mortality. All of these have fallen without exception in those States and cities where reliable records are available.

Typical experience is expressed in the following:

The greatest reduction in the death rate from tuberculosis has been in children under ten. The highest tuberculosis death rates for the country as a whole are those of women from 20 to 30 years of age and for men from 45 to 60.



BY COURTESY OF BUREAU OF MEDICAL ECONOMICS OF AMERICAN MEDICAL ASSOCIATION
FROM ANNUAL EPIDEMIOLOGICAL REPORTS. HEALTH ORGANIZATION. LEAGUE OF NATIONS. 1931-36: SPECIAL ARTICLE, *J.A.M.A.*, JUNE 26, 1937

Typhoid fever, from being an endemic disease of cities, chiefly due to polluted water, is now characterized by its epidemic character resulting from carriers, milk products, oysters and accidental occasional failures of water purification. The endemic typhoid areas are now the small towns and villages of rural States where unprotected water and unpasteurized milk are used.

Diarrhoea and enteritis, from being the leading cause of death in children under five, and particularly among city children and especially in the summer months, now plays a minor rôle, is less prevalent in cities than in rural areas and is hardly more frequent in summer than in winter.

Diphtheria. Now that means of permanent and universal protection of children against diphtheria by active immunization are available, in addition to the resources for specific therapy and determination of susceptibility, the practical disappearance of diphtheria as a frequent cause of death in children under five years of age is within sight.

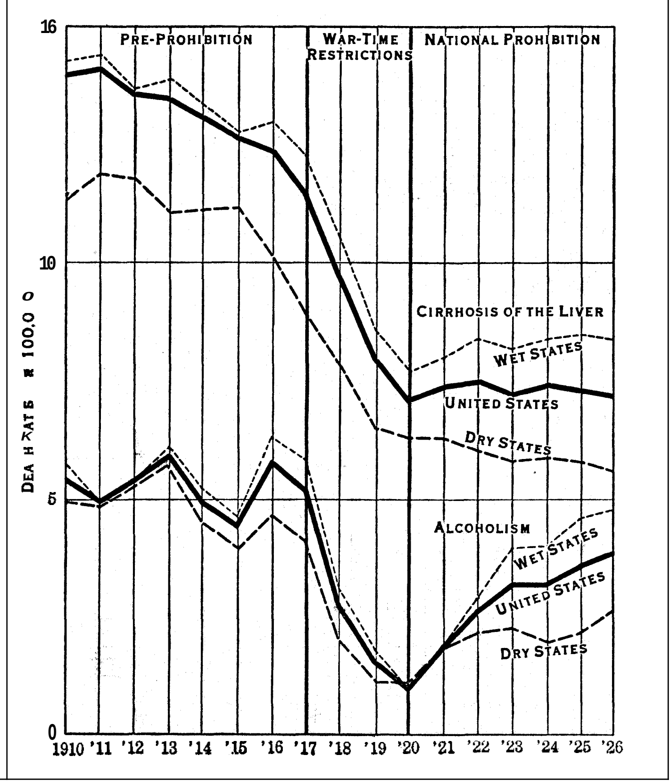
Infant Mortality. While 50 years ago one out of every four babies born alive died within the first year of life, now only one in 20 is so sacrificed. This saving in child life has occurred wherever education of the mother has been provided by doctors and nurses, and water and milk supplies have been safeguarded. It is common to find infant mortality rates lower in the cities than in rural communities, a reversal of the conditions 50 or even 25 years ago.

Increasing Death Rates.—The saving of life in the early years of childhood, particularly from diseases peculiar to infancy and from communicable diseases affecting chiefly children under five, and from tuberculosis in persons from 15 to 30 years of age, since about 1900, has, together with the limitation of immigration altered the age composition of the population to a degree affecting the rates from such causes of death as affect persons over 45 years of age. Of these the most important are heart diseases, cancer and diabetes

The increases in the death rates from heart diseases, cancer and diabetes are in part due to the higher age grouping of the population as a whole, but in addition to this, the death rates for each decade over 45 show increases for each of these diseases.

Deaths from violence and accidents, particularly those due to automobiles, and from appendicitis have increased sharply in recent years. Deaths from causes connected with childbirth have not declined greatly, and those in the United States are above those of other countries with reliable records.

While in 1866 in New York city one death out of every 2,400 was due to diabetes, now (1940) one in 40 is from this cause. The increase, while greater in the cities, is found also in rural populations and among the coloured as among the white races, but everywhere especially among women over 35 years of age.



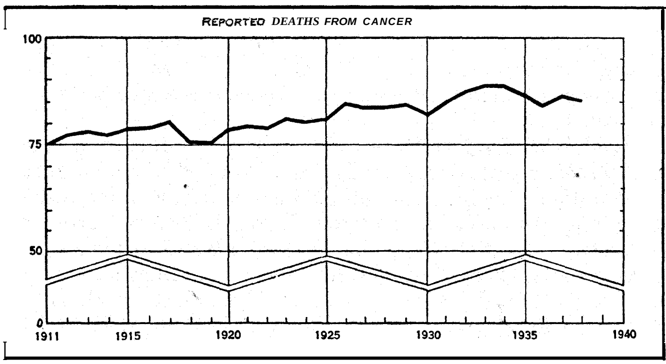
MORTALITY DUE TO ALCOHOLISM AND CIRRHOSIS OF THE LIVER IN THE UNITED STATES (1910-1926)

The shift in proportion of deaths occurring in the various decades of life is a striking evidence of the effective control of the communicable diseases of childhood and early maturity.

Drop in the Birth Rate.—With the reduction in loss of infant life has come a lowering of the birth rate in the United States as a whole and for each State and racial group. Within the past 50 years the birth rate has dropped from approximately 40 per 1,000 population per annum to 16·7. From 1921–25 the birth rate was 22·5 in the birth registration area and in 1936 it was 16·7.

The Three Eras of Public Health.—For the first 125 years of the life of the nation, public health work was limited to control or improvement of man's physical environment and enforcement of quarantine by the exercise of the authority of the official health agencies, the boards and departments of health acting under the police powers which are reserved to the States under the federal constitution. This may be called the era of sanitation, the great accomplishment of which was the reduction of communicable diseases transmitted largely, if not exclusively, through drinking water polluted by human wastes. Sanitary disposal of sewage, the protection and purification of water supplies, the control of nuisances and the improvement of housing constituted the first effective attack on environmental hygiene and saved the cities from destruction. At the beginning of this era death rates in the large cities equalled or exceeded the birth rates. The health officer relied upon legal rather than scientific authority, upon the force of police powers rather than the power of education and authority, upon his individual or departmental services rather than upon the technical assistance and popular influence of volunteer co-operating agencies and associate professional groups.

Not until Lemuel Shattuck in Massachusetts in 1848 and Dr. Stephen Smith and his associates in New York city in 1865 had disclosed by careful surveys of the health of the population the



BY COURTESY OF BUREAU OF MEDICAL ECONOMICS OF AMERICAN MEDICAL ASSOCIATION

STANDARDIZED DEATH RATE PER 100,000 INDUSTRIAL POLICY-HOLDERS, AGES 1-74 YEARS. THE 1938 RATE IS PROVISIONAL.— SOURCE: "TWENTY-FIVE YEARS OF LIFE CONSERVATION," AND STATISTICAL BULLETINS, METROPOLITAN LIFE INSURANCE COMPANY

true extent of preventable disease and death, and the fact that the death rates in the cities were higher than the birth rates did the public demand something approaching qualified direction and consistent scientific operation of a well-organized department of health. The first State department of health was organized in Louisiana in 1853.

In 1900 there began the movement for public education in health which has been a factor of tremendous importance ever since, not only in the widespread dissemination of popular information about preventable disease, but in bringing to the support of the official health department or health officer interest, knowledge, financial assistance and public opinion through the influence of volunteer or unofficial health agencies.

The initial movement of this educational or public informational era of public health was that of the tuberculosis committees and societies and national, State, and local associations, now operating with undiminished vigour and sustained interest and financial strength as the National Tuberculosis Association. The three simple facts with which the public was approached were the communicability, curability and preventability of tuberculosis. Once accepted, it was inevitable that knowledge of these facts should lead to appropriate communal action. The National Tuberculosis Association, its 48 State societies and 1,300 other local societies have been the exciting, if not the driving, force which has brought 600 tuberculosis clinics, 60,000 sanatorium beds for tuberculous patients (1922), a tuberculosis division in all important State and local health departments and a scientific program of prevention uniformly accepted as an essential part of the work of the public health officer and department of every community.

The most important features of the program of the National, State and local tuberculosis associations since the beginning of the movement in 1904, have been those measures which have brought about "notification and supervision of persons afflicted with tuberculosis; the construction and maintenance by cities, counties and States, of institutions for the care and treatment of tuberculous patients of all types; institutions for the prevention of tuberculosis, such as preventoria, open-air schools and camps; the instruction of the public in the methods of avoiding and curing tuberculosis; and finally the intensive scientific study of methods to be used in the prevention and treatment of tuberculosis."

Following the leadership and example of the tuberculosis associations, there were developed similar private health agencies first as local societies and later on a national scale to carry a lesson of prevention and of health on the subject of infant mortality and child hygiene, on pre-natal care of the expectant mother, on social hygiene, a synonym in the United States for venereal disease control, on mental hygiene, cancer, blindness, heart diseases, etc., until the country was swept with successive waves of specialist health propaganda to stimulate appropriate public and official action. It is not unusual to find that twice as much money is spent for public health through the private agencies as is invested by the taxpayers in their official health department.

The third era of public health which was just emerging in 1928 as a definite new phase, out of that of public information or health education, had its inception in the World War experience from which the conviction developed that only by the systematic use of the periodic health examination could all the potential benefits of preventive medicine be made effective for the individual.

With the common action of the American Medical Association and the unofficial and official health agencies through the National Health Council in 1922 an agreement was reached which has been followed with much success. The objective of the present era of public health is to obtain from the prenatal stage until old age for each individual the benefits of personal medical guidance in a healthy way of life, in addition to medical services for the care of sickness. The supervision of the expectant mother, the guidance of the infant's growth, the supervision of the development of the runabout child of two to five, the protection of the health of young people and adults of middle age until their years of work are over in old age all depend for their effectiveness upon individual application of the principles of personal hygiene according to the requirements of age, sex, work, personality and the limitations of inheritance and of economic and social status.

The policy has been to inform the public through official and volunteer health agencies of the benefits to be obtained from a periodic medical examination and to train physicians to carry out the technical service required. Personal interest in and responsibility for individual health is essential if the present knowledge is to be effectively applied through the mechanism of medical examinations and health conferences.

In all health matters pertaining to interstate and foreign comnierce the responsibility rests with the Federal Government through the United States Public Health Service of the Treasury Department. In addition to large functions in medical relief, particularly for merchant seamen, the Public Health Service maintains active consulting and co-operative relations with State and local health authorities, carries on widespread attack upon the venereal diseases through a variety of channels, supervises and controls the standards and production of biological products used for diagnosis and treatment of disease, maintains an effective information and education service of national scope, and carries on researches in sanitation, preventable diseases and vital statistics.

Health activities of various kinds are carried out under six other Cabinet departments and many more independent establishments of the executive branch of the Government.

Local health organizations may not set up standards or enforce local ordinances inconsistent with those established by the competent State authority.

Not only cities, towns and incorporated villages, but counties and rural districts to an increasing degree maintain self-contained health departments adequately performing the essential functions.

A minimum provision for any unit of population of 50,000 persons or over as conceived by the professional public health workers of the United States is as follows: a full time health officer, qualified by training and experience, free from partisan political interference in tenure of office, and paid a salary in proportion to the responsibility of the position; a board of health or advisory health council; trained personnel, including public health nurses to the number of one to every 3,000 of the population, capable of carrying on the seven functions previously described, and a budget based upon an appropriation from public funds of $1.00 to $2.00 per capita for health purposes.

Adequate provision for the organized care of sickness in any community of 50,000 persons or more includes at least:

A general hospital with a capacity of five beds for each 1,000 of the population for the use of general medical and surgical patients, and for maternity cases, and space for the cubicle isolation of acute communicable diseases (one bed for each 2,000 of the population). Beds for diagnosis and observation of tuberculosis, venereal disease and mental patients should be included.

A tuberculosis sanatorium with accommodations for one patient for every 1,000 of the population.

Hospital facilities for three mental patients for each 1,000 of the population. Institutional provision for chronic invalids and convalescent patients according to the social, economic and industrial status of the people.

While all local health departments do not have direct responsibility for the care of the indigent and other sick of the community, the hospital care of the acute communicable diseases and often of tuberculosis and venereal diseases is commonly under the health officer and in a number of large cities, *e.g.*, Philadelphia and Detroit, public hospitals for general medical, surgical and maternity care and district or city physicians to visit the sick poor are under the health department.

Interest in treatment and prevention of all sickness is within the proper province of the health officer and unless the institutional and private physician facilities for the diagnosis and care of sickness are adequate, a community cannot have a wholly satisfactory service for health.

ORGANIZED HEALTH WORK

In the United States the problem of the proper or desirable division of public health authority between Federal, State, and local agencies is one as yet unsettled. By the Federal Constitution, the State is the ultimate authority and each State jealously guards its autonomy in matters pertaining to public health.

In the same way the local authorities demand ultimate power in relationship to certain health functions which relate wholly to the health problems of the local community. The development of many non-governmental health agencies is also to be considered in the evaluation of public health work in the United States.

The chief questions of recent years have related to the inequality of the distribution of the benefits of modern public health and medical science. Thus recent years have seen the conduct of a National Health Survey to determine the amount of chronic disabling illness and the extent of medical service available for its care. Innumerable surveys have also been made of local, State, and national health services. As a result there has been proposed a National Health program, involving the appropriation of vast funds to be distributed to the individual States as grants-in-aid for specific health purposes. Moreover, under the Social Security Act of 1934 extensive funds have been appropriated to the United States Public Health Service and the Bureau of Maternal and Child Welfare in the Department of Labor to carry on extensive preventive, medical, and educational services in the individual States. Under this system, the States must match the appropriation of the national Government and must submit plans for the approval of national bureaus before grants are made.

There is also widespread agitation for compulsory sickness insurance in some of the individual States and by certain agencies which would ask the Federal Government to provide funds for establishing such systems in the individual States. (*See* also HEALTH VISITOR).

BIBLIOGRAPHY.—Annual Reports of Chief Medical Officer to the Ministry of Public Health; Annual Reports of the Chief Medical Officer to the Board of Education; Annual Reports of the Chief Inspector of Factories and Workshops; Simon, *English Sanitary Institutions* (1890); First Report and Minutes of Evidence of the Royal Commission on Local Government (1923–27); Lumley, *The Public Health Acts* (1923); Robertson and Porter, *Sanitary Law and Practice* (1927); Bannington, *English Public Health Administration* (1915) (another edition in preparation); Hamer and Hutt, *A Manual of Hygiene* (1925); Hope and Stallybrass, *A Textbook of Public Health* (1926); Parkes and Kenwood, *Hygiene and Public Health* (1923); Newsholme, *Vital Statistics;* Mess, *Factory Legislation and its Administration* (1926); Hutchins and Harrison, *A History of Factory Legislation* (1926); Collis and Greenwood, *The Health of the Industrial Worker* (1921); M. J. Rosenau, *Preventive Medicine and Hygiene* (1921); Wm. H. Park, *Public Health and Hygiene* (1928); *Preventive Medicine and Public Health* (2 vols.) (1928); Chas. V. Chapin, *Municipal Sanitation in the United States* (1900); *The Public Health Service Monograph No. 10,* Institute of Government Research (1923); James A. Tobey, *National Government and Public Health,* Institute of Government Research (1926); Robt. D. Leigh, *Federal Health Administration in the United States* (1927); American Child Health Association, *Health Survey of 86 Cities* (1925); Carl E. McCoombs, *City Health Administration* (1927); M. J. Ravanel, *A Half-Century of Public Health* (1921); Harry H. Moore, *Public Health in the United States* (1927) and *American Medicine and the People's Health* (1927); Louis I. Dublin, *Health and Wealth* (1928); Nathan Sinai, *Organization and Administration of Public Health* (1933); Committee on the Costs of Medical Care: "Final Report, Medical Care for the American People," University of Chicago Press. (H. E.; M. FI.)

PUBLIC HOUSE, in its general English acceptation, a house in respect of which a licence has been obtained for the consumption of intoxicating liquors. Public houses are frequently distinguished as "tied" and "free." A tied house is one rented from a person or firm from whom the tenant is compelled to purchase liquors or other commodities to be consumed therein. A free house has no such covenant. (See INN; LIQUOR LAWS; TEMPERANCE; PROHIBITION.)

PUBLIC SCHOOLS. In the United States this term is used to describe free, tax-supported, public controlled and directed, non-sectarian schools. The term public school in England includes not only the schools of ancient foundation like Eton, Harrow and Winchester (see SCHOOLS), but also schools of comparatively recent creation like Clifton, Cheltenham and Marlborough. As forming part of the secondary school system of England (see SECONDARY EDUCATION) they are included in the official statistics as non-aided schools.

PUBLIC SERVICE CORPORATION OF NEW JERSEY, a holding company carrying on its activities through subsidiaries, was incorporated in 1903, and thereupon acquired the ownership of the principal electric, gas and street railway companies of New Jersey. It was one of the first great aggregations of public utility properties in the United States. Its principal subsidiaries, Public Service Electric and Gas Company and Public Service Co-ordinated Transport, operated (1939) in 426 New Jersey municipalities, providing gas, electric, street-car and motor-bus service. The territory served reaches from the Hudson to the Delaware river, and includes the cities of Newark, Jersey City, Paterson, Trenton, Camden, Hoboken, Passaic and Bayonne—in all of these services, and the cities of Elizabeth and Perth Amboy in all except gas service. This territory contains 95% of the State's population and 90% of its industrial activity.

The Public Service electric system, interconnected for exchange of power with large systems in New York and Pennsylvania, included five large steam operated power plants and some 80 substations. The system of gas mains extends across the State and is all interconnected; the motor-bus and the street railway systems are among the largest in the United States.

Upwards of $415,000,000 of new capital has been expended in the last 36 years, in extending and developing the plants of the subsidiaries of the corporation. The securities of the corporation and its underlying companies are distributed among approximately 104,000 owners, the number of individual stockholders of the corporation itself being in the neighbourhood of 85,000. The operating revenues of the Public Service Corporation of New Jersey for the year 1938 approximated $127,000,000. (T. N. McC.)

PUBLIC UTILITIES,[1] a designation for a special grouping of industries. These industries should be distinguished from State services or public works, which are administered as public functions and hence supported by taxation, and from that variety of industrial, commercial and agricultural undertakings which are usually comprehended under the term "private business." Public utilities, properly so-called, need not be privately owned. In

[1]The writer is indebted to the Macmillan Company for permission to adapt from his recent work, *Outlines of Public Utility Economics,* certain summaries for substantial portions of this article.

almost every country a varying number of them are owned and operated by the State. But these publicly managed enterprises, instead of looking to the State for financial support, sell their services to the general public. Both publicly and privately owned utilities sell their services at prices which are not fixed in the open market but are governmentally fixed. This is the most important aspect of the process known as public utility regulation. Although economic and technical evolution is continually changing the character of these industries besides creating new ones, public utilities may be classified according to the generalized function which they perform in economic life.

The following have been treated as and classified into groups of public utilities: (1) Services of transportation (common carriers); (2) Services incidental to transportation; (3) Services facilitating communication; (4) Facilities providing power, light, heat and refrigeration; (5) Facilities providing water and sanitation in urban communities; (6) Facilities regulating water-supply for agricultural purposes.

HISTORICAL SURVEY

Public utilities are closely associated with our developing civilization, supplying wants so fundamental for communal living that Government has at all times subjected them to some measure of control. With the growth of trade in ancient empires facilities providing transport and communication were set up. The governmentally maintained highway system of the Roman empire and its many aqueduct systems are celebrated ancient public works. The need of some system of public communication was so great that even our letter post has its ancient parallel. In the more populous ancient cities systems of sanitation also became a necessity. Along with this came the recognition that services used collectively should be supplied by the State. Public utilities thus began as State functions. By the middle ages most of the ancient public utilities had declined or virtually disappeared. By slow stages, upon the manors and in the mediaeval cities, these public facilities again appeared. Of great importance in British and American legal history, is the fact that out of the economic and legal relationships of feudalism there arose the concept of a "public calling" upon which is based the present-day policy of public utility regulation.

The modern national State gradually supplanted the elements of the feudal system of social control. The expanding domestic system of manufacture was displacing the gild and manorial system of production; foreign trade was growing. National systems of transport involving highways and canals were undertaken and the regulation of utilities became national rather than local.

Effects of the Industrial Revolution. — The greatest impetus in the expansion of public utilities came with the industrial revolution. The factory system so stimulated production that the need for ever-expanding markets became the limiting factor in economic evolution. Cities grew as never before, creating a new municipal need for systems of water-supply, sanitation, transport, communication, illumination and finally of power.

But the philosophy of laissez *faire* was not fertile ground for extending public functions. Hence, although the rapid industrial changes intensified needs, the tendency was to give greater scope to private enterprise.

However, the evils of a system which left the supply of basic economic wants to private industry insufficiently regulated by government became too flagrant to be overlooked. Beginning about 1840 the revolt against laissez *faire* doctrines caused an enlargement of the scope of governmental action. The older public utility services were continued for the most part as public enterprises, while the newer services were supplied by private initiative under some form of public supervision and assistance. Thus emerged the modern notion of a public utility, distinct from strictly governmental services and strictly private business.

Need **for** New **Utilities.**—The beginnings of the modern postal system date back to the 15th century. In the 18th century England was covered with improved roads built by public authority or by private turnpike companies. The first canal in a new era of canal building was completed in 1761. The first steam railroad was built in 1825 and the first regular steamboat began operation in 1812. The steam railway has developed into the backbone of land transportation, yet canals and inland-waterways continue to serve as important arteries of commerce. With the coming of the automobile, in the United States as elsewhere, highway systems are being reorganized upon an unprecedented scale. The motor-bus and the motor-truck are making use of this development and are rapidly cutting into the short-distance traffic of steam railroads. Since 1850, systems of rapid, world-wide communication have been perfected. The commercial electric telegraph and the telephone are now of tremendous importance. (See TELEPHONE; TELEGRAPH.) After 1900 radio-telegraphy and since 1907 radio-telephony have increased the varieties of means of communication. The ancient art of irrigation is undergoing a rebirth.

In the field of municipal public utilities local transportation was supplied, at first, by fleets of omnibuses in the '20s of the 19th century. The horse-car came in the '30s. Artificial gas for illumination was introduced commercially in London in 1812 and was widely in use for lighting by 1840. A new development in water-supply systems appears to have been introduced by the municipality of London in 1583, followed by Plymouth in 1585 and by Oxford in 1610. Boston in 1652 installed the first modern central water-supply system of the gravity type in America. Central water-supply systems became general in the large cities by 1820. Growing out of experiences in the cholera epidemic, British sanitary authorities put forward the trilogy of public hygiene—street paving, canalization and water-supply. As a final achievement in the development of municipal sociology came a new city-planning movement, begun in Paris about 1850. (See TOWN PLANNING and related articles.)

New public utilities centring in cities have developed out of the industrial applications of electric power. In 1882 the first central station for electric lighting began operation in the United States. By 1885, electric power was applied to street-railways. The first hydro-electric plant began operation in 1882, the precursor of a new movement in power production.

In this historical survey it is important to note that public utilities were not definitely segregated from public functions until the laissez fake philosophy of the 18th century restricted the scope of governmental activity and created institutions and processes whereby the supplying of these changing public needs could be left to private initiative. Industrial interdependence now prevails. Thus public utilities, although privately owned, must be subjected to governmental regulation. The term socialization has been chosen to describe this latest phase of utility development because it implies that government may actively promote these enterprises through public ownership or arrive at the same result by creating private agencies and controlling them through well-conceived policies of regulation.

ECONOMIC CHARACTERISTICS

Developments in the engineering arts bring changes in economic organization. For instance, lighting of the home has been transformed first from a self-sufficient household industry (as the making of candles) to a commercial competitive industry (the supply of candles, lamps, whale-oil and petroleum), and then to monopolistic industry (as in electric lighting and the various forms of gas illumination), where central sources of supply satisfy all demands. Perhaps the most significant economic conclusion founded upon these changes is that the social value of public utility services is increased and the economic cost of rendering them is reduced by a consolidation of enterprises. The individual user of water in our urban centres no longer depends for his supply upon his own well, nor does he buy from one of several competing sources. He resorts to a single common source of supply along with other users. This has been found to be more convenient, economical and, indeed, the only practical solution. But this process of integration of supply has been a long process. In some public service industries it is not even yet completely realized. There are still competing gas, electric, transportation and telephone utilities. This tendency toward monopoly, whether the result of a competitive struggle or brought about by legislation, is a fundamental characteristic of public utility business.

Every public utility must be in possession of the natural resource upon which that industry is based. A gas or electric company must have possession of sites for the location of its works; a transportation company must have rights of way and terminal sites. These properties must have strategic locations. Limitation in the choice of this agent of production tends to make the cost of acquiring or leasing these facilities greater than it would be if the industry had a wider range of choice. Furthermore, utilities must make allowances in advance for probable increase in the required capacity. For these reasons utilities are provided with the governmental power of *eminent domain* which makes possible the compulsory sale of private property. Thus the law recognizes that, socially considered, these properties are being put to the highest uses of which they are capable.

Fixed Capital Characteristics. — In constructing public utility plants we meet all the varying stages of transmutation of capital. The so-called free or liquid capital is changed into durable and specialized types of buildings, structures and equipment, capable of use in only one industry. The roadway and track of a railway, for instance, is so completely "specialized" that only the rails and rail-fastenings can be salvaged. These characteristics of specialization, durability and immobility are included in the definition of "fixed capital." It is also well to bear in mind the specialized managerial and engineering talent required in constructing and operating these enterprises.

A utility which has assembled its plant and thereby incurred heavy construction costs of a "fixed" character anticipates that the product can be sold at a profit. If expectations are not realized the utility will suffer a pecuniary loss because the government has not generally undertaken to secure the utility against such risks. It is therefore highly important that each enterprise take into account the economic principle of proportionality which requires that enterprises be so planned that the maximum of physical output may be secured at the lowest possible money cost and that this maximum supply does not exceed the reasonable, long-run demand for service.

But there is another aspect of the matter. Technical improvements involving much fixed investment of capital are also more economical. A double-track railway has more than twice the efficiency of a single track railway. Electrical generators of large capacity cost less per kilowatt than do generators of small capacity. The cost of operating large plants thus tends to be less than for small plants. Public utilities are therefore anxious to increase the volume of business. Economical operation is also secured by "interconnection" of power sources into so-called super-power systems. A super-power system consists of two elements: the utilization of highly economical generating stations, steam or hydro, and the interconnection of power stations by transmission lines. Not only is the fuel consumption per unit of output reduced by using only large steam plants but the investment cost per unit of capacity is also lowered. By interconnecting such power systems the reciprocal sale of power from one system to another is made possible and a common reserve is made to serve for a large area. Co-operative action thus ensures the utilization of surplus power, safeguards the service from interruptions and secures the advantages of long hour use of investment by building up the diversity of use. This movement for interconnection is growing particularly in the instance of gas and electric utilities.

Availability of Utility Services. — There are also peculiarities arising out of the time when the demand of customers comes and these have a special influence upon cost of production. All public utilities must stand ready to supply their services when demanded and from this point of view utilities may be divided into two classes according to the ease or difficulty with which they meet this situation.

The first class comprises the utilities which must adjust themselves to demand variations by having constantly ready a productive capacity equal to or exceeding the maximum demand for service. Thus utility plants will have spare capacity for service at other times in the shape of idle equipment and reserves of employees. This class of utilities has been called the "service type" and is exemplified by electric utilities, telephone and telegraph utilities, the different kinds of transportation utilities and the postal service. Here the nature of the service is such as not to permit of delay if it is to be performed efficiently. Technical development has not been successful in making available for instant use surplus service which existing equipment might have produced at times of low demand. Changes in the volume of business can not be met by a policy of meeting peak requirements in part by stored supplies of the past. This has a tendency, therefore, to increase the cost of operation.

The second class consists of those utilities where the inequalities in customers' requirements may be met, at least in part, by a policy of production and storage of surplus to meet future deficiencies. This class has been called the "product type." It is exemplified by water and gas utilities which may produce at a uniform rate, impounding the water and storing the gas not required to meet the immediate demands against the excess demands of the future. Storage facilities thus enable the "product type" to operate at a uniform output within the productive limits for which the plant was designed. Utilities of the second class need have a producing capacity equated only to meet an average demand but they must provide storage capacity.

We must, therefore, compare the operating efficiency of the product-type utility, based upon a constant output with costs enhanced by an added investment in storage facilities, with the operating efficiency of the service-type with its lessened efficiency resulting from a variable output and with costs enhanced by "standby" losses and the carrying charges for idle equipment. The services of public utilities are thus conditioned by factors which tend to differentiate them from other business enterprises. They minister to wants which are regarded as basic. From a social point of view they are necessary economic functions because they are the basis for the specialization of occupations and the interdependence which exist in modern economic society.

SOCIAL CONTROL OF PUBLIC UTILITIES

Public service enterprises are regulated by governments throughout the civilized world. It is impossible in this article to trace this development or to outline the present structure of regulation. Those desiring a detailed presentation are referred to the bibliography. In this summary is mainly given a discussion of the development of social control of public utilities in Anglo-American countries. The regulation of national systems of transportation and communication is also excluded except in so far as their prior development has influenced the course of regulation of local utilities.

Munn v. Illinois Decision. — The legal basis of public utility regulation may best be disclosed by considering the famous decision of the U.S. Supreme Court in *Munn* v. *Illinois* (94 U.S. 113 [1876]). In this decision is focused the common historico-legal background of public utility regulation in both the United States and Great Britain. *Munn* v. *Illinois* involved the validity of an Illinois statute fixing maximum rates for storing grain in elevators at Chicago. Munn had been engaged in the elevator business since 1862, long before the enactment of the statute, and had been in the habit of charging rates fixed by agreement among the elevator owners in Chicago and had continued to charge these rates although they were in excess of those fixed by the act. Munn was convicted and fined in the State courts but appealed to the U.S. Supreme Court upon the ground that the act violated the 14th amendment in that it deprived him of his property without due process of law.

Chief Justice Waite, in upholding the validity of the statute, said in substance that under the circumstances in which the elevators were being operated in Chicago, that is, standing in "the very gateway of commerce and taking toll from all who pass," they had become business "affected with a public interest and had ceased to be *juris* private only." This was not his own language but was quoted from Lord Chief Justice Hale who had penned it some 200 years ago in England. This legal doctrine, he said, had been a rule of the law of property ever since; that under this rule and in exercising the police power of the State, "it had been customary in England from time immemorial and in America from its first colonization to regulate ferries, common carriers, hackmen, bakers, millers, wharfingers, innkeepers, and so forth," and to fix maximum charges. In further explanation of this "public interest" doctrine, the court said that private property is being used "in a manner to make it of public consequence, and affecting the community at large. When, therefore, one devotes his property to a use in which the public has an interest, he, in effect, grants to the public an interest in that use, and must submit to be controlled by the public for the common good, to the extent of the interest he has thus created. He may withdraw his grant by discontinuing the use; but, so long as he maintains the use, he must submit to the control."

In a recent case *(Charles Wolff Packing Co.* v. *Court of Industrial Relations of the State of Kansas,* 262 U.S. 522 [1923]), Chief Justice Taft of the U.S. Supreme Court gave further precision to this "public interest" doctrine by saying: "In a sense, the public is concerned about all lawful business because it contributes to the prosperity and well-being of the people. The public may suffer from high prices or strikes in many trades, but the expression 'clothed with a public interest' as applied to a business means more than that the public welfare is affected by continuity or by the price at which a commodity is sold or a service rendered. The circumstances which clothe a particular kind of business with a public interest, in the sense of *Munn* v. *Illinois* and other cases, must be such as to create a peculiarly close relation between the public and those engaged in it, and raise implications of an affirmative obligation on their part to be reasonable in dealing with the public."

Obligations of Public Utilities. — The affirmative obligations upon public utilities arising out of their peculiarly close relation to the public are usually spoken of as that system of rights and duties which constitutes the law of public service undertakings. Briefly, this law places upon a public utility the extraordinary duty to render reasonably adequate service to all who apply. It is required to serve them up to the limit of its capacity, with capacity being defined as the limit of profitableness. It may not let customers' wants go unsatisfied. Nor may it attach unreasonable conditions to contracts for service so as in effect to negative its duty "to serve all comers." Furthermore, it must serve without discrimination all customers similarly circumstanced. Finally, a public utility must observe more than ordinary care in the rendition of service in view of the dependence of the public. On the other hand, the law concedes a public utility the right to collect a reasonable price, to render service subject to reasonable rules and regulations, and to withdraw service under prescribed conditions after giving notice to customers. While customers are given the right to demand that a public utility live up to its duties, they are, on the other hand, required to accept recip rocal obligations.

In determining whether a given industry is subject to this coercive law of public utility the courts have adopted certain practical tests of both a legal and an economic nature. The economic tests look to the presence of elements of natural monopoly in such number and strength that competition can not work successfully. Under these conditions fair prices, in the sense of competitive prices, are not realized. The power of the State will be used either to regulate industries so as to restore equality of bargaining power by maintaining competition and controlling competitive practices, or used to promote the inherent trend toward monopolistic organization by conferring upon such industries legal monopolies and then controlling their economic relations by means of the system of rights and duties just outlined.

From an economic point of view it is clear, therefore, that the notion of a public utility is made up of two ideas: *(a)* the idea of monopoly and (b) the idea of common necessity. Both must be present in order that an industry may become a public utility. Neither alone will suffice. The supply of housing facilities is a necessary economic function, and when it is furnished upon a competitive basis the customer is not coerced. But when, in emergencies such as the acute housing shortage *(see* HOUSING) during the World War, the consumer is forced to bargain for a necessity under conditions of temporary monopoly, the courts will uphold the regulation of rents. Yet the character of regulation will be attuned to the normal condition. The emergency having passed, as building operations are resumed, competition again sets in, and the reason for regulation disappears. The housing industry therefore represents a border line case which, nevertheless, ought not to be classed as a public utility under normal conditions.

Legal Conception of a Utility. — When freedom of choice is seriously restricted — that is, when the coercion residing in private property makes itself felt as a monopolistic power — public interest arises in proportion as equality of opportunity to choose is restricted, provided that the wants supplied are recognized as a common necessity. Monopolization of a luxury will not call forth regulation, for public opinion is the arbiter in the selection of those common economic needs whose monopolization engenders regulation. The concept of public utility thus becomes a legal instrumentality to achieve an improvement of the standard of life. In a society which is accustomed to look to governmental initiative for the supply of common needs, the facility will be supplied as a public function On the other hand, a society which is distrustful of the State will leave the supplying of such common needs to a private agency under a franchise privilege, not as a matter of common right, but as an agency of the State.

Since the law has long recognized the rights and duties of public utilities, this legal conception has attained a certain fixity in the form of legal rules. But the number and kind of industries that may be subjected to these rules is not fixed. It may be said that the legal notion of public utility is that of a fixed concept with a changing content. The industries at any time recognized as "clothed with a public interest" are not necessarily the industries which may legally be classified as public utilities at another time. The industrial and political situation as mirrored in public opinion will determine: (a) the number and kind of industries classified as public utilities; (b) the elaboration of the system of rights and duties which make up the institution; (c) the regulating agencies and instrumentalities employed (whether the legal rules and decrees of courts or the charters, special franchises and statutes of legislatures); and (d) the subordinate administrative standards which are evolved in practice. The trend in the development and application of the institution will be a resultant of the amount of social inertia, of the pressure of the economic environment and of the influence of intellectual progress. Special attention should be directed to these dynamic factors: *(a)* the growth and extension of monopoly; (b) war and other conditions creating special emergencies; (c) the movement for conservation of natural resources; (d) the movement for public ownership.

Regulation in the United States is accomplished in three distinct ways (1) judicialiy by means of suits at law where the common law duties and rights of public utilities are applied in specific cases; (2) legislatively by means of corporate charters or special franchises; (3) legislatively by means of the police power of the States or its Federal equivalent, the power of Congress over interstate and foreign commerce. Judicial regulation is the oldest and constituted almost the only form of control during the first half of the 19th century. Legislative regulation has now largely supplanted judicial regulation, but the latter remains in the background as a potential agency which may become active again if legislative regulation should disappear. The function of the judiciary by 1928 had been restricted to the review of legislative and administrative acts.

Legislative regulation by means of the charter or special franchise was the next to be tried. The special franchise is now generally conferred under constitutional or statutory authority by local governments. The method of special franchise regulation is applied to so-called local public utilities, furnishing telephone, gas, electric, water and transportation services in local communities.

The weakness of legislative regulation by charter was that the maximum rates therein provided were largely in excess of those actually charged by the companies. Competition of carriers with each other, the decreasing unit cost of operation on account of increased utilization of plant capacity, the decline in the level of prices after the Civil War, continuous improvements in technique, made necessary and possible the rendition of service at rates below those fixed in the charters. The failure to provide adequately for financial and accounting control enabled the issuance of more stock and the padding of investment accounts, thus vitiating the control based upon net income. Special franchise regulation followed the procedure applied in the case of carriers. Maximum rates were fixed in the local franchise of telephone, gas, electric and water undertakings. These maximum rates soon became obsolete because the growing business of the companies required more complex and flexible rate schedules. Moreover, the companies began to appreciate that increased earnings, both gross and net, could be secured by means of rate reductions.

When State legislatures in the case of national carriers and local councils in the case of local utilities attempted to adjust these rates downward, they were met by the objection that the change would violate a contractual obligation and confiscate the property of the companies. Only when the franchise was silent on rate questions or when the power to alter, amend or repeal the terms of franchises was reserved, could the power to regulate rates or service be exercised by State or local legislatures. Another evil that had crept into the administration of public utilities due to the ineffectiveness of rate control was discrimination in rates. This was also induced by the fact that competition had never been entirely eliminated. Added to this, in the case of the limited term franchises of local utilities, was the growing insecurity of tenure. Failing to obtain a renewal the properties would be worth only their scrap value. Often there were no provisions for public purchase or for purchase by some other grantee at the end of the franchise period. The inducement was too great, therefore, to manipulate operations so as to enable investors to recoup their capital out of earnings.

Thus the fundamental drawbacks of charter and special franchise regulation were: that such regulation proved inadequate when communities grew rapidly; or when, as during the period of the World War, underlying economic conditions changed rapidly, so that the administrative machinery for the execution of franchise terms proved inadequate.

About 1870–80 a policy was adopted of fixing rates by direct legislation. Legislatures realized that statutory regulation should be general rather than specific; that the rate and service problems require continuous attention; that the subject matter of statutes should be the laying down of principles and standards; that the new policy of continuous regulation required an effective agency, sufficiently "informed by experience" to carry legislative standards and principles into effect. This agency is the modern administrative commission, acting as an agent of the legislature. All States except Delaware now have regulatory commissions with varying jurisdictions. The Interstate Commerce Commission (1887), the Maritime Commission (1938), the Federal Power Commission (1920) and the Securities and Exchange Commission (1935), are Federal commissions regulating the interstate operations of national utilities. The administrative commission applies the common law rule of reasonableness to the concrete facts in each case and names the particular rate or service regulation reasonable under the circumstances. Practically all States prohibit discrimination in rates for service. This legislative injunction has been made operative in connection with another one calling for publicity of rates and providing that only those rates and regulations which are on file and have been approved by the administrative authority are the lawful rates. In some States designated local utilities continue to be controlled by means of franchises. One form of these local franchises, the so-called service-at-cost franchise, deserves special mention. In general, service-at-cost franchises seek to protect invested capital by giving the company an exclusive right to conduct the particular utility, the right being terminable upon purchase of the property at a stipulated price. See also **UNITED STATES**.

REGULATION IN EUROPE

On the continent of Europe practically all of the telephone and telegraph systems and so many of the railroad systems are nationally owned and operated that there is little opportunity for the development of anything approaching the American system of public utility control. This also holds true in a large measure of local utilities. Where local utilities are privately owned they are operated under franchise contracts with the municipalities.

In Great Britain, however, all of the railroads and so many of the local utilities are in private hands that there has been considerable development in policies of social control. Restricting ourselves again in the main to local utilities we find that here also these undertakings have been put in a position of special privilege, and have had conferred upon them special powers with a corresponding measure of special restriction in the public interest. The rendering of water, gas, electric and tramway services is by private corporations, municipal corporations, urban and rural district councils, and also occasionally by joint boards with a distinct corporate existence. Some public utility undertakings were originated by royal charter but this has been supplanted by parliamentary action.

Regulation of public utilities in England is accomplished by the method of "private bill legislation," which is a special act of parliament for each undertaking and which performs the double function of conferring a franchise and of laying down regulatory standards. Usually certain applicable general laws are by reference made a part of the special act, such as the legislation controlling the acquisition of land by condemnation as set forth in the Lands Clauses Consolidation Act of 1845.

Other important general legislation is contained in the following: Railways Clauses Consol. Act, 1845; Companies Clauses Consol. Act, 1845; Watenvorks Clauses Act, 1847; Gasworks Clauses Act, 1847; Harbours, Docks and Piers Clauses Act, 1847; Tramways Act, 1870; Electric Lighting (Clauses) Act, 3899.

In certain cases of common occurrence special legislation by parliament establishing public service undertakings is made unnecessary by permitting some appropriate department of the Government to issue "provisional orders" under general legislation after due inquiry. But full parliamentary control is retained by requiring confirmation of provisional orders, either by parliament itself or, in some cases, by an agency such as the Board of Trade, made effective by resolution of each house of parliament.

The English system of regulation is, accordingly, comparable to the charter or special franchise system in the United States. The most recent legislation of this type is the Gas Regulation Act of 1920, the Electricity Supply Acts of 1919, 1922 and 1926 and the Railways Act of 1921. The focal point of control is the regulation of rates. In the case of private gas companies the first method of control, after a brief preliminary period of competition, was the so-called "Official Revision System." Maximum rates and maximum dividends were fixed in special acts but the power to reduce rates was given to the court of quarter sessions.

Later another method, the system of sliding scales, was used, the adoption of which was optional. There was established a standard selling price for gas and a standard maximum rate of dividend. Then it was provided that the dividend rate might vary in inverse ratio to the rate of charge. Since the maximum dividend method, even when accompanied by official revisions of rates, failed to bring about reductions in charges, the sliding scale method was proposed as a means of automatic regulation and as a stimulus to more efficient management. In 1920 the Board of Trade was empowered temporarily to relieve private gas companies, operating under either method of rate control, of specified rate limitations by reason of changes in economic conditions since 1914.

In order to bring about mergers and reorganizations in the electrical industry which would make possible the generation of electricity in large units and the attainment of greater economy and efficiency, the Electricity Act of 1919 created a board of "Electricity Commissioners" of five members, appointed by the minister of Transport with the approval of the Board of Trade. Most of the regulatory powers over electric undertakings vested in governmental departments were transferred to this body.

Although the world-wide movement toward concentration in electricity supply was apparent in England as elsewhere, it had not progressed as far as in the United States. In order to bring about a more rapid concentration of generation by means of interconnected super-power systems, the commissioners were authorized to define provisional electricity districts, the area of which was to be grouped in a manner "as to be most conducive to efficiency and economy of supply and to convenience of administration." Interested parties comprised within each district, chiefly public and private distributors of energy, might then suggest a "scheme" for the reorganization of the district, or the commission might itself formulate one. On the whole the act failed to achieve its end because many public and private authorities refused to co-operate.

Accordingly the Electricity Act of 1926 created a "Central Electricity Board" with power to carry the "scheme" prepared by the electricity commissioners into effect. For this purpose the Central Electricity Board, operating as a limited company, was authorized to sell stock to the public not exceeding £33,500,000, principal and interest of these loans being guaranteed by the National Treasury. The funds are to be used for the construction of high-tension transmission lines, together with transforming equipment, which will interconnect the power stations selected by the electricity cominissioners in the particular district. The board is to purchase electrical energy from these plants at cost and such other surplus energy as is available in the district, and sell it again at wholesale to the authorized distributing utilities in the district. It is contemplated that the loans will ultimately be paid off out of profits.

Continental Europe. — Similar movements to bring about the large scale generation of electrical energy are being pushed in Italy, France, Germany and elsewhere. In Germany public joint-stock companies are being created, similar to the German Railways Company, with the shares in the hands of the cities co-operating under the plan. In this way it is planned to separate the technical administration and financial management from the political arm of the government, at the same time providing for flexibility in the economic area within which service is supplied.

BIBLIOGRAPHY.—F. N. Keen, *The Law Relating to Public Service Undertakings* (1925); D. Knoop, *Principles and Methods of Municipal Trading* (1912); M. G. Glaeser, *Outlines of Public Utilzty Economics* (1927); W. M. Wherry, *Public Utilities and the Law* (1925); W. M. Acworth, *Elements of Railway Economics* (1905; new ed. 1924, revised by author and W. T. Stephenson); William A. Robson, *Public Enterprise* (1938); Marshall E. Dimock, *British Public Utilities and National Development* (1933); Wilson, Herring, and Eustler, *Public Utility Industries* (1936); Idem, *Public Utility Regulation* (1938); H. E. Batson, *The Price Policies of German Publzc Utility Undertakings* (1933). (M. G. G.)

PUBLIC WELFARE LAW: see POOR LAW.

PUBLILIUS (less correctly PUBLIUS) **SYRUS,** a Latin writer of mimes, flourished in the 1st century B.C. He was a native of Syria and was brought as a slave to Italy, but by his wit and talent he won the favour of his master, who freed and educated him. His mimes, in which he acted himself, had a great success; he was perhaps even more famous as an improvisatore, and received from Caesar himself the prize in a contest in which he vanquished all his competitors, including the celebrated Decimus Laberius. All that remains of his works is a collection of Sentences (*Sententiae*), a series of moral maxims in iambic and trochaic verse, which has been much interpolated with later extracts.

The best texts of the *Sentences* are those of E. Wölfflin (1869), A. Spengel (1874) and W. Meyer (1880), with complete critical apparatus and index verborum; recent editions with notes by O. Friedrich (1880), R. A. H. Bickford-Smith (1895), with full bibliography; *see* also W. Meyer, *Die Sammlungen der Spruchverse des Publilius Syrus* (1877).

PUBLISHING. The modern publisher, as we understand the term, is one who produces printed books and puts them on the market. Of recent years, and especially since the World War, there have been some instances of English and United States publishers conjoining the business of the printer, and in a less degree of the bookseller, with their ordinary function. But it is not the usual practice.

The first problem of the publishing profession is naturally the relation between authors and publishers. The diatribes of authors against publishers are familiar to every one; and publishers, on their side, have some hard things to say about authors, though their sentiments are less piquantly expressed.

However, within the last half century, especially in Great Britain many new developments have taken place, which have helped to bring about a better understanding of the conditions affecting author and publisher, on both sides. The Society of Authors was established in London in 1883, with Tennyson as its first president. It offered useful assistance to authors ignorant of business in the way of examining contracts, checking publishers' accounts, revising their sometimes too liberal estimates of costs of production, and giving advice as to the publishers to be applied to or avoided in any given case. It has, no doubt, been of great service in checking the abuses of the publishing trade, and in compelling the less scrupulous among the publishers to conform more or less exactly to the practice of the more honourable.

In 1896, with a similar aim of co-operation and self-protection, was formed the Publishers' Association, which has undoubtedly tended to raise the standard of their efficiency all round. One of the first questions they had to deal with was the market price of books. Many attempts have been made in the past to destroy free trade in books. In July 1850, 1,200 booksellers within 12 m. of the London General Post Office signed a stringent agreement not to sell below a certain price This agreement was broken almost immediately. Another attempt was made in 1852; but at a meeting of distinguished men of letters resolutions were adopted declaring that the principles of the Booksellers' Association of that period were opposed to free trade, and were tyrannical and vexatious in their operations. *The Times* took an active part in defending and enforcing the conclusions which they sanctioned. The question was eventually referred to a commission, consisting of Lord Campbell, Dean Milman and George Grote, which decided that the regulations were unreasonable and inexpedient, and contrary to the freedom which ought to prevail in commercial transactions. An attempt was also made in 1869 to impose restrictions upon the retail bookseller; but that also failed, mainly by reason of the ineffective organization which the publishers then had at command.

Feeling their hands greatly strengthened by the establishment of their association, the publishers were emboldened to make another effort to put an end to reductions in the selling price of books. After much discussion between authors, publishers and booksellers, a new scheme was launched on Jan. 1, 1900. Books began to be issued at net prices, from which no bookseller was permitted to make any deduction whatever. This decree was enforced by the refusal of all the publishers included in the association to supply books to any bookseller who should dare to infringe it in the case of a book published by any one of them.

The **"Net** System."—With the question of the "net system" of publishing books is connected that of their fixed price, and both have been hotly contested. An earlier encyclopaedist, writing on the matter, put the case strongly against the fixed price. "The cast-iron retail price," he said, "is economically wrong. A bookseller with a large turn-over in the midst of a dense population can afford to sell at a small profit. He finds his reward in increased sales. His action is good for the public, for the author, and for the publisher himself, were he enlightened enough to see it. But a small bookseller in a remote country town cannot afford to sell at an equally low profit, because he has not access to a public large enough to yield correspondingly increased sales. Yet both are arbitrarily compelled to sell only at a uniform price fixed by the publisher. What makes the matter worse is that there is no cast-iron wholesale price. The small bookseller has to pay more for his books than the large one who buys in dozens of copies. Carriage on his small parcels often eats up what profit is left to him. As he is not allowed to have books 'on sale or return,' he has no chance whatever; and as a distributing agency the small bookseller has become negligible." It has-been said, on the other hand, that, "whatever one may think of the Net Book agreement, its function is not to protect the publisher against the bookseller, but to protect the retail trade by forcing the public to pay high prices for books. It is exactly on a par with any other industrial protection; by solidarity the trade is able to exact what it considers its fair prices from the community, and this reacts in favour of all engaged in the trade — authors, publishers, printers, paper-makers, booksellers." The booksellers, we may add, admit that they gained materially by the net system, in bringing which about two publishers, the late J. M. Dent and Sir Frederick Macmillan, were the active pioneers.

In estimating the market value of books, considered as publishers' wares, we have to note that, despite the huge popular vogue of the novel, which enables it to be maintained at a fixed price, above its real value, literature and the classics of literature are now often priced relatively low. This is in spite of the greatly increased cost of production since the World War.

There are certain classes of books which must always be relatively expensive, because they appeal only to students of some particular branch of science or of art or of literature, whose number is not great. But these are books of enduring value. Their price is justified not only by their prolonged service, but by the erudition or the exceptional qualities which go to the writing of them, as well as by the frequently exceptional cost of producing them. But as regards the vast output of books which merely amuse an idle hour, the existence of a large body of readers is the only excuse for their appearance, and if they cannot be produced at a low price, ensuring an extensive sale, they ought not to be produced at all. Thus there is more than a mere money question involved in the contention about price. An artificial system of prices leads to the printing of a vast quantity of trash, which demoralizes the reading public and is a serious obstacle to the success of the better books. Such a system operates, in fact, as a protective duty in favour of mediocrity, and even of something worse.

Then there is the troublesome system of "remainders," that is to say, the unsaleable copies of thousands of books published every year. The editions are small enough—probably not more than 1,000 copies—yet, in spite of circulating libraries, a third or a half of that modest number remains in the warehouses of the publishers. They are often sold for about the cost of their covers; sometimes they simply go to be reduced to their original pulp at the paper mills.

Book Production.—Half a publisher's business, it is said, is taken up with the intricate details of book production. To produce a book well and in a comely or durable form, the publisher needs the eye of a craftsman, and stands to gain if he has had experience in printing, book-binding and all the allied processes of the craft. He must be learned in type, paper, illustrations; in the book cloths, "jackets" and end-papers. It has been calculated that the whole time taken in the production of an ordinary book of about 100,000 words, from the "casting off" and the composition to the machinery and binding, and from the first despatch of the "copy" to the printers, to the return of the completed books, is about 12 weeks in all. Even then, the business of actual publication has not been counted in the estimate. The actual selling is another intricate matter, because of the extent and varied demands of the market. The "publishers' traveller" is in this respect an indispensable assistant. In London, the "town traveller" usually takes a week to a fortnight for his rounds; while the "country traveller," who maps out the whole country in his area, may take six or seven weeks.

Publicity.—This brings us to the other means of making the published book known and creating a demand for copies, by means of advertisement and of press notices. "About the advertising of books," confessed an American publisher (the late Walter H. Page, United States minister to Great Britain), "nobody knows anything. The most that can be said is that some publishers are making very interesting experiments." To this may be added the still more recent comment of an English publisher, who says, "Does any author think his book has been adequately or properly advertised? The answer to that question will explain how dangerous it is for a publisher to mention, or even to suggest, that there are any limitations to what can be accomplished by advertising. Should a publisher ever be rash enough to do so, it is at once assumed that he does not believe in advertising, and he is dismissed as a bad publisher."

As to the cost of advertising, no English figures are available, but for a German publisher 3 to 4% on the cost of production is given by Kliemann as the average amount. He adds that, in addition, German retail booksellers spend about 3% of their turnover on advertising. George H. Doran, the American publisher, claims to spend 10% of his gross income on "promotion." In England the publisher's expenses on advertising are given as about 6% of the turnover.

American and Continental Methods.—Towards the end of the 19th century came a large influx into England of American literature, especially fiction. Not only was there a growing appreciation of many American writers, but the attractive "get-up" of American books made its influence felt upon the British market. Some of the American methods of distribution were also introduced into Great Britain, but at first with only partial success. The most successful effort was the sale of important expensive works through the medium of newspapers.

The methods of publishing in America are in many ways similar to those in Great Britain, but the discount to the booksellers is generally given *pro rata* according to the number purchased. It is, however, in respect of the means of distribution that the systems of the two countries differ most. In America the big stores to a large extent take the place of the English bookseller, and by their energy and extensive advertising a wider public is served. In the distribution of fiction the American plan of "booming" a book by copious advertising, although expensive, is often the means of inducing a large sale, and of bringing an author's name before the public. In 1901 the net system, as adopted in Great Britain, was partially introduced into America.

The Continental methods of publishing and distributing, especially in Germany, differ, in many respects very materially, from those of Great Britain. In even the smallest German towns there is a bookseller who receives on sale, immediately upon publication, a supply of such new books as he or the publisher may think suitable to his class of book-buyers. The bookseller submits these books to his customers, and by this method most books issued are at once placed at the disposal of any buyer interested in the particular subject. The large sums spent in other countries upon advertisements are thus saved. At the book fairs held in Leipzig at Easter and Michaelmas the accounts for books sent on sale are made up and paid. In France all books have to be licensed before publication, but the methods of publication differ little from those of other Continental countries, in all of which book prices are much lower than in England.

In bringing the record down to the last decade, we have to count in the passing of a crisis with the World War. The period 1910–25 saw first a brief time of prosperity, then, during and following the war, a time of extreme disorganization in book publishing. The year 1910 was a prosperous one in the book market, as publishers are apt to remember. New books and reprints were in good demand and were readily supplied under normal conditions. Four years later those conditions were violently disarranged.

Effects of the War.—The World War, which raised the cost and the market value of many staple commodities, had a specifically stringent effect on book production and the book market all the world over. The book, of all manufactured articles, is most subject to the caprices of popular taste and one of the most sensitive to any change in the normal economic conditions or the ratio of supply and demand. It is not, like food and clothes, an absolute necessity, nor is it to the idle rich what a great sybarite called an "essential luxury." The process of recovery after a war does not affect books, any more than works of art, with the economic certainty that we observe in boots and shoes, for instance, or in the cotton trade. At the same time certain forms of literature, which offer an escape from actuality and the newspaper, are bound, after a war, to be in growing favour. It is interesting to examine on both counts the post-war returns of books published in Great Britain.

In 1918, when the war ended, the number of new books printed and published was 6,750, the number of reprints 966, which together give us a total of 7,716. In 1924, six years later, the new books had risen to over 9,500, while the reprints, which had suffered badly during the war because of the cost of production and the impossibility of supplying cheap books at a profit, showed a startling recovery. They had increased to over 3,190, actually 255 volumes more than the number of reprints in the year that immediately preceded the war—1913. The total number of new books was not quite so large as in the earlier year, whose October output—a test month in book publishing because of its nearness to the Christmas season—had established a record, namely 1,699 volumes, new books and reprints included. The October return in 1924, it is significant to note, was only 180 behind that figure.

The increasing vogue of the reprint is remarkable. During the war a new taste for reading grew up among the soldiers who had leisure days to pass in hospital or at the base. Some millions of volumes were collected and sent over to the army huts under the auspices of various societies organized for the purpose, or under the seal of the Red Triangle. The editor of one popular series supervised the collection in London and the dispatch to France of over 2,000,000 volumes, new and old, obtained from a house-to-house canvass of the metropolis. This popularizing of literature at large helped to increase the available reading public. But certain classes of books did not maintain their hold on the public when peace came again. In technology, for instance, whose manuals were specially required while the ex-soldiers were seeking work in the skilled trades, the demand fell off noticeably in the succeeding years. The analysis of books in *The English Catalogue* for 1923–24 marks a decrease in the latter year of over 100 published works in technology. In science the decrease was not very far short of that figure. History, medicine and geography also showed a decrease; on the other hand, fiction—easily first—biography, travel and guide books, including what we may call picturesque topography, poetry and the drama, religious books, sports and games and sociology all showed an increase of circulation.

A Ten-year Survey.—If we take a ten years' survey, we discover some curious fluctuations in the returns. In 1914 fiction came first, religion second and science third. Sociology and technology followed close. Poetry, juvenile literature, travel and topography, literature and criticism, history, biography and finally naval and military books, complete the list of a dozen sections, named in the order of their relative popularity. In 1924 fiction was still at the head. Juvenile literature had advanced from the seventh to the second place in the list. Religion was third. Science had fallen from the third to the seventh place. Poetry had advanced while technology had lost a point. Biography, thanks in part to the interest in characters and personalities who had come into prominence during the war, or because of some new reaction to its sharp stimulus, had gained markedly. It is harder to explain why, in that case, history books should have dropped in the comparative scale. Books of travel and books dealing directly or indirectly with literature had also declined slightly.

It would be easy to make too much of these differences. As between one year, or one publishing season, to another, it is necessary to allow a margin for accidental delays owing to strikes, as in the winter season of 1925–26, when the packers caused a serious break in the ordinary supply of books and periodicals, or for diversions of the public interest, as at the time of political excitement or of general elections. On the whole the yearly average in every class of book offers a very fair test of popularity. But as we note the startling preponderance of the first of those classes—fiction, especially the novel—we are driven to consider again how deceptive are the signs of success, and to recognize the notorious discrepancy between the seasonal and the permanent result.

The Publishing of Novels.—We have it on the authority of one large firm of London publishers, that nine out of every ten novels published are comparative failures; that is, they show no decided profit to author or publisher. Another firm put the percentage of failures still higher, and it has been estimated that the average life of a market novel is no more than a month, and that very few survive the year of their birth. In an essay written by Andrew Lang on "The Last Fashionable Novel," he lamented that the type of story in which lords and ladies were favourite characters as during the Victorian vogue, has ceased to exist. That fall from favour serves to remind us that the novel, whether viewed as one of a group or as a single product, is the most perishable of all quasi-literary commodities, and that the producers of such books are tempted to inflate their selling value artificially. It was so when the three-volume novel was given the absurd price of 31s. 6d. It is so when the novel is put upon the market at a net price of 7s. 6d.

Two comments by a successful American fiction publisher, on the market success of the novel may be added:—"To sell a novel that has the mysterious quality of popularity in it is not difficult. Properly launched, it sells itself. To sell a novel that lacks the inherent quality of popularity—that is almost impossible. Apparently it has sometimes been done, but nobody can be sure whether the result after all was due to the book or the salesman. Every publisher has proved, over and over again, to his disgust, that he cannot make the people buy a novel that they do not want; and when a novel appears (no better novel) that they do want, the novel readers find it out by some free-masonry and would buy it if the publishers tried to prevent them.

"Nobody has discovered a rule—to say nothing of a principle—whereby the popularity of a novel by a new writer may be determined. If it be a really great, strong book, of course it is easy to understand that it will sell; but whether it will sell 10,000 copies or 100,000 nobody knows. If it be a slap-dash dime novel, full of action, it is easy to guess that it will sell, but whether 5,000 or 500,000 nobody knows. Sometimes a book of the sheerest commonplace happens to hit the public mood at the happy angle and sells beyond all expectation. The truth is, every new novel by an unknown writer presents a problem peculiar to itself; and in advertising it and offering it for sale, every book's peculiar problem must be studied by itself."

Great Britain **and** the United States: a Comparison.—The trade organ in New York that corresponds to *The Publishers' Circular* in London, namely, *The Publishers' Weekly*, does a like service in collecting annually the returns of new books and reprints that are issued from the press. In 1924 the number of new books published in the United States—or "new titles," as the register more precisely terms them—written by American authors, was 6,380. In addition, over 600 English and foreign works were printed and manufactured in America, and over 1,700 were imported. Roughly summarized, the American production, that is so far as it is comprised in the New York returns for the whole book trade, is compared with that of Great Britain in the ratio of eight to six. More to our present purpose is the comparison instituted in the *Publishers' Weekly* between the book returns for 1923–24 in America with a further recast to the year 1910. There was effectively a 2% increase in 1924 over 1923, but the new titles registered in 1924 were only on a par with those of 20 years before—1904. Six years later, in 1910, the number of new titles was 11,671, or nearly double that of 1924.

As regards the comparative popularity in America of the different classes of books, in 1924 fiction was at the head of the list, but not with anything like the preponderance it showed in the British book trade. Religion came second, poetry and the drama together came third, with a total of 13 new titles more than those registered in Great Britain. Science stood relatively low in the scale and showed a decrease from the figures of the preceding year. Juvenile books, too, lost a point or two; but biography, as in the London book market at the same period, marked a distinct rise. Business books, which are rather an American speciality, also had appreciated in the scale.

Conditions in Other Countries.—Certain wider questions which affect book production and the writers, publishers and sellers of books can only be treated summarily. We must turn to the *Bibliographie de la France* if we would estimate the signs of recovery in the French book market since the war. In 1923 the returns give a total of 8,784 books, a pro rata advance since 1918, steadily maintained year by year, but not so marked in recent seasons. At the same rate of progression, the returns for 1924 should give a total of books registered slightly ahead of that for the year when the war broke out—1914.

In Germany the returns are noticeably higher than in any other country, displaying a total for 1923 of over 35,000 publications. But that includes miscellaneous publications which are not counted as books in the returns for other book-producing countries. In the Italian census furnished by the *Bolletino delle Publicazioni Italiane,* the lists for 1921 and 1922 are relatively encouraging, and in the international scale show an unusually high percentage of educational text-books and manuals. In the former year, for example, the number of works of fiction issued from the press was 580, while in social science the number was 660, and students' manuals are little behind that high figure. Poetry and the drama together number 477 volumes, religion only 206. Philology, surprising to say, stands higher than history. Philosophy is well placed, but cannot compete with the science of words. In the returns for the following year these classes preserve very much the same comparative position, but fiction and religion lose ground; history and biography gain. So do volumes dealing with the fine arts, and also those with military and naval science. Among other European returns may be noted those for Norway, Spain and Switzerland, as marking a slight advance in 1922 from the figures of the year previous.

In the republic of books all the world over the signs are in the main encouraging, and disclose a healthy state of recovery from the war years of stagnation. In a 25 years' review and retrospect, the publishers' organ in New York pointed to several notable factors in the increased power of the book and the widening of its market since the opening of the 20th century. The better ordering and specializing of the bookshops, the greater intelligence of the booksellers and the national development of children's libraries, have all contributed to that advance.

England might learn some practical lessons from America in these things. By the forming of such associations as the National Book Council and the Society of Bookmen she has, however, shown herself of late years newly alive to the cordial co-operation of publishers, booksellers and authors. A recent writer, alluding to the book fairs in Florence, Frankfurt and Paris, advocated a similar yearly event in London itself. Paris had two book fairs in 1925, one at the Universal Exposition, the other, a smaller, more specialized bibliophilic festival, was held in connection with the time honoured Fair of Saint Germain. Either of these might be imitated, with an English or American difference, in London or New York, with good effect in stimulating the interest of the public and the activities of the book producers and publishers.

BIBLIOGRAPHY.—4. H. and J. B. Putnam, *Authors and Publishers: A Manual* (1897); W. H. Page, *A Publisher's Confession* (1924); S. Unwin, *The Truth about Publishing* (1926); (American ed. with notes by F. Greenslet, 1927); *The Publisher and Bookseller,* official organ of the British book trade (London); *The Publishers' Circular and Booksellers' Record* (London); *Publishers' Weekly and Annual Summary* (New York); *Bibliographie de la France* (Paris); *Börsenblatt für den deutschen Buchhandel* (Leipzig); *Brinkman's Lyst Van Boeken* (Amsterdam); *Bollettino delle Publicazione Italiane* (Florence); *Bibliothèque universelle et revue de Génève* (Geneva); *The Bookseller and Stationer* (New York). (E. RH.)

PUCCINI, GIACOMO (1858–1924), Italian operatic composer, was born at Lucca on June 22, 1858, of a family already distinguished in music: his great-great-grandfather Giacomo, great-grandfather Antonio, grandfather Domenico, and father Michele, having all been professional musicians. He was educated at the Milan Conservatoire where he studied under Ponchielli. In 1889, *Edgar* was performed at La Scala, and in 1893 his *Manon Lescaut* in Turin. The former, based on *La Coupe et les lèvres* of Alfred de Musset, was a failure, but the latter, founded on the well-known story of the Abbé Prévost (which had been previously treated by three other composers, Halévy, Auber and Massenet) was favourably received, and still holds the stage. Its success was as nothing compared with that of the work which followed it, the sparkling *La Bohème* (Turin, Feb. 1, 1896). The libretto is based on Murger's novel from which four scenes are taken, and the skill and resource and effectiveness with which they are treated leave no room for doubt as to the merits of the work. In *La Tosca* (Rome: Jan. 14, 1900), based on Sardou's tragedy, Puccini had an altogether different task, of which, however, he acquitted himself no less successfully. The work contains indeed some of the strongest and most genuinely dramatic music which he ever wrote, and like *La Bohème* has enjoyed unlimited popularity at the hands of the general public from the first.

Madame Butterfly, on its first performance at La Scala on Feb. 17, 1904, was pronounced an absolute failure. Probably the libretto of the opera, with its unusual setting in Japan, had at least as much to do with this result as its music, but in any event the Milan public's unfavourable verdict was speedily reversed when the work was heard again at Brescia three months later, and since then its popularity has been prodigious and world-wide. If equal success did not attend its successor *La Fanciulla del West* (The Girl of the Golden West), this was easily accounted for, not only by the unsatisfactory character of its "book," but also by the undoubted inferiority of its music, so that the work, though favourably received when first performed in New York (Dec. 10, 1910), has never found general favour. Of the one-act operas *Il Tabarro, Suor Angelica,* and *Gianni Schicchi,* which followed, all contain clever and characteristic music, but only the third, based on a most amusing libretto, has kept its place in the general repertory. As regards *Turandot,* the composer's last work, which he had not quite finished at the time of his death, and which was completed by Alfano, and produced at La Scala on April 25, 1926, critical opinion has been sharply divided. While some condemn it severely, others reckon it the composer's finest achievement. Puccini died at Brussels on Nov. 29, 1924.

See A. Weissmann, *Giacomo Puccini* (Munich, 1922); A. Fraccarroli, *La vita di G. Puccini* (Milan, 1925); and Wakeling Dry, *Giacomo Puccini (Living Masters of Music)* (London, 1906).

PUDDINGS. The word pudding denotes a sweet dish; it is also used in connection with meat, but then its use is restricted to meat boiled or steamed inside a case of suet pastry *(see* **COOKERY** and PASTRY: *Home-made).*

The following recipes are for typical British puddings: *Milk Puddings:* Allow 4oz. of rice (Carolina), sago or tapioca to one quart of milk, 1 tablespoonful of sugar or more to taste and a pinch of salt. Grease a pie dish. Put into it the cereal, add salt, sugar and milk and, if liked, a grate of nutmeg, or keep a piece of stick vanilla in the sugar jar and so obtain a flavour of vanilla. Stir well, and then occasionally for the first hour. If a dessert-spoonful of butter or a little cream is stirred in after the first hour the pudding will be better. Cool oven. Time 3 hours.

Variations of milk puddings which are cooked on the hot plate and served cold are: *Creamed Rice, Tapioca or Sago* (cold): 2oz. of rice, tapioca or sago, cream, 1 pint of milk, powdered chocolate or other garnish. Cook the cereal in the milk in a double pan until quite soft and thick, sweeten and flavour to taste. Spread in a glass dish: when cold cover with cream or custard and garnish with powdered chocolate, hundreds and thousands, or cherries and angelica.

General Directions for Steamed Puddings: Grease the basin, allow room for the mixture to swell, and cover with a greased paper; the reason for this covering is that steam condenses on the inner side of the lid of the pan, and would drip into the pudding and make it heavy if it were not protected. The water must be boiling in the outer pan or steamer when the pudding is put in and must be kept boiling steadily. Be sure the water does not boil away, and add more boiling water if necessary.

Suet **Puddings:** *Plain Suet Pudding:* 6 oz. dry sifted flour, ½ teaspoonful baking powder, pinch of salt, 2½oz. suet, cold water. Mix flour, baking powder and salt well together, then with clean floured hands rub into it the suet, finely shred, using the finger tips. Mix in by degrees a small teacupful of cold water, using a knife for the mixing. Finish according to general directions.

Plain Suet Pudding (with bread crumbs): Use recipe No. 1 but allow 4oz. flour and 2 to 3oz. fine stale bread crumbs.

Richer Suet Pudding: Proceed as in No. 2 but allow 3 to 4oz. suet and add 1 egg and milk instead of water. Beat egg into the milk.

Roly-Poly, Treacle, Jam or Sultana: Mixture for suet pudding

1 or 2; treacle, bread crumbs, lemon. When the dough is mixed roll it out on a floured board in a long thin strip. Spread with syrup thickened with bread crumbs and flavoured with lemon. Roll up, seal the ends well, tie in a scalded floured cloth, and put into a pan of boiling water. Boil steadily for about 3 hours. Untie the cloth and put the pudding on a hot dish Slice it and dust it with castor sugar. For *jam* roll proceed as above but use jam and omit bread crumbs as the jam does not need thickening. For *sultana roll* add 3oz clean, dry, floured sultanas to the pudding mixture.

Boiled Fruit Pudding (hot): Suet crust (*see* **PASTRY**, HOME-MADE) fruit, sugar. Roll out the crust two or three times and let it stand a little after rolling. Line a greased basin with it, fill with prepared fruit and sugar (if the fruit is dry add a little water) put on a cover of paste and press the edges together. Tie in a scalded floured cloth and boil for 1½ hours, or steam for 3 to 3½ hours with a greased paper tied over the top.

Christmas Puddings: The "king's *empire recipe*" for Christmas pudding contains the following ingredients, the proportions of which may be taken as standard: 2½lb. currants, 2½lb sultanas, 2½lb. stoned raisins, ⅝lb. minced apple, 2½lb. bread crumbs, 2½lb. beef suet, 1lb. cut candied peel, 1¼lb. flour, 1¼lb. Demarara sugar, 10 eggs, 1oz ground cinnamon, ¾oz. ground cloves, ¾oz. ground nutmeg, ½ teaspoonful pudding spice, ½ gill brandy, 1 gill rum, 1 quart old beer

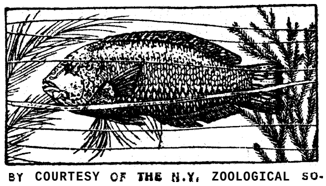
Chop suet very finely, add flour and bread crumbs, fruit (washed, picked, dried and floured), candied peel chopped fine, spice, lemon rind, sugar and eggs Over all pour the liquids, stir well and put all aside to swell and blend until next day, then put mixture into a basin, filling it quite full, tie a scalded floured cloth over it, making a pleat in the cloth to allow for the pudding swelling, put into a pan of boiling water and boil for 6 hours at least. The pudding should then be hung up in a cool dry place and re-boiled for 2 hours when needed.

To scald a cloth, dip it into boiling water and squeeze it dry and then dredge flour over it.

Sunday Plum Pudding (hot) : ½lb. flour, 1 teaspoonful baking powder, 6oz. suet, ½lb. sultanas, 2 eggs, ½ teacupful golden syrup, a little milk. Mix according to directions, but steam at once for 4 hours in a greased basin. This pudding is a deep golden brown, light and crumbly when well made.

Sponge *Pudding:* 4oz. flour, 3oz. sugar, 2oz. butter, 2 eggs, 1 teaspoonful baking powder, milk. Cream butter and sugar together, add each egg, separately. Beat well, stir in flour and baking powder iigbtly, add milk until mixture drops easily from the spoon. Pour into greased mould, steam for about 1 hour and serve with jam or custard sauce. (D. C. PE.)

PUDDING-WIFE. A tropical American fish of the wrasse family (Labridae), called also doncella. It has a deep, compressed body, which is covered with large scales except on the head, has strong canine teeth in the front part of the jaw, and attains a lengrh of 18 inches. In colom the pudding-wife is a vivid blue-green tinged with bronze or soft orange, though varying somewhat with sex and age. Spots and streaks of blue, especially on the head, fins and through the eye, add to its attractive appearance.



BY COURTESY OF THE N.Y. ZOOLOGICAL SOCIETY

THE PUDDING-WIFE (IRIDIO RADIATUS), A

PUDSEY, a municipal borough in the Pudsey and Otley parliamentary division of the West Riding of Yorkshire, England, served by the L.N.E.R. Pop. (est. 1938) 27,880. Area, 8.3 sq.mi. It has an important woollen trade and dyeing and fulling mills. It was incorporated in 1900 and considerably enlarged in 1937.

PUDUKKOTTAI, a state of southern India, lying between the British districts of Tanjore and Madura. Area, 1,179 sq.mi. Pop. (1931), 400,694. The state consists mainly of an undulating plain, largely barren; it is interspersed with rocky hills, especially in the south-west. Rice is the chief crop. There are no large industries. The chief, whose title is tondaman, is of the Kallan or robber caste. His ancestors received a grant of territory for loyal services to the British during the wars in the Carnatic at the end of the 18th century.

The town of Pudukkottai had a population in 1931 of 28,776. It is well laid out and contains several fine public buildings, a college and a training school.

PUEBLA, a State of Mexico, occupying the south-east angle of the great central plateau, or that part of it known as the Anáhuac table-land with an elevation of from 5,000 to 8,000 feet. Area, 13,125 sq. miles Pop. (1930) 1,150,425, largely civilized Indians and mestizos. Lofty mountains overlook the plateau from the north-east and west, three of the highest peaks, Orizaba, Popocatépetl and Ixtaccihuatl rising above the permanent snow-line, while another, Malinche, lifts its isolated mass nearly to that limit. In the south the table-land breaks away and long fertile valleys lead downward toward the warm southern plains. The central table-land forms part of the watershed between the eastern and western drainage systems, some of the streams in the north and south-east emptying into the Gulf of Mexico, while the Atoyac, which has its source in Tlaxcala, crosses the State and discharges into the Pacific through the Rio Balsas or Mescala. Puebla has a temperate, healthy climate, one of the best in Mexico. The soil is generally fertile and the rainfall moderate (36 in.). Agriculture is the principal industry. The Mexican, Interoceanic and Mexican Southern railways, cross the State.

PUEBLA (full title *La Puebla de* lor *Angeles,* and more recently, *Puebla de* Zaragoza), a city of Mexico and capital of the State of the same name, on the banks of the Atoyac river, 130 m. S.E. of the city of Mexico. Pop. (1930) 114,793, including a large percentage of Indians. Its railway connections put it in daily communication with the national capital, Vera Cruz, Pachuca, Oaxaca and the terminal ports of the Tehuantepec railway — Puerto Mexico and Salina Cruz. The city is built on a broad healthy plain, about 7,200 ft. above sea-level. It is well provided with street railways, electric and gas illumination, water and drainage. The great Doric cathedral, about 165×320 ft., is perhaps the finest ecclesiastical building in Latin America. It was begun about 1552, but not completed until 1649. Among other churches, famous for their lavish decorations, are those of San José, San Cristóbal, Santa Catalina and Santo Domingo. The "Teatro Principal," built in 1790, is said to be the oldest existing theatre on the continent. There are several other theatres, and an immense bull-ring. In 1911 a terrible massacre of revolutionary forces by the Federal troops took place within and around this bull-ring. Among the more conspicuous public buildings are the palace of justice, the building of the State legislature, a school of medicine to which is attached the Palafoxiana library of over 100,000 volumes, an academy of fine arts, and the national college. At Ft. Guadalupe, near the city, there are several hot sulphur springs, which are used for medicinal baths. Puebla is one of the busiest manuiacturing cities in Mexico, and among its products are cotton and woollen textiles, soap, glass, straw hats, pottery and leather goods. There are also some large foundries.

Puebla was founded in 1532 by Sebastián Ramirez de Fuenleal, archbishop of Santo Domingo and the celebrated Franciscan friar Toribio Motolinia. In 1550 it became the see of the bishopric originally created in 1526 at Tlaxcala. The appellation "de los Angeles," which is now practically dropped, originated in a popular belief that during the building of the cathedral two angels every night added as much to the height of the walls as the workmen had completed on the preceding day. Its present title was given in honour of Gen. Ignacio Zaragoza (1829–62), who successfully defended the city against the first French attack in 1862.

PUEBLO. The agricultural, town-dwelling Indians of the semi-desert south-western United States. They are of four distinct linguistic groups: (1) Shoshonean, comprising the seven Hopi (*q.v.*) villages in Arizona; (2) Zuñi (*q.v.*), one town in western New Mexico; (3) Keres. comprising Acoma (*q* v.), Laguna, Sia, Cochiti, Santa Ana, Santo Domingo, San Felipe, all but the first two in the Rio Grande valley; (4) Tano, consisting of three divisions, all near the Rio Grande: (a) Tiwa, five towns, of which Taos is the most northerly and best known; (b) Tewa, six pueblos (including Hano among the Hopi); (c) Jemez. The aggregate population is not far from 10,000, stationary or slowly decreasing, and approximately equally divided between the four speech groups. At the discovery in 1540 the Hopi, Zuñi and Keres may have been twice, the Tano three or four times, as numerous as to-day; the number of towns has also decreased, though some new ones have been founded. The Pueblos live on ancestral lands and cultivate these much as in the prehistoric period, though they have added wheat to maize and acquired some sheep, cattle, horses and asses; their houses, though larger, are of the old type; their religion has been successfully maintained by the Hopi and Zuiii and partly preserved alongside Roman Catholicism by the Keres and Tano. They are peaceable, gentle, unenterprising. quietly industrious and conservative. Physically they are fairly uniform; below average in stature, generally brachycephalic, with the skull somewhat flattened occipitally from the cradle-board.

Of all the tribes of the United States the Pueblos are most similar to the advanced native peoples of southern Mexico, and the bases of their culture — maize-beans-squash agriculture, cotton growing and weaving, turkey rearing, painted pottery, masonry architecture, ritualism — are no doubt derived from these Mexican civilizations. They lack, however, a number of accomplishments characteristic of the Aztec, Toltec and Maya, such as metallurgy, political organization, calendrical system, ideographic writing, temples and pyramidal substructures. Since some of these traits have an age of about 2,000 years, the main influences emanating from Mexico are likely to have reached the Pueblos perhaps as much as three millennia ago.

South-western archaeology reveals a development through several stages: (1) Basket maker, possessing maize but apparently no other cultivated plants; no pottery or stone houses; spear thrower, but no bow; the physical type was long-headed. (2) Post-basket-maker, with crude pottery, slab-lined pit houses, the bow and arrow. (3) Proto-Pueblo, with the short-headed type which has persisted to the present; masonry, painted and neck-corrugated pottery, cotton, the turkey, the essentials of historic Pueblo culture, are already present. (4) Early Pueblo, in small house clusters; black-on-white and body-corrugated pottery; this is the era of most of the cliff dwellings and of the greatest geographical extension of Pueblo culture, ruins in Nevada and well north in Utah belonging to this period. (5) Great Pueblo period, with large towns like Pueblo Bonito and Aztec, centring in the San Juan drainage; the northernmost area had been given up, but the ruins in Chihuahua, like Casas Grandes, seem to be of this epoch. (6) Late Prehistoric Pueblo, with glaze-painted pottery; the San Juan area and Chihuahua extension had been given up, but there were still Pueblos on the middle Rio Grande near El Paso. The Spanish discovery of 1540 falls in this period, which may be assumed to have continued until the influence of the missions became strong in the early 17th century, or until the general Pueblo rebellion of 1680. (7) Historic Pueblo, after the unsettlement caused by the rebellion; pottery is again painted instead of glazed, but both black-on-white and corrugated ware are long since forgotten; domesticated mammals have been introduced and sheep's wool tends to take the place of cotton for clothing.

In general, the Pueblos did not irrigate, although they knew how to choose farmlands containing sub-soil water. They are matrilineal and matrilocal, women owning the houses; but men order all public and religious matters. On the Rio Grande the clans weaken and moieties appear, until in the extreme northern towns clans are, to-day at least, lacking. The religious edifice is the kiva, Spanish estufa, a small semi-underground structure for the performance of esoteric rites. Temporary altars are erected in these, often with ritualistic sand or meal paintings; feathers are "planted" as offerings at outdoor shrines; and for all religious organizations, offices and clans there are fetish bundles. The mythology is characterized by tales of emergence from the lower world and long tribal wandering. Cults take three chief aspects: (1) Youths are initiated into a communal men's society performing masked dances representative of gods and ancestors — kachinas. (2) Men and women are initiated individually into "fraternal" societies whose main function is curing, although there are also war and hunt societies; masks are little used. (3) Hereditary priests fast, entreat and pray for rain for the crops and communal welfare, and ultimately direct not only all religious affairs but the civil officials. Ritual symbolism is rich, especially as regards the idea of fertilization and number-colour-direction symbol patterns.

P. E. Goddard, *Indians of the South-west* (1921) and A. V. Kidder, *South-western Archaeology* (1924), summarize the ethnology and archaeology and list the principal monographic works. (A. L. K.)

PUEBLO, a city of Colorado, U.S.A., on the Arkansas river at the mouth of Fountain creek, 120 m. S. by E. of Denver; the county-seat of Pueblo county and the second city of the State in size. It is on Federal highways 50 and 85; has airmail service; and is served by the Colorado and Southern, the Colorado-Kansas, the Denver and Rio Grande Western, the Missouri Pacific and the Santa Fe railways. The population was 43,050 in 1920 (79% native white) and 52,162 in 1940 by federal census. It lies at an altitude of 4,690 ft., near the coalfields of the state and many of the metal deposits, in an irrigated region of 50,000 ac., which produces 65% of all the cucumber seed grown in the U.S. and great quantities of red clover, cantaloupe, squash and onion seed. San Isabel national forest (600,000 ac.) is 20 mi. to the south and west. Pueblo is an important manufacturing centre, "the Pittsburgh of the west." The industrial pay roll for the city and its suburbs amounts to about $20,000,000 annually. At Minnequa, on the mesa south of the city, is the plant of the Colorado Fuel and Iron corporation, employing 5,000 men in mining and 5,000 more in the Pueblo mills in the manufacture of iron and steel. There are plants for meat packing, brooms, brick, tile, tents, awnings; also foundries and machine shops. The debits to individual accounts in the city's banks totalled $35,558,367 in 1940. The assessed valuation of property for 1940 was $27,507,-522. Since 1911 the city has had a commission form of government. It is the seat of the State hospital for the insane (established 1879). In 1806 Lieut. Pike and his exploring party camped at the confluence of Fountain creek with the Arkansas ("The Forks," he called it), and the spot was visited by Major Long in 1820. A band of Mormons settled here temporarily in 1846–47 on their way to Utah. In 1850 a trading post was established. In 1858 a settlement (Fountain City) was made on the east side of Fountain creek, and the following winter (1859–60) the townsite of Pueblo was laid out and the first house was built on the site of the present city. Regular stage service to Denver began in 1862, but development was slow until the Denver and Rio Grande Railroad reached the Arkansas in 1872. The two pioneer settlements were consolidated and chartered in 1870, when the population was about 500.

By 1880 this had grown to 3,217. Other railroads reached the city in 1875, 1887 and 1888; the Colorado Coal and Iron Company had its steel works in operation in 1881; and in 1890 the population of the city was 24,558.

PUENTE GENIL, a town of southern Spain, in the province of Cordova; on the right bank of the river Genil or Jenil, a tributary of the Guadalquivir. Pop. (1930), 23,410. Puente Genil is on the Cordova-Malaga railway, and is the starting-point of the line to Linares. A bridge across the Genil, from which the name of the town is derived, joins the lower part of Puente Genil with the higher. The principal industry is the manufacture of olive oil. There are also flour-mills and linen factories.

PUERPERAL FEVER. A medical term implying a general blood-poisoning of the same nature as that arising from an infected wound (see SEPSIS), its specific name indicating merely its origin from childbirth or miscarriage. The area becoming the seat of infection is usually the raw surface inside the womb left after separation of the afterbirth, though lacerations at the mouth of the womb and elsewhere in the genital passages may also provide an avenue for the entry of organisms.

The infecting organisms are the pus-producing cocci, of which the streptococcus pyogenes is the commonest and its haemolytic forms the most serious. Other pyogenic cocci (*e.g.,* staphylococcus, gonococcus, pneumococcus) and bacteria from the bowel (*e.g.,* colon bacillus and the gas-forming B. Welchii) are occasional infecting agents.

Infection may either be *exogenous, i.e.,* introduced from without by those attending the woman, or *autogenous, i.e.,* due to further spread of organisms already present in the patient's genital tract (cervix or vagina) or from septic foci elsewhere in her body {mouth, tonsils, etc.). It is generally accepted that the majority of puerperal infections are exogenous, but the autogenous infections are held by some to be more frequent than is commonly supposed. Rarely cases of puerperal fever arise in patients who have delivered themselves naturally and without any internal examination being made, and streptococci are not infrequently discovered before labour in the neck of the womb or vagina, especially in women who have suffered from gonorrhoea or have had previous labours or abortions, but they are very rarely of a haemolytic or virulent type.

Some idea of the frequency and seriousness of the disease may be gathered from the fact that over 1,000 women die from it every year in England and Wales, and a much larger number recover, many of them being left with some permanent invalidity or disability. The Registrar General's returns show that the death-rate from puerperal fever is about 1·5 mothers per 1,000 live births registered. It forms about 40% of the total maternal mortality in childbearing.

Symptoms commonly arise about the third day after delivery, the first sign being fever with quickening of the pulse. If the temperature exceeds 103° F rigors may occur and heavy sweats with remissions of the fever. The womb remains enlarged, the discharges from it may be profuse and foul-smelling or more rarely scanty and free from odour. Serious symptoms are persistent high fever and pulse-rate, repeated rigors, presence of streptococci in the blood, especially if haemolytic, sleeplessness, delirium and diarrhoea. Lung and abdominal complications are of evil omen. The disease has always grave possibilities but the case-mortality is under 10%.

Prevention on antiseptic principles has not succeeded to a like degree to that accompanying the prevention of sepsis after surgical operations, and the reasons therefor are not fully understood. The more natural the labour and the less the interference, the less is the incidence of fever. Conversely, the more prolonged and extensive (*i.e.,* the higher up the genital canal) the interference and the greater the trauma caused, the greater the risk of infection. Cleansing of the external genitals, disinfection of instruments and dressings, wearing of sterilized gloves, lessen the risk but will not wholly eliminate infection, because it is impossible to render the external genitals, anus and surrounding skin absolutely germ-free. Hence the introduction of hands and instruments within the genital passage carries with it the risk of conveying organisms. Manual removal of the afterbirth retained in the womb is specially liable to be followed by fever and this time-saving manoeuvre must be avoided to the greatest extent possible.

Infection is readily carried from other puerperal patients and from septic wounds and may be spread by the coughing or breathing of those with septic tonsils over instruments and dressings. The readiness with which the infection may be carried by doctors, nurses and instruments from patient to patient accounts for the appalling mortality that used to obtain in lying-in hospitals and institutions. Such mortality is now a thing of the past.

The severity of the disease depends not only on the virulence and dose of the infecting agent but also on the power of resistance of the patient. Ill-health, especially kidney disease, diabetes, loss of blood and exhaustion, lower resistance generally. The local resistance of the tissues of the generative tract is lowered by bruising and injury.

Treatment is first of all preventive; the most urgent measures are to adopt the same antiseptic and aseptic precautions in labour as for a major surgical operation; and further by antenatal care to maintain the vitality at its best, avoiding all foreseeable complications in labour, and generally to secure natural delivery without interference. Complete emptying of and free drainage from, the womb are likewise essential, and these also must be carried out under the strictest antiseptic and aseptic conditions.

Curative treatment of puerperal sepsis depends on good nursing and attention to every detail of the patient's comfort. Fresh air and sunshine increase the powers of resistance, and artificial methods of increasing tissue-resistance by antitoxic sera and vaccines are also adopted. Antiseptic injections intravenously are tried but are not very successful. Local treatment of the infected uterus has the danger of spreading the infection and is now restricted to such simple measures as the injection of glycerine to promote a free flow of lymph. Pelvic abscesses and other complications must be looked for and treated surgically. Recognition of the fact that puerperal fever must be a preventable condition in the large majority of cases has led to the formation of a strong departmental committee of the British Ministry of Health to enquire into the conditions of its occurrence and devise means for its better prevention and treatment. There is reason to believe that the condition is more common in certain districts (*e.g.,* the low-lying Thames valley) than in others but the establishment of this as a fact together with its explanation, if true, await elucidation. (J. S. FA.)

PUERTO CABELLO, a city and port of Venezuela, in the State of Carabobo, 34 m. N. by W. of Valencia, the capital of the State. Pop. (1936), 20,622. Puerto Cabello has railway and motor road connections with Valencia and thence with Caracas. It stands on a small peninsula which partly shelters a large bay. After La Guayra the harbour is the principal port of Venezuela, and is provided with mole, wharves, and other facilities for the handling of merchandise and produce. The protected area is small but easily accessible to the largest vessels calling at Venezuelan ports.

Puerto Cabello ranks first as a port of export for hides and skins, second for coffee and third for cacao. Of additional importance to the port has been the establishment there of the national dry dock and navy yard, which has two floating docks in operation for the repair of coasting vessels and small steamers, a large machine shop and building facilities for small vessels. The town and harbour were strongly fortified in colonial times. Among the exports are coffee, cacao, dyewoods, hides, skins and copper ores. Puerto Cabello suffered much in the War of Independence, changing hands several times and remaining in the possession of Spain down to 1823.

PUERTO DE SANTA MARIA, a seaport of southern Spain, in the province of Cádiz, on the right bank of the river Guadalete, with a station on the railway from Cádiz to Seville. Pop. (1930), 19,714. Puerto de Santa Maria, commonly called "El Puerto," is probably the *Menesthei Portus* of Ptolemy. Its most important industry is the wine trade; there are also glass. liqueur, alcohol, starch and soap manufactures.

PUERTOLLANO, a town of central Spain in the province of Ciudad Real, on the Madrid-Ciudad Real-Mérida railway and at the north-east of the Valle de la Alcudia. Puertollano is 2,345 feet above sea-level and possesses mineral baths. Its population (19,275 in 1930) more than doubled in the 20th century.

PUERTO MONTT, a city and port of Chile, capital of the province of Chiloé. It is located at the northern end of the gulf of Reloncavi, about 670 mi. S.W. of Santiago. Population (1940) 21,552. It is the southern terminal of the southern section of the Chilean state railways and is served by the air line from Santiago to Magallanes. Its chief importance lies in its geographical location, which makes it the logical point of contact between the northern and southern sections of Chile.

Puerto Montt is built on a plain surrounded by wooded hills and by grazing land. Its principal industry is lumber. The city was founded in 1853 by a group of German emigrants led by Vicente Pérez Rosales, and was named for Manuel Montt, then president of Chile.

PUERTO PRÍNCIPE: *see* CAMAGÜEY.

PUERTO REAL, a seaport of southern Spain, on the Bay of Cádiz and on the Seville-Cádiz railway. Pop. (1930) 11,185. Puerto Real (Port Royal) is the *Portus Gaditanus* of the Romans, and is probably the most ancient trading-station on the Bay of Cádiz. It owes its modern name to the fact that it was rebuilt in 1488 by Ferdinand and Isabella. The port has good quays, a dry dock and deep water for large steamers.

PUERTO RICO: *see* PORTO RICO.

PUFENDORF, SAMUEL (1632–1694), German jurist, was born at Chemnitz, Saxony, on Jan. 8, 1632, the son of a Lutheran pastor. He was educated at Grimma and the University of Leipzig, and then at Jena. Pufendorf quitted Jena in 1657 and became a tutor in the family of Petrus Julius Coyet, one of the resident ministers of Charles Gustavus, king of Sweden, at Copenhagen. As a result of Danish resentment of Gustavus' conduct in suddenly declaring war, Pufendorf with the rest of the suite was imprisoned. He occupied himself during this time in meditating upon what he had read in the works of Grotius and Hobbes. He mentally constructed a system of universal law; and when, at the end of his captivity, he accompanied his pupils to the University of Leyden, he was enabled to publish, in 1661, the fruits of his reflections under the title of *Elementa jurisprudentiae universalis.* The work was dedicated to Charles Louis, elector palatine, who created for Pufendorf at Heidelberg a new chair, that of the law of nature and nations, the first of the kind in the world. In 1667 he wrote, with the assent of the elector palatine, a tract, *De statu imperii germanici, liber unus.* Published under the cover of a pseudonym at Geneva in 1667, it was supposed to be addressed by a gentleman of Verona, Severinus de Monzambano, to his brother Laelius. The pamphlet made a great sensation. It was a direct attack on the Holy Roman Empire and the house of Austria. In 1670 Pufendorf was called to the University of Lund, where he published in 1672 the *De jure naturae et gentium, libri octo,* and in 1675 a résumé of it as *De officio hominis et civis.*

In the *De jure naturae et gentium* Pufendorf took up in great measure the theories of Grotius and sought to complete them by means of the doctrines of Hobbes and of his own ideas. His first important point was that natural law does not extend beyond the limits of this life and that it confines itself to regulating external acts. He combated Hobbes's conception of the state of nature and concluded that the state of nature is not one of war but of peace. But this peace is feeble and insecure, and if something else does not come to its aid it can do very little for the preservation of mankind. As regards public law Puiendorf, while recognizing in the state *(civitas)* a moral person *(persona moralis),* teaches that the will of the state is but the sum of the individual wills that constitute it, thus showing himself a precursor of J. J. Rousseau and of the *Contrat social.* Pufendorf powerfully defends the idea that international law is not restricted to Christendom, but constitutes a common bond between all nations.

In 1677 Pufendorf was called to Stockholm as historiographer-royal. To this new period belong *Einleitung zur Historie der vornehmsten Reiche und Staaten,* also the *Commentarium de rebus suecicis,* and *De rebus a Carolo Gustavo gestis.* In his *De habitu religionis christianae ad vitam civilem* he traces the limits between ecclesiastical and civil power. This work propounded for the first time the so-called "collegial" theory of church government (*Kollegialsystem*), which, developed later by Pfaff (1686–1760), was the basis of the relations of church and state in Germany.

This theory makes a fundamental distinction between the supreme jurisdiction in ecclesiastical matters (*Kirchenhohheit* or *jus circa sacra),* which it conceives as inherent in the power of the state in respect of every religious communion, and the ecclesiastical power *(Kirchengewalt* or *jus in sacra)* inherent in the church, but in some cases vested in the state by tacit or expressed consent of the ecclesiastical body. The theory helped towards the principle of toleration.

It was put into practice to a certain extent in Prussia in the 18th century. The theory, of course, has found no acceptance in the Roman Catholic Church, but it none the less made it possible for the Protestant governments to make a working compromise with Rome.

In 1688 Pufendorf took service under Frederick William, elector of Brandenburg, but he had no sooner arrived than the elector died. His son, Frederick III, fulfilled the promises of his father; and Pufendorf, historiographer and privy councillor, was instructed to write a history of the Elector Frederick William (De *rebus gestis Frederici Wilhelmi Magni*). Pufendorf was also created baron.

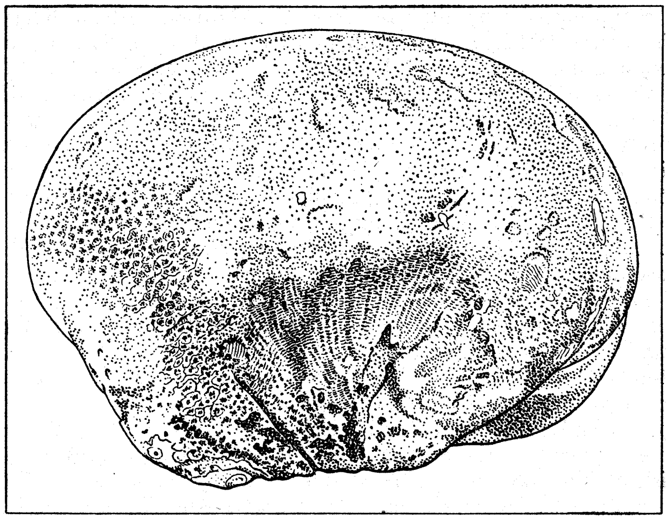
Pufendorf died at Berlin on Oct. 26, 1694.

The value of Pufendorf's work was much underestimated by posterity. Much of the responsibility for this injustice rested with Leibnitz, who would never recognize the incontestable greatness of one who was constantly his adversary, and whom he dismissed as "vir parum jurisconsultus et minime philosophus." His *Jurisprudence* is the standard one for the 17th and 18th centuries.

See H. von Treitschke, "Samuel von Pufendorf," in *Preussische Jahrbücher* (vol. xxxv., 1875, and xxxvi., 1876); J. Bluntschli, in *Deutsches Staats-Wörterbuch* (1857–70), and *Geschichte des allgemeinen Staatsrechts und der Politik* (1864); J. Lorimer, *The Instituter of the Law of Nations* (2 vols., 1883–84); J. C. Droysen, "Zur Kritik Pufendorfs" in his *Abhandlungen zur neueren Geschichte* (1876); W. Roscher, *Geschichte der National Oekonomik in Deutschland* (1892); O. Franklin, *Das deutsche Reich nach Severino von Monzambano* (1874).

PUFF ADDER: *see* ADDER; VIPERS; SNAKES.

PUFF-BALL, the popular name of a group of fungi belonging to the Basidiomycetes *(see* FUNGI), and so called because of the cloud of brown dust-like spores which is emitted when the mature plant bursts or is struck a blow. They are common in meadows and woods and on heaths or lawns, and when young



COURTESY OF THE DOMINION BOTANIST, DEPARTMENT OF AGRICULTURE, OTTAWA
Puff-ball. A medium sized specimen of the giant puff-ball (approximately 8½ in. wide)

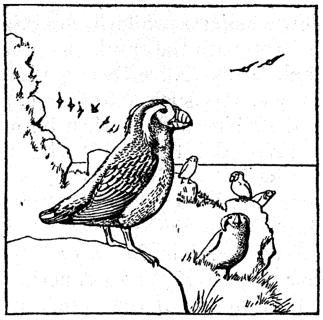
resemble white balls, sometimes with a short stalk, and are fleshy in texture. While white and fleshy they are edible.

The giant puff-ball, *Calvatia maxima,* may sometimes attain a weight of 15 pounds or more and measure up to 4 to 5 ft. or more in circumference. It has been estimated that a specimen measuring 15.7 x 11.0 x 7.8 in. will produce approximately 7,000,000,000,000 spores.

PUFF-BIRD, the name given to a group of birds forming the family *Bucconidae,* of the order Piciformes, which also includes the woodpeckers (*q.v.*). The *Bucconidae* are confined to the neotropical region, in the middle parts of which, and especially in its sub-Andean subregion, they are, as regards species, abundant; while only two seem to reach Guatemala and but one Paraguay. *Chelidoptera* breeds in holes in banks, and lays white eggs. The *Bucconidae* are plainly coloured, and the majority have a spotted or mottled plumage suggestive of immaturity.

PUFFIN, a sea-bird *(Fratercula arctica*), known also as bottle-nose, coulterneb, pope, sea-parrot and tammy-norie. Of old time, puffins were a valuable commodity to the owners of their breeding-places, for the young were taken from the holes in which they were hatched, and were "kept salted and reputed for fish." Puffins resort in vast numbers to certain stations on the coast, reaching' them in spring with remarkable punctuality. They lay their single egg (white, with a few grey markings at first, but which speedily becomes begrimed by the soil) in a shallow burrow, which they either dig for themselves or appropriate from a rabbit.

The plumage of both sexes is glossy black above—the cheeks grey, encircled by a black band—and white beneath; the feet are of a bright reddish orange. The most remarkable feature of these birds is their huge bill. In the breeding season this is very deep, laterally flattened, parti-coloured—blue, yellow and red—and curiously grooved and embossed in places. The puffin's bill undergoes an annual moult, some of its most remarkable appendages, dropping off at the end of the breeding season. The puffin, when feeding its young, manages to arrange crosswise in its bill, a number of fish at a time. In the north Pacific we find the horned (*F. corniculata*) and the crested puffin (*Lunda cirrhata*).



BY COURTESY OF THE NATIONAL ASSOCIATION OF AUDUBON SOCIETIES

TUFTED PUFFIN (LUNDA CIRRHATA)

A blackish brown bird, with a white cheek, and a yellow plume over the eye

PUGACHEV, EMEL'YAN IVANOVICH (1741?–1775), Russian pretender, the date of whose birth is uncertain, was the son of a small Cossack landowner. He married a Cossack girl Sofia Nedyuzheva, in 1758, and the same year was sent with his fellow Cossacks to Prussia, under the lead of Count Zachary Chernuishev. In the first Turkish War (1769–74) of Catherine II. Pugachev, now a Cossack ensign, served under Count Peter Panin and was present at the siege of Bender. Invalided home, he led for the next few years a wandering life; was more than once arrested and imprisoned as a deserter; and finally, after frequenting the monasteries of the "Old Believers," who exercised considerable influence over him, suddenly proclaimed himself (1773) to be Peter III. Pugachev asserted that he and his friends had escaped from Catherine, and were resolved to redress grievances, give liberty to the Cossacks and put Catherine in a monastery. He held a mimic court at which one Cossack impersonated Nikita Panin, another Zachary Chernuishev and so on. At the beginning of Oct. 1773 500 roubles was considered a sufficient reward for the head of the troublesome Cossack. At the end of November 28,000 roubles were promised. Still, Catherine, in her correspondence with Voltaire, affected to treat *"l'affaire du Marquis de Pugachev"* as a mere joke. By the beginning of 1774 the forts on the Volga and Ural were in the hands of the rebels; the Bashkirs had joined them; and the governor of Moscow reported great restlessness in central Russia. Pugachev captured Kazan, reduced most of the churches and monasteries there to ashes and massacred those who refused to join him. Panin, the conqueror of Bender, was sent against the rebels with a large army, but the innumerable and ubiquitous bands of Pugachev were victorious in nearly every engagement. Not till August 1774 did General Mikhelson inflict a crushing defeat upon the rebels near Tsaritsyn, when they lost ten thousand in killed and prisoners. Suvorov completed their discomfiture. Pugachev was delivered up by his own Cossacks on attempting to fly to the Urals (Sept. 14), and was brought in an iron cage to Moscow, where he was executed on Jan. 11, 1775.

See N. Dubrovin, ***Pugachev and his Associates*** (Rus.; Petersburg, 1884); *Catherine II., Political Correspondence* (Rus. Fr. Ger.; Petersburg, 1885, &.); S. I. Gnyedich, ***Emilian Pugachev*** (Rus.; Petersburg, 1902); also the literature quoted *s.v.* CATHERINE II.

PUGACHEVSK (formerly NIKOLAYEVSK), a Russian town in the Samara province, in 52° 1' N., 48° 48' E., on the Irgiz river. Pop. (1926) 17,460. It is a collecting point for agricultural produce. Under the name of Mechetnoye, Nikolayevsk was founded in 1762 by Raskolniks who had fled to Poland and returned when Catherine II. undertook to grant them religious freedom. In 1828 serious persecutions began, with the result that the monasteries were closed with the exception of three, which were handed over in 1829 and 1836 to the United Greek Church. In 1835 the name of the town was changed to Nikolayevsk.

PUGET, PIERRE (1622–1694), French painter, sculptor, architect and engineer, was born at Marseille, on Oct. 31, 1622. He travelled in Italy as a young man, and was employed by Pietro di Cortona on the ceilings of the Barberini palace. On his return to Marseille in 1643, he painted portraits and carved the colossal figure-heads of men-of-war; he also painted numerous pictures for Aix, Toulon, Cuers and La Ciotat; his caryatides for the hôtel de ville of Toulon were executed between 1655 and 1657. Fouquet employed him to sculpture a "Hercules" for his château in Vaux. In 1655, owing to a serious illness, he was forced to give up painting. In 1660 he was in Genoa, where he executed his French Hercules (Louvre) and the statues of St. Sebastian and of Alexandre Sauli in the church of Carignano (*c.* 1664). In 1669, at the summons of Colbert, he returned to France, and took up his old work in the dockyards of Toulon, until in 1685, disheartened by the destruction by fire of an arsenal he was constructing, he returned to Marseille. Here he continued the series of sculptures on which he had been employed by Colbert. His statues of Milo (1682), Perseus and Andromeda (1684), and the bas-relief, Alexander and Diogenes (1685) are in the Louvre. In 1688 he visited Paris, but court intrigues obliged him to abandon the project of an equestrian statue of Louis XIV., and he retired to Marseille, where he died on Dec. 2, 1694. His best work, the St. Sebastian at Genoa, shows energy and life. In the museum of Aix in Provence is the bust of a long-haired young man, believed to be Louis XIV., made by Puget in 1660.

See L. Lagrange, ***Pierre Puget*** (1868, with a catalogue of works); C. Ginoux, ***Annales de la vie de P. Puget*** (1894); P. Auquier, ***Pierre Puget . . . biographie critique*** (1903).

PUGILISM, the practice or sport of fighting with the fists (from Lat. *pugil*, boxer, Gr. πύξ, with clenched fist). The first mention of such fighting in literature is found in the 23rd book of the Iliad; another full description is in Virgil, Aeneid.

Although fist-fighting was supposed by the Greeks of the classic period to have been a feature of the mythological games at Olympia, it was not actually introduced into the historic Olympic contests until the 23rd Olympiad after the re-establishment of the famous games by Iphitus about 880 B.C. Onomastos was the first Olympic victor. Wearing no belt, or ζῶμα, the contestants, except for the cestus, fought entirely naked, since the custom had been introduced in the 15th Olympiad, and was copied by the contestants at the Pythian, Nemean, Isthmian and Panathenaic games (see GAMES, CLASSICAL). At Olympia the boxers were rubbed with oil to make them supple and limit the flow of perspiration, a precaution the more necessary as the Olympic games were held during the hottest part of the year. The cesti, of which there were several varieties, were bound on the boxers' hands and wrists by attendants or teachers acting as seconds. On account of the weight of the gloves worn, the style of boxing differed from that now in vogue (see BOXING), the modern straight-from-the-shoulder blow having been little used. Both Homer and Virgil speak of "falling blows," and this was the common method of attack, consisting more in swinging and hammering than in punching. The statue of a Greek boxer in the Louvre shows the right foot forward, the left hand raised as if to ward off a blow from above, and the right hand held opposite the breast, the whole attitude more resembling that of a warrior than of a modern boxer. The Greek champions trained for months before the games, but encounters between athletes armed with such terrible weapons as the loaded cestus were bound to result in very serious bruises and even disfigurement. Pluck was as highly thought of as at the present day, and it was related of a certain Eurydamas, that, when his teeth were battered in, he swallowed them rather than show that he was hurt, whereupon his antagonist, in despair at seeing his most furious blows devoid of effect, gave up the battle. As, on account of the swinging style of blows, the ears were particularly liable to injury ear-protectors (ἀμφωτίδες) were generally used in practice, though not in serious combats. The so-called "pancratist's ear," swollen and mis-shapen, was a characteristic feature of the Greek boxer.

The rules of Greek boxing were strict. No wrestling, grappling, kicking nor biting were allowed, and the contest ended when one combatant owned himself beaten. On this account pugilism and the *pancratium* (see pp. 758) were forbidden by Lycurgus, lest the Spartans should become accustomed to an acknowledgment of defeat (Plutarch, *Lycurgus*). Moreover, it was strictly forbidden to kill an adversary, on pain of losing the prize. Rhodes, Aegina, Arcadia and Elis produced most of the Olympic victors in boxing, which was considered an excellent training for war.

The Greek athletic contest called pancratium (παγκράτιον, complete or all-in, contest), which was introduced into the Olympic games in the 38th Olympiad. was a combination of boxing and wrestling in which the contestants, who fought naked, not wearing even the cestus, were allowed to employ any means except biting to wring from each other the acknowledgment of defeat. Boxing, wrestling, kicking, dislocation of joints, breaking of bones, pulling of hair and strangling were freely indulged in. The fight began with sparring for openings and was continued on the ground when the contestants bit the dust. Sudden attacks were also taught, reminding one of the Japanese *jiu-jitsu.* The pancratium was considered by the Greeks the greatest of all athletic contests. It became popular in Rome during the empire and remained so until the time of Justinian. Diagoras of Rhodes, his three sons ahd many grandsons, who were sung by Pindar (Olymp. 7), were the most celebrated of the Olympic boxing champions. A celebrated fighter and wrestler was Milo of Crotona (520 B.C.).

Boxing was evidently in vogue in very ancient times in Italy, imported, in all probability, from Greece, for Livy (i. 35) relates that, at the first celebration of the great Roman games (ludi, *Romani magnique varie appellati*) by Tarquinius Priscus (6th century B.c.), boxers were brought from outlying provinces; and there was an old tradition that a school of pugilism flourished in Etruria in heroic times. During the republic boxing was cultivated as a gentlemanly exercise, and we find Cato the Elder giving his son instruction in the art (Plutarch, Cato Major). Tacitus (Ann. xvi. 3) says that the emperor Caligula imported the best Campanian and African pugilists for the gladiatorial games, and Strabo (iii. 3) records that the Lusitanians and also the Indians, who gave virgins as prizes, boxed. The art remained popular in Italy down to a late period of the empire.

Pugilism in England. — From the fall of the Roman empire to the beginning of the 19th century pugilism seems to have been unknown among civilized nations with the single exception of the English. The first references to boxing in England as a sport occur towards the end of the 17th century, but little mention is made of it before the time of George I., when "prize-fighters" engaged in public encounters for money, with the backsword, falchion, foil, quarter-staff and single-stick, and, to a less extent, with bare fists, the last gradually gaining in popularity with the decline of fencing. The most celebrated of these fighters and the one who is generally considered to have been the first champion of England, fighting with the bare fists, was James Figg, who was supreme from 1719 to 1730. Figg was succeeded by Pipes and Gretting, both of whom made way in 1734 for Jack Broughton, who built the amphitheatre for public displays near Tottenham Court road and who was undisputed champion until 1750. Broughton seems to have been a man of intelligence, and to him is ascribed the scientific development of the art of boxing. During his time the sport became truly national and the prize-fighter the companion of the greatest in the land. Among Broughton's successors were Slack, "Big Ben" Brain, Daniel Mendoza (a Jew who flourished about 1790 and was the proprietor of the Lyceum in the Strand), J. Jackson, Tom Cribb, Jern Belcher, Pearce (called the "Game Chicken"), and John Gully, who afterwards represented Pontefract in parliament.

To Broughton is ascribed the invention of boxing-gloves for use in practice. All prize-fights, however, took place with bare knuckles in roped-off spaces called rings, usually in the open air. Pugilists toughened their hands by "pickling" them in a powerful astringent solution. A fight ended when one of the "bruisers," as they were called, was unable to "come to the scratch," *i.e.,* the middle of the ring, at the call of the referee at the beginning of a new round. Each round ended when one fighter fell or was knocked or thrown to the ground, but a pugilist "going down to avoid punishment," *i.e.,* without being struck by the opponent, was liable to forfeit the fight. Wrestling played an important rôle in the old prize-ring, and a favourite method of weakening an adversary was to throw him heavily and then fall upon him. seemingly by accident, as the manoeuvre, if done intentionally, was foul. The fighting was of the roughest description, low tricks of all kinds being practised when the referee's attention was diverted, gouging out an adversary's eye being by no means unknown. Until 1795 pugilists wore long hair, but during a fight in that year Jackson caught Mendoza by his long locks and held him down helpless while he hit him. This was adjudged fair by the referee, with the result that prize-fighters have ever since cropped their heads. Nevertheless, there were rules which no fighter dared to overstep, such as those against kicking, hitting below the belt, and striking a man when he had fallen.

From the time of Cribb the English champions were Tom Spring (1824), Jern Ward (1825), Jern Burke (1833), W. Thompson, called "Bendigo" (1839–4j), Ben Caunt (1841), W. Perry the "Tipton Slasher" (1850), Harry Broome (1851), Tom Sayers (1857–60), Jern Mace (1861–63), Tom King (1863), and again Mace, until 1872. In America boxing began to be popular about the beginning of the 19th century. The first recognized national champion was Tom Hyer (1841–48), who was followed by James Ambrose (born in Ireland), called "Yankee Sullivan"; John Morrissey (afterwards elected to the United States Congress); John C. Heenan; Tom Allen (of England); Jern Mace (of England); J. Kilrain; John L. Sullivan (1880–91). Sullivan was the last of these to fight with the bare fists. Pugilism (*i.e.,* fighting with the bare fists) was driven out in favour of boxing (*i.e.,* fighting with the glove) by public opinion and by the general adoption after 1866 of the Marquis of Queensberry rules. The last championship fight under the old prize ring rules was fought between Frank Slavin and Jern Smith in Belgium, the latter retaining the championship. The old prize ring being illegal and extinct no champion can succeed him. See BOXING.

See Egan, *Boxiana* (1818–1824) ; *Fistiana* (1868) ; *American Fistiana* (1876).

PUGIN, AUGUSTUS WELBY NORTHMORE (1812–1852), English architect, son of Augustus Charles Pugin (1762–1832), a Frenchman who settled in London as an architectural draughtsman, was born in Store Street, Bedford Square, on Mar. 1, 1812, and died on Sept. 14, 1852, at Ramsgate. He was educated at Christ's Hospital and in his father's office, where he helped to prepare a large series of works on the Gothic buildings of England. All through his life he made numerous drawings and sketches, in pen and ink or with sepia monochrome, perfect in their delicacy and precision of touch. After his reception into the Roman Catholic Church in 1833, he became a leader in the English Gothic revival. In 1837–43 he assisted Sir Charles Barry by working out the details of the designs for the new Houses of Parliament at Westminster; and though his exact share was the subject of bitter controversy after both he and Barry were dead, there is no doubt that the excellence of the details was partly due to him and to his training of the masons and carvers. Many of his executed works suffered from the fact that his designs were altered, both by cutting down their proportions and by introducing shams, such as plaster groining and even cast-iron carving. The cathedral of St. George at Southwark, and the church in Farm Street, Berkeley Square, London, are melancholy instances of this. The cathedral of Killarney and the chapel of the Benedictine monastery of Douai best express the original conception. Pugin was very broad in his love for the mediaeval styles, but on the whole preferred the Perpendicular of the 15th century as being best suited to modern requirements. He used this with success in his own house at Ramsgate and in the stately Adare Hall in Ireland built for Lord Dunraven.

In 1836 Pugin published his Contrasts; or *a* Parallel between the Architecture of the *15th* and *19th* centuries; *True* Principles of *Christian Architecture* (1841); Glossary of Ecclesiastical *Ornament* (1844); and Treatise *on Chancel* Screens *and* Rood Lofts (1851) He was a skilful etcher.

See B. Ferrez, *Recollections* of *A. W. Pugin and his Father* (1861); Paul Waterhouse, "The Life and Work of Welby Pugin" in the *Architectural Review,* iii., iv. (1898).

PUINAVIAN, a tribe of South American Indians, which appear to constitute by itself alone an independent linguistic stock. The Puinavis live or lived on the border between Venezuela and Colombia, on the Inirida river, just south of 4° N. lat.

See A. F. Chamberlain, *Sur quelques familles linguistiques . . . de l'Amérique du Sud* (J. Soc. Americanistes de Paris [n.s.], vol. vii., pp. 179–202).

PUISNE, a term in law meaning "inferior in rank." It is pronounced "puny" and the word, so spelt, has become an ordinary adjective meaning undersized. By the Supreme Court of Judicature act, 1877, a "puisne judge" is defined as a judge of the High Court other than the lord chancellor, the lord chief justice of England, the master of the rolls, the lord chief justice of the common pleas, and the lord chief baron, and their successors respectively; but the last two offices have since been abolished.

PUJA, Hindu "worship": whence *pujāri,* "priest." Colloquially the word is used for any rite; and "pujah of the Rag" is the sepoy term for trooping the colours.

PUKET, sometimes spelled BHUKET (the Chinese name is *Tongkah*), leading Thai port on the west coast of the Malay peninsula, on Junk Ceylon island (also called Puket) in 7° 50′ N. and 98° 24′ E. The island constitutes one of the 70 changvads (districts) of Thailand; pop. (1937) 41,827, nearly half Chinese. Rich tin deposits have been worked by Chinese from ancient times. A European company commenced modern dredging operations in 1907. The 1938–39 tin ore production was 4,256 tons. Exports of ore from the Puket customs area (the Thai west coast) amounted to 31,873,287 bhat (about $14,000,000) in 1939–40. Rubber stood second among exports, followed by betelnuts, oriental equivalent of chewing tobacco. European merchants began trading at Puket in the 16th century. It was besieged by the Burmese during the 18th century wars between Burma and Thailand, but was relieved by troops from the mainland.

PULASKI, CASIMIR, COUNT (1748–1779), Polish soldier. was born in Podolia in 1748, and took a prominent share, under his father Count Joseph Pulaski, in the formation of the confederation of Bar and in the military operations which followed, becoming ultimately commander-in-chief of the Polish patriot forces. Driven into exile about 1772, Pulaski went to America and joined the army of Washington in 1777. He distinguished himself at Brandywine, was made a brigadier-general and chief of cavalry by Congress, and fought at Germantown, and in the battles of the winter 1777–78, after which he raised a mixed corps called the Pulaski legion, with which he defended Charleston in May 1779. He was mortally wounded at Savannah, dying on Oct. 11th.

PULASKI, a town of Virginia, U.S.A., county seat of Pulaski Co.; 50 mi. S.W. of Roanoke, on federal highway 11 and Norfolk and Western Ry. Pop. (1940) 8,792. It is in a region of beautiful scenery and of coal, lead and iron mines, between the Blue Ridge and Allegheny mountains. It is a summer resort.

PULCI, LUIGI (1432–1484?), Italian poet, was born at Florence on Dec. 3, 1432, of a well-connected family. His elder brother Luca (d. 1470) was also a poet, and the share of each of the two brothers in the poems *Pistole, Driadeo d'amore,* and *Ciriffo Calvaneo* is not easily distinguishable. Luigi was patronized by Cosimo, Piero, and Lorenzo de' Medici. He used to find an object for his mockery in the long romances of chivalry recited in the streets and in public places. He chose for his semi-burlesque poem, *Morgante,* generally known as *Morgante Maggiore* (complete ed. Venice 1482; critical ed. Milan 1875), the epic of Charlemagne. The story centres in Ganelon's hatred of Roland and the Christian Paladins. Pulci's *Letters* were edited at Lucca 1886.

See L. Einstein: *L. Pulchi and the Morgante Maggiore* (Berlin 1902) A. Momigliano: *L'Indole e il Riso di Pulci* (1907); E. Walser: "Die Religion des L. Pulci" in *Die Neueren Sprachen* 10 Beiheft (1926).

PULICAT, a town of British India, in Chingleput district, Madras, 25 m. N. of Madras city. Pop. (1931), 4,164. The Dutch built a fort here as early as 1609, and it was for a long time their chief settlement on the Coromandel coast. Repeatedly captured, it did not finally become British until 1825. It gives its name to the Pulicat lake, a shallow lagoon stretching for about 37 m. along the coast. The seaward side is formed by the island of Sriharikota, which supplies firewood to Madras city.

PULITZER, JOSEPH (1847–1911), American editor and newspaper proprietor, was born in Mako, Hungary, April 10, 1847. His father, a grain-merchant, was Magyar-Jewish; his mother Austro-German. Pulitzer was educated privately in Budapest. Excluded from the army as a result of physical defects, and failing in an attempt to join the French Foreign Legion, he was induced by an American agent to emigrate to the United States as a prospective recruit for the Union army. He enrolled in Company L, 1st New York Lincoln cavalry, for a term of one year. Discharged on July 7, 1865, in New York city, he looked in vain for work there. In the autumn he started west for St. Louis, where he arrived penniless.

In St. Louis, with its large German population, Pulitzer's progress was rapid. While making his living by odd employments, he studied for the bar and was admitted in 1867. On March 6 he was naturalized, and in 1868 he became a reporter on the *Westliche-Post* staff; in Dec. 1869 he was elected to the lower house of the legislature. Here he led a successful movement to reform the corrupt county government of St. Louis. When the revolt against Grant led to the Liberal Republican movement in 1871–72, Pulitzer helped to organize this party in Missouri and was one of the secretaries of the Cincinnati convention which nominated Greeley.

Pulitzer then became a newpaper proprietor. Some owners of the *Westliche-Post* sold him a share on liberal terms. This he soon resold for $30,000, using part of the proceeds for an extended tour of Europe. On his return he purchased a moribund German daily, the St. Louis *Staats-Zeitung,* for a song, and sold its Associated Press franchise to the *Globe* for $20,000. In 1876 he took an active share in the presidential campaign, breaking loose from all his Republican associates.

On June 19, 1878, he married Miss Kate Davis, a distant relative of Jefferson Davis. On Dec. 9 of the same year he laid the foundation of his fortune by purchasing at auction the worn-out St. Louis *Dispatch,* paying $2,500 cash and giving a $30,000 lien. This newspaper he merged with the *Post,* owned by John A. Dillon, as the *Post-Dispatch,* which immediately began to pay and soon dominated the St. Louis evening field. It was independent in politics and devoted to "hard money" and tariff reform. In 1880 Pulitzer became sole owner. He laboured with unremitting energy, and the profits were soon running from $40,000 to $85,000 a year. Unfortunately in Oct. 1882 his chief editorial aid, Col. John A. Cockerill, shot and killed a lawyer, Col. Alonzo W. Slayback, in a bitter quarrel of political origin. The case did not come before the courts, but public reprobation was so great that the *Post-Dispatch* lost revenue and Pulitzer thereafter felt unwelcome in St. Louis. He departed for the East in the spring of 1883, and bought the New York *World* for $346,000, taking possession on May 10.

In 1884 he was elected to Congress from the Ninth District, a position he resigned before his term expired. Under its new management the *World* won an immediate prosperity. It was aided by a quarrel in which its rival, the *Herald,* became engaged with the newsdealers, and by the *Sun's* disastrous decision in 1884 to support Benjamin F. Butler for the presidency. By 1886 the annual earnings of the *World* were more than $500,000. With these resources Pulitzer in 1887 established the *Evening World,* which lost $100,000 the first year, but by 1890 was highly profitable. William R. Hearst's purchase of the New York *Journal* in 1895 brought the *World* a powerful competitor, and it met the challenge on Feb. 10, 1896, by reducing its price from two cents to one. The daily circulation of the *World* quickly rose to 300,000 and its Sunday circulation before the end of 1896 reached 623,000 copies. To the *World,* as to the *Post-Dispatch,* Pulitzer gave a tone of aggressive editorial independence. The paper earnestly supported Cleveland in his contests for the presidency in 1884, 1888 and 1892. It was sympathetic to labour, and in 1892 took the side of the striking steel workers at Homestead. Pennsylvania. It opposed Bryan for the presidency in 1896. A year later the *World* became an advocate of war with Spain, for Pulitzer sympathized with the Cuban struggle for liberty. Meanwhile Pulitzer's health, including his eyesight, compelled him to live the secluded existence of an invalid, but he kept in intimate touch with the *World* until within a few weeks of his death in Charleston (S.C.), Oct. 29, 1911.

During his lifetime Pulitzer had given liberally. In 1903 he endowed the School of Journalism of Columbia university, opened in 1912. In his will he established a series of prizes, known as the Pulitzer prizes, to be awarded annually, for letters, the drama, music and newspaper work.

BIBLIOGRAPHY.—Don C. Seitz, *Joseph Pulitzer, His Life and Letters* (1924); Alleyne Ireland, *Joseph Pulitzer—Reminiscences of a Secretary* (1914); W. G. Bleyer, *Main Currents in the History of American Journalism* (1927). (W. LI.; A. N.)

PULKOVO (Pulkowa), the most important meteorological observatory in Russia, 10 m. S. of Leningrad in 59° 47' N., 30° 18' E., altitude 248 ft. and built 1833–9. Russian longitude is usually indicated from Pulkovo, though some recent Russian atlases and maps give longitude east of Greenwich, the difference having been fixed by wireless.

War conditions (1914–21) made a considerable break in international exchanges with Pulkovo. Yudenich captured Pulkovo in his march against Leningrad in 1919, and its re-capture by Soviet troops was the beginning of the collapse of his army.

PULLEY, a wheel, either fixed to a turning axle or carried freely on a stationary one, the periphery of which is adapted to receive some form of wrapping connector. A pulley carried on a rotating shaft and connected to another pulley on a second shaft by an endless band consisting of a flat belt, rope, chain or similar connector serves for the transmission of power from the one shaft to the other and is known as a driving pulley; while combinations of pulleys or "sheaves" mounted in fixed or movable frames or "blocks" facilitate the raising of heavy weights.

Driving Pulleys.—These are usually constructed of cast iron, and are of circular form, having a central nave by which they are secured to the shaft by keys or other fastenings, and straight or curved arms connecting the nave to the rim, which latter is of a form adapted to the connector. Pulleys are usually cast in one piece, and the proportions of the various parts are designed to resist the unknown stresses due to contraction of the casting in cooling. The rim is slightly wider than the belt, and is of such a section as will suffice to resist the stress due to the pull of the belt, which is commonly taken as 80lb. per inch of width for single belting and 140lb. per inch of width for double belting. The rim is also subject to a centrifugal tension of amount wv^2/g pounds per square inch of section, where w is the weight in pounds of a length of one foot of the pulley rim one square inch in section, and v is the velocity of the rim in feet per second. This stress amounts to 1,043lb. per square inch, if the velocity is 100 ft. per second. The combination of these stresses generally limits the rim velocity of cast-iron pulleys to 80 or 100ft. per second. The arms, preferably straight, are elliptical in cross-section, diminishing from the nave to the rim, and are usually designed as equally loaded cantilevers, fixed at the nave and free at the rim. The statical experiments of C. H. Benjamin (American Machinist, 1898) showed that the rim is usually not sufficiently rigid to load the arms equally, and that the ends of the arms are subjected to bending movements of opposite sign, that at the nave being almost invariably the greater.

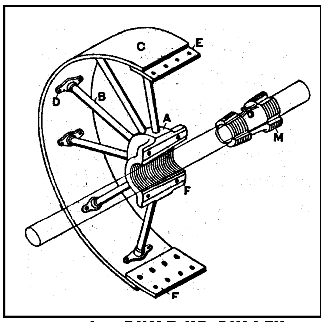


FIG. 1.—BUILT-UP PULLEY

Pulleys are also built up of wrought iron and steel, and can then be constructed entirely free from internal stress; they are thus much lighter and stronger, and are not liable to fly to pieces like cast iron if they break. Fig. 1 shows a built-up pulley having a cast-iron nave A, straight wrought-iron arms B, screwed therein and connected to a steel plate-rim C by riveted ends, and also by screwed flanges D riveted on each side to the rim. The pulley is in halves to facilitate fixing, and when in place the sections C are joined by plates E bolted or riveted to the rim. The two halves of the nave are secured by bolts or rivets passing through the flanges F, and the pulley is connected to the shaft by a sunk key or by conical keys driven in between the shaft and the boss, which latter is bored to suit. A modified form of this arrangement of cone keys is shown in the figure, in which a screwed conical bush M, divided into several parts longitudinally, is clamped round the shaft, and screwed into the corresponding part of the nave until the grip is sufficient. The parts of the bush are glued to a sheet of emery paper, so that its rough side may give a better grip on the shaft.

Pulleys are also made of paper, wood and other materials. Wooden pulleys are preferably made of maple, the rim being formed of small sections morticed, pinned and glued together, with the grain set in such directions that any warping of the material will leave the cylindrical form practically unaltered. Wooden pulleys are generally made in two halves, bolted together at the rim and nave, and are provided with wooden spokes dovetailed into the rim and secured by keys.

If the centre of gravity of a pulley is on the axis of rotation, and the whole mass is distributed so that the axis of inertia coincides with the axis of rotation, there can be no unbalanced force or unbalanced couple as the pulley revolves. The magnitude of the unbalanced force, for a mass of w pounds at a radius of r feet and a velocity of v feet per second, is expressed by wv^2/gr lb.; and, since the force varies as the square of the velocity, it is necessary carefully to balance a pulley running at a high speed to prevent injurious vibrations. This can be accomplished by attaching balance-weights to the pulley until it will remain stationary in all positions, when its shaft rests on two horizontal knife-edges in the same horizontal plane, or, preferably, the pulley and shaft may be supported on bearings resting on springs, and balanced by attached masses until there is no perceptible vibration of the springs at the highest speed of rotation.

The rims of pulleys, round which flat bands are wrapped, may be truly cylindrical, in which case the belt will run indifferently at any part of the pulley, or the rim may be swelled towards the centre, when the central line of the band will tend to run in the diametral plane of the pulley. This self-guiding property may be explained by the tendency which a flat band has, when running upon a conical pulley in a direction normal to its axis, to describe a spiral path as it wraps on to the surface because of the lateral stiffness of the material; the advancing side therefore tends to rise towards the highest part of the cone. In practice the pulley rim is curved to a radius of from three to five times its breadth.

Parallel Shafts.—Parallel shafts may be driven by flexible bands or connectors passing over pulleys, the central planes of which coincide, without any guiding arrangements for the belting. The shafts revolve in the same or opposite directions, according as the belt is open or crossed. Means of changing the relative speeds of rotation are furnished by pulleys of continuously varying diameter, or by speed cones (see MECHANICS: *Applied*). A common arrangement for driving a lathe spindle, in either direction at several definite speeds, is to provide a countershaft on which are mounted two fixed pulleys and two loose pulleys to accommodate two driving belts from the main shaft, one of which is open and the other crossed. The belts are moved laterally by the forks of a striking gear pressing on the advancing sides of the belts, and the pulleys are arranged so that the belts either wrap round the loose pulleys, or can be shifted so that one wraps round a fixed pulley, while the other still remains on its loose pulley. Motion in either direction is thereby obtained and a considerable variation in the speed of rotation can be obtained by providing a cone pulley on the countershaft, which drives the cone pulley secured to the lathe spindle by a separate band. The dimensions of the pulleys are generally so arranged that the return motion of the lathe spindle is faster than the forward motion.

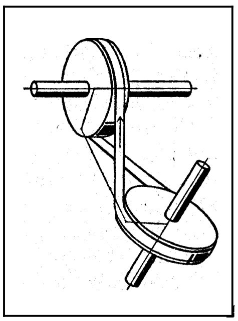


FIG. 2

When pulleys are mounted on shafts which are parallel to one another, the band will retain its position, provided that its central line advances towards each pulley in the diametral plane of this latter. This condition is fulfilled in the example shown by fig. 2, in which the central planes of each pulley pass through the points of delivery of the other pulley for the given direction of motion. If the motion is reversed the condition is no longer satisfied and the belt will leave the pulleys. In more complicated cases guide pulleys must be used. In the most general case for inclined pulleys, any two points may be chosen on the line of intersection of the diametral planes, and tangents drawn to the pitch circles of the pulleys. Guide pulleys are set with their diametrical planes in the planes containing corresponding pairs of tangents, and a continuous belt wrapped round these pulleys in due order can then be run in either direction.

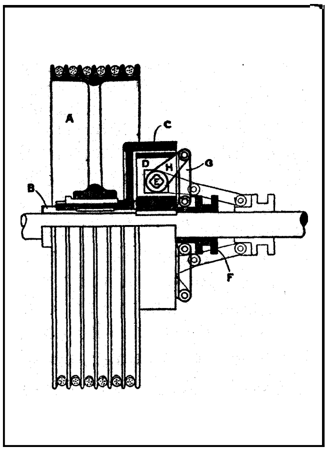


FIG. 3.—FRICTION CLUTCH FOR ROPE-PULLEY

The rims of pulleys for hemp or other ropes or cords are grooved, and the sides are usually either inclined at 45° or curved to give a sharper angle at the outside than at the bottom of the groove; in the latter case, as the rope wears it engages in a groove of greater angle and less effective grip. Wire ropes are injured by the lateral crushing of the material, and in this case the grooves are wide enough to allow the rope to rest on the rounded bottom, which is lined with leather or wood to diminish the wear and increase the friction. In English practice there are as many separate endless ropes as there are pairs of grooves in the two pulleys to be connected, but in cases of American practice the rope is continuously wound round the two pulleys, and the free end passes over a pulley mounted on a'movable weighted carriage to adjust the tension.

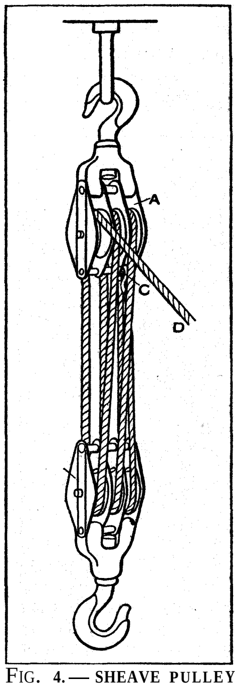


FIG. 4.— SHEAVE PULLEY BLOCK

Pulleys may be detachably connected to a shaft by friction clutches, so that they may be thrown in and out of engagement at will. The section, fig. 3, shows a clutch for a rope-driven pulley A, which runs freely on a bush B on the shaft, and is provided with an enlarged cylindrical nave or clutch box C. A split ring D, carried by the clutch and turning with it, can be thrust against the clutch box by right- and left-handed screws E, so that a sufficient grip is obtained to cause the clutch and the pulley to turn as one piece. The engagement of the pulley and clutch is determined by a hand-controlled block F sliding on the shaft, the movement of which is communicated to the right- and left-handed screw shafts by links G connected to the levers H.

Pulley Blocks.—Frames or blocks containing pulleys or sheaves are used in combination for lifting heavy weights. There are usually two blocks, of which one A (fig. 4) is fixed, and the other B is movable, and a rope or chain, with one end secured to one of the blocks at C, passes round the sheaves in a continuous coil, leaving a free end D at which the effort is applied. In the arrangement shown there are three equal sheaves in each block, and each set turns on a pin secured in the framing. The load, supported by the lower hook, is raised by hauling on the free end and, neglecting any slight obliquity of the plies of rope, the free end moves six times as fast as the lower block carrying the weight, and in the absence of friction and other resistances the mechanical advantage will be in the same ratio of the effort to the resistance. In practice the full advantage of this or any other similar combination is not realized, because of the friction of the sheaves against the pin or shaft, and more important stilt is the stiffness of the rope, which requires work to be done upon it to bend it round the sheave and straighten it again.

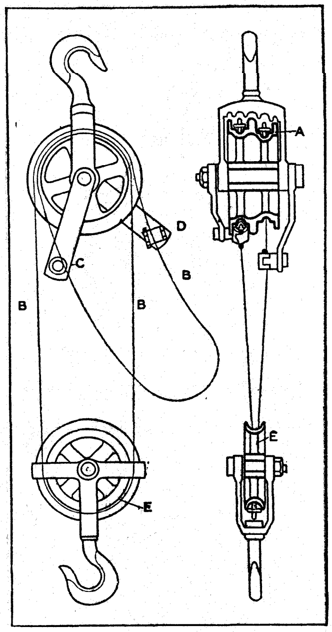


FIG. 5.—WESTON DIFFERENTIAL PULLEY BLOCK

Differential Pulley Block.—To obtain a greater ratio of resistance to effort, without using a large number of sheaves, various arrangements are used, of which the Weston differential pulley block is a typical example. The upper block carries a pair of chain pulleys A (fig. 5), strongly secured together and of slightly different effective diameters. An endless chain B, passing through guides C and D, encircles these pulleys and the single loose pulley E of the lower block, as indicated. If a greater difference of effort from resistance is required, a further mechanical advantage can be obtained by employing a separate hand-wheel and chain, or by forming the upper sheave with an annular spur-wheel gearing with a pinion driven by a hand-wheel and chain, as in the Tangye form of Weston pulley-block. The efficiency of the Weston pulley-block is less than 50%, and it does not therefore overhaul. An objection to this form of block is the great length of the endless chain, which may drag on the ground and pick up dirt and grit, and thereby interfere with the smooth working of the mechanism. Other forms, which do not require so lengthy a chain, sometimes employ an epicyclic train to obtain the reduced velocity of the load.

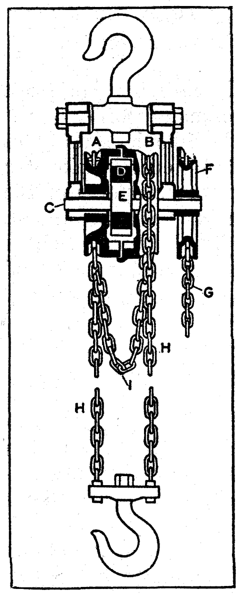


FIG. 6.—MOORE AND HEAD PULLEY BLOCK

The Moore and Head block has two equal chain-wheels A, B, fig. 6, loosely mounted on an axle C, and provided with annular toothed gear-wheels which usually differ by one tooth. A spur pinion D, gearing with both wheels, is carried loosely upon an eccentric E forming part of the central pin, so that when this latter is turned by the hand-wheel F and chain G the axis of the pinion describes a circle the diameter of which equals the throw of the eccentric, and a small relative motion of the two sheaves takes place, depending on the number of the teeth of the annular wheels. The motion obtained is divided between the two vertical parts of the chain H, which is wrapped round each sheave in opposite directions, with a free loop I between, while the ends are attached to the lifting hook. This form is self-sustaining at all loads.

Worm Gear Pulley.—To obtain a self-sustaining pulley tackle, which will have an efficiency of more than 50%, various arrangements are adopted, which during lifting automatically throw out of action a brake and cause it to come into action again when the effort is removed. A worm-gear tackle of this description is shown in fig. 7, in which a worm A, operated by a hand-wheel B and chain C, drives the worm-wheel D, thereby coiling up a chain E, one end F of which is secured to the upper block, and the other end hangs loosely, after passing round the sprocket-wheel. The worm is of great pitch, so that if the effort were removed the weight would descend, did not the axial end thrust of the worm shaft throw into action a friction brake H, the resistance of which prevents motion downwards. In the brake shown, the cone I is pressed against a corresponding recess in the ratchet-wheel J, which latter turns loosely in the casing and is provided with a pawl not shown in the figure; this pawl allows freedom of motion when the load is being raised. The frictional grip between the two surfaces prevents return motion of the worm shaft and the load remains suspended, but it may be lowered by turning the hand-wheel so as to overcome the friction brake. Various other arrangements of friction brakes have been devised to give a resistance proportional to the load.

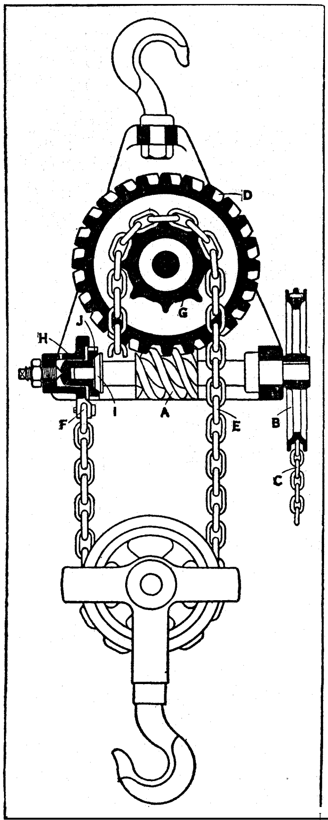


FIG. 7.—WORM-GEAR PULLEY BLOCK WITH AUTOMATIC BRAKE

Blocks, for lifting very heavy weights, are sometimes provided with an electric motor for driving the worm. The worm-wheel shaft then sometimes carries a spur-pinion gearing, with a spur-wheel on the lifting shaft, whereby a much greater advantage is obtained with a small loss by friction of the spur gearing.

BIBLIOGRAPHY.—W. J. M. Rankine, *Machinery and Millwork and Applied Mechanics;* W. C. Unwin, *Machine Design;* Ad. Ernst, *Die Hebezeuge;* A. Ritter, *Lehrbuch der technischen Mechanik;* J. Weisbach and G. Herrmann, *The Mechanics of Hoisting Machinery;* F. Reuleaux, *Der Constructeur;* A. B. W. Kennedy, *Mechanics of Machinery;* J. Perry, *Applied Mechanics;* W. E. Dalby, *Balancing of Engines.*
(E. G. Co.)

PULLMAN, now a part of the city of Chicago. The place was founded in 1880 by George Mortimer Pullman (1831–97), the inventor of the Pullman sleeping car, and the founder (1867) of the Pullman Palace Car Company, who attempted to make it a "model town." Even the public works were the property of the Pullman Company and were managed as a business investment. Popular discontent with the conditions led to the annexation of Pullman to Chicago in 1889, but until 1910 the corporation held most of the property. In June and July 1894 a bitter railway strike developed in the Pullman works.

PULLMAN, a city of Whitman county, Washington, U.S.A., 75 mi. S. of Spokane, in the Palouse river valley, at an altitude of 2,750 feet. It is on federal highway 195, and is served by the Northern Pacific and the Union Pacific railways. Pop. (1940) 4,417. The State college of Washington (established 1890) had in 1940-41 an enrolment of 4,100. The campus and agricultural experiment station occupy 910 acres. Pullman was settled about 1884 and incorporated as a city in 1889.

PULLMAN INCORPORATED (DELAWARE), a holding company formed in 1927, has three important subsidiaries: The Pullman Company (Chicago)—originally incorporated in 1867 as Pullman's Palace Car Company, with a capital of $100,000—is the largest operator of sleeping and other super-comfort railway cars in the world, controlling practically all the business in the United States and Mexico and part of that in Canada; Pullman-Standard Car Manufacturing Company (Chicago), the world's largest car building unit, and the Pullman-Standard Car Export Corporation (New York). At the beginning of 1940 The Pullman Company owned some 7,000 cars of which about 6,000 were sleeping cars. Over zoo of these were of the new light-weight and streamlined type. There were 750 parlour cars of different combinations, 143 composite cars, including baggage-club and other variations, and 15 private cars for special parties. In the year 1939, 15,655,135 revenue passengers were carried in Pullman cars, equal to a daily average of 42,890 in 5,100 cars. The passenger mileage was 8,485,-399,123mi., or an average distance of 542 miles. Pullman-Standard Car Manufacturing Company in 1940 had 9 plants and 3 wheel foundries with these annual capacities: 2,370 passenger, 74,700 freight cars; 49,000 tons forgings, 287,500 wheels. Pullman-Standard Car Export Corporation's capacity is 1,500 freight and 150 passenger cars annually. (G. A. K.)

PULP: see PAPER MATERIALS.

PULPIT, a raised platform with enclosed front, whence sermons are delivered. Pulpits were probably derived from the *ambones* in the early Christian Church. (See AMBO.) There are many old pulpits of stone, though the majority are of wood. Those in churches are generally hexagonal or octagonal; and some stand on stone bases, and others on slender wooden stems, like columns. The designs vary according to the periods in which they were erected, having panelling, tracing, cuspings, crockets and other ornaments. Some are extremely rich, and ornamented with colour and gilding. A few also have rich canopies or sounding-boards. Their usual place is in the nave, mostly on the north side, against the second pier from the chancel arch. Out-door pulpits were common in the mediaeval period, and stood near a road or cross. Pulpits, for reading during the meals of the monks, are found in refectories.

Shortly after the Reformation the canons ordered pulpits to be erected in all churches. Many of the time of Elizabeth and James are beautifully carved, and are of Flemish workmanship. The pulpits in mosques, known as "mimbars," are canopied and approached by a straight flight of steps. These have a doorway at the foot, with an enriched lintel and boldly moulded head; the work is of wood, often inlaid, gorgeously painted and gilt.

PULQUE or **PULQUE FUERTE,** the national beverage of the Mexican natives. It is prepared by fermenting the juice of a number of species of the agave (Agave *americana,* etc.). The cultivation of the agave for purposes of pulque manufacture constitutes a considerable local industry. The juice of the agave termed aguamiel is allowed to ferment naturally for about ten days, and the product is termed *madre* pulque (mother of pulque). A small quantity is added to fresh aguamiel, and a rapid fermentation is induced, the pulque being ready in a day or two. It has a heavy flavour, resembling sour milk, but it is esteemed by the natives on account of its cooling and, according to them, nutritious properties.


GATHERING SAP OF THE AGAVE ON THE PLATEAU NEAR MEXICO CITY
In the making of pulque, the favourite drink of the Mexican people, the sap is sucked out of the plant into a tube, and from there poured into a pail or skin bag and allowed to ferment for about ten days

PULSE, throbbing or beating; in physiology the rhythmical beating due to the changes of blood-tension in the arteries consequent on the contractions of their elastic tissues (see VASCULAR SYSTEM). In botany, a collective term for beans, peas, lentils and other members of the family Leguminosa (*q.v.*).

PULSOMETER: *see* VACUUM PUMP.

PULTUSK, a town of Poland, on the Narew. Pop. 15,510. The town was entirely destroyed by fire in 1875, but was rebuilt on a more modern scale. In 1703 Charles XII of Sweden defeated and captured a Saxon army here, and in 1806 Napoleon defeated the Russians. The town was occupied by the Germans in 1915 and again in 1939. It was formerly part of the large estate of the bishops of Plock, whose former palace, dating from 1319, was destroyed in the fire.

PULVERIZED FUEL. The use of coal in the form of dust for raising steam has been known from isolated experiments for about the last forty years, but the fact that it was one of the most difficult methods of burning coal long delayed the development of the practice.

The theoretical advantages of burning crushed coal become obvious when one considers that if a cubic inch of coal, which has an exposed surface of six square inches, is crushed into cubes each of which has a side one-hundredth of an inch in length, the area of the exposed surface is multiplied one hundred times, and a more intimate mixing of the coal and air is rendered possible, and this without using a large excess of air. It is considered good practice under normal conditions with an average boiler furnace under conditions of mechanical stoking if 150 to 200 per cent of excess air is being admitted to the furnace. Under pulverized coal conditions of firing no difficulty is experienced in working regularly with not more than 20 to 30 per cent of excess air.

Inasmuch as coal-dust cannot be burnt in the ordinary way, special burners have to be provided. These differ in design, but the principles underlying all of them are the same. The coal is dried, pulverized, and the dust passing to the furnace is conveyed to a burner, mixed with air and burnt in the form of a jet. A point common to all the systems is that of the fineness to which it is necessary to reduce the coal. It has to be so fine that all of it will pass through a 100 mesh screen (that is to say a screen containing $100 \times 100 = 10{,}000$ apertures to the square inch) and 85 per cent of it through a 200 mesh screen.

There are a number of different forms of burners, the dust being driven into the fire-box by means of either fans or compressed air. In one system the air pressure is exerted in the tank, which is connected with the furnace by means of a pipe* and the dust forced in a stream, unmixed with air, through the pipe to the furnace. In another it is drawn as required from the storage bin, mixed with air, and carried in suspension through pipes to the furnace at a high velocity. In yet another system the dust from the feed worm is blown into the fire-box.

Whilst the chief use of powdered fuel is in its application for raising steam, it is also largely used in cement works and in steel furnaces.

The economies claimed in respect of the use of coal in the powdered form over the lump coal are: —

(1) A reduction (by reason of the more complete combustion) in the amount of fuel necessary to secure a given heat result.

(2) Ability to use low-grade fuel.

(3) Saving in labour as stoking is rendered unnecessary.

(4) Flexibility of the operation, coal dust firing in this respect being almost equal to oil firing.

(5) Elimination of "banking" and easier disposal of ashes.

(6) Ease of control of furnace conditions in the case of metallurgical furnaces.

Of late years oil has been taking the place of coal in the generation of power in the movement of ships. Thus of the ships under construction in the year 1927 only about 31 per cent were those in which coal will be used, 69 per cent being driven by oil either to raise steam or used in internal combustion (Diesel) engines. The relative comparative efficiencies and costs of oil versus coal driven ships may be expressed as follows: —

The high efficiency of oil engines gives 1 S.H.P. for $& lb. of oil and 1 lb. of oil costs $\frac{43}{100}$ of a penny, so that 1 S.H.P. in a Diesel engine costs $\frac{17}{100}$ of a penny. In an ordinary marine steam engine and boiler, 1 S.H.P. requires 1·7 lb. of coal, which (with coal at 24/– per ton) costs $\frac{13}{100}$ of a penny, and one coal produced S.H.P. costs $\frac{22}{100}$ of a penny. In the particular case of "King George V.," built in 1926 and using high pressure steam, this has been reduced to $\frac{14}{100}$ of a penny, so that it has been demonstrated that coal is a cheaper fuel than oil for ship propulsion where high pressure steam is used, *i.e.,* 500 to 600 lb. per square inch. With pulverized fuel still further economies would be secured.

In America the development in the use of pulverized coal since 1920 has been exceptionally rapid and probably the world's consumption of pulverized fuel at the present time exceeds 150 million tons annually. In the United States of America the use of pulverized coal per annum has been estimated as follows: —

Cement kilns	50 million tons
Metallurgical furnaces	20 " "
Steam boilers	30 " "

On the Brazilian, Central Railway some locomotives are being worked with pulverized coal derived from local deposits of inferior quality in place of using high-grade imported lump coal. In England also a system for locomotive use has been successfully developed.

BIBLIOGRAPHY.—L. C. Harvey, *Pulverized Coal Systems in America,* Fuel Research Board Report No. 1 (H.M. Stationery Office, 1919, 3rd ed. 1923), and *Pulverized Fuel, Colloidal Fuel, Fuel Economy and Smokeless Combustion* (1924); R. A. S. Redmayne, "Pulverized Fuel as a Combustible" in *Nature* (Aug. 25, 1921); P. Frion, "Le Chauffage au Carbon pulverisé" in the *Bulletin de la Société d'Encouragement pour l'Industrie nationale* (May 1921), and in *Annales des Mines* 12th series, Vol. I. pt. 2, (1922); J. Blizard, *Preparation, Transportation and Combustion of Powdered Coal,* U.S. Bureau of Mines, Bulletin 217 (1923); F. C. Brand, *Pulverized Fuel for Marine Purposes,* Publ. by the Institute of Naval Architects (July 12, 1927); Sir J. H. Biles, *The Present Position of the Question of Fuel for Ships,* Publ. by the Institute of Naval Architects (March 1928). (R. R.)

PUMA, a name for one of the largest cats (*Felis concolor*) of the New World. It is called "couguar" by the French and "panther" by hunters of the United States (*see* CARNIVORA).

BY COURTESY OF THE N.Y. ZOOLOGICAL SOCIETY

THE PUMA OR MOUNTAIN LION, (FELIS CONCOLOR)

Though often spoken of as the mountain lion, on account of the tawny colour of its upper parts, it rather resembles the leopard of the Old World in size and habits: measuring from nose to root of tail about 40in., the tail being rather more than half that length. The head is small and has no mane. The ears are large and rounded. The tail is cylindrical, with some bushy hairs near the end, but no distinct tuft. The lower parts, inner surface of the limbs, throat, chin, and upper lip are dirty white; the outside of the ears, and a patch on each side of the muzzle black; the end of the tail dusky. The young are born spotted a dusky brown and with the tail ringed.

The puma has a wide range, extending from Canada in the north to Patagonia in the south, and formerly was generally distributed in suitable localities from the Atlantic to the Pacific Ocean. In Central America it is still common in the dense forests which clothe the mountain ranges. Though an expert climber, it is by no means confined to wooded districts, being also found in scrub and reeds along the banks of rivers and in the open pampas and prairies. Its habits resemble those of the rest of the group to which it belongs. It rarely attacks man.

PUMICE, a very porous, froth-like, volcanic glass. It is an igneous rock which was almost completely liquid at the moment of effusion and was so rapidly cooled that there was no time for it to crystallize. When it solidified the vapours dissolved in it were suddenly released and the whole mass swelled up into a froth which immediately consolidated. Had it cooled under more pressure it would have formed a solid glass or obsidian (*q.v.*);

in fact if we take fragments of obsidian and heat them in a crucible till they fuse they will suddenly change to pumice when their dissolved gases are set free. Hence it can be understood that pumice is found only in recent volcanic countries. Any type of lava, if the conditions are favourable, may assume the pumiceous state; but basalts and andesites do not so often occur in this form as do trachytes and rhyolites. Pumices are most abundant and most typically developed from acid rocks; for which reason they usually accompany obsidians, in fact in Lipari and elsewhere the base of a lava flow may be black obsidian while the upper portion is a snow white pumice.

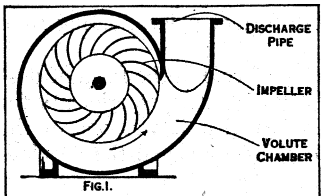
Small crystals of various minerals occur in many pumices; the commonest are felspar, augite, hornblende and zircon. If they are abundant they greatly diminish the economic value of the rock, as they are hard and wear down more slowly than the glassy material; consequently they produce scratches. The cavities of pumice are sometimes rounded, but may also be elongated or tubular owing to the flowing movement of the solidifying lava. The glass itself forms threads, fibres and thin partitions between the vesicles. Rhyolite and trachyte pumices are white, contain 60 to 75% of silica and the specific gravity of the glass is 2.3 to 2·4; andesite pumices are often yellow or brown; while pumiceous basalts, such as occur in the Sandwich islands, are pitch black when perfectly fresh.

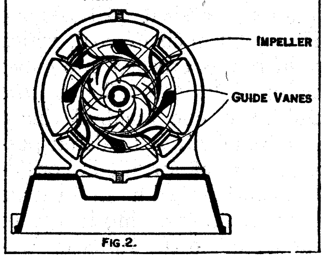
Good pumice is found in Iceland, Hungary, Nevada, Teneriffe, New Zealand, Pantellaria and the Lipari islands. The last-named are the chief sources of pumice for the arts and manufactures. At Campo Bianco in Lipari there is an extinct volcanic cone with a breached crater from which a dark stream of obsidian has flowed. For industrial purposes the best varieties are obtained from Monte Pelato and Monte Chirica. The pumice is extracted by shafts and tunnels driven through the soft incoherent stone.

Among the older volcanic rocks pumice occurs, but usually has its cavities filled up by deposits of secondary minerals introduced by percolating water; hence it is of no value for industrial purposes. Pumice, in minute fragments, has been shown to have an exceedingly wide distribution over the earth's surface at the present day. It occurs in all the deposits which cover the floor of the deepest portion of the oceans, and is especially abundant in the abysmal red clay. In some measure this pumice has been derived from submarine volcanic eruptions, but its presence is also accounted for by the fact that pumice will float on water for months, and is thus distributed over the sea by winds and currents. After a long time it becomes waterlogged and sinks to the bottom, where it gradually disintegrates and is incorporated in the muds and oozes which are gathering there. After the great eruption of Krakatoa in 1883 banks of pumice covered the surface of the sea for many miles and rose in some cases for four or five feet above the water level. In addition much finely broken pumice was thrown into the air to a great height and was borne away by the winds, ultimately settling down in the most distant parts of the continents and oceans. Pumice stone has been satisfactorily used as a packing material for vinegar generators, its porous nature affording large oxidation surfaces, which are favourable to the development of dilute alcoholic liquids (washes) into vinegar. (J. S. F.)

PUMP, a machine to raise or move fluids. The method to be adopted in raising the elevation or the pressure of a fluid depends largely on the volume to be handled and the magnitude of the lift. For large volumes the centrifugal pump is almost universally used. In its modern forms this type is capable of pumping against any pressure up to about 1,500 lb. per sq.in. Where small volumes are to be handled, under high heads, the reciprocating pump is more suitable, while where corrosive liquids are to be pumped, other types of air-lift pumps often offer advantages. *(See* VACUUM-PUMP.)

Centrifugal Pump.—In its simplest form the Centrifugal *Pump* consists of an impeller fitted with vanes and rotating in a closed casing. Water is supplied to the centre of the impeller. Due to its rotating in the impeller its pressure is increased by centrifugal force, and it is delivered at the periphery with an increased pressure and a high velocity. The kinetic energy involved in this exit velocity would be wasted if no means were available for converting it into pressure energy before leaving the pump, and various means are adopted for affecting this conversion. In the majority of pumps the impeller is surrounded by a spiral volute chamber (fig. 1) whose area gradually increases in the direction of flow, so that the velocity is gradually reduced before the water leaves the pump. Such a device is capable of converting at most about 40% of the kinetic energy into pressure energy. Where higher efficiencies are required a ring of guide vanes is used, surrounding the impeller (fig. 2). These vanes are so designed as to receive the water without shock on leaving the wheel and to direct it through passages having gradually diverging walls into the collecting volute from which it is fed to the discharge pipe. In these passages the pressure increases as the velocity is gradually reduced, and under favourable circumstances such an arrangement is capable of converting some 75% of the kinetic energy into pressure energy.





FROM BIGSON, "HYDRAULICS AND ITS APPLICATIONS" (CONSTABLE & CO.)

FIG. 1.—CENTRIFUGAL PUMP WITH VOLUTE CHAMBER

FIG. 2.— CENTRIFUGALPUMP WITH GUIDE VANES SURROUNDING IMPELLER

The necessary peripheral speed of a centrifugal pump increases with the working head, and since fluid frictional losses increase rapidly with the speed, the efficiency begins to fall off appreciably if the working head per impeller is more than about 150 feet. Where very high heads have to be handled, multi-stage pumps are used in which the water passes through one impeller after another in series. Pumps of this type are extensively used for boiler feed work and for hydraulic power pumping stations.

The characteristics of a centrifugal pump depend essentially on the vane angles of its impeller, and under suitable conditions its overall efficiency may attain a value as high as 85%. At the inner periphery the vane angle β (fig. 3) should be such that the water enters the impeller without shock. This condition is satisfied if $\tan \beta = f_2/u_2$ where f_2 is the radial component of the velocity of the water, and u_2 is the peripheral velocity of the impeller at this point. At the point of discharge the vanes may either be radial, or may be curved forwards, or backwards from the direction of rotation depending upon the duty for which the pump is designed. If γ be the vane angle at this point, and if u_3 be the peripheral velocity and f_3 the radial component of velocity of the water, the gain of pressure head in the impeller is, neglecting frictional losses, equal to

$$\frac{u_3^2 - f_3^2 \operatorname{cosec}^2 \gamma + f_2^2}{2g} \text{ feet}$$

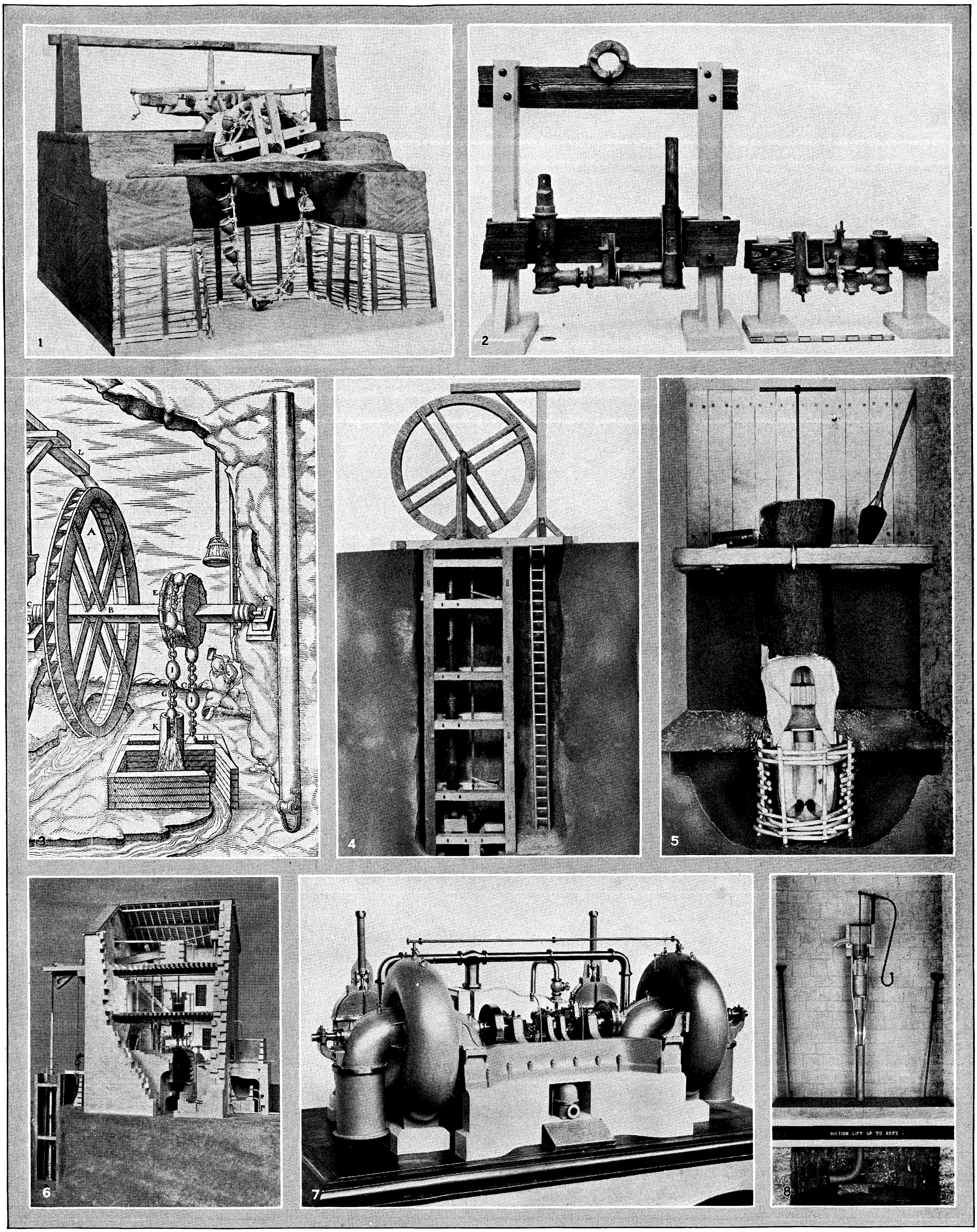
while if K represents the proportion of the kinetic energy of discharge which is converted into pressure energy in the volute chamber or guide vanes, the total gain of pressure in the pump is given by

$$u_3^2(K+1) + f_3^2 \operatorname{cosec}^2 \gamma (K-1) - 2Ku_3 f_3 \cot \gamma \text{ feet.}$$

In the majority of pumps the angle γ is between 30° and 75°, the value increasing with the height of lift.

Reciprocating Pumps.—These may be either of the single acting or double acting type. In the former, water is drawn into the pump through a suction valve on one stroke, and is forced out through the delivery valve on the return stroke. By fitting suction and delivery valves on both sides of the plunger, the pump becomes double acting.

The acceleration and retardation of the plunger at the ends of the stroke causes corresponding retardations and accelerations in the supply and delivery columns, and if these are long considerable momentum effects may be experienced. If the speed is



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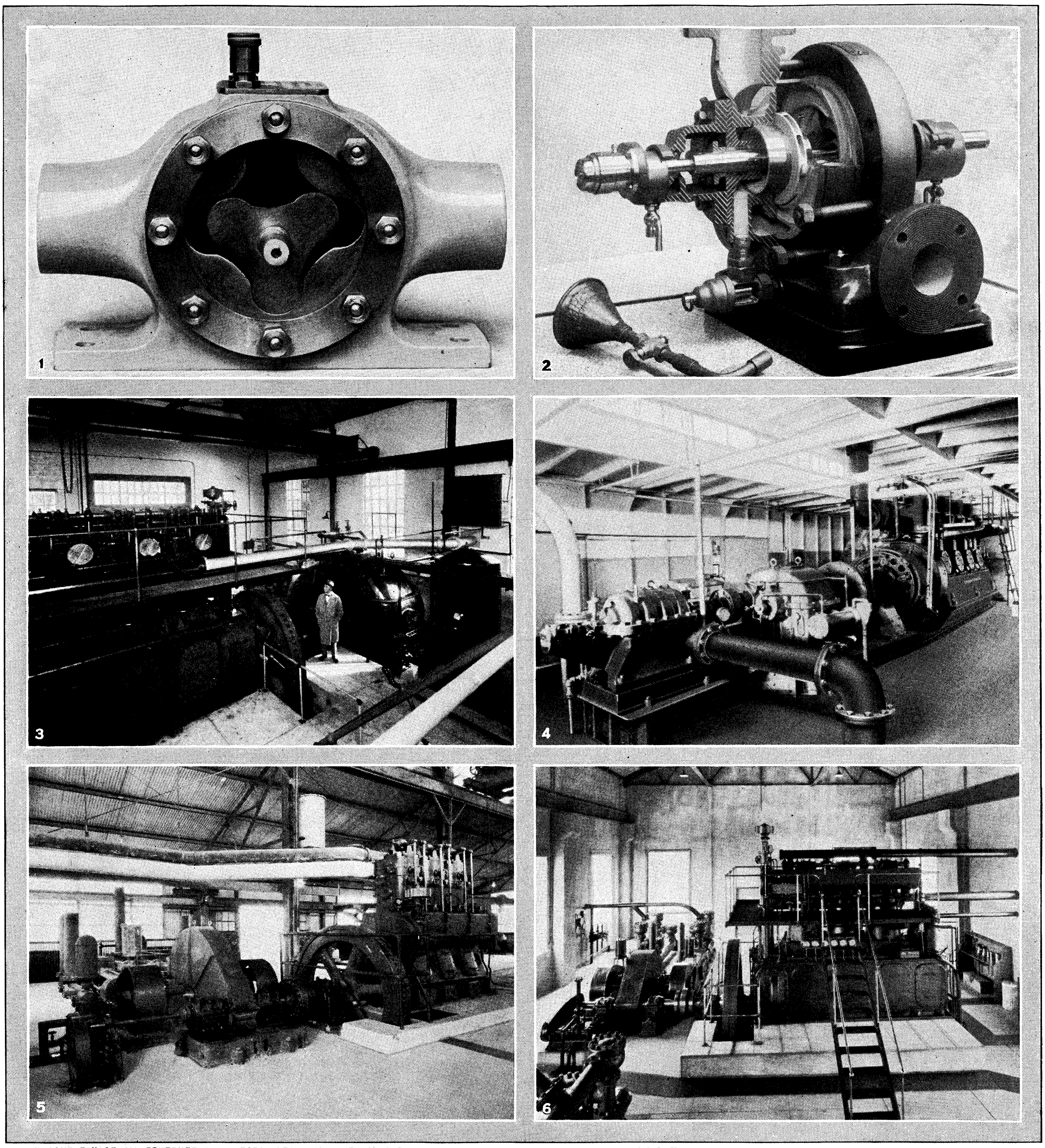
DEVELOPMENT OF PUMPING MACHINERY

1. Model of an Egyptian chain of pots, by means of which water was pumped from the Nile many centuries ago. 2. Copy of the Roman pumps salvaged from the ruins of ancient Rome. 3. Sixteenth-century rag and chain mine pump, using a bundle of rags. 4. Model of a 16th-century Saxon reciprocating mine pump. 5. Model of a 16th-century Saxon wooden hand pump, whose cylinder consisted of a hollow tree-trunk, part of which is cut away to show construction. 6. Model of an early 18th-century French Newcomen mine pumping plant, with top and front removed for inspection of interior. 7. Centrifugal land drainage pump (1874–76). 8. Early 18th-century model of French lead hand pump



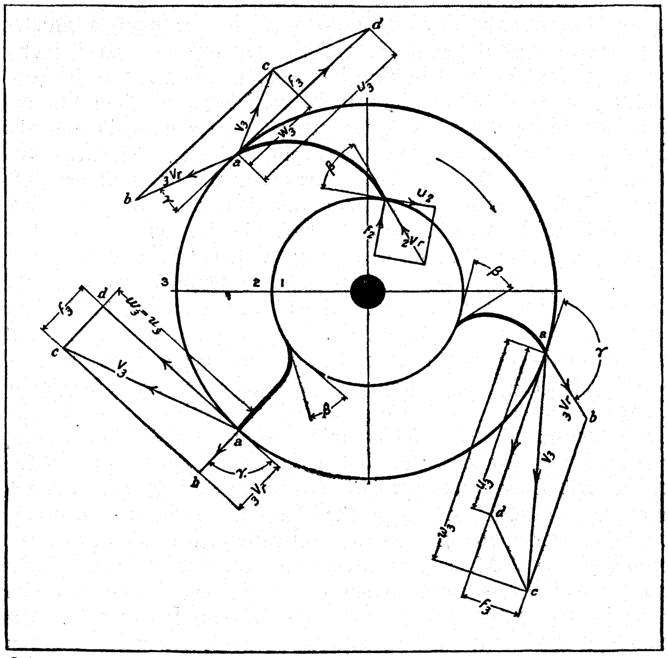
BY COURTESY OF (1) FEUERHEERD'S ROTORS, LTD., (2) THE SCIENCE MUSEUM, LONDON, (3, 6) THE WORTHINGTON PUMP AND MACHINERY COMPANY, (4) FAIRBANKS, MORSE AND COMPANY. (5) THE DE LA VERGNE MACHINE COMPANY

VARIOUS TYPES OF PUMPS

1. Rotary displacement pump
2. Section of a two-stage turbine pump
3. A 330 h.p. Diesel engine, connected to an 80-in. drainage pump, to the right
4. High pressure Diesel pump set, showing multi-stage pump to the left
5. A 200 h.p. Diesel engine, direct connected to a high-pressure plunger pump serving an oil pipe line
6. A 4-cycle air injection engine used in petroleum pipe line stations

sufficiently high the columns may be unable to maintain contact with the plunger and "cavitation" is set up, which gives rise to considerable shock in the pump. To avoid this an air vessel should always be fitted on the suction side of the pump, and often on the delivery side. This equalizes the flow along the pipe lines.

For low speed pumps, disc valves of rubber or metal, which are returned to their seat either by the action of a spring or by their



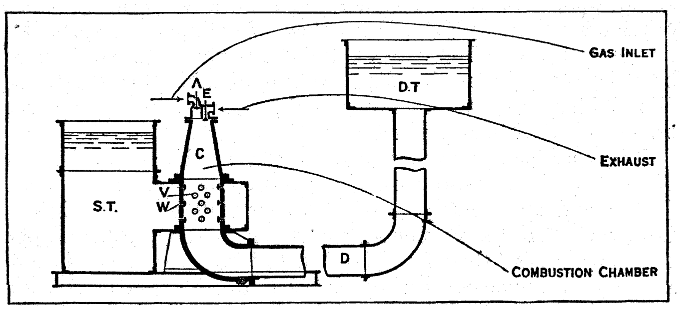
FROM GIBSON. "HYDRAULICS AND ITS APPLICATIONS" (CONSTABLE & CO.)

FIG. 3.— VELOCITY DIAGRAMS FOR VANES OF CENTRIFUGAL PUMP. HAVING DIFFERENT DEGREES OF BACKWARD CURVATURE

own elasticity, are usually used. For high speed pumps mechanically operated valves are often used.

Rotary Pumps.—Pumps of the rotary type are well adapted for working over a wide range of speeds with comparatively low head and with widely varying discharges. They have the advantage over the reciprocating pump that the discharge is practically continuous, while the efficiency does not fall off nearly so quickly with discharge variations as the centrifugal pump.

There are two main types of rotary pump. In one a drum mounted eccentrically in its casing carries one or more sliding diaphragms which make contact with the interior of the casing.



FROM GIBSON, "HYDRAULICS AND ITS APPLICATIONS" (CONSTABLE & CO.)

FIG. 4.— HUMPHREY GAS PUMP

In the other type two rotating drums are used mounted on parallel axes and coupled together by two equal gear wheels mounted on the shafts outside the casing.

Humphrey Gas Pump.—In the Humphrey Gas Pump water is raised by the direct action of the pressure accompanying the explosion and expansion of a gas-air mixture. At the beginning of the power stroke a compressed charge of air and gas in the combustion chamber C (fig. 4) is ignited by an electric spark and expands forcing the column of water D between the combustion chamber and the delivery tank D T towards the tank and discharging part of it in the process. Due to the momentum of this column, expansion continues until the pressure at the lower part of the water column falls to atmospheric, when the suction valves V, communicating with the suction tank ST, open and water is drawn through them into the pipe. At the same time the exhaust valve is opened. When the momentum of the water column is exhausted it oscillates back, driving the products of combustion out of the combustion chamber until it reaches the exhaust valve, which it closes by impact; on the next rebound of the water column the gas inlet valve opens and a fresh charge is drawn in; at the end of the outward oscillation the gas inlet valve is closed and the returning oscillation compresses the charge which is fired as the column comes to rest.

The **Air Lift** Pump.—This consists of an open ended vertical lift pipe, of which the lower end is submerged in the liquid to be raised, and the upper end delivers into a discharge tank at the height which is required. Air is supplied from an air compressor through an air pipe to the lower end of the lift pipe, and rising in the form of small bubbles through the liquid in this pipe forms a mixture having a specific gravity lower than that of the liquid itself. The pressure of the liquid surrounding the pipe then raises the lighter mixture above the supply level and out of the top of the lift pipe. The possible lift depends upon the amount of air supplied and upon the depth of submersion of the bottom of the lift pipe. For best results the depth of submersion should be approximately 1·5 times the height of the lift. For high efficiency the air should be supplied to the lift pipe through a foot-piece having a series of small openings so arranged as to distribute the air in a series of small bubbles through the liquid. If well designed such a pump is capable of converting some 60% of the energy in the compressed air at the foot-piece into useful work in lifting water. Air lift pumps have been constructed for lifting against heads of upwards of 400 ft., and with lift pipe diameters up to about 1 j inches.

Jet Pump.—In the jet pump a high pressure water supply is conducted to a small nozzle, whence it issues into a suction chamber as a jet having a high velocity and a relatively low pressure. The suction chamber surrounding the jet is connected to the suction reservoir. If the pressure at the jet is sufficiently low, water is lifted into this chamber and is forced by the impact of the high velocity jet into a discharge pipe, whose suction gradually increases in the direction of flow. There the kinetic energy is partially converted into pressure energy, enabling the pump to discharge against a head considerably higher than that of the suction reservoir. Owing to the loss due to eddy formation accompanying the admixture of the high and low velocity water, the efficiency of such a pump is low and does not usually exceed about 20%. When the fluid used for the high pressure jet is steam. the pump becomes the boiler feed injector so largely used in locomotive work.

The Hydraulic Ram.—This is an apparatus devised to utilize the energy of a water supply at a low head, to pump up part of this water to a height greater than that of the supply head. It consists of an inclined supply pipe leading straight into a valve-box which is fitted with a waste valve opening inwards, and a delivery valve opening outwards. This valve discharges the water into an air vessel from which it is delivered in a steady stream to the discharge pipe.

The action of the ram is as follows: The waste valve being opened, water is free to escape, and flow is set up along the supply pipe. The velocity of flow increases under the influence of the supply head until the dynamic pressure on the under side of the valve becomes sufficiently great to overcome its weight. The valve now closes rapidly and the sudden check to the momentum of the supply column causes a rapid increase of pressure in the valve-box until this pressure becomes sufficiently great to open the delivery valve. Water then escapes through this valve into the air vessel, compresses the air, and flows away along the rising main. As soon as the momentum of the supply column is destroyed the delivery valve closes, the water below the valve partaking of the backward motion thus instituted. This motion, once set up, can only be checked by a reduction of pressure in the valve-box below that corresponding to the statical head of the supply, and consequently the pressure in the valve-box is reduced rapidly until at some instant the waste valve reopens, and the whole cycle of operations is repeated. The efficiency of the hydraulic ram falls off as the ratio of the delivery head to the supply head is increased. When this ratio does not exceed about 4 : 1, the efficiency may be high as 75%. If the ratio is increased to 20 : 1 the efficiency does not exceed about 25%.

A pumping device known as the "Hydrotomat" has been recently introduced which also utilizes a large quantity of water under a low head to raise a portion of itself to some greater height. This works by alternately compressing and exhausting air in a series of containers.

BIBLIOGRAPHY.—A. H. Green, *Pumping* Machinery (1911); L. C. Loewenstein & C. P. Chrissey, Centrifugal Pumps (1911); G. G. de Laval, Centrifugal Pumping Machinery (1912); F. Neumann, Die *Zentrifugalpumpen* mit besonderer *Berücks.* der Schaufelschmitte (1912); F. Prasil, Technische Hydrodynamik (1913); J. W. Cameron, *Centrifugal* Pumps (1921); N. Swindin, Modern Theory & Practice of Pumping (1924); B. Eck, Hydrodynamical Theory of Turbine & Centrifugal Pumps (in Engineering, Jan. 22 & 29, 1926); C. Pfleiderer, Die *Kreiselpumpen* (1926). (A. H. G.)

PUMPKIN, the fruit of certain varieties of Cucurbita pepo or of C. moschata, members of the family Cucurbitaceae. The names pumpkin and squash, especially in America, are applied rather inconsistently to certain varieties of both these species. The quick-growing, small-fruited bush or non-trailing varieties of C. pepo, (see SQUASH and VEGETABLE MARROW) are called squash in America, while the long-season, long-trailing, large-fruited varieties are called pumpkin. The fruits are large, generally 10–20 lb. or more, yellowish to orange in colour and vary from oblate through globular to oblong. The rind is smooth and usually lightly furrowed or ribbed, the fruit stem is hard and woody, ridged or angled, and in C. *pepo* not flared at its point of attachment to the fruit. The very largest varieties of "pumpkin" are more properly designated as winter squash, C. *maxima,* and may weigh 75 lb. or more. Varieties cross-pollinate very readily within each of the three species mentioned, but the species do not cross naturally. A few inter-specific crosses have been recorded but the hybrids were highly self-sterile and set no fruit with their own pollen. Neither pumpkins nor squash will cross with cucumbers or with melons.

Pumpkins are commonly grown in Great Britain, Europe and North America for human food and also for livestock feed. The varieties commonly called pumpkin produce very long vines and are usually planted in hills of 2–3 plants each, about 8x8 ft. apart. They are also planted at wide intervals in fields of corn Pumpkins mature in early fall and can be stored a few months in a dry place well above freezing. They are prepared for food in a wide variety of ways. (V. R. B.)

PUNANS, a nomad, hunting, and forest-people of Borneo, without agriculture, and owning neither houses nor boats, but relying on their jungle-lore and the use of the blow-pipe for the supply of their daily needs. In their purity they are found almost exclusively in the interior, where there are also kindred tribes, such as the Ukits and Sians; but in certain parts of Sarawak "modified Punans," such as the Penans and Milanos are found. The Punans are closely akin to the Sakais of the Malay Peninsula and the Kubus of Sumatra. Physically they are of short stature, with a proportionately long body, their complexions are of a pale yellow, shading off into a greenish hue, a circumstance due, no doubt, to the fact that they never expose themselves to direct sunlight, but live perpetually in the half-light of the forest. See BORNEO.

PUNCH, the abbreviated form of Punchinello (Ital. *Policinella*, Pulcinella), the most popular of the puppets or marionettes (*q.v.*), and the chief figure in the "Punch and Judy" show. It is of Italian origin, though its history is by no means free from obscurity. The earlier etymologists sought to trace the name to various mythical individuals, by whom, it was alleged, the type was first furnished. F. Galiani adopts the theory which derives it from the name of Puccio d'Aniello, a vintager of Acerra near Naples, who, having by his wit and grotesque appearance vanquished some strolling comedians in their own sphere, was induced to join the troop, and whose place, by reason of his popularity, was supplied after his death by a masked actor who imitated his dress and manner. The claims of other individuals — Paolo Cinella, Polliceno and Pulcinella, a Neapolitan dealer in fowls — have also found supporters, and the derivation of the name and character from some old mystery representing Pontius (O. Eng. Pownce; Fr. *Ponce*) Pilate and Judas, or the Jews, was formerly popular. It has even been suggested that the title is a modification of πολὺ κινέω (I move much) as expressive of the restlessness which is characteristic of the puppet; and the assumption that the character was invariably of diminutive size has given rise to its reference to the word *pollice,* the thumb (cf. *Däumling,* Tom Thumb). The most plausible theory, however, regards the name in its Italian form as a diminutive of *pulcino,* fem. *pulcina,* a chicken. It is sometimes stated that, in consequence of the habit of using the word "chicken" as a term of endearment, it came to mean "a little child," and hence "a puppet" (W. Skeat). The choice, however, seems to lie between the theory of Quadrio, that it was applied on account of the resemblance of the hooked nose to a beak, and that of J. Baretti, which ascribes its employment to the nasal squeak and timorous impotence of the original character. With respect to the development of the modern type, it has been assumed that the whole family of Italian *maschere* (Arlecchino, Brighella and the like) are modified survivals of the principal Oscan characters of the Atellanae, and that Punchinello is the representative of Maccus, the fool or clown. In proof of this it is urged that Acerra, the supposed residence of Puccio d'Aniello and the traditional source of the character, is in the neighbourhood of Aversa, the old Atella; and reference is also made to a bronze statue of Maccus, discovered at Rome in 1727, an engraving of which has been preserved in Ficoroni's Le Maschere *sceniche e le figure comiche* d'antichi Romani. But the resemblance of the statue to the puppet is scarcely a striking one, and the large nose and deformed figure are somewhat hazardous ground on which to base a theory.

Andrea Perrucci (1699) and Gimma assert with some show of authority that Silvio Fiorillo, a comedian named after his principal part, Captain Matamoros (the Italian Miles *Gloriosus*), invented the Neapolitan Pulcinella. It was afterwards improved by Andrea Calcese, surnamed Ciuccio, who died of the plague in 1656, and who, according to Gimma, imitated in the character the peasants of Acerra. This would place the origin of the Italian Pulcinella somewhere about the commencement of the 17th century, the original character appearing to have been that of a country clown, hook-nosed, shrill-voiced, cowardly, boastful and often stupid, yet given at times to knavish tricks and shrewd sayings. In thorough accordance with this date, we find that the earliest known appearance of Polichinelle in France is at the beginning of the reign of Louis XIV., in the show of the puppet-playing dentist Jean Brioché. The date of its introduction into England has been disputed, J. Payne Collier being of opinion that Punch and King William came together, a second theory suggesting an earlier origin with the Huguenot refugees.

It is more than probable that it crossed the channel in the wake of the Royalists. Apart from the general references by S. Pepys (1662) and by J. Evelyn (1667) to an Italian puppet-show at Covent Garden, the former makes 'mention (1669) of some poor people who called their fat child Punch, "that word being become a word of common use for all that is thick and short." An allusion to "Punchinellos" is also to be found in Butler's satire on English imitation of the French, and Aubrey speaks of "a Punchinello holding a dial" as one of the ornaments of Sir Samuel Lely's house at Whitehall. But, though the puppet did not travel in the train of William of Orange, allusions to it became far rnore frequent after the Revolution of 1688, and the skill of the Dutch in their treatment of puppet mechanism may have enhanced its attractiveness. In 1703 it was introduced at Bartholomew Fair into a puppet play of the creation of the world; in 1709 (*Tatler,* No. 16) it was to be found in a representation of the Deluge, though in a different part from that of the Momus Polichinelle of Alexis Piron's *Arlequin-Deucalion* (1722); and in 1710 (Spectator No. 14) it is mentioned as a leading figure in Powell's puppet-show at Covent Garden. The alleged satire on Robert Walpole, entitled *A Second Tale of a Tub, or the History of Robert Powell, the Puppet-Showenan* (1715), furnishes some details of Punch performances, and has an interesting frontispiece representing Powell with Punch and his wife. The Judy (or Joan, as she appears to have been sometimes called) is not of a specially grotesque order, but the Punch is easily recognizable in all but the features, which are of the normal puppet type.

The older Punchinello was far less restricted in his actions and circumstances than his modern successor. He fought with allegorical figures representing want and weariness as well as with his wife and with the police, was on intimate terms with the patriarchs and the seven champions of Christendom, sat on the lap of the queen of Sheba, had kings and dukes for his companions. Powell seems to have introduced a trained pig which danced a minuet with Punch, and the French (among whom Punch is now usually styled Guignol, originally a puppet hailing from Lyons) occasionally employed a cat in the place of the dog Toby, whose origin is somewhat uncertain. A typical version of the modern play, with illustrations, was published by Payne Collier and Cruikshank in 1828 (3rd ed.. 1844). (R. M. WH.)

PUNCHING AND SHEARING MACHINES. The quickest method of making holes in, or severing, materials is by punching or shearing, and there are few forms of manufacture that do not utilize machines for these operations. Paper, card, leather, cotton, cloth, slate, tin, brass, iron and steel all undergo such treatment. Circular and other shaped holes are made, pieces are punched out to give various outlines, and various shapes are sheared off. The most striking examples are in steel works, where blades of 12 feet in length will shear through 2 in. cold steel plate, or hot slabs 43 in. by 20 in. thick are cut through. Many industries are suited by hand-worked machines, others require belt, electric motor or steam-engine drive, while the largest punches and shears are worked hydraulically. Hand machines are employed by tinsmiths and other light metalworkers, also by boxmakers, and these machines rest on the bench. Larger punches or shears are actuated by treadle, the latter machines having blades up to about 4 feet in length. Some have blades formed to cut curves in tinplate or iron plate, instead of using a die to stamp the outlines, and corrugated blades are used for shearing corrugated iron. Blacksmiths and others make use of a combined type of machine, with a single lever moving the punch and the shear blade. This principle is also applied in many big machines of the engineering works, but using power drive.

Punching and shearing are alike in action which amounts to a rather violent separation of the fibres of the material. In soft substances there is little injury, because the cutting edges can be

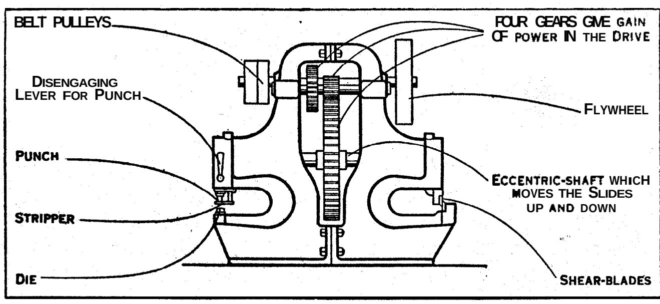


DIAGRAM OF A PUNCHING AND SHEARING MACHINE, WHICH PUNCHES AT ONE END AND SHEARS AT THE OTHER

made of a keen angle, but iron and steel become more or less torn unless very thin, and the edge reveals minute cracks. For certain purposes these would be undesirable, as tending to increase under stress; consequently plates and strips for steam-boilers are not punched, but drilled for reasons of safety. And where structures are subject to heavy loads of a fluctuating nature, the best plan is undoubtedly to ream punched holes, the reamer taking away the cracked and torn walls and leaving a smooth and whole surface. Shorn plates for boilers and certain other constructions are also machined on the edges, by turning, planing or milling, until a clean faultless metal is left. Obviously in order to ensure neat punching or shearing, as well as to minimize cracks and damaged edges, the tools should be kept ground up sharp, and set so that the material is well supported at the moment of impact. In a great many cases a slotted finger, termed a *stripper,* is fixed a fraction of an inch above the material, so that as the punch rises after the stroke the material cannot be pulled up with it, but is automatically stripped off. Some substances, especially when laid in piles for simultaneous treatment, must be clamped down firmly to prevent faulty results, while the thicker steel plates are held immovably by a mechanically-operated clamping device which comes into play just before the descent of the slide. Hydraulic vice rams perform this function in the large hydraulic shears of the steel-works. In rolling-mills, plates and slabs are transported under the shear on sets of power-driven rollers.

Types of Punching and Shearing Machines. — The power-driven punching machines vary in design according to whether the material is thin or thick. For the general run of tinware and similar thin stock the crank-driven power-presses are used, being of much the same or identical design as for other operations on sheetmetal parts. The machine frame must be stiff, and if necessary braced with tie-rods to prevent spring, otherwise the act of penetration will cause the punch and die to come out of alignment, and they will be injured, and poor work will result. The slide which moves the punch up and down must be well fitted, as any slackness will have a similar effect. The fit of the punch in the die, through which it pushes the punching, must be fairly close to ensure getting a sharp impression around the edges. The fit is closer in very thin metal than it need be in thick stuff. Many special mandrels or supports are attached to presses to carry the lower die when the object is of a difficult outline, such as a pipe.

For engineering manufactures, including all sorts of steel construction (boilers excepted), ships, agricultural machinery, tanks, cisterns, piping, fencing, railway carriage and wagon frames and so on, the punching machines are either single or multiple, or are combined in one frame with a shearing machine, so that one drive actuates each slide (see the sketch). The punch slide has a disengaging device, rendering the punch inoperative until the attendant has accurately located the plate beneath it, whereupon he pulls a little lever and the punch descends. The purpose of the flywheel is to give a reserve of energy to carry the punch or shear through the metal. The larger machines possess self-contained jib cranes, enabling heavy plates to be slung and moved along as necessary without keeping the shop crane engaged. Punching-machines only have an eccentric action to the slide (similar in principle to that of the diagram) and are often double-ended, using a differently sized punch in each slide. Instead of eccentric motion, powerful levers are often utilized in collaboration with a central eccentric which rocks them and so moves each slide. Sometimes a third slide is included in a double-ended punching and shearing machine to cut angle-iron, which requires a special shape of blade. Provision for shearing off angles, tees, channels, girders or H-irons is incorporated in some machines, there being apertures of corresponding section through which the shapes are pushed and sheared by a knife behind. The framings of such machines are frequently made in either cast-steel or steel plates riveted together, to afford extra strength without such weight as is necessary for cast-iron framings.

Multiple punching is greatly in favour because of the economy of production. The regular machines may have an attachment to take two or three punches, but otherwise a special machine has to be used, with a wider slide than usual. The punches are either adjustable as to distance apart, or fixed in this respect. Plates and bars for tanks, agricultural machines, carriages and wagons and various machinery may have any number up to roo holes pierced at a stroke. If several rows must be put through a sheet (as for mine screens) the sheet can be handled rapidly on an automatic spacing table, which feeds it accurately to the successive positions past the punches. Alternatively the plate may remain stationary and the punching head travel intermittently to the successive positions.

The massive shears required in steel works and those making big boilers are actuated by powerful gearing and eccentrics, or by hydraulic cylinders. The parts must be extremely strong in order to withstand the enormous force exerted at the moment of shearing and powerful spring buffers are often provided to take the shock as the blade goes through the plate. In these, as in most other shears, the blade is set at an angle so that it only shears progressively from one end to the other.

Hydraulic action furnishes a simpler mode of actuating a punch or shear slide than gearing in some of the shipyards, for punching big holes necessary in some of the plates. Portable machines for either punching or shearing are often used in the yards, being either carried about or transported on wheels. The working of a lever operates the pump and sends water to the actuating cylinder. Small machines are termed punching bears.

Rotary shears are so named because bevel-edged discs are used for the shearing. Some cut straight, others in circles, the plate being rotated on a central stud. Both circles and rings are sheared thus in large numbers for the tinware industry and other branches requiring these forms to build up shapes, or to stamp to further outline in dies. Some are built as slitting shears, that is suitably to make a long straight cut to divide a plate in two, or shear it up into strips, and there are also scroll *shears* which will cut intricate outlines between the discs, the attendant suitably manoeuvering the sheet as he feeds it along. (F. H.)

PUNCTUATION, the art of "pointing" a literary composition so as to divide it into sentences and portions of sentences, which the "points" mark at their close, thus indicating what would in speech be pauses or changes of expression (Lat. *punctum,* a point). The uses of the chief "points" are thus explained in the "Rules for Compositors" at the Oxford University Press, compiled by Mr. Horace Hart:—

The "full stop" or "period" (.) marks the end of a sentence. The "colon" (:) is at the transition point of the sentence. The "semicolon" (;) separates different statements. The "comma" (,) separates clauses, phrases and particles. (The terms "period," "colon," "comma," were borrowed from the Greek grammarians, who originally described either the whole sentence or a part of it in this way.) The "dash" (—) marks abruptness or irregularity. The "exclamation" (!) marks surprise. The "interrogation" or "query" (?) asks a question. The apostrophe (') marks elisions or the possessive case. "Quotes," quotation-marks or "inverted commas" (" ") define quoted words. Interpolations in a sentence are marked by various forms of bracket () or parenthesis. Usage and practice vary however. The subject may be studied in such works as H. Beadnell's Spelling and Punctuation, P. Allardyce's ,Stops: or how to punctuate, and T. L. de Vinne's Correct *Composition.* In the earlier forms of writing the letters ran on continuously in lines; only by degrees were words divided up by spacing within the line; later came the distribution into sentences by points, and the introduction by Aldus Manutius (16th century) of a regular system for these. The chief signs were derived from the dots of the Greek grammarians, but these have often changed meanings; thus the Greek interrogation mark (;) becomes the semicolon. (See PALAEOGRAPHY and TYPOGRAPHY.)

PUNIC WARS, a name specially appropriated to the wars between Rome and Carthage in the 3rd and 2nd centuries B.C. The origin of these conflicts is to be sought in the position which Rome acquired about 275 B.C. as suzerain and protector of all Italy. Her new obligation to safeguard the peninsula against foreign interference made it necessary that she should not allow the neighbouring island of Sicily to fall into the hands of a strong and expansive power. Carthage, on the other hand, had long been anxious to conquer Sicily and so to complete the chain of island posts by which she controlled the western Mediterranean.

First Punic War (264–241 B.C.[1]).—The proximate cause of the first outbreak was a crisis in the city of Messana, commanding the straits between Italy and Sicily. A band of Campanian mercenaries, which had forcibly established itself within the town and was being hard pressed in 264 by Hiero II. of Syracuse, applied for help both to Rome and Carthage and thus brought a force from either power upon the scene. The Carthaginians, arriving first, occupied Messana and effected a reconciliation with Hiero. The Roman commander nevertheless persisted in throwing troops into the city, and by seizing the person of the Carthaginian admiral during a parley induced him to withdraw. The Romans thus won an important strategic post, but their aggression met a declaration of war from Carthage and Syracuse.

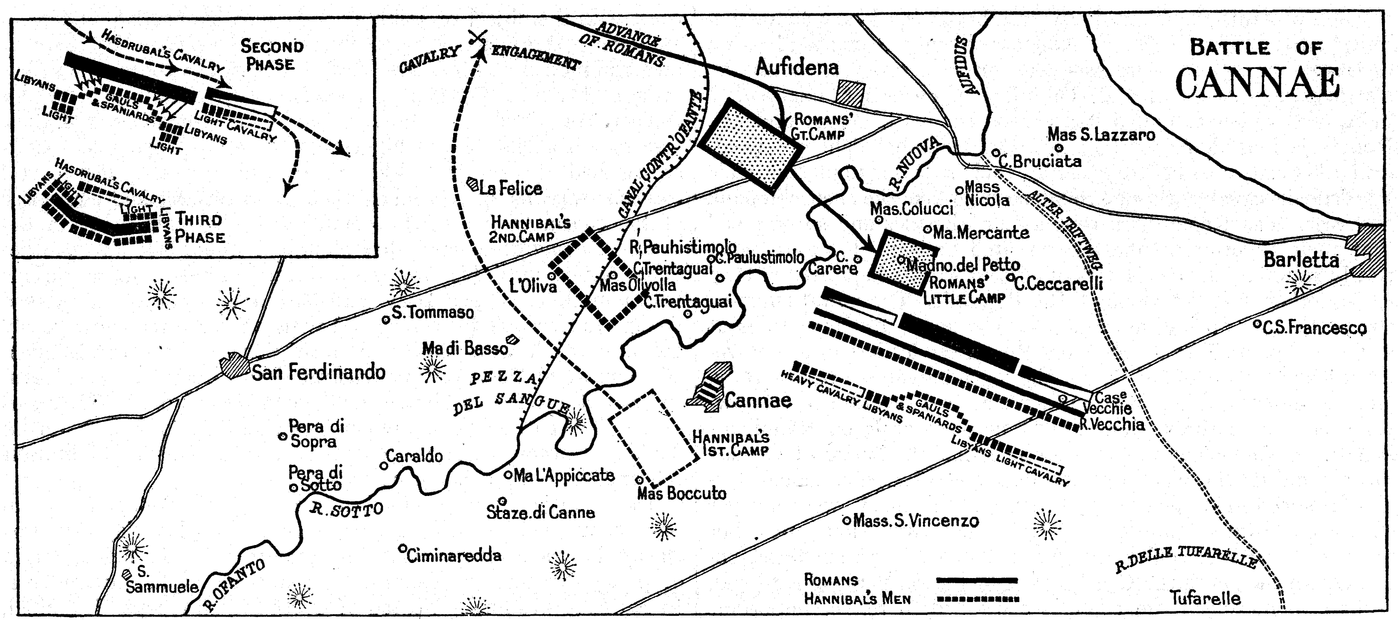
Operations began with a joint attack upon Messana, which the Romans easily repelled. In 263 they advanced with a considerable force into Hiero's territory and induced him to seek peace and alliance with them. Having thus secured their foothold on the island they set themselves to wrest it completely from Carthage. In 262 they besieged and captured the enemy's base at Agrigentum, and proved that Punic mercenary troops could not stand before the infantry of the legions. But they made little impression upon the Carthaginian fortresses in the west of the island and upon the towns of the interior which mostly sided against them. Thus in the following campaigns their army was practically brought to a standstill.

In 260 the war entered upon a new phase. Convinced that they could gain no serious advantage so long as the Carthaginians controlled the sea and communicated freely with their island possessions, the Romans built their first large fleet of standard battleships. At Mylae, off the north Sicilian coast, their admiral C. Duilius defeated a Carthaginian squadron of superior manoeuvring capacity by a novel application of grappling and boarding tactics. This victory left Rome free to land a force on Corsica and expel the Carthaginians (259), but did not suffice to loosen their grasp on Sicily.

After two more years of desultory warfare the Romans decided to carry the war into the enemy's home territory. A large armament sailed out in 256, repelled a vigorous attack by the entire Carthaginian fleet off Cape Ecnomus (near Agrigentum) and established a fortified camp on African soil at Clypea. The Carthaginians, whose citizen levy was utterly disorganized, could neither keep the field against the invaders nor prevent their subjects from revolting. A single campaign compelled them to sue for Peace, but the terms which the Roman commander Atilius Regulus offered were intolerably harsh. Accordingly they equipped a new army in which, by the advice of a Greek captain of mercenaries named Xanthippus, cavalry and elephants formed the strongest arm. In 255, under Xanthippus's command, they offered battle to Regulus, who had taken up position with an inadequate force near Tunis, outmanoeuvred him and destroyed the bulk of his army. A second Roman armament, which subsequently reached Africa after defeating the full Carthaginian fleet off Cape Hermaeum, did not venture to reopen the campaign, but withdrew all the remaining troops.

The Romans now directed their efforts once more against Sicily. In 254 they carried the important fortress of Panormus (Palermo) by an attack from the sea; but when Carthage threw reinforcements into the island the war again came to a standstill. In 251 at last the Roman general L. Metellus brought about a pitched battle near Panormus in which the enemy's force was effectively crippled. This victory was followed by an investment of the chief Punic base at Lilybaeum by land and sea. The besiegers met with a gallant resistance, and in 249 were compelled to withdraw b~ the loss of their fleet in a surprise attack upon the neighbouring harbour of Drepanum (Trapani), in which the admiral Claudius Pulcher was repulsed with a loss of 93 ships. Meanwhile other losses in storms on the high seas so reduced the Roman fleet that the attack upon Sicily had to be suspended. At the same time the Carthaginians, who felt no less severely the financial strain of the prolonged struggle and had a war in Africa on their hands, reduced their armaments and made no attempt to deliver a counter-attack. The only noteworthy feature of the ensuing campaigns is the skilful guerrilla war waged by a new Carthaginian commander, Hamilcar Barca, from his strong positions on Mt. Ercte (247–244) and Mt. Eryx (244–242) in western Sicily, by which he effectually screened Lilybaeum from the Roman land army.

[1] The chronology here given is the traditional one, but recent researches tend to show that many events have been antedated by one year.



PLAN OF THE BATTLE OF CANNAE, AN ENCOUNTER OF THE SECOND PUNIC WAR, WHERE THE ROMANS WERE PRACTICALLY ANNIHILATED BY HANNIBAL IN 216 B.C.

In 242 Rome resumed operations on sea. By a magnificent effort on the part of private citizens a fleet of zoo warships was equipped and sent out to renew the blockade of Lilybaeum. The Carthaginians hastily collected a relief force, but in a battle fought off the Aegates or Aegusae islands (west of Drepana) their fleet was caught at a disadvantage and mostly sunk or captured (March 10, 241). This victory, by giving the Romans undisputed command of the sea, rendered certain the ultimate fall of the Punic strongholds in Sicily. The Carthaginians accordingly opened negotiations and consented to a peace by which they ceded Sicily and the Lipari islands to Rome and paid an indemnity of 3,200 talents (about £800,000).

The Interval Between the First and Second Wars (241–218 B.C.).—The loss of naval supremacy not only deprived Carthage of her predominance in the western Mediterranean, but exposed her oversea empire to disintegration under renewed attacks by Rome. The temper of the Roman people was soon made manifest during a conflict which broke out between the Carthaginians and their discontented mercenaries. Italian traders were allowed to traffic in munitions of war with the mutineers, and a gross breach of the treaty was perpetrated when a Roman force was sent to occupy Sardinia, whose insurgent garrison had offered to surrender the island (239). To the remonstrances of Carthage the Romans replied with a direct declaration of war, and only withheld their attack upon the formal cession of Sardinia and Corsica and the payment of a further indemnity.

From this episode it became clear that Rome intended to use her victory to the utmost. To avoid complete humiliation Carthage had no resource but to humiliate her adversary. The recent complications of foreign and internal strife had indeed so weakened the Punic power that the prospect of renewing the war under favourable circumstances seemed remote enough. But the scheme of preparing for a fresh conflict found a worthy champion in Hamilcar Barca, who sought to compensate for the loss of Sicily by acquiring a dominion in Spain where Carthage might gain new wealth and form a fresh base of operations against Rome. Invested with an unrestricted foreign command, he spent the rest of his life in founding a Spanish empire (236–228). His work was continued by his son-in-law Hasdrubal and his son Hannibal, who was placed at the head of the army in 220. These conquests aroused the suspicions of Rome, which in a treaty with Hasdrubal confined the Carthaginians to the south of the Ebro, and also guaranteed the independence of Saguntum, a town on the east coast which pretended to a Greek origin. In 219 Hannibal laid siege to Saguntum and carried the town in spite of a stubborn defence. It has always been a debatable point whether his attack contravened the new treaty. The Romans certainly took this view and sent to Carthage to demand Hannibal's surrender. But his defiant policy was too popular to be disavowed; the Carthaginian council upheld Hannibal's action, and drew upon itself a declaration of war.

Second Punic War (218–201 B.C.).—It seemed as though the superiority of the Romans at sea must enable them to choose the field of battle. They decided to embark one army for Spain and another for Sicily and Africa. But before their preparations were complete Hannibal began that series of operations by which he dictated the course of the war for the greater part of its duration. Realizing that so long as Rome commanded the resources of an undivided Italian confederacy no foreign attack could beat her down beyond recovery, he conceived the plan of cutting off her supply of strength at the source by carrying the war into Italy and causing a disruption of the League. His chances of ever reaching Italy seemed small, for the sea was guarded by the Roman fleets and the land route was long and arduous. But the very boldness of his enterprise contributed to its success; after a six months' march through Spain and Gaul and over the Alps, which the Romans were nowhere in time to oppose, Hannibal arrived in the plain of the Po with 20,000 foot and 6,000 horse, the pick of his African and Spanish levies (autumn 218: for details *see* HANNIBAL).

His further advance was here disputed by some Roman troops which had been recalled from the Spanish expedition. But the superiority of the Carthaginian cavalry and the spread of insurrection among the Gaulish inhabitants forced the defenders to fall back upon the Apennines. At the end of the year the Roman army was reinforced by the division from Sicily and led out to battle on the banks of the Trebia (*q.v.*). Hannibal, by superior tactics, repelled the assailants with heavy loss, and thus made his position in north Italy secure.

In 217 the campaign opened in Etruria, into which the invading army, largely reinforced by Gauls, penetrated by an unguarded pass. A rash pursuit by the Roman field force led to its being entrapped on the shore of Lake Trasimene (*q.v.*) and destroyed with a loss of 40.000 men. This catastrophe left Rome completely uncovered; but Hannibal, having resolved not to attack the capital before he could collect a more overwhelming force, directed his march towards the south of Italy, where he hoped to stir up the peoples who had formerly been Rome's most stubborn enemies. The natives, however, were everywhere slow to join the Carthaginians, and a new Roman army under the dictator Q. Fabius Maximus ("Cunctator"), which, without ever daring to close with Hannibal, dogged his steps on his forays through Apulia and Campania, prevented his acquiring a permanent base of operations.

The eventful campaign of 216 was begun by a new aggressive move on the part of Rome. An exceptionally strong field army, estimated at 85,000 men, was sent forth in order to crush the Carthaginians in open battle. On a level plain near Cannae (*q.v.*) in Apulia, which Hannibal had chosen for his battle-ground, the Roman legions delivered their attack. Hannibal deliberately allowed his centre to be driven in by their superior numbers, while Hasdrubal's cavalry wheeled round so as to take the enemy in flank and rear. The Romans, surrounded on all sides and so cramped that their superior numbers aggravated their plight, were practically annihilated, and the loss of citizens was perhaps greater than in any other defeat that befell the Republic. The moral effect of the battle was no less momentous. The south Italian nations at last found courage to secede from Rome, the leaders of the movement being the people of Capua, the second greatest town of Italy. Reinforcements were sent from Carthage, and several neutral powers prepared to throw their weight into the scale on Hannibal's behalf. At first sight it seems strange that the battle of Cannae did not decide the war. But the resources of Rome, though terribly reduced in respect both of men and of money, were not yet exhausted. In north and central Italy the insurrection spread but little, and could be sufficiently guarded against with small detachments. In the south the Greek towns of the coast remained loyal, and the numerous Latin colonies continued to render important service by interrupting free communication between the rebels and detaining part of their forces. In Rome itself the quarrels between the nobles and commons, which had previously unsettled her policy, gave way to a unanimity unparalleled in the annals of the Republic. The guidance of operations was henceforth left to the senate, which by maintaining a persistent policy until the conflict was brought to a successful end earned its greatest title to fame.

The subsequent campaigns of the Italian War assume a new character. Though the Romans contrived at times to raise 200,000 men, they could only spare a moderate force for field operations. Their generals, among whom the veterans Fabius and M. Claudius Marcellus frequently held the most important commands, rarely ventured to engage Hannibal in the open, and contented themselves with observing him or skirmishing against his detachments. Hannibal, whose recent accessions of strength were largely discounted by the necessity of assigning troops to protect his new allies or secure their wavering loyalty, was still too weak to undertake a vigorous offensive. In the ensuing years the war resolved itself into a multiplicity of minor engagements which need not be followed out in detail. In 216 and 215 the chief seat of war was Campania, where Hannibal vainly attempted to establish himself on the coast but experienced a severe repulse at Nola. In 214 the main Carthaginian force was transferred to Apulia in hopes of capturing Tarentum. Though Croton and Locri on the Calabrian coast had fallen into his hands, Hannibal still lacked a suitable harbour by which he might have secured his oversea communications. For two years he watched in vain for an opportunity of surprising the town, while the Romans narrowed down the sphere of revolt in Campania and defeated other Carthaginian commanders. In 212 the greater part of Tarentum and other cities of the southern seaboard at last came into Hannibal's power. But in the same year the Romans found themselves strong enough to place Capua under blockade. They severely defeated a Carthaginian relief force, and could not be permanently dislodged even by Hannibal himself. In 211 Hannibal made a last effort to relieve his allies by a feint upon Rome itself, but the besiegers refused to be drawn away from their entrenchments, and eventually Capua was starved into surrender. Its fall was a sign that no power could in the long run uphold a rival Italian coalition against Rome. After a year of desultory fighting the Romans in 209 gained a further important success by recovering Tarentum. Though Hannibal still won isolated engagements, he was being slowly driven back into the extreme south of the peninsula.

In 207 the arrival of a fresh invading force produced a new crisis. Hasdrubal, who in 209–208 had marched overland from Spain, appeared in north Italy with a force scarcely inferior to the army which his brother had brought in 218. After levying contingents of Gauls and Ligurians he marched down the east coast with the object of joining hands with his brother in central Italy for a direct attack upon Rome. By this time the drain of men and money was telling so severely upon her confederacy that some of her most loyal allies protested their inability to render further help. Yet by a supreme effort the Romans raised their war establishment to the highest total yet attained and sent a strong field army against either Carthaginian leader. The danger to Rome was chiefly averted by the prompt insight and enterprise of the consul C. Nero, who commanded the main army in the south. Having discovered that Hannibal would not advance beyond Apulia until his brother had established communications with him, Nero slipped away with part of his troops and arrived in time to reinforce his colleague Livius, whose force had recently got into touch with Hasdrubal near Sena Gallica (Sinigaglia). The combined Roman army frustrated an attempt of Hasdrubal to elude it and forced him to fight on the banks of the Metaurus (*q.v.*). The battle was evenly contested until Nero by a dexterous flanking movement cut the enemy's retreat. Hasdrubal himself fell and the bulk of his army was destroyed.

The campaign of 207 decided the war in Italy. Though Hannibal still maintained himself for some years in Calabria, this was chiefly due to the exhaustion of Rome after the prodigious strain of past years and the consequent reduction of her armaments. In 203 Italy was finally cleared of Carthaginian troops. Hannibal, in accordance with orders from home, sailed back to Africa, and another expedition under his brother Mago, which had sailed to Liguria in 205 and endeavoured to rouse the slumbering discontent in Cisalpine Gaul and Etruria, was driven back on the coast and withdrawn about the same time.

Campaigns in Sicily and Spain.—Concurrently with the great struggle in Italy the Second Punic War was fought out on several other fields. It will suffice merely to allude to the First Macedonian War (214–205) which King Philip V. commenced when the Roman power seemed to be breaking up after Cannae. The diversions which Roman diplomacy provided for Philip in Greece and the maintenance of a patrol squadron in the Adriatic prevented any effective co-operation on his part with Hannibal.

In view of the complete stagnation of agriculture in Italy the Romans had to look to Sardinia and Sicily for their food supply. Sardinia was attacked by a Carthaginian armament in 215, but a small Roman force sufficed to repel the invasion. In Sicily a more serious conflict broke out. Some isolated attacks by Punic squadrons were easily frustrated by the strong Roman fleet. But in 215 internal complications arose. The death of Hiero II., Rome's steadfast friend, left the kingdom of Syracuse to his inexperienced grandson Hieronymus. Flattered by the promises of Carthaginian emissaries the young prince abruptly broke with the Romans, but before hostilities commenced he was assassinated. The Syracusan people now repudiated the monarchy and resumed their republican constitution, but they were misled by false threats of terrible punishment at the hands of Rome to play into the hands of the Carthaginians. The attacks of a Roman army and fleet under Marcellus which speedily appeared before the town were completely baffled by the mechanical contrivances of the Syracusan mathematician Archimedes (213). Meantime the revolt against Rome spread in the interior, and a Carthaginian fleet established itself in the towns of the south coast. In 212 Marcellus at last broke through the defence of Syracuse and in spite of the arrival of a Carthaginian relief force mastered the town by slow degrees. A guerilla warfare succeeded in which the Carthaginians maintained the upper hand until in 210 they lost their base at Agrigentum. They were dislodged from their remaining positions, and by the end of the year Sicily was wholly under the power of Rome.

The conflict in Spain was second in importance to the Italian war alone. From this country the Carthaginians drew large supplies of troops and money which might serve to reinforce Hannibal; hence it was in the interest of the Romans to challenge their enemy within his Spanish domain. Though the force which Rome at first spared for this war was small in numbers and rested entirely upon its own resources, the generals Publius and Gnaeus Scipio by skilful strategy and diplomacy not only won over the peoples north of the Ebro and defeated the Carthaginian leader Hasdrubal

Barca in his attempts to restore communication with Italy, but carried their arms along the east coast into the heart of the enemy's domain. But eventually their successes were nullified by a rash advance Deserted by their native contingents and cut off by Carthaginian cavalry, among which the Numidian prince Massinissa rendered conspicuous service, the Roman generals were slain and their troops were destroyed in detail (212 or 211).

Disturbances in Africa prevented the Punic commanders from reaping the full fruit of their success. Before long the fall of Capua enabled Rome to transfer troops from Italy to Spain, and in 209 the best Roman general of the day, the young son and namesake of the recently slain P. Scipio, was placed in command. The new leader signalized his arrival by a bold and successful *coup-de-main* upon the great arsenal of Carthago Nova (*see* CARTAGENA). Though he was unable to prevent Hasdrubal Barca from marching away to Italy, Scipio profited by his departure to push back the remaining hostile forces the more rapidly A last effort by the Carthaginians to retrieve their losses with a fresh army was frustrated by a great victory at Ilipa (*q.v.*), near Corduba, and by the end of 206 they were driven out of Spain

The War in Africa.--In 205 Scipio, who had returned to Rome to hold the consulship, proposed to follow up his victories by an attack upon the home territory of Carthage. Though the presence of Hannibal in Italy at first deterred the senate from sanctioning this policy, the general popularity of the scheme overbore all resistance. Scipio was granted a force which he organized and supplemented in Sicily, and in 204 sailed across to Africa. He was here met by a combined levy of Carthage and King Syphax of Numidia, and for a time penned to the shore near Utica But in the winter he extricated himself by a surprise attack upon the enemy's camp, which resulted in the total loss of the allied force by sword or flame. In the campaign of 203 a new Carthaginian force was destroyed by Scipio on the Great Plains not far from Utica, their ally Syphax was captured, and the renegade Massinissa (*q.v.*) reinstated in the kingdom from which Syphax had recently expelled him. These disasters induced the Carthaginians to sue for peace, but before the very moderate terms which Scipio offered could be definitely accepted a sudden reversal of opinion caused them to recall Hannibal's army for a final trial of war, and to break off negotiations. In 202 Hannibal assumed command of a composite force of citizen and mercenary levies stiffened with a corps of his veteran Italian troops. After an abortive conference with Scipio he prepared for a decisive battle at Zama (*q.v.*), an inland site not yet identified with certainty Scipio's force was smaller in numbers, but well trained throughout and greatly superior in cavalry. His infantry, after evading an attack by the Carthaginian elephants, cut through the first two lines of the enemy, but was unable to break the reserve corps of veterans. The battle was ultimately decided by the cavalry of the Romans and their new ally Massinissa, which by a manoeuvre recalling the tactics of Cannae took Hannibal's line in the rear and completely destroyed it. The Carthaginians having thus lost their last army again applied for peace and accepted tht terms which Scipio offered. They were compelled to cede Spain and the Mediterranean islands still in their hands, to surrender their warships, to pay an indemnity of 10,000 talents (about £2,400,000) within 50 years and to forfeit their independence in affairs of war and foreign policy.

The Second Punic War, by far the greatest struggle in which either power engaged, had thus ended in the complete triumph of Rome. This triumph is not to be explained in the main by any faultiness in the Carthaginians' method of attack. The history of the First Punic War, and that of the Second outside of Italy, prove that the Romans were irresistible on neutral or Carthaginian ground Carthage could only hope to win by invading Italy and using the enemy's home resources against him. The failure of Hannibal's brilliant endeavour to realize these conditions was not due to any strategica! mistakes on his part. It was caused by the indomitable strength of will of the Romans, whose character during this period appears at its best, and to the compactness of their Italian confederacy, which no shock of defeat or strain of war could entirely disintegrate. It is this spectacle of individual genius overborne by corporate and persevering effort which lends to the Second Punic War its peculiar interest.

The Third Punic War (149–146 B.C.).—The political power of Carthage henceforth remained quite insignificant, but its commerce and material resources revived in the 2nd century with such rapidity as to excite the jealousy of the growing mercantile population of Rome and the alarm of its more timid statesmen. Under the influence of these feelings the conviction—sedulously fostered by Cato the Elder, the Censor—that "Carthage must be destroyed" overbore the scruples of more clear-sighted statesmen. A *casus belli* was readily found in a formal breach of the treaty, committed by the Carthaginians in 154, when they resisted Massinissa's aggressions by force of arms. A Roman army was despatched to Africa, and although the Carthaginians consented to make reparation by giving hostages and surrendering their arms, they were goaded into revolt by the further stipulation that they must emigrate to some inland site where they would be debarred from commerce. By a desperate effort they created a new war equipment and prepared their city for a siege (149). The Roman attack for two years completely miscarried, until in 147 the command was given to a young officer who had distinguished himself in the early operations of the war—Scipio Aemilianus, the adoptive grandson of the former conqueror of Carthage. Scipio made the blockade stringent by walling off the isthmus on which the town lay and by cutting off its sources of supplies from oversea. His main attack was delivered on the harbour side, where he effected an entrance in the face of a determined and ingenious resistance The struggle did not cease until he had carried house by house the streets that led up to the citadel. Of a population probably exceeding half a million only 50,000 remained at the final surrender. The survivors were sold into slavery; the city was razed to the ground and its site condemned by solemn imprecations to lie desolate for ever. The territory of Carthage, which had recently been much narrowed by Massinissa's encroachments, was converted into a Roman province under the name of "Africa."

BIBLIOGRAPHY.—1. *Ancient Authorities.* For the First Punic War Polybius, bk. 1, provides a trustworthy and impartial account, but owing to his conciseness leaves many problems of chronology and strategy unexplained. For the Second War bks. 2 and 3 of Polybius present a complete and detailed record down to Cannae; bks. 7–15 contain fragmentary notices of which the most continuous deal with the campaigns of Scipio. Livy (bks. 23–30) gives a continuous and detailed narrative, partly based upon Polybius and other good authorities, partly upon untrustworthy Roman annalists. The Third War is described in Appian's *Res Libycae,* chs. 67 *sqq.*, and the fragments of Polybius, bks. 36–39

The subsidiary authorities are. Diodorus, bks. 20–27, 32; Appian, *Res libycae, hispanicae, hannibalicae;* Zonaras' epitome of Dio Cassius, frs. 43, 54, 57; Plutarch's *Lives of Fabius'and Marcellus;* Cornelius Nepos's *Lives of Hamilcar and Hannibal,* and short references in Justin, Eutropius, Aurelius Victor and Orosius. The sources and methods of composition of these authors have been discussed in numerous articles and dissertations, mostly German, of which the most important are mentioned in Niese's work (quoted below). These essays have brought out few certain results, but they tend to show that the narratives, so far as they are not based on Polybius or earlier authorities, are of little value.

2. *Modern Works. a.* For general accounts *see* the respective passages in the general histories of Rome, especially Mommsen (Eng. trans., 1894, vol. ii.), Ihne (Eng. trans., vol ii.) and de Sancti's; also C. Neumann, *Das Zeitalter der punischen Kriegs* (breslau, 1883), and R. B. Smith, *Rome and Carthage* (1881) The battles are methodically evamined in J. Kromager, *Antike Schlachtfelder* (1912 *et seq.),* and in Kromager-Veith, *Schlachten-Atlas zur antiken Kriegsgeschichte* (Leipzig, 1922). *See* also H. Delbriick, *Gesch. der Kriegskunst* (1901–07).

b For the First War.—0. Meltzer, *Geschichte der Karthager,* ii. 252–356 (1879–86); J. Beloch, *Gricchische Geschichte,* vol. iii. pt. i. pp. 664–684 (Strasbourg, 1893–1904); B. Niese, *Geschichte der grtechischen und makedonischen Staaten,* ii. 174–199 (Gotha, 1893–1903); W. W. Tarn, "The Fleets of the First Punic War," in *Journal of Hellenic Studies* (1907), pp 48–60. For the chronology, *see* F. Reuss, in *Philologus* (1901), pp. 102–148, and especially P. Varese, in *Studi di storia antica,* vol. iii. (1902)

c. For the period 241–238.—O. Gilbert, *Rom und Karthago 513–536 A.U.C* (Leipzig, 1876); Meltzer, *op. cit.* ii. 357–456.

d. For the Second War.—T. Arnold, *The Second Punic War* (ed. W. T. Arnold, 1886); T. A. Dodge, *Great Captains, Hannibal* (Boston and New York, 1889); G. Bossi, in *Studi di storia e diritto,* vols. x.–xiii.; P Cantalupi, Le Legioni romane nella guerra d'Annibale *(Studi di storta antica,* 1891, i. 3–48), Th Zielinski, *Die letzten Jahre des*

zweiten punischen Krieges (Ldpzig, 1880); B. H. Liddell Hart, A Greater than Napoleon--Scipio Africanus (London and Boston, 1926).

e. Special articles.—On Sicily: Niese, *op. cit.* ii. 505–561. On Spain: J. Frantz, Die Kriege der *Scipionen* in *Spanien* (Munich, 1883).

For further bibliographical references consult B. Niese, *Grundriss* der *römischen* Geschichte, pp. 81–88, 94–108, 138–142 (Munich, 1906). See also the articles on chief personages (especially HANNIBAL and SCIPIO), and under ROME: Ancient History; ROMAN ARMY; CARTHAGE; SICILY. (M. C.)

PUNISHMENT, the infliction of some kind of pain or loss upon a person for a misdeed, *i.e.,* the transgression of a law or command. See CRIMINAL LAW; CRIMINOLOGY; CAPITAL PUNISHMENT; PRISON, etc.

PUNJAB, province, British India, named from the "five rivers" by which it is watered: the Jhelum, Chenab, Ravi, Beas and Sutlej, all tributaries of the Indus. It is primarily the triangular country of which the Indus and the Sutlej to their confluence form the two sides, the base being the lower Himalaya hills between those two rivers; but the British province now includes a large tract outside those boundaries. On the other hand certain areas once included in the administrative province are now excluded, the Frontier Province having been cut off in 1902 and the Delhi Enclave in 1912.

The Punjab includes two classes of territory, that belonging to the British Crown, and that in possession of 34 feudatory chiefs, Of the latter the 13 more important have direct relations with the Government of India, the rest being under the Punjab Government. The total area of the province is 136,261 sq.m., of which 99,200 sq m. are British territory and the remainder belongs to the native states. The British territory is divided into 29 districts, grouped under the five divisions of Amballa, Lahore, Jullundur, Rawalpindi and Multan; while the states vary in size from Bahawalpur, with an area of 15,003 sq.m., to the tiny state of Darkoti, with an area of 8 sq.m. and a total population of 531 souls.

Physical Features. — The mountain regions of the Punjab fall under four separate groups. To the north-east of the province lies the Himalayan system, with the fringing range of the Siwaliks at its foot. In the south-eastern corner the Aravalli system sends out insignificant outliers, which run across Gurgaon and Delhi districts and strike the Jumna at Delhi. The lower portion of the western frontier is constituted by the great Suliman chain; while the north-western districts of the province are traversed by the hill system known as the Salt range.

The "five rivers" of the Punjab are each of large volume; but, on account of the great width of sandy channel in their passage through the plains, their changing courses, and shifting shoals, they are of no value for steam navigation, though they all support a considerable boat-traffic. Of recent years they have been utilized for purposes of irrigation, and have turned the sandy desert of the Punjab into a great wheat-growing area.

South of the Himalayas stretch the great alluvial plains. From the Jumna on the east to the Sulimans in the west, one vast level, unbroken save by the wide eroded channels within which the great rivers ever shift their beds, by the insignificant spurs of the Aravalli range in the south-eastern corner, and the low hills of Chiniot and Kirana in Jhang.

Geology. — By far the greater part of the Punjab is covered by alluvial and wind-blown deposits of the plain of the Indus. The Salt range hills form a plateau with a steeply scarped face to the south, along which there is an axis of abrupt folding, accompanied by faulting. The rocks found in the Salt range belong to the Cambrian, Carboniferous, Permian, Triassic and Jurassic systems, while Tertiary beds cover the plateau behind. The extensive and valuable deposits of salt, from which the range takes its name, occur near the base of the Cambrian beds. Gypsum, kieserite and other salts are also found. Between the Cambrian and the Carboniferous beds there is an unconformity, which, however, is not very strongly marked, in spite of the lapse of time which it indicates. At the bottom of the Carboniferous series there is usually a boulder bed, the boulders in which have been brought from a distance and are scratched and striated as if by ice. It is generally admitted that this deposit, together with contemporaneous boulder beds in tbe peninsula of India, in Australia and in South Africa, indicate a southern glacial period in late Carboniferous times. Above the sandstone series at the base of which the boulder bed lies, come the Productus and Ceratite limestones. The former is believed to belong to the Upper Carboniferous and Permian, the latter to the Trias. Jurassic beds are found only in the western portion of the range.

Climate. — Owing to its sub-tropical position, scanty rainfall and cloudless skies, and the wide expanse of untilled plains, the climate of the Punjab presents greater extremes of both heat and cold than any other part of India. From the middle of April to the middle of September it is extremely hot, while from the beginning of October to the end of March there is a magnificent cool season, resembling that of the Riviera, with warm bright days and cool nights. Frosts are frequent in January. In the first three months of the hot season, from April till the end of June, a dry heat is experienced, with a temperature rising to 120° F in the shade. At the end of June the monsoon arrives, the rains break in the East of the Province, and though the heat is less intense the air is moist, and from the middle of August the temperature gradually falls. This is the most unhealthy period of the year, being exceedingly malarious. The Punjab enjoys two well-marked seasons of rainfall; the monsoon period, lasting from the middle of June till the end of September, on which the autumn crops and spring sowings depend; and the winter rains, which fall early in January, and though often insignificant in amount materially affect the prosperity of the spring harvest. Excepting in the Himalayas the rainfall is greatest in the east of the province, as the Bombay monsoon is exhausted in its passage over the great plains of Sind and Rajputana, while the west winds from Baluchistan pass over an arid tract and leave such moisture as they may have collected on the western slopes of the Suliman range; so that the Punjab depends for its rain very largely on the south-east winds from the Bay of Bengal. The submontane tract has an annual average of 36 to 32 in., the eastern plains vary from 20 to 14 in., and the western plains from 10 to 5 in.

Minerals.—Besides rock-salt, the mineral products of the Punjab are not many. Limestone, good for building, is obtained at Chiniot on the Chenab and at a few other places. There are extensive alum-beds at Kalabagh on the Indus. A small quantity of coal is found in the Salt range in disconnected beds, the Dandot colliery in the Jhelum district being worked by the North-Western railway. Petroleum is found in small quantities at a number of places in Rawalpindi, and there is an oil company extracting oil by modern methods. In almost all parts of the Punjab there is kankar, rough nodular limestone, commonly found in thick beds, a few feet below the surface of the ground, used for road metal and burned for lime.

Agriculture. — As in other parts of India, there are commonly two harvests in the year. The spring crops are wheat, barley, gram, various vegetables, oil-seeds and tobacco; the autumn crops are rice, millets, maize, pulses, cotton, indigo and sugar-cane. Wheat has become the most important export of the province. In the spring of 1938 an area of 11½ million acres was harvested, producing 4½ million tons. Tea is cultivated in Kangra district. Potatoes are grown extensively on cleared areas on the hills. The Punjab produces freely many of the Indian fruits. Grapes are grown in many of the Himalayan valleys where the rain is not excessive; but they are inferior to those brought from Kabul.

Forests. — The forest area of the Punjab consists of 6,251 sq.m., of which 1,682 sq.m. are preserved and 3,270 sq.m. protected. The principal reserved forests are the deodar (*Cedrus* Deodara) and chil (*Pinus longifolia*) tracts in the hills, the plantations of shisham (*Dalbergia* Sissu) and sal (*Shorea robusta*) in the plains, and the fuel rakhs or preserves (Acacia, Prosopis, etc.).

Manufactures and Trade. — Most of the native manufactures of the Punjab are those common to most other parts of India. Among other manufactures, not so general, yet not peculiar to the Punjab, are woollen fabrics, carpets and shawls, silk cloths and embroidery, jewellery, ornamental metal-work, wood and ivory carving, turned and lacquered woodwork, glazed pottery, arms and armour and musical instruments. But some of these classes of manufacture are represented by work of special kinds or special excellence in particular parts of the Punjab, notably the silk fabrics of Multan and Bahawalpur; the carpets of Lahore and Amritsar; the *kashi* or glazed tilework (an ancient art still practised in a few places); koft-kari, inlaid metal-work (gold wire on steel), chiefly made at Gujrat and Sialkot; shawls and other fine woollen fabrics, made by Kashmiri work-people at Ludhiana and Nurpur, as well as in Kashmir; silk embroidery for shawls, scarfs and turbans, at Delhi, Lahore and Multan; embroidery on cloth for elephant-trappings, bed and table covers, etc., at Lahore and Multan; enamelled ornaments, in Kangra and Multan; quill embroidery on leather, in Kangra and Simla; lacquered woodwork, at Pak Pattan. Cotton-weaving gives employment to about a million persons, but the most flourishing industry is the woollen factories of Amritsar, Gurdaspur and elsewhere.

Trade.—The trade of the Punjab is almost wholly dependent upon agriculture. In a normal year the principal feature of the trade is the movement of wheat to Karachi, which is the chief port for the province. But in a bad season, when the rains fail, this movement is at once checked, the wheat is held up in reserve and an eastward movement in cheaper grains begins. The other chief articles of export are pulse and raw cotton. The Punjab has a trans-frontier trade with Kashmir, Ladakh, Yarkand and Tibet on the north, and with Afghanistan on the west.

Irrigation and Railways.—Irrigation for large areas is from canals and from reservoirs, and for smaller areas from wells. The canals are of two kinds: those carrying a permanent stream throughout the year, and those which fill only on the periodical rising of the rivers, the latter being known as "inundation canals." There are only a few parts of the country presenting facilities for forming reservoirs, by closing the narrow outlets of small valleys and storing the accumulated rainfall. The present canal system is probably the finest in the world. The old canals made by the Mohammedan rulers, of which the principal are Feroz's Canal from the Jumna and the Hasli Canal from the Ravi, have been improved or reconstructed by the British government and are now represented by the Western Jumna and Bari Doab Canal. They were followed by the Sirhind Canal (1883) and by the two great Colony Canals, the Lower Chenab and Lower Jhelum (1892–1901). Then succeeded the so-called Triple Canal Scheme (1912–15) comprising the Upper Jhelum, Upper Chenab and Lower Bari Doab Canals. And these again were followed by the Sutlej Valley Canals completed in 1933. The canals irrigated 12½ million acres in 1936–37 and produced a net return of some £3½ million, representing about 14½% on capital.

Railways.—The Punjab is well supplied with railways, and Lahore, the headquarters of the North-Western Railway system has a very large railway population. One main line of the North-Western runs from Umballa through Lahore and Rawalpindi towards Peshawar; another main line runs from Lahore to Multan, and thence to the sea at Karachi; while a third runs along the left bank of the Indus, from Attock southwards. From Delhi to Umballa there are two lines, one of the North-Western through Meerut and Saharanpur in the United Provinces, and a more direct one, which is continued to Kalka and Simla. The south-east of the province is served by three branches of the Rajputana system, which have their termini at Delhi Hissar and Ferozepore; and also by the Southern Punjab, from Delhi to Bahawalpur.

Population and Administration.—The total population of the Punjab (including states) according to the census of 1931 was 28,490,857. The Jats, who number some six millions, form the backbone of the cultivating community. Large numbers of them have become Sikhs or Mohammedans in the tracts where those religions predominate. The Rajputs, with a total of two million and three-quarters, comprise tribes of different religions, races and social systems. By religion they are mostly Mohammedan, only about one million being Hindus and half a million Sikhs. The Gujars are an important agricultural and pastoral tribe. Baluchis and Pathans are strongly represented in the south-west and nest. The distinctive religion of the Punjab is Sikhism (*q.v.*), though Sikhs form only 14·3% of the total population. The Mohammedans represent 52% of the population. The people bear a martial character and entered with enthusiasm into the War of 1914–18. Nearly half a million of men were mobilized and the Punjab supplied more than 40% of the combatants from India.

Language.—Of the 28,490,857 people in the Punjab about 21,893,342 speak the provincial language, Punjabi, which varies in character in different parts of the province. About 3,988,000 speak Hindustani (see HINDOSTANI), this number including those whose ordinary vernacular is Hindi, but who understand and are gradually adopting the more comprehensive Hindustani. These two languages are the most generally used throughout the province, but not equally in all parts. The other languages in use are more or less local. The hill dialects, known as Pahari, are akin to the language spoken in Rajputana. Hindustani is the language of the law courts and of all ordinary official and other communications with chiefs and people.

Administration.—The administration is conducted by a Governor, a premier and five ministers of developments. Two Financial Commissioners take the place of the board of revenue in most of the provinces and each of the five Divisions is under a Commissioner. A survival of the "non-regulation" system is to be found in the title of deputy-commissioner for the district officer elsewhere called collector. The highest judicial authority is the high court, consisting of a Chief Justice and ten puisne judges. A legislative council, first created in 1897, was enlarged in 1909 to 26 members, and in 1921 to 94. Under the reform scheme of 1935 a legislation assembly was constituted with 175 members.

Education.—The Punjab University, which was founded in 1882 serves the Kashmir State and the Frontier Province as well as the Punjab. In the Province there were in 1938 34 arts colleges and 10 professional colleges, 397 high schools, 3,336 middle schools and 7,730 primary schools. The number of enrolled pupils, which in 1921 was 556,989 had risen in 1938 to 1,302,461. (E. D. MACL.)

HISTORY

Proofs of a remarkable prehistoric culture (about 2500 B.C) have been found at Harappa; seals unearthed there, almost identical with Sumerian seals discovered in Babylonia, suggest an art connection between Babylonia and India at that time, but racial affinity cannot be deduced. For early history to the fall of the Mogul dynasty see INDIA: History. From the time of Alexander onwards Greek settlers remained in the Punjab and Greek artists gave their services for Buddhist work, introducing new features into Indian architecture. The most conspicuous and distinctive Buddhist buildings are the topes (stupa), plain hemispheres on platforms of two or more stages. One of the largest is at Manikiala, 14 m. east of Rawalpindi. These buildings and sculptures date probably from zoo B.C. to A.D. 400.

The early colonists formed clans (not identical with castes, but often joining them), which generally preserved distinct characteristics and followed certain classes of occupation. Some existing Punjab tribes are traced to these settlers, as the Bhattis of Bhattiana south of the Sutlej, who have also in the village of Pindi Bhattian a record of early occupation of the left bank of the Chenab. The Dogras, another Aryan clan, belong to the lower hills between the Chenab and the Ravi. So with others. To the earlier settlers—the dark race (Dasyu, commonly called aborigines), whom the Aryans found in the country, may have belonged the old Takka tribe, whose name is found in Takshasila or Taxila. From the later foreigners, the Indo-Scythians, are probably descended the Jat cultivators, the Gujars and others.

During the events which brought Babar to the throne, the sect of the Sikhs was founded by Nanak (born 1469) and under the persecution of Aurangzeb they were raised into a nation of warriors by Govind Singh (1675–1708), the tenth and last Guru. (See SIKHISM.) Upon the break-up of the Mogul Empire in the 18th century the Sikhs formed confederacies on both banks of the Sutlej. After long internecine warfare one of their chieftains secured a position of authority over the rest. This was Ranjit Singh, born in 1780, who acquired Lahore as his capital in 1799. When he tried to include within his jurisdiction Sirhind and Malva, the Sikh States south of the Sutlej, their chiefs sought British protection. The British desired an alliance with Lahore as well as Kabul against supposed French designs on

India. A British envoy, Charles Metcalfe, was received by Ranjit at Kasur in 1809 and the alliance was formed.

In 1809 Ranjit secured Kangra which the Nepalese were besieging, and in 1813 the fort of Attock on the other side of the Punjab; in that year he obtained from Shah Shuja, then a refugee in Lahore, the celebrated Koh-i-Nur diamond carried off by Nadir Shah from Delhi. In 1818 he captured Multan; Kashmir and the southern part of the country between the Indus and the hills were annexed in the following year. He added the Peshawar valley four years later, but placed an Afghan governor in charge. These trans-Indus and other outlying tracts were left very much to themselves and received a military visit only when revenue was wanted. Peshawar was never really ruled till Avitabile went there in later years. While Ranjit was raising his powerful army, French and other foreign officers drilled his troops and improved his artillery. He relied on them for military and sometimes administrative services, but he drew round him able Indian ministers of whom the brothers Gulab Singh and Dhian Singh of Jammu were the most influential. He always remained friendly with the British and before his death gave tacit approval to the scheme for placing Shah Shuja on the throne of Kabul.

Wars Against British, **1845–49.**—Ranjit's death in 1839 was followed by six years of anarchy, princes and ministers being murdered in quick succession, while all real power passed to the army of 120,000 trained troops who, unpaid and discontented, demanded to be led into British territory. They crossed the Sutlej in Dec. 1845. The battles of Mudki, Firozshah and Aliwal were followed by the rout of the Sikh army at Sobraon, Feb. 10, 1846; the British advanced to Lahore and a treaty was made on March 9 with the chiefs and ministers who were to hold the government on behalf of the young maharaja, Dalip Singh (b. 1837, d. 1893). The Jullunder Doab, Kangra and the maharaja's possessions on the left bank of the Sutlej were ceded to the British. In addition a payment of £1,500,000 was agreed upon. Gulab Singh, raja of Jammu, for his services to the Lahore state in restoring friendly relations was granted independent sovereignty in such lands as might be made over to him. The Sikh government ceded, as equivalent for two-thirds of the stipulated amount, the hill country between the Beas and the Indus, including Kashmir and Hazara. Gulab Singh received Kashmir, March 1846, in return for a sum of money. At the durbar's request a British force was left at Lahore to protect the maharaja and preserve peace. A British resident was appointed to guide the council of regency, and assistants were stationed in different places. Peace was soon broken. The governor of Multan, Diwan Mulraj, resigned. Two British officers, sent to take charge of the fort, were murdered, April 19, 1848, and their escort went over to the diwan. One of the assistants to the resident, Lt. Herbert Edwardes, then in the Derajat, west of the Indus, collected a force and attacked the Multan army with signal success, but had not sufficient troops to take the city. Sikh and British forces again took the field and Multan fell.

Annexation to British India.—The severe battle of Chilianwalla, Jan. 13, 1849, left the Sikhs as persistent as ever, and the war ended only after the defeat of Gujrat, Feb. 21, 1849. The Punjab was annexed on April 2, 1849.

To govern the new province, including the Jullunder Doab, previously annexed, and the cis-Sutlej states, an administration board was appointed, consisting of three members, replaced in 1853 by a chief commissioner aided by a judicial commissioner and a financial commissioner. British troops, European and Indian, were stationed in the chief cities, including Peshawar, and other places. For the rest of the trans-Indus territory a special body of Indian troops, called the Punjab frontier force, was raised. During the Mutiny of 1857 Sir John Lawrence as chief commissioner sent important aid to the force besieging Delhi and dealt with disturbances in the Punjab itself. In 1858 the Delhi territory, as it was called, west of the Jumna, was transferred to the Punjab, and on Jan. 1, 1859 the chief commissioner became lieutenant-governor. In 1901 the districts beyond the Indus were made into a separate province called the North-West Frontier Province and in Oct. 1912 Delhi, the new capital, with the country round it became a separate district under a chief commissioner.

The races of the Punjab are full of vigour and virility in both war and religion. They show this sometimes by striking loyalty and sometimes by an inclination to turbulence. Thus the Punjab is the birthplace or stronghold of religious bodies like the Sikhs, the Arya Samaj, the Ahmadiyyas and others. During the Great War, 1914–8, it made a splendid response to the call of the Empire, yet there were sporadic internal troubles in 1915, grave disorders in 1919 and excitement among the Sikhs from 1922 to 1924 in connection with the Akalis. However the feeling of toleration and mutual assistance increased and in 1928 the Simon Commission received a general, though quiet, welcome. In 1920 the province was raised in rank and the Lieutenant-governor was given the title of Governor. (T. G. Ba.)

Bibliography.—*See* the annual *Administration Report* and, for the industrial development of the country, A. C. Badenoch, *Punjab Industries* (1917). *See* also Sir J. Dowie, *The Punjab, North-western Frontier Province and Kashmir* (1916), and M. S. Leigh, *Punjab and the War* (1922).

PUNKTMENGEN: *see* Aggregates, Theory of.

PUNO, a south-eastern department of Peru. It includes the shores of Lake Titicaca, the high plateau on which the lake is situated, together with the mountains west, north and east enclosing the plateau. It also includes the headwaters of several tributaries of the Madre de Dios river east of the eastern cordillera and draining into the Amazon, but the greater part of the northern provinces were taken in 1912 to form part of the new department of Madre de Dios (*q.v.*). Puno has an area of 26,133 sq.mi.; population (1940) 646,385. Connection is by the Southern railway with Cusco, 200 mi. to the north, also with the Pacific port of Mollendo and by steamer (across Lake Titicaca) and railway to La Paz, Bolivia. A projected section of the Pan American highuay will eventually traverse the department.

Around the shores of the lake (12,466 ft. above sea-level) the plateau is cultivated and well settled, but the altitude is so great that only potatoes, barley and a few other cereals will mature. The department of Puno produces about 70% of all the gold of Peru. It comes chiefly from the mountain provinces of Sandia and Carabaya. Coal, salt, copper, antimony, tin, quicksilver, zinc, marble and cobalt are also found. The manufacturing of woollen goods is important and in the Province of Lampa there is a considerable manufacture of pottery.

Puno, the town, capital of the department of Puno and also of the Province of Puno, is located on the shore of Lake Titicaca. Pop. (1940) 15,999. It is the lake terminus of the railway.

PUNTARENAS or **PUNTA ARENAS,** a seaport and capital of the province of Puntarenas, Costa Rica; on the Gull of Nicoya, an inlet of the Pacific ocean, and at the western terminus of the interoceanic railway from Limón. Pop. (1940) town. 7,722; province, 41,517. Puntarenas is the principal harbour of Costa Rica on the Pacific, and a port of call for the United States liners which ply between San Francisco and Panamá. It has a growing export trade in coffee and bananas. The district of Puntarenas comprises the entire littoral from Burica point to the Rio de las Lajas, an effluent of the Gulf of Nicoya.

PUNXSUTAWNEY, a borough of Jefferson county, Pennsylvania, U.S.A., 70 mi. N.E. of Pittsburgh; served by the Buffalo, Rochester and Pittsburgh and the Pennsylvania railways. Pop. (1930), 9,266; 1940 it was 9,482. The bank clearance for 1940 was $39,000,000. It is a trading centre for agriculture, surrounded by coal operations and gas fields. Punxsutawney was founded about 1812 and incorporated in 1845.

PUPIN, MICHAEL IDVORSKY (1858–1935), American inventor, aas born in Idvor, Hungary (now in Jugoslavia), Oct. 4. 1858. He went to America, 1874, graduating from Columbia university, 1883. The first to hold the John Tyndall fellowship (1886–88), he later studied physics and mathematics at Cambridge university and under Von Helmholtz at the University of Berlin (Ph.D., 1889). He was instructor in mathematical physics at Columbia, 1890; and was appointed adjunct professor of mechanics, 1892, becoming professor of electro-mechanics there in 1901 and later director of the Phoenix research laboratories.

By means of inductance coils placed at predetermined intervals of the transmitting wire, he greatly extended the range of long-distance telephony, particularly over telephone cables. The patent for this invention was acquired in 1901 by the Bell Telephone company and by German telephone interests. He has made several other inventions in electrical wave propagation, electrical resonance and multiplex telegraphy. He discovered secondary X-ray radiation in 1896 and invented in the same year means for short exposure X-ray photography by the interposition of a fluorescent screen. He was active during the World War aiding Serbia and the United States. He wrote *From Immigrant to Inventor.*

PUPPIS, one of the three southern constellations into which the large Ptolemaic constellation Argo (*q.v.*) was subdivided (*puppis:* poop).

PUQUINAN, a group of tribes of South American Indians, doubtfully constituting an independent linguistic stock. Their identity with the modern Uros (*q.v.*) has been much discussed. The area occupied (if this identity be accepted) would include the whole basin of lakes Titicaca and Poopo, and the Salar de Uyuni in the Bolivian plateau, together with the Peruvian-Chilean coast from about 16° to 22° S. lat. Within this area they lived in scattered small groups, amongst the Aymaran (*q.v.*) tribes. Rivet thinks that the Puquinan language (together with the Uro) is in reality a member of the Arawakan (*q.v.*) stock, and that this whole group of Puquinan and Uran tribes represent a very ancient intrusion westward of the Arawakan peoples.

See G. de Crequi-Montfort and P. Rivet, "La Langue Uru ou Puquina" (*J. Soc. Américanistes de Paris* [n.s.] vol. xvii., 211–244; vol. xviii., 111–139, with bibliography).

PURCELL, HENRY (1659–1695), English composer, was born in Westminster. His recent biographer, Dennis Arundell, points out that the statement *aet. suae. 24* on the printed edition of his *Sonatas* in June 1683 places his birth between June and November 1659, Nov. 20, 1695 being the date of his death in his thirty-seventh year. His father Henry Purcell, or Pursell, was a gentleman of the Chapel Royal, whose eldest son Edward (1653–1717) became gentleman usher to Charles II., and afterwards distinguished himself in the army, while Henry and Daniel, the two younger sons, became musicians. On his father's death in 1664, Henry Purcell was placed under the guardianship of his uncle Thomas Purcell (d. 1682), also a gentleman of the Chapel and a man of extraordinary probity and kindness. Both he and Henry Purcell the elder sang at the coronation of Charles II. Through his uncle's interest Purcell was admitted as a chorister of the Chapel and was placed under Captain Henry Cooke (d. 1672), "master of the children," an excellent teacher and a composer of anthems, to whom Pepys makes a number of references in his *Diary.* On Cooke's death Pelham Humfrey (1647–1674) became "master," and he again mas an excellent teacher as well as a musician of genius; but as a pupil of Lully he naturally stood for the French school, and in this respect failed to influence Purcell, who took the Italian masters for his models.

Purcell's third and last master was the distinguished composer and organist Dr. John Blow (1648–1708), to whom Purcell's great indebtedness is not always sufficiently realized. In 1673, when his voice broke, Purcell was dismissed with an ex-chorister's salary of £30 a year and presented with certain articles of dress. He was also given the appointment of (unpaid) assistant to John Kingston, keeper of the king's instruments, together with a promise to succeed him. In 1677 he was appointed "composer in ordinary for the violin" in succession to Matthew Lock. Purcell had been copyist at Westminster abbey since 1677, and in 1680 he succeeded Dr. Blow as organist.

The year 1680 was the beginning of a period of great productivity. In it he wrote the music to Lee's *Theodosius,* the first of a long series of dramas for which he provided incidental music, and one in which an introductory ritual scene gave him unusual scope; this was followed by D'Urfey's *Virtuous Wife.* He also produced the first of his court odes or "Welcome Songs" at this date and wrote several anthems. many of which were composed especially for the prodigious basso profondo of the Rev. John Gostling (or Gosling), a singer at Canterbury and later at the Chapel Royal, to whom Evelyn alludes as "that stupendous bass." Either in 1680 or the following year he married Frances Peters, and in 1682 his eldest son was born. From 1682 he held the post of organist to the Chapel conjointly with his appointment at the Abbey. His first printed composition was the 12 *Sonnatas of III. Parts: two violins and basse: to the organ or harpsichord.* These, though avowedly based on Italian models, show great power and originality. Purcell had now become "composer in ordinary to the king" and his official life was a very full one. For each public event he composed an ode or an anthem: some of the finest of these are the ode, "Swifter, Isis, swifter flow" (1681); the "St. Cecilia" odes; the "Fly, bold Rebellion" (in celebration of the suppression of the Rye House Plot, 1683); two anthems written for James II.'s coronation: "O I was glad" and "My heart is inditing." The *Te Deum* and *Jubilate,* written for St. Cecilia's Day 1694, was notable as being the first English anthem with orchestral accompaniment. It was performed annually at St. Paul's cathedral until 1712 and in alternate years with Handel's Utrecht *Te Deum* until 1743. In all his anthems there is a large proportion of instrumental music.

The opera *Dido and Aeneas,* which above all Purcell's works inspires admiration and affection in an equal degree, was written to a libretto furnished by Nahum Tate at the request of Josiah Priest, a dancing-master who also kept a boarding-school for young gentlewomen, first in Leicester Fields and afterwards at Chelsea. The date of its composition and original performance at the school has been fixed by W. Barclay Squire of the British Museum as about the year 1689. In this work there is no spoken dialogue, but only recitative, and it is characterized from beginning to end by the dramatic directness which Purcell possessed in so high a degree. Dido's exquisite song of farewell is one of the flawless things in music, classical in form and in its dignified restraint, and yet of rare emotional quality. As is so often the case when he has some poignant emotion to express, Purcell chooses here to build up the song on a "ground," and the relentless reiteration of the bass contributes greatly to the dramatic effect. Graceful dance choruses, lumbering sailor dances and witches' incantations relieve the tragedy, and, avoiding an anti-climax after Dido's farewell, the composer ends with a soft and tenderly expressive chorus, "With drooping wings, ye Cupids, come," in which music and words achieve perfect union.

Although *Dido and Aeneas* stands out to-day as an isolated phenomenon in the age in which it is written, it was rather the peak of a movement in which Purcell's predecessors did valuable experimental work; and here, again, Dr. Blow's influence is seen, for in his only known dramatic work, *Venus and Adonis,* he sets the example of having every word sung and none spoken. He is no doubt also partly responsible for Purcell's skill in the use of a ground, and he probably encouraged, rather than discouraged, his pupil's audacities of harmony, since he himself was a notorious offender. Among the peculiarities of Purcell's idiom are the constant false relations and the use of the descending melodic minor in ascending passages, and vice versa. He had a marked preference for the flat minor keys. His fine feeling for rhythm, form and climax invests even his smaller pieces with a quality that is unmistakable. In judging Purcell's scores it should be remembered that he was practically restricted to oboes and trumpets as regards wind instruments, since even the modern flute had not come into use in his time.

In 1690 Purcell wrote the music to Betterton's *Dioclesian,* which includes a masque. He was associated with Dryden in *Tyrannic Love* (1687), *Amphitryon* (1690) and *King Arthur* (1691), in all of which the music consists of separate numbers which form no integral part of the drama. In *King Arthur,* Josiah Priest was responsible for the dances. This play, which contains the famous song, "Fairest Isle," had a great success and was revived on various occasions up to 1803, and once in 1842. It was first published in 1843 by the Musical Antiquarian Society. The score of Purcell's songs and music to *The Fairy Queen* (an adaptation of Shakespeare's *The Tempest)* written in 1693, was discovered in 1901 and edited for the Purcell Society by J. S. Shedlock in 1903.

Purcell suffered much at the hands of his editors until, in 1876, the Purcell Society was founded for the purpose of bringing out a complete and authoritative edition of his works, the majority of which were still in manuscript. There are signs of the beginning of a great Purcell revival, not only in England, but also on the Continent, where recent performances of *Dido and Aeneas* in Vienna, Miinster and Basle aroused enthusiasm and interest.

Purcell died at his house in Dean's Yard, Westminster, on Nov. 21, 1695, and was buried in Westminster abbey on Nov. 26. He left a widow and three children, three others having died before him. His widow died in 1706. In 1682 and 1702 she published *Orpheus Britannicus,* a collection of his works, in two parts. A famous portrait of the composer is that by Kneller, bequeathed to the National Portrait Gallery, London, by Barclay Squire. There is also an engraved portrait by R. 'White on the first edition of his Sonatas (1683).

Other dramatic works by Purcell were *Don Quixote, The Indian Queen,* and *Bon duca* (all in 1695), and many earlier works. Smaller works are the Fantasias and Sonatas for three or more parts, the Suites and many miscellaneous pieces for harpsichord, and songs. For a complete list, *see* Grove's *Dictionary* and the publications of the Purcell Society, now nearly complete. Recent publications include the *Chacony* for string quartet (Chester Ltd. 1926) ; *Dido and Aeneas* with Eng. and German text, ed. by E. J. Dent; and Dennis Arundell's life, *Henry Purcell* (both by the Oxford University Press, 1928) ; Henri Dupré, *Purcell* (Eng. trans., Knopf, New York and London, 1929) ; the life by Dr. W. Cummings in the *Great Musicians* series (1903) remains a standard work.

PURCHAS, SAMUEL (1575?–1626), English compiler of works on travel and discovery, was born at Thaxted, Essex, and studied at St. John's college, Cambridge, and at Oxford. In 1604 he was presented by James I. to the vicarage of Eastwood, Essex, and in 1614 became chaplain to Archbishop Abbot and rector of St. Martin's, Ludgate, London. Purchas died in Sept. or Oct. 1626, according to some in a debtors' prison. As an editor and compiler he was often injudicious, careless and even unfaithful; but his collections are often the only sources of information upon questions affecting the history of exploration. His works include: *Purchas, his Pilgrimage; or, Relations of the World and the Religions observed in all Ages* (1616); *Purchas, his Pilgrim. Microcosmus, or the histories of Man. Relating the wonders of his Generation, vanities in his Degeneration, Necessity of his Regeneration* (1619); *Hakluytus Posthumus or Purchas his Pilgrimes, contayning a History of the World in Sea Voyages and Lande Travells, by Englishmen and others (4* vols., 1625).

PURCHASE, in its common sense, that which is acquired by the payment of money or its equivalent. The term was early used by the lawyers (*e.g.,* Britton, in 1292) for the acquirement of property by means other than inheritance or mere act of law, including acquirement by escheat, prescription, occupancy, alienation and forfeiture; more generally, purchase in law means acquisition of land by bargain or sale, according to the law of "vendor and purchaser." *(See* CONVEYANCING.) A later meaning is the mechanical contrivance by which power can be used, a hold or fulcrum. This first appears (16th century) in the nautical use of the verb, to haul up a rope or cable, that is, to "gain" advantage over the rope bit by bit.

PURDAH, the curtain which screens women from the sight of men in Eastern countries; a *purdah-nashin* is a woman who sits behind the curtain (Pers. *parda).* In Anglo-Indian usage, to "lift the purdah" means to reveal a secret.

PURE LINE. A pure line consists of a self-fertilized individual and its progeny; it is a group of individuals all possessing the same hereditary constitution, in which all the factors are present in duplicate. Until Johannsen studied the effects of selection on the weights of individual seeds of the Princess bean there was no general explanation of the manner in which this process operates *(see* BREEDS AND BREEDING; INBREEDING; ANIMAL BREEDING; GENETICS ; HEREDITY ; MENDELISM and SELECTION, *Artificial Selection).*

See W. Johannsen, *Ueber Erblichkeit in Populationen und in reinen Linien* (1903).

PURGATORY, according to Roman Catholic faith, a state of suffering after death in which the souls of those who die in venial sin, and of those who still owe some debt of temporal punishment for mortal sin, are rendered fit to enter heaven. It is believed that such souls continue to be members of the Church of Christ; that they are helped by the suffrages of the living — that is, by prayers, alms and other good works, and more especially by the sacrifice of the Mass; and that, although delayed until "the last farthing is paid," their salvation is assured. Catholics support this doctrine chiefly by reference to the Jewish belief in the efficacy of prayer for the dead (2 Macc. xii. 42 *seq.),* the tradition of the early Christians, and the authority of the Church.

The state of Purgatory is usually thought of as having some position in space, and as being distinct from heaven and hell; but any theory as to its exact latitude and longitude, such as underlies Dante's description, must be regarded as imaginative. Most theologians since Thomas Aquinas and Bonaventura have taught that the souls in purgatory are tormented by material fire, but the Greeks have never accepted this opinion. It must be inferred from the whole practice of indulgences as at present authorized that the pains of purgatory are measurable by years and days; but here also everything is indefinite. The Council of Trent, while it commands all bishops to teach "the sound doctrine of purgatory handed down by the venerable fathers and sacred councils," bids them exclude from popular addresses all the "more difficult and subtle questions relating to the subject which do not tend to edification."

The Eastern Church affirms belief in an intermediate state after death, but the belief is otherwise as vague as the expressions of the pre-Nicene fathers on the subject. The Longer Catechism of the Orthodox Church (Q. 376) states: —

"Such souls as have departed with faith but without having had time to bring forth fruits meet for repentance may be aided towards the attainment of a blessed resurrection by prayers offered in their behalf, especially such as are offered in union with the oblation of the bloodless sacrifice of the Body and Blood of Christ, and by works of mercy done in faith for their memory."

The efficacy of prayers for the dead, and indirectly the doctrine of purgatory, were denied by early Gnostic sects, by Aëtius in the 4th century, and by the Waldenses, Cathari, Albigenses and Lollards in the middle ages. Protestants, with the exception of a small minority in the Anglican communion, unanimously reject the doctrine of purgatory, and affirm that "the souls of believers are at their death made perfect in holiness and do immediately pass into glory." Rejection of an intermediate state after death follows the Protestant idea of justification by faith as logically as the doctrine of purgatory results from the Catholic idea of justification by works.

An analogy to purgatory can be traced in most religions. Zoroaster conducts souls through twelve stages before they are sufficiently purified to enter heaven; and the Stoics conceived of a middle place of enlightenment which they called ἐμπύρωσις.

BIBLIOGRAPHY.—The principal authoritative statements of the Catholic Church on the doctrine of purgatory were made at the Council of Florence *(Decret. unionis),* and at that of Trent (Sess. vi. can. 30; Sess. xxii., c. a, can. 3; Sess. xxv.). *See* H. J. D. Denziger's *Enchiridion;* J. Bautz, *Das Fegfeuer* (Mainz, 1883) ; and L. Redner, *Das Fegfeuer* (Regensburg, 1856). A very elaborate treatise from the Catholic standpoint is that of Cardinal Bellarmine, *De purgatorio.* The subject is discussed, moreover, in all major works on dogmatic theology. There is a representative Catholic statement in the *Catholic Encyclopaedia,* and *a* Protestant presentation by Rud. Hoffmann in Herzog-Hauck's *Realencyklopädie,* 3rd ed. vol. v. pp. 788–792.

PURI or **JAGANNATH,** a town and district of British India, in the Orissa division of Bihar and Orissa. The town is on the seacoast, and has a railway station. Pop. (1931) 37,568. As containing the world-famous shrine of Jagannath *(see* JUGGERNAUT), Puri is perhaps the most frequented of all Hindu places of pilgrimage; of recent years also it has won some popularity as a seaside health resort. The great temple of Jagannath was built in the 12th century by Choda Ganga, the greatest of the Eastern Ganga kings of Kalinganagara (Ganjam).

The DISTRICT OF PURI has an area of 2,492 sq.m. and a population (1931) of 1,035,154. Most of the country is flat. The middle and eastern divisions of the district, forming the southwestern part of the Mahanadi delta, consist entirely of alluvial plains, watered by a network of channels through which the most southerly branch of that river, the Koyakhai, finds its way into the sea. The other rivers are the Bhargavi, the Daya and the Nun, all of which flow into the Chilka lake. During the rainy season the rivers come down in floods, sometimes bursting their banks and carrying everything before them. The Chilka lake is one of the largest in India; its length is 44 m., and its mean breadth 13 m. in the north and 5 m. in the south. It is separated from the sea only by a narrow strip of sand. The lake is saline and everywhere very shallow, its mean depth ranging from 3 to 5 feet.

Puri first came under the British in 1803. Later events were the rebellion of the maharaja of Khurda in 1804 and the rising of the paiks or peasant militia in 1817–18. In the Orissa famine of 1866 more than one-third of the population is said to have perished. The district is served by the Bengal Nagpur railway which was opened throughout from Calcutta to Madras in 1891, with a branch to Puri town.

Puri district is rich in historical remains, from rock-hewn caves to the magnificent mediaeval shrines at Bhubaneswar and Konarak. On a hill at Dhauli, 4 m. S.W. of Bhubaneswar, are rocks with edicts inscribed by Asoka in the 3rd century B.C. and an elephant carved out of the solid rock, the oldest carving of an elephant known in India. In the hills of Udayagiri and Khandagiri are Jaina caves hewn out of the rock, and some (such as the Rani Gumpha or queen's palace) profusely carved, between the 3rd and 1st centuries B.C. The greatest architectural glory of the district is its collection of temples built between the 8th and 13th centuries A.D. Bhubaneswar is crowded with Saiva shrines of which the largest is the Lingaraj, while the Raja Rani temple has been described by Fergusson as one of the gems of Orissa art. More magnificent, even in its ruin, is the sun-god's temple of Konarak, of which Sir John Marshall writes: "There is no monument of Hinduism, I think, that is at once so stupendous and so perfectly proportioned."

PURIFICATION. Purification denotes the processes employed to prepare individuals or communities for contact with persons or things otherwise dangerous, or to prevent the consequences of contact with such persons or things. To deal first with the latter aspect, a man may unwittingly violate a tabu and such is the sense of social solidarity that the whole community feels itself menaced with calamity. He must be purified. The society must be protected. All conditions of diminished social activity on the part of an individual are dangerous. (*Andaman Islanders*, p. 303.) Thus, "among most or all African tribes a sin, wrong doing or breach of custom is not merely a matter demanding punishment or redress but it imparts a bane or evil influence which remains unless the necessary purification follows. The point to be emphasized is that this mysterious force affects not the evildoer but the person injured, so that it is he who must be purified. For instance, a man who is wounded is purified by the one who wounded him." (C. Dundas, Kilimanjaro and its People, 1924, p. 155.) Contact with persons and things possessing this dangerous potency is often essential. In this sense cleanliness is very close to godliness. In general food is regarded as something that may only be approached with ritual precautions. (*Andaman Islanders,* p. 273.) The savage must come to his meals clean. Primitive communities insist on the purification of the successful warrior. (*Andaman Islanders,* p. 133; *Ila* Speaking Peoples, I., 179; Akamba 198, see note; *The* Sema *Nagas,* p. 175; and *42nd Annual* Report, Bureau of American Ethnology, p. 423.) The sacrificial priest must be purified before he touches the holy object. He must be purified again when the rite is over.

It is evident that the dangerous qualities whose effect has to be neutralized are in one aspect of a spiritual nature and that intention, motive, purpose are not essential elements. The automatic effect of a breach of the law gives strength to the social order since, where the results of sin may affect all or any of the members of the society it is the business and interest of each man to keep the law and to see that his neighbour keeps it.

Whenever and wherever sin has come to be viewed as a breach of a divine order, punished by the Divinity, a judge of the heart of man, a just judge, motives and purposes assume importance. Purification is here directed to the conscience. The preventive action of the rites of purification comes in course of time to include deep, permanent modifications of the personality of the sinner, so that he sins no more. Coercion comes from within and is self-determined. See Bibliography to article ANTHROPOLOGY.

PURIM, a Jewish festival on Adar 14 and 15, to commemorate the deliverance of the Jews from Haman, the minister of Ahasuerus (Artaxerxes?), as related in the book of Esther (lit. lots, Heb. פור, Esther iii. 7; ix. 24, 26, possibly from Assyrian *puru,* stone or Vedic *pûrti,* portion): so called from the lots cast by Haman to determine an auspicious day for the massacre. The origin of the festival is much disputed: some hold that it developed from a primitive spring festival because (a) it is celebrated just before the advent of the New Year in *Niṣṣan* and that the preliminary fasting was actually ordained in Esther iii. 7; iv. 16 for *Niṣṣan.* But the fasting is a later institution (on this see Jew. *Enc.,* x. 278); (b) the feast is secular rather than religious: it has all the characteristics of a spring carnival including the ironical crowning of the buffoon-king or vegetation-god who was put to death after mockery (*cf.* Frazer, *Golden* Bough, ed. ii., vol. iii, pp. 154). S. Langdon (Bab. Epic of Creation, 1923, pp. 28, 33, etc.) traces a similar festival to Marduk (cf. Mordecai; Ishtar-Esther?) during *Niṣṣan,* with the mystic ceremony of the death and resurrection of *Bêl,* from primitive times in Babylonia. Zimmern (see refs. in Langdon) drew a parallel with the leading features in the scourging and death of Jesus. But the Jewish beating of Haman or burning of his effigy is late and clearly borrowed from mediaeval carnival customs, probably in the 13th century. On the contrary, during the synagogal reading of the book of Esther the reader hurries over the execution of the ten sons of Haman (Esther ix. 7–10), pronouncing them in one breath. This goes back to the Talmud (Neg. 16 b) and is ordained (1) to denote their simultaneous death and (2) to avoid gloating over a fallen foe. If Purim were purely a Babylonian feast, the Jews of Palestine and Egypt would hardly have accepted or retained it long after their connection with the Persian Empire ceased, whereas Purim has always been most popular. (c) On the other hand, there are features in the Jewish liturgy which strongly suggest a secular origin and it is most likely that this festival, first secular and national, ultimately became sanctified and was made a religious occasion. The growth of this process may be traced in the service. The name of God is absent from the *Megillah* and various devices of the scribe make good the deficiency, *e.g.,* when the letters of the Tetragrammaton occur close together they are crowned or written large: in iv. 14 "another place" is interpreted of God because "place" (*Maqōm*) is used in this way. The only religious allusions in the book are iv. 16 and ix. 31. The scroll is called *'Iggereth* or letter (ix. 26 and 29) and the reader folds the scroll so as to make it resemble a letter and holds it aloft when he recites the word "letter" in the verses just named. This tends to mark the lower or secular category of the book, *i.e.,* it is classed as an "Epistle" rather than as a "Gospel." For the service itself see Singer's *Authorized* Daily Prayer Book, p. 276 (and p. ccvi. of annotated ed.), where the alphabetical poem (אֲשֶׁר הֵנִיא) may be noted.

A characteristic of Purim and the book of Esther often overlooked is its similarity to the Euripidean drama. A cardinal feature is the punishment of ὕβρις. Purim plays are frequent, by Christian (*e.g.,* Racine) as well as by Jewish authors.

BIBLIOGRAPHY.—W. Nowack, Hebr. *Archäologie,* ii. 194, foll. and refs.; S. Jampel *Das* buch Esther, 1907; P. Haupt, Book of Esther (1908). On Effigies of Haman, L. Ginzberg, Geonica ii.; I. Davidson, Parody in Jew. Lit. (1908); M. Steinschneider, Purim *u.* Parodie, 1902; generally I. Abrahams, Purim in his Jewish Life (various edns.). For illustrations and for fuller details see Jew. *Enc.* (various articles cited under Purim); Hastings' E.R.E.

PURINES. The purines comprise a large group of nitrogenous compounds, a few of which occur widely distributed throughout nature. They derive their name from the fact that they can be regarded as derived from one substance, purine itself. This name was coined by the German chemist, Emil Fischer, from the two Latin words *purum* and *uricum,* the latter being chosen because the best known purine at that time, uric acid, occurs in urine. Fischer named this compound and pointed out its relation to known purines about 14 years before he actually prepared it in the laboratory.

Of the several hundred purines known, only 12 have been isolated from natural sources. All other purines are synthetic products and are only of academic interest. The following discussion will be limited almost entirely to eight of these purines which occur widely distributed throughout nature, namely, uric acid, guanine, adenine, xanthine, hypoxanthine, caffeine, theobromine and theophylline.

THE INDIVIDUAL PURINES

Uric Acid.—This was the first purine known, being discovered in human urinary calculi by the Swedish chemist Scheele in 1776. Scheele made careful investigations of its reactions and properties, these results being still used to identify uric acid. Thirty years later it was found that uric acid occurred in guano, and still later it was found that birds' excrement consisted largely of uric acid. Guano consists of the excrement of certain South American sea birds, which, with the help of a dry climate, has been accumulating for untold years. By far the best source of uric acid, however, is the excrement of serpents, which consists of over 95% of uric acid combined with small amounts of potassium and ammonia. It is only necessary to dissolve snakes' excrement in dilute alkali, filter, and reprecipitate with mineral acid.

Uric acid, however, occurs in other ways. As the mono-sodium salt it is the substance precipitated in body tissues in cases of gout, and is responsible for the formation of the gouty nodules with the subsequent inflammation and irritation which characterize this disease. Uric acid also occurs normally in the blood of man and other animals. In man the blood normally contains less than 0·1 mg. per cu. cm. Uric acid confines itself to the animal kingdom, although other purines are common as plant products.

The following table (Givens and Hunter) shows the variation in the relative amounts of allantoin, uric acid and bases (other purines) excreted in the urines of different species of mammals.

Order and Species.	*Allantoin*	*Uric acid*	*Nitrogen (%) present as Bases*
Marsupialia:			
Opossum	76·0	19·0	6·0
Rodentia:			
Guinea-pig	91·0	6·0	3·0
Rat	93·7	3·7	2·7
Ungulata:			
Sheep	64·0	16·0	20·0
Goat	81·0	7·0	12·0
Cow	92·1	7·3	0·7
Horse	88·0	12·0	0·5
Pig	92·3	1·8	5·8
Carnivora:			
Raccoon	92·6	5·4	2·0
Badger	96·9	1·9	1·2
Dog	97·1	1·9	1·3
Coyote	95·6	2·6	1·8
Primates:			
Monkey	66·0	8·0	26·0
Man	2·0	90·0	8·0

Man stands out as eliminating 90% of his purine-allantoin nitrogen in the form of uric acid, this proportion being 11 times as much as the monkey, which is biologically his closest relative. Too much importance must not be attached to the biological significance of this, however, as the ratio is known to vary considerably, even within a species.

The origin of uric acid as an excretory product has long been a matter of interest. According to A. P. Mathews (*Physiological Chemistry*, New York, 1915), the reason for the excretion of protein nitrogen in the form of uric acid rather than urea by birds and reptiles, is to be ascribed to their environment during evolution. The birds were evolved from the reptiles, and the reptiles were probably evolved in a dry, arid region, as indicated by other body characteristics. Urea is very soluble in water, and has a great affinity for it, whereas uric acid is insoluble, with no affinity for water, so that the excretion of nitrogen as uric acid rather than urea, saves much water for the organism, and would be an important adaptation in a region comparatively devoid of water.

In man the excreted uric acid may be divided into two varieties, the endogenous and the exogenous uric acid. The endogenous uric acid, about 0.4 grams a day, is very nearly constant for a given individual, but varies slightly in amount in different persons. It represents the uric acid which is formed in the body by synthesis and by the breakdown of nuclear tissue. On a diet which is free from purines, it is independent of the amount of fat, carbohydrate, protein or number of calories ingested. It is thought to originate from the oxidation of the hypoxanthine constantly formed in muscle and other tissues.

The exogenous uric acid is that formed by the oxidation of purines taken in as part of the food, chiefly in meat. All meat. and particularly glandular meat such as liver and sweetbreads, contains varying amounts of nucleic acid, which contains about 20% of the purines guanine and adenine. In the body these two substances are changed, by means of enzymes, into two other purines, xanthine and hypoxanthine, which are both oxidized to uric acid. The amount of exogenous uric acid depends, then, on the purine intake. Furthermore, it has repeatedly been shown that uric acid and other purines, injected hypodermically into the body, can be recovered nearly quantitatively in the urine.

Man excretes ingested purines almost entirely as uric acid, although other mammals excrete theirs almost entirely as allantoin, because the human body is lacking in a specific enzyme, uricase. which oxidizes uric acid to allantoin. The small amount of allantoin excreted by the human is probably preformed in the food. In the livers and other organs of animals which excrete allantoin, we find varying amounts of uricase, and if these organs are ground up and digested with uric acid, it is oxidized to allantoin. Different animals apparently differ in the efficiency with which this reaction is performed.

When the uric acid metabolism is disturbed, for reasons which are not as yet understood, the uric acid output in the urine is lowered. As the individual constantly ingests more purine, the result is that it is stored up. At first this storage takes place in the blood, but owing to the very low solubility of uric acid and its mono-sodium salt, only a limited amount can be held in this way. The excess crystallizes out, mainly in the cartilages and joints, as acid sodium urate, and the irritation resulting from these deposits is known as gout. It is evident that a gouty person should avoid foods which contain purines, such as meat, and confine his protein diet to such foods as milk and eggs, which are virtually purine free.

Guanine and Nucleic Acid.—Guanine, one of the two amino-purines occurring in nature, takes its name from the fact that it was discovered in guano, by B. Unger in 1845. Since that time, however, it has been found widely distributed throughout the animal and plant world. It occurs in the scales and skin of the bony fishes, and in the swim bladders, to which it gives their characteristic pearly appearance. It also is the chief constituent of the excrement of spiders. Human and pig urine contain small amounts of guanine. By far its most important occurrence, however, is in organs rich in cells, such as the pancreas, liver, spleen, testicles, etc., in animals, and in the germ cells of plants. It occurs here as a constant constituent of nucleic acid, of which it constitutes about 10%.

Nucleic acid, a compound occurring in the nuclei of all cells, is built up from four molecules of phosphoric acid, four of sugar. two of pyrimidines, and one each of guanine and adenine. When taken into the body as food, the guanine and adenine are eventually excreted as uric acid. These changes are brought about by the action of enzymes, which eventually break the nucleic acid up into its component molecules. The guanine is then changed by an enzyme, guanase, into its corresponding oxygen derivative, xanthine, which is then oxidized by an enzyme, xanthine oxidase, to uric acid.

It is an extremely interesting fact that in the pig the organs are entirely lacking in guanase; it is thus impossible for it to change guanine into allantoin, and consequently the pig frequently suffers from a form of gout, similar in all respects to that in humans, except that the deposit in the joints consists of crystalline guanine instead of acid sodium urate.

Adenine. — Adenine and guanine are the only two amino-purines, and differ from one another by only one atom of oxygen, guanine being an oxidized adenine.

Adenine, discovered by A. Rossel in 1884 among the hydrolytic products of pancreatic nucleic acid, is found in all glandular tissues, which are rich in nucleins. In addition, it occurs free in the leaves of plants, for example tea leaves and alfalfa leaves. It has also been found combined with sugar in the blood stream.

Adenine, like guanine, is one of the chief contributors to the uric acid and allantoin output of mammals. After the enzymic cleavage of the nucleic acid there are two special enzymes to take care of the adenine. One of these, adenase, replaces the amino-group by an hydroxyl, giving hypoxanthine. Another enzyme, an oxidase, oxidizes the hypoxanthine to xanthine, which is further metabolized as in the case of guanine.

Xanthine.—This purine, first discovered by Marcet, in 1817, in a urinary stone, derives its name from the Greek word, *xanthos*, meaning yeiiow. when it is evaporated in a dish with HNO_3, a yellow spot remains. Xanthine occurs widely distributed in animal and plant matter, wherever guanine is found, being probably derived from guanine by enzymic and putrefactive processes.

Hypoxanthine **(Sarcine).**—Hypoxanthine is a reduced xanthine, which was discovered by Scherer in 1850 in an extract of spleen. In general, it may be found in all nuclear tissues, and is probably there as a decomposition product of adenine, from which it is derived by the substitution of an hydroxyl by an amino-group. This change is brought about by the enzyme, adenase, as a result of either normal degradation or putrefactive processes. It is also found in small amounts in bone marrow.

Caffeine or **Theine.**—These two names are applied to a well-known purine discovered in 1820 in tea leaves by Ferdinand Runge. Caffeine is found only in vegetable matter, occurring to the extent of 0·8–1·7% in coffee beans, 0·1–0·8% in cocoa beans, 1–2% in Kola nuts, 2–5% in tea leaves, and 2·5–5% in guarana, the roasted fruit of *Paullinia,* which is eaten in South America. It is this purine, along with theobromine and theophylline, which gives the stimulating effects to drinks made from the above sources.

Caffeine has the notable effect of stimulating the central nervous system. In addition it is a cardiac tonic, and, in common with nearly all purines, has a strong diuretic action. In the body it is oxidized to uric acid and excreted as such. There is a tendency among many medical practitioners to warn patients to do without tea and coffee. In certain cases there are undoubtedly very good reasons why caffeine is harmful. For example, in the case of a person suffering with gout, everything must be done to lower purine ingestion, and thus to lessen the load on the already over-burdened kidneys. Specially prepared brands of tea or coffee are available from which caffeine has been removed without any alteration of taste. In the case of tea this is done by extracting the leaves with light petroleum to remove the volatile oils which are responsible for the flavour. The caffeine is then removed by extraction with chloroform, after which the original petroleum extract is added to the leaves and the solvent allowed to evaporate, thus restoring to the tea its original flavour. Green coffee beans are treated with live steam and ammonia gas to swell them, the caffeineis then chloroform processed, and the beans subsequently roasted.

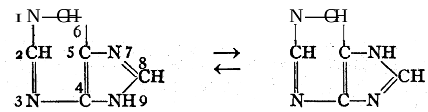
Theobromine.—This purine is unfortunately named, for it is devoid of bromine. It was noted first by A. Woskresensky, in 1842, in an extract of cocoa beans, where it occurs to the extent of 1·5–2·4%. This bean is the seed of the plant *Theobroma Cacao* hence the name theobromine. As in the case of caffeine and theophylline, it occurs only in plant matter, being present in the kola nut and in tea leaves, but not in coffee beans. It is a powerful diuretic, and in the body is oxidized to and excreted as uric acid.

Theophylline.—In 1888 A. Kossel discovered very small traces of this purine in tea extract.

Paraxanthine, Heteroxanthine, **1-Methylxanthine** and Epiguanine have all at one time or another been isolated from human urine. They are regarded as secondary products, arising from the action of the body on caffeine (*see* p. 780).

THE CHEMISTRY OF THE PURINES

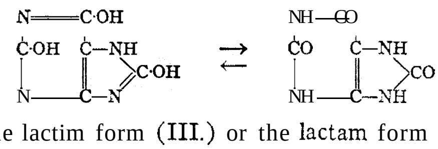
Purine has the empirical formula, $C_5H_4N_4$, the atoms being joined together according to one or other of the following structural schemes:

I.  II.

In order to endow the many purines with names which may at once be distinctive and descriptive, each atom in the purine ring is given a number, as indicated in formula I.

It will be noted that, as the arrows indicate, purine is a mixture of two substances which readily pass from one to another. This mutation is known as tautomerism (*q.v.*). In purine, one of the hydrogen atoms is labile and can pass from the nitrogen atom at 7 to the nitrogen at 9, and vice versa. Any of the four hydrogen atoms in purine may be substituted by any of a large number of groups, the most important being the hydroxyl group (OH), amino- (NH_2), chlorine (Cl), and methyl (CH_3) groups.

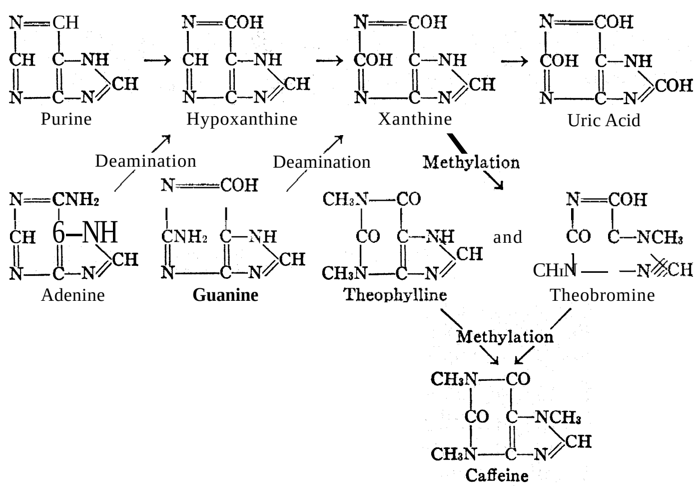
A substitution on nitrogen in either the 1 or 3 position is only possible when the hydrogen at either or both of the 2 and 6 positions is substituted by an hydroxyl. For instance, uric acid (2:6:8-trihydroxypurine) is a tautomeric substance, existing

III.  IV.

either in the lactim form (III.) or the lactam form (IV.). As a lactim uric acid yields salts with metals, the hydrogen on oxygen being replaceable. The lactam form explains why substitution occurs on the 1 and 3 nitrogen atoms.

The following diagram explains the relationships existing between the purines. Starting with purine, and successively substituting hydroxyl groups for the hydrogen atoms attached to carbon, hypoxanthine, xanthine and uric acid are obtained, these being the mono-, di- and tri-hydroxypurines respectively. Similarly, adenine is a mono-aminopurine and guanine is a mono-aminohypoxanthine.

Uric Acid. — This dibasic acid is a white, finely crystalline substance, insoluble in water and all organic solvents. Alkaline salts of weak acids, such as potassium phosphate, sodium acetate, and particularly lithium carbonate, increase the solubility in water owing to the fact that these salts all form alkaline solutions, and the sodium salt of uric acid is much more soluble than the free acid. (Lithium salts have been used in the treatment of gout on the erroneous assumption that, lithium urate being more soluble



than sodium urate, the uric acid would be eliminated more quickly.) Uric acid, when heated, decomposes into ammonia, carbon dioxide, urea and cyanuric acid. It is unstable and decomposes if left in moderately strong alkali for any length of time. Uric acid is identified by the "murexide" reaction. The suspected substance is evaporated to dryness with nitric acid; if uric acid is present this leaves a yellow spot which when moistened by ammonia turns purple, due to ammonium purpurate formed.

Although uric acid was discovered in 1776, its structural formula was not investigated until 1875, when L. Medicus proposed the formula which has since been established by numerous syntheses.

Guanine is a white amorphous powder, insoluble in water and organic solvents. It is a much weaker acid and stronger base than uric acid. It is, however, such a weak base that ammonia will precipitate it from solution. Owing to the hydroxyl group on carbon, it will dissolve in strong bases, such as sodium hydroxide. The amino-group present in its structure makes it soluble in acids, and thus separable from uric acid. Silver nitrate precipitates guanine in either neutral or alkaline solution, and forms double salts with guanine nitrate. The nitrate is insoluble in strong nitric acid. If treated with nitrous acid, or digested with the enzyme guanase, the amino-group is replaced by hydroxyl giving xanthine.

Adenine crystallizes from water in clusters of leaflets which contain $3H_2O$. When anhydrous it melts at 360–365° F; it is a stronger base than guanine, and hence is not precipitated by ammonia, this difference affording a separation of the two bases. Like guanine, it is precipitated by phosphotungstic or picric acid, the picrate forming beautiful silky yellow needles. Nitrous acid, or the enzyme adenase, decomposes adenine, the resulting replacement of amino- by hydroxyl giving hypoxanthine. Adenine is stable to weak oxidizing agents, but unstable to even mild reducing agents. At 200° F hydrochloric acid decomposes it completely to carbon dioxide, ammonium formate and glycine acid.

Xanthine, a white crystalline substance forming salts with both strong acids and bases, occurs in nature but is best prepared by the action of nitrous acid upon guano. When heated dry it decomposes into carbon dioxide, ammonia and hydrocyanic acid.

Hypoxanthine occurs as small colourless needles, soluble in both acids and bases. Its hydrochloride crystallizes with one molecule of water. The picrate is very insoluble, and can be used to remove hypoxanthine from solution. This purine is not precipitated by ammonia and is a strong enough acid to decompose carbonates. Hypoxanthine is obtained from adenine by deamination with nitrous acid or adenase.

Theophylline, like theobromine, is a weakly basic substance. Upon oxidation with hydrochloric acid and potassium chlorate it gives dimethylalloxan, in contrast to xanthine, hypoxanthine and uric acid, which give alloxan. When methylated, theophylline and theobromine give caffeine.

Theobromine, an isomeride of theophylline, occurs as colourless needles having a very bitter taste. It is prepared by the methylation of the lead salt of xanthine. Oxidation with hydrochloric acid and potassium chlorate gives methylalloxan and methylurea, whilst boiling with baryta produces methylamine, ammonia, carbon dioxide, formic acid and methylglycine.

Caffeine crystallizes with one molecule of water in beautiful, glistening needles, having a slightly bitter taste. They are sparingly soluble in cold water and alcohol, and soluble in chloroform. It is most conveniently prepared by the extraction of tea. Upon oxidation with hydrochloric acid and potassium chlorate it gives dimethylalloxan, methylurea and carbon dioxide. In the body, caffeine undergoes a number of changes, being excreted as uric acid and four other purine bases mentioned earlier.

BIBLIOGRAPHY.—E. Fischer, *Untersuchungen in der Puringruppe* (Berlin, 1907) (This book is highly technical organic chemistry, and is unintelligible to the layman.); G. Lusk, *The Science of Nutrition* (Philadelphia and London, 1921). (R. de W. C.)

PURITANISM. The name Puritan, "would-be purifier," was applied in England about 1564 to groups who disapproved of Queen Elizabeth's choice of a middle path between Rome and Geneva, and sought further purification of the Church of England. Originally scornful, Puritan has become, particularly in New England, a term of honor.

The initial principles of Puritanism were brought to England from Zurich or Geneva by English Protestant refugees. There was frequent objection to the surplice as not expressly authorized in Scripture; to this "vestiarian controversy," succeeded in 1570–72 the second stage of Puritan agitation, the strife over Church polity. Thomas Cartwright, spokesman of the party which wished to reform the Church of England from within, on the Presbyterian model, found no warrant in the Bible for prelacy. Archbishop Whitgift vigorously opposed this movement, as he did the Separatist movement led by Robert Browne.

James I rejected the Millenary Petition, a syllabus of Puritan requests, and demanded that the Puritans conform or be harried out of the land. By 1610 most of the opponents of the growing Stuart tendency toward autacracy found in political Puritanism a rallying-point against tyranny. A generation later the Grand Remonstrance accused the party of Charles I and Archbishop Laud of plotting to expel the Puritans. Civil war ensued.

The Solemn League and Covenant (1643) led to the attempt to reform the Church of England on the Scottish model; but Cromwell successfully opposed the plan. Charles II's Act of Uniformity (1662) threw nearly two thousand Puritan clergymen out of their benefices.

The Restoration reopened the theatres and took many a fling at the Puritans, the classical attack being Butler's *Hudibras:* low-born, sour-faced hypocrites, jealously disapproving the pleasures of their superiors. Puritanism, however, was never a mere class movement: many great noblemen and statesmen were Puritans as were most of the wealthy merchants. London and the University of Cambridge were strongholds of Puritanism. The ethical standards of later Puritanism, seen in Perkins and in Baxter, were deduced from the detailed injunctions of Scripture. The economic life on both sides of the Atlantic has been deeply influenced by Puritan discussions.

Seventeenth-century Puritanism diverged at a number of points from continental Calvinism, particularly because of the publication in 1595 of Robert Bounde's treatise on Sabbath observance. Puritanism influenced Pietism in Holland and in the Empire; and many emphases survived in the Methodist and in the Evangelical movement. New England gave the first opportunity for putting the Puritan theories into practice; there an earnest effort was made to model legislation on Scripture.

Posterity tends to misrepresent Puritan standards. Very few Puritans were total abstainers from alcoholic beverages. They did not hate art, and when they had power, as in 1644, did not smash all "images," but spared effigies of statesmen and others not likely to be worshipped. Cromwell himself patronized painters, and loved athletic games, fast horses, and music.

G. W. Prothero, *Select Statutes*, 4th ed. (Oxford, 1913); S. R. Gardiner, *Constitutional Documents of the Puritan Revolution,* 3rd ed. (Oxford, 1906); J. Crouch, *Puritanism and Art*, London, 1910; J. S. Flynn, *The Influence of Puritanism*, London, 1920; R. H. Tawney, *Religion and the Rise of Capitalism*, London, 1926; R. Bronkema, *The Essence of Puritanism* (thesis, Univ. of Amsterdam), 1929. (W. W. R.)

PURLIN, in architecture, the longitudinal timbers of a roof, carried by the principal rafters or trusses and the end walls, and supporting the common rafters.

PURNEA, a town and district of British India, in the Bhagalpur division of Behar and Orissa. The town is on the little river Saura, with a railway station. Pop. (1931) 15,474.

The DISTRICT OF PURNEA has an area of 4,972 sq.m. and a population (1931) of 2,186,543, extending from the Ganges northwards to the frontier of Nepal. It is a level tract of country, traversed by several rivers flowing from the Himalayas, the greatest of which is the Kosi, which has been known to move 20 m. in 25 years, leaving behind it a trail of sterile sand. The principal crops are rice, pulses and oilseeds. The cultivation of indigo has declined, but that of jute has greatly increased. Branches of Eastern Bengal State railway join the Bengal and North-Western railway at Katihar, which is a rapidly growing town with 15,864 inhabitants. Kishanganj (pop. 5,939) is the centre of the jute trade and is a branch terminus of the Darjeeling-Himalayan railway.

PURPLE, a shade varying between crimson and violet. Formerly it was used of the deep crimson colour called in Latin purpura, from the name of the shellfish (Purpura) which yielded the famous Tyrian dye. Tyrian purple during many ages was the most celebrated of all dyed colours, and possibly the first to be permanently fixed on wool or linen. Being extremely costly, robes of this colour were worn as a mark of imperial or royal rank, whence the phrase "born in the purple." In the Roman Catholic church "promotion to the purple" is promotion to the rank of cardinal.

The ancients derived their purple from the mollusc, Purpura *haemastoma,* known to Pliny as "Buccinum," and Murex bran*daris,* termed by Pliny "Purpura," the shells of which have been found adjacent to ancient dyeworks at Athens and Pompeii. The colour-producing secretion is contained in a small cyst adjacent to the head of the animal, and this pus-like matter when spread on textile material in presence of sunlight develops a purple-red colour. According to Pliny these receptacles after being laid in salt were boiled with water for several days, the liquor being tested from time to time as to its dyeing properties. Before dyeing the wool could be grounded with a second colouring matter. for which purpose alkanet root (*Anchusa tinctoria*) and "orchil" were employed. Friedländer has shown that the dye developed from the molluscs is 6:6′-dibromoindigotin. (A. G. P.)

PURPURA, a pathological condition in which blood leaves the smaller blood-vessels and is deposited in the tissues in patches, which, if minute, are termed "petechiae," if large, "ecchymoses." The condition depends upon an alteration of the blood itself, particularly the blood-platelets; coagulation time is prolonged and the plasma often contains haemoglobin that has left the red blood corpuscles owing to disturbance of their normal relations. Probably these modifications act on the endothelial walls of the capillaries and venules and lead to changes in them also. In the main the haemorrhages constituting purpura occur beneath free surfaces such as skin, mucous and serous membranes and are there most visible but they also occur in the substance of organs and bleeding may occur in dangerous quantity from nose, mouth, bowel, kidney, etc. Blood effused into the tissues undergoes subsequent changes like those seen in a receding bruise.

The clinical causes of purpura are various. Following snakebite, or the administration of such drugs as copaiba and belladonna, or the onset of jaundice, it seems to be caused by the action of a chemical poison and probably the same is true when it accompanies acute infectious fevers (*e.g.,* severe forms of scarlet fever and small-pox), heart disease, especially ulcerative endocarditis, and some forms of Bright's disease. It is a short step from this to invoking a chemical poison of microbial origin in those forms of purpura which are associated with articular or rheumatic pain or even constitute apparently the substantive disease, but of this there is, as yet, no proof. From the fact that haemorrhage is present in both instances purpura has many clinical resemblances to haemophilia (*q.v.*) and the two morbid conditions may often have been confused. Probably similar blood changes occur in both, but they appear to be distinct diseases.

Treatment is that of any underlying condition, but astringents (such as iron, gallic acid), may be required in severe cases. Sir A. Wright holds that in all cases of purpura the coagulation time should be determined and if prolonged, calcium should be given internally. In severe haemorrhage adrenalin is often useful.

See H. L. Tidy, "The Haemorrhagic Diathesis," *Brit. Med. Jn.* 1928; 583. (W. S. L.-B.)

PURRAH, PURROH or **PORO,** a secret society of Sierra Leone, West Africa. Only males are admitted to its ranks while the Bundu is strictly reserved to women.

The Purrah had its special ritual and language, markings and symbols and exercised authority by the imposition of tabus which were enforced by various methods. In 1897 the British local government was compelled to pass a special ordinance absolutely forbidding the imposition of the tabu on all indigenous products.

See T. J. Alldridge, *The Sherbro and its Hinterland* (1901); N. W. Thomas, *Anthropological Report on Sierra Leone,* Part I. (*Law* and *Custom* of *the* Timne and other tribes).

PURSH, FREDERICK (1774–1820), American botanist, was born at Tobolsk, Siberia, in 1774. He received his education in Dresden, Germany. In 1799 he went to the United States where he devoted 12 years to botanical exploration and the scientific study of North American plants. In 1811 he visited England and in 1814 he brought out in London his important Flora *Americae* Septentrionalis. He then returned to the United States and resumed his botanical investigations. On one of his solitary tours afoot he discovered the hart's-tongue (*q.v.*), one of the rarest of the ferns found in North America. Pursh's original contributions regarding the plants of the north-eastern United States, rank among the most valuable made by early American botanists. While collecting materials for a flora of Canada he died suddenly at Montreal on June 11, 1820. (See BITTERROOT.)

PURSLANE, the common name for a small fleshy annual with prostrate stems, entire leaves and small yellow flowers, known botanically as Portulaca *oleracea* (family Portulacaceae). It is a native of India, which was introduced into Europe as a salad plant, and in some countries has spread so as to become a noxious weed; it is found in England but is rare. In certain parts of the United States the evil qualities of "pussly" have become proverbial. The persistence of purslane plants is due to their ability to retain moisture and thus blossom and ripen seeds long after they have been removed from the soil. The capsules opening by a lid produce many small seeds of great longevity. Besides the common purslane, some 10 other species occur in North America, chiefly in the southern United States. Some of the species of the same genus, such as P. *grandiflora* and its varieties, are grown in gardens on rockwork.

PURSUIVANT, a member of the third and lowest rank of heraldic officers, formerly an attendant on the heralds.

PURVEYANCE was a prerogative of purchasing goods for the royal household, enjoyed by all English kings up to Charles II. Certain officers attached to the king's court were charged with the duties of buying and arranging for the cartage of goods where necessary, the ancient prerogative of the King entitling him to demand carriage services from his subjects. The possibilities of abuse were obvious. Magna Carta (*q.v.*) ordered that goods should be paid for at once, and that horses and carts should not be taken for carriage duty, nor timber taken for castles without the consent of the owner. These stringent regulations were considerably modified to the King's advantage in later issues of the charter.

Many early statutes were passed against purveyance. People particularly resented the exercise of this right by royal officials and ministers for their own benefit. Statutes therefore limited its use to the immediate households of the king and queen. The name purveyor was so much hated that it was provided by statute that it should be changed to *achatour* (buyer). But statutes had little effect. In Elizabeth's reign complaints against purveyance were particularly bitter. In her early years the queen seems to have made use of her rights of purveyance to victual her navy. Later an arrangement was made by which some, if not all, counties agreed to furnish definite provisions at a fixed rate in order to get rid of the uncertainty which made the burden so much heavier. These compositions were arranged between the officers of the Board of Green Cloth and the Justices of Peace for each county at fixed prices. These fixed prices were very much lower than the market value of the goods and the difference was met by an assessment on the county. Cattle supplied in this way were kept in certain royal pastures. The parliaments of James I. determined to get rid of the abuses of purveyance, and Sir Francis Bacon made a famous speech against the purveyors in the first parliament of the reign. It was held that only the abolition of the right would put an end to its abuse. The purveyors made a practice of demanding far more goods than were necessary and sold the surplus for their own advantage. They ordered goods to be taken to remote places that people might buy from them exemption from coming with their portions. There were innumerable ways in which purveyors could make dishonest profit. Despite complaints, the right of purveyance went on until it fell into disuse during the Commonwealth. Its abolition was part of the Restoration Settlement, though till the end of the century it was sometimes partially revived during royal progresses.

An elaborate treatise on the subject was written by the ardent royalist Fabian Philipps, The Antiquity, legality, reason, *duty* and necessity of preemption and *pourveyance for the king* (1663). *See also* W. Money, *A Royal Purveyance* (Newbury, 1901). (D. M. S.)

PURVITS, VILHELMS (1872–), famous Latvian landscape painter, one of the first artists to introduce the contemporary tendencies of Western art, not only into Latvian art but also into the whole of eastern Europe. During his travels he studied French Impressionist art and reached a standard of perfection in this branch. He did not, however, stop at this stage, but, following closely the movements of international art, he ceaselessly varied and perfected his powers of expression. Starting from pure Impressionism he gradually developed a style of landscape painting, methodical linear construction, into a conscious composition. He paints numerous and varied pictures of the landscape of his own country. Purvits is undoubtedly the most important of the first two generations of Latvian artists. He may be considered as being the founder of Baltic landscape painting and of a special school of art. He is director of the Latvian Academy of Arts in Riga.

PUSA, a village of British India, in Darbhanga district, Bihar and Orissa, near the right bank of the Burh Gandak river; and 6 m. from the Pusa Road station on the Bengal and North-Western railway. The Government acquired an estate here in 1796, long used as a stud depot and afterwards as a tobacco farm. The estate, which covers 1,280 ac. was made over in 1904 to the Imperial Agricultural Department (of the Government of India), of which it is the headquarters. The Research Institute here comprises, in addition to a farm, an agricultural college, at which officers are trained for the higher posts in the Agricultural Department, and a research laboratory bearing the name of Mr. Phipps, an American gentleman, who contributed £30,000 towards its cost. The institute, which owed its inception to Lord Curzon, has, within the comparatively short period of its existence, done magnificent service to Indian agriculture by producing improved varieties of crops. In particular, it has achieved remarkable success by evolving strains of wheat which give a high yield, have powers of resistance to rust, are able to mature with less water than the generality of Indian wheats, and give good results under diverse conditions of soil and climate. The Pusa varieties are now grown on over 1½ million acres of the United Provinces, the Punjab and the North-Western Frontier province. The institute has also produced a heavy-yielding variety of bearded wheat suitable for areas where the crop is liable to damage by birds. The institute has introduced berseem, or Egyptian clover. It has been proved that a small irrigated area of poor land, in which berseem is followed by early maize, can provide a large herd with all the bulky green food it requires—a discovery of immense importance in a country depending so largely on cattle, where the pasture lands are for a large part of the year parched and bare. Further, valuable results have been obtained by selective breeding of cattle, *e.g.,* by doubling the milk yield of a pure herd in ten years. In order to improve both the quality and quantity of sugar production, a Sugar Bureau has been established, which gives advice to cultivators, manufacturers, etc. The institute studies soil improvement and the use of phosphates found in India.

PUSEY, EDWARD BOUVERIE (1800–1882), English divine, was born at Pusey near Oxford on Aug. 22, 1800, the son of Philip Bouverie, who took the name of Pusey on succeeding to the manor of that name. Edward Pusey was educated at Eton and at Christ Church, Oxford, and became a fellow of Oriel in 1824. He thus became a member of a society which included J. H. Newman and John Keble. Between 1825 and 1827 he studied Oriental languages and German theology at Göttingen. In 1828 the duke of Wellington appointed him to the regius professorship of Hebrew with the canonry of Christ Church.

By the end of 1833 he showed a disposition to make common cause with those who had already begun to issue the *Tracts* for the Times. "He was not, however, fully associated in the movement till 1835 and 1836, when he published his tract on baptism and started the Library of the Fathers" (Newman's *Apologia,* p. 136). He became a close student of the fathers and of that school of Anglican divines who had continued, or revived, in the 17th century the main traditions of pre-Reformation teaching. A sermon which he preached before the university in 1843, *The* Holy *Eucharist, a Comfort* to the Penitent, so startled the authorities that he was suspended for two years from preaching. The effect of his suspension was the sale of 18,000 copies of the condemned sermon and Pusey at once became an influence in the Anglican Church.

The movement, in the actual origination of which he had had no share, came to bear his name: it was popularly known as Puseyism (sometimes as Newmania) and its adherents as Puseyites. His activity, both public and private, as leader of the movement was enormous. He was not only on the stage but also behind the scenes of every important controversy, whether theological or academical. In the Gorham controversy of 1850, in the question of Oxford reform in 1854, in the prosecution of some of the writers of *Essays and Reviews,* especially of Benjamin Jowett, in 1863, in the question as to the reform of the marriage laws from 1849 to the end of his life, in the Farrar controversy as to the meaning of everlasting punishment in 1877, he was always busy with articles, letters, treatises and sermons. Some of his sermons before the university marked distinct stages in the history of the High Church party which he led.

The revival of confession in the Church of England practically dates from his two sermons on *The Entire Absolution of the Penitent,* in 1846. The sermon on *The Presence of Christ in the* Holy *Eucharist,* in 1853, first formulated the doctrine round which almost all the subsequent theology of his followers revolved, and which revolutionized the practices of Anglican worship. Of his larger works the most important are: his two books on the Eucharist—*The Doctrine of the Real Presence* (1855) and *The Real Presence* . . . the *Doctrine* of the *English Church* (1857); *Daniel the Prophet* in which he endeavours to maintain the traditional date of that book; *The Minor Prophets, with* Commentary, his chief contribution to the study of which he was the professor; and the *Eirenicon,* in which he endeavoured to find a basis of union between the Church of England and the Church of Rome.

In private life Pusey's habits were simple almost to austerity. He had few personal friends, and rarely mingled in general society; though bitter to opponents, he was gentle to those who knew him, and his munificent charities gave him a warm place in the hearts of many to whom he was personally unknown. The deaths of his wife (1839) and of his only son (1880) saddened his life. He died on Sept. 16, 1882, and was buried at Oxford in the cathedral of which he had been for fifty-four years a canon. In his memory his friends purchased his library, and endowed for it a house in Oxford, known as Pusey House.

See B. W. Savile, Dr. Pusey, an Historic Sketch, with Some Account of the Oxford Movement (1883); the Life by Canon Liddon, completed b~ J. C. Johnston and R. J. Wilson (5 vols., 1893–99); Newman's Apologia, and other literature of the Oxford Movement.

Pusey's elder brother, Philip Pusey (1799–1855), was a member of parliament and a friend and follower of Sir Robert Peel. He was one of the founders of the Royal Agricultural Society, and was chairman of the implement department of the great exhibition of 1851. He was a fellow of the Royal Society, a writer on varied topics for the reviews and the author of the hymn "Lord of our Life and God of our Salvation."

PUSHBALL, a game played by two sides on a field usualiy 140yds. long and 50yds. wide, with a ball 6ft. in diameter and 50lb. in weight. The sides usually number 11 each, there being five forwards, two left wings, two right wings and two goalkeepers. The goal consists of two upright posts 18ft. high and 20ft. apart with a crossbar 7ft. from the ground. The game lasts for two periods with an intermission. Pushing the ball under the bar counts five points; lifting or throwing it over the bar counts eight. A touch-down behind the goal for safety counts two to the attacking side. The game was invented by M. G. Crane of Newton, Massachusetts, in 1894, and was taken up at Harvard University the next year, but has never attained any considerable vogue. In Great Britain the first regular game was played at the Crystal Palace in 1902 by teams of eight. The English rules are somewhat different from those obtaining in the United States. Pushball was one of the games frequently played by teams of military men at the training camps during the World War. It is usually considered one of the feature events at American circuses when played by teams of Indians and cowboys on horseback. It is also played by mounted organizations of the U.S. army at various military posts. Pushball on horseback was introduced in 1902 at Durland's riding academy in New York, and has been played in England at the Military 'Tournament.

PUSHKIN, ALEXANDER (1799–1837), Russian poet, was born at Moscow on June 6, 1799. He belonged to an ancient family of boyars; his maternal great-grandfather was an Abyssinian general in the Russian service, ennobled by Peter the Great. In 1811 the future poet entered the newly founded lyceum of Tsarkoe Selo, situated near St. Petersburg. On quitting the lyceum in 1817 he was attached to the ministry of foreign affairs, and in this year he began to write his *Ruslan and Ly'udmila,* a romantic epic in six cantos, which was completed in 1820. Meanwhile Pushkin mixed in all the gayest society of the capital, and it seemed as if he would turn out a mere man of fashion instead of a poet. Rut a very daring *Ode to Liberty* written by him and circulated in manuscript in St. Petersburg came to the notice of the governor, and the young author was exiled to the south of Russia where he held official positions at Ekaterinoslav and at Kishinev.

In company with General Rayevsky he visited the baths of the Caucasus for the re-establishment of his health in 1820. The Rayeyskys introduced him to the poetry of Lord Byron, and the magnificent scenery of the Caucasus kindled his own poetic genius. The first fruit of the Caucasian visit was *The Captive of the Caucasus* (1822), narrating the story of the love of a Circassian girl for a Russian officer. This was followed by the *Fountain of Bakhchisarai* (1827) which tells of the detention of a young Polish captive in the palace of the khans of the Crimea. About the same time he composed the lines on Ovid, whose place of banishment, Tomi, was not far distant, and the *Ode to Napoleon.* The next long poem was the *Gipsies* (Tsygany) (1827). During his stay in southern Russia he mixed with the secret societies then rife throughout the country. In 1823 he was allowed to leave Kichinev, where the life was hateful to him, and was transferred to Odessa where he was once more on real Russian soil, and on the coast of the sea which delighted him. But he came into conflict with his official superior, and was dismissed from the service, because of an intercepted letter in which he spoke favourably of atheism. He was ordered to reside at Mikhailovskoe, near Pskov, where he soon involved himself in trouble on all sides. In his retirement he studied old Russian popular poetry. Recollections of Byron and André Chenier gave the inspiration to some fine lines consecrated to the latter, in which Pushkin appeared more conservative than was his wont. In 1825 he wrote his tragedy *Boris Godunov,* not published till 1831, a bold effort to imitate the style of Shakespeare, thus breaking with the French traditions.

In 1825 the conspiracy of the Dekabrists broke out. Many of the conspirators were personal friends of Pushkin, especially Kiichelbecker and Pustchin. The poet himself was to a certain extent compromised, but he succeeded in getting to his house at Mikhailovskoe and burning all the papers which might have been prejudicial to him. The emperor, to whom he was presented at Moscow soon after his coronation, summoned him to Moscow and assured him of pardon and "protection." The story goes that Nicholas said to Count Bludov on the same evening, "I have just been conversing with the most intelligent man in Russia." In 1829 appeared *Poltava,* a spirited narrative poem, in which the expedition of Charles XII. against Peter and the treachery of the hetman Mazeppa were described. In 1829 Pushkin again visited the Caucasus on this occasion accompanying the expedilion of General Paskevich, which is described in *A Voyage to Arzrum* (pr. 1836). The lyrics are delightful. In 1831 Pushkin married Natalia Goncharov, and in the following year was again attached to the ministry of foreign affairs, with a salary of 5,000 roubles. He now began his *History of the Revolt of Pugachev of 1773* (pr. 1834) an admirable piece of historical writing. While engaged upon this he wrote The *Captain's Daughter* (1836), one of the best of his prose works. In 1832 was completed the poem *Evgeni Onegin* (1825–33), again influenced by Byron.

In 1837 the poet, who had been long growing in literary reputation, fell mortally wounded in a duel (Feb. 8) with Baron George Heckeren d'Anthès, the adopted son of the Dutch minister who had married a sister of the poet's wife. Pushkin died on Feb. 10. D'Anthès was tried by court-martial and expelled from the country. In 1880 a statue of the poet was erected at the Tver Barrier at Moscow. He left four children; his widow married an officer named Lanskoi; she died in 1863.

Pushkin's poetical tales are full of drama. *Boris Godunov* and *Evgeni Onegin* are the basis of operas by Mussorgsky and Tschaikowsky respectively. Pushkin's lyrical pieces are the finest in the language. Interspersed among his minor works will be found many epigrams. He was one of the earliest Russian novelists. Indeed most of his work after 1831 was done in prose. In 1831 he published a small volume of tales under the pen name of Ivan Belkin. These all show great narrative powers. The one long novel finished is *The Captain's Daughter,* a tale of the times of Catherine II., which exercised a great influence on later Russian novelists. The most famous of all his short stories is *The Queen of Spades* (1834). In the *History of the Manor of Goryukhino* (1857), Pushkin parodied Polevoy's *History of the Russian People,* and presented an amusing picture of the fictitious author of his own Tales, Ivan Petrovich Belkin.

See Prince *D. S.* Mirsky, *Pushkin* (1926), which contains a bibliography; and the bibliography in the editions of Gennadi (7 vols., St. Petersburg, 1861), and Annenkov (6 vols. St. Petersburg, 18jj).

PUSHTU, PAKHSTO, PAKKHTO (PASHTO), the language of the Afghans, belongs to the Eastern Iranian group, the oldest form of which is probably found in the Zend. Numerous terms are traceable to the Avesta. *(See* Paul Horn's *Grundriss der Neupersischen Etymologie*). The remainder of its vocabulary cames from Arabic, Persian and from the Indian Prakrits. Among the last, Sindhi takes first place. It has thus considerable claims to antiquity.

About 10% of the Afghans are able to read and write, and education is making rapid progress.

Structure. — There are nine declensions. The accusative is the same as the nominative. The agent and oblique forms are identical. The genitive, dative and locative are formed by adding suffixes to the oblique form. Most adjectives form the feminine by adding a. Pronominal suffixes are used as well as definite, personal, demonstrative and reflexive pronouns. The regular verb has two main tenses, the imperfect and the present. There are 37 classes of verbs, 13 intransitive and 24 transitive.

BIBLIOGRAPHY.—*Linguistic Survey of India*, vol. x., 1924 (full bibliography; also vol. i. [1927]); Rev. T. P. Hughes, *Kalīd-Afghānī* (English trans., 1893). Manual: G. W. Gilbertson, *The Pakkhto Language* (Hertford, 1929). Dictionary: G. W. Gilbertson, *English-Pakkhto Colloquial Dictionary* (Hertford, 1929).

PUT AND CALL: *see* OPTIONS.

PUTEOLI, an ancient town of Campania (mod. *Pozzuoli, q.v.*), Italy, on the northern shore of the Bay of Puteoli, a portion of the Bay of Naples, from which it is 6 m. W. The city was probably founded under the name of Dicaearchia by a colony of Samians from Cumae about 520 B.C., before which Misenum was the original port. In 21j the Romans introduced a garrison of 6,000 men and Hannibal besieged it in vain in 214. In 194 a Roman colony of 300 men was established. Puteoli belonged to the tribus Palatina, thus breaking the rule (the only other exception is Turris Libisonis [*q.v.*] which belonged to the Colluia) that *municipia* and *coloniae* were not enrolled in the four urban tribes. The *lex parieti faciundo,* 105 B.C., relating to building works in front of the temple of Serapis, shows that Puteoli had considerable administrative independence. Sulla retired to Puteoli after his resignation of the dictatorship in 79. Cicero had a house in Puteoli itself, and a villa on the edge of the Lucrine lake (*q.v.*), and many other prominent men of the republic possessed country houses near by. *(See* BAIAE; AVERNUS: LUCRINUS LACUS; and MISENUM.) In A.D. 61 St. Paul landed here, and spent seven days before leaving for Rome (Acts xxviii. 13). Vespasian gave the town part of the territory of Capua, and installed more colonists

—whence it took the title Colonia Flavia.

The remains of Hadrian, who died at the neighbouring town of Baiae, were at first deposited at Puteoli, and Antoninus Pius erected a temple to his memory on the site of Cicero's villa. It was mainly, however, as a great commercial port that Puteoli was famous in ancient times. It exported iron from Elba, mosaics, pottery, perfumes, pozzolana earth (taking its name from the place), glass cups engraved with views of Puteoli, mineral dyes, etc., but its imports were considerably greater. During the Punic Wars it was a naval port, but in the latter part of the 2nd century B.C. it became the greatest commercial harbour of Italy and we find Lucilius about 125 B.C. placing it next in importance to Delos, then the greatest harbour of the ancient world.

The corn supply of Rome came partly through Puteoli, partly through Ostia. Seneca (*Epist.* 77) describes the joy of the inhabitants in the spring when the fleet of corn vessels from Alexandria was seen approaching, and Statius tells us that the crew of the ship which arrived first made libations to Minerva when passing the promontory which bore her name (the Punta Campanella at Sorrento).

Claudius established here, as at Ostia, a cohort of *vigiles* as a fire-brigade. Brundisium was similarly protected. There was also a station of the imperial post, sailors of the imperial fleet at Misenum being apparently employed as couriers. The artificial mole was probably of earlier date than the reign of Augustus; and by that time at any rate there were docks large enough to contain the vessels employed in bringing the obelisks from Egypt. Alaric (410), Genseric (455) and Totila (54j) devastated Puteoli.

The original town of Puteoli stood on the narrow hill of the Castello. The streets of the old town preserve the ancient alinement. There are also traces of the division of lands near the town into squares by parallel paths (*decumani* and cardines) at regular intervals of $1,111\frac{1}{9}$ Roman feet, postulating as the basis af the division a square with a side of 10,000 Roman feet, divided into 81 smaller squares. The market hall (*macellum*), generally known as the temple of Serapis, from a statue of that deity found there, was excavated in 1750. In the centre of the ancient city was a round colonnade with sixteen columns of Numidian marble (giallo antico) now in the theatre of the palace at Caserta. In the amphitheatre there were exceedingly interesting arrangements for flooding the arena, but these can only have been in use before the construction of the greater part of the subterranean portion with its cages, etc. The whole amphitheatre is 489×381 ft.; the arena 24j×138 ft. Inscriptions record that it was built by the Colonia *Flavia, i.e.,* not before Vespasian. In the older amphitheatre (426×312 feet), which was found in excavations for the new railway to Naples, Nero fought in games given in honour of Tiridates, king of Armenia. Remains of thermae also exist in various places. The cathedral of S. Proculus (containing the tomb of the musician Pergolesi, d. 1736) is built into a temple of Augustus, 6 columns of which, with their Corinthian capitals, still exist. Other ruins--of a circus, of tombs, villas, etc., exist.

Puteoli was supplied with water by two aqueducts, both subterranean, one of which, bringing water from springs in the immediate neighbourhood, is still in constant use. Puteoli was reached direct by a road from Capua traversing the hills to the north by a cutting (the Montagna Spaccata), which went on to Neapolis, and by the Via Domitiana from Rome and Cumae. There was also a short cut from Puteoli to Neapolis by the tunnel of Pausilipon, made under Augustus. In 305, S. Januaris (S. Gennaro, the patron saint of Naples), bishop of Beneventum, S. Proculus, patron of Puteoli. and others, were martyrs at Puteoli,

See the study of C. Dubois, *Pouzzoles* antique (Paris, 1907) (Bibliothèque des écoles françaises d'Athènes et de Rome, fasc. 98). (T. A)

PUTNAM, GEORGE HAVEN (1844–1930), dean of American publishers, at eighty-five (1929) the active head of one of the oldest publishing houses in the country, the house that gave to American literature such names as Washington Irving and Fenimore Cooper; with sixty-five years of publishing experience behind him, he had time to win honors as a soldier, a writer, and a man of public affairs.

This sterling American citizen, whose forefathers fought for George Washington, and who himself languished in Libby prison, upholding the Union cause, was born in England on April 2, 1844. His father, George Palmer Putnam, had founded the American publishing concern in 1837, and after that date had found it important for his publishing business to make annual trips to England. In 1841, he brought into organization the London publishing house, being the first American publisher to invade England. He was a resident of England for seven years, and it was in this way that his son came to be born in London.

It was not until 1848, that young George Haven Putnam was brought to America. Among his early memories are such outstanding figures as Washington Irving, Charles Dickens, Thackeray, Louis XVII. ("Eleazar Williams"), and Lincoln.

The major's father was a member of the Committee that invited Lincoln to New York in 1860, and the younger Putnam sat on the platform during the delivery of the Cooper Union address. After the address, he was introduced by Bryant to Lincoln.

His boyhood education was completed at Columbia grammar school, followed by studies abroad at the Sorbonne and the University of Gottingen, studies which were cut short by the beginning of the Civil War. Mr. Putnam hastened home from Europe in 1862 to enlist in the Union Army. He was taken prisoner at Cedar Creek, and sent to Libby Prison and later to Danville.

Major Putnam's outstanding contribution to publishing history was his championship of international copyright, which resulted, in 1891, in the present copyright relations between the United States and Europe. He died in New York city on Feb. 27, 1930.

PUTNAM, HERBERT (1861–), American librarian, was born in New York city on Sept. 20, 1861. He graduated from Harvard college in 1883 and thereafter studied law at Columbia university, being admitted to the bar in 1886. His calling, however, proved to be that of librarian. He was librarian of the Minneapolis Athenaeum in 1884–87, of the Minneapolis Public library in 1887–91 and, after a few years spent in the practice of law, of the Boston Public library in 1895–99. Thence he was called in 1899 to the librarianship of the Library of Congress, in Washington. He was president of the American Library association in 1898 and 1904 and wrote on library science.

PUTNAM, ISRAEL (1718–1790), American soldier, was born in Salem Village (now Danvers), Mass. on Jan. 7, 1718, and in 1740 removed to a farm in the vicinity of Pomfret, Conn. He was active in the French and Indian War, rising to the rank of major in 1758. News of the fighting at Lexington and Concord reached him while he was ploughing on his farm; he instantly left the plough in the furrow and hastened to Cambridge; and he was later made second brigadier of the Connecticut forces. He was with the force, commanded by Col. William Prescott. which on the night of June 16, 1775, fortified Breed's Hill, and on the next day he took a conspicuous part in resisting the British attack (see BUNKER HILL). After the evacuation of Boston he was in command of New York city till Washington's arrival (April 13, 1776), and then was put in general charge of the city's fortifications. Immediately before the battle of Long Island he succeeded Gen. John Sullivan in command of the troops on Brooklyn Heights, and in the battle of Long Island (of Aug. 27) he was in immediate command of the American side. In the retreat from New York city he took part in the battle of Harlem Heights (Sept. 16). In May, 1777, he took command of the Hudson highlands at Peekskill, which with Forts Montgomery and Clinton he abandoned in October, being out-manoeuvred by the British. After a few months' recruiting service in Connecticut he returned to the main army at White Plains. In the winter of 1778–79 he commanded the troops quartered near Redding, Conn. In May, 1779, he took command of the right wing on the west side of the Hudson. An attack of paralysis in Dec. 1779 terminated his active service in the war. He spent his last years on his farm in Brooklyn, Conn, where he died May 29, 1790. A bronze equestrian statue by Karl Gerhardt, over a sarcophagus, was erected at Brooklyn, Conn., by the State in 1888, and there is another statue (1874) in Bushnell park, Hartford, by J. Q. A. Ward.

Putnam was a brave, intrepid and very industrious soldier rather than a great general. His bluff heartiness has made him one of the popular heroes in American history.

See W. F. Livingston, *Israel Putnam, Pioneer, Ranger and Major-General* (1901) in the "American Men of Energy" series; I. N. Tarbox, *Life of Israel Putnam* (Boston, 1876); and *Essay on the Life of the Honorable Major-General Israel Putnam* (Hartford, 1788; enlarged ed., Boston, 1818), by David Humphreys, for a time Putnam's aide-de-camp.

PUTNAM, RUFUS (1738–1824), American soldier and pioneer, was born in Sutton, Mass., on April g, 1738 (O.S.). He served in the French and Indian War in 1757–60; was a millwright in New Braintree in 1761–68, during which time he studied surveying; and from 1769 until the American Revolution was a farmer and surveyor. He became lieutenant colonel in one of the first regiments raised after the battle of Lexington, and served before Boston. In 1777 he served in the Northern army under Gen. Horatio Gates, commanding two regiments in the second battle of Saratoga. In 1778 he laid out fortifications, including Ft. Putnam, at West Point, and in 1779 he served under Gen. Anthony Wayne after the capture of Stony Point. After the war he returned to Rutland, Mass., where he had bought a confiscated farm in 1780. In March, 1786, he founded, with other officers of the American Revolution, the Ohio Company of Associates for the purchase and settlement of Western lands. In Nov. 1787, he was appointed by the company superintendent of its proposed settlement on the Ohio, and in 1788 he led the small party which founded Marietta, Ohio. He was a brigadier-general in the army and a commissioner to treat with the Indians in 1792–93; was surveyor general of the United States in 1796–1803; and in 1802 was a member of the Ohio State Constitutional convention. He died, in Marietta, May 4, 1824. He has been called "the father of Ohio," and greatly contributed to its development.

See John W. Campbell, *Biographical Sketches* (Columbus, O., 1838); Sidney Crawford, "Rufus Putnam, and his Pioneer Life in the North-West," vol. xii., new series, pp. 431–454, *Proceedings of the American Antiquarian Society* (Worcester, 1899), and Rowena Buell (ed.), *The Memoirs of Rufus Putnam* (Boston, 1903), in which his autobiography, his journal and other papers, now in the library of Marietta College, are reprinted. His *Journal, 1757–1760,* dealing with his experiences in the French and Indian War, was edited with notes by E. C. Dawes (Albany, N.Y., 1886).

PUTNAM, a city of north-eastern Connecticut, U.S A , on the Quinebaug river, at the mouth of the Mill; the county seat of Windham county. It is served by the New York, New Maven and Hartford railroad. Population (1930) 7,318; (1940) 7,775. It manufactures cotton, woollen and silk goods, steam heaters and castings. The town of Putnam was formed in 1855 and named after Gen. Israel Putnam. The city was chartered in 1895.

PUTNIK, RADOMIR (1847–1917), Serbian general, was born on Jan. 25, 1847, at Kraguyevats. After serving against Turkey in 1876 and 1877, and against Bulgaria in 1889, he was made deputy-chief of the general staff, and professor at the military academy in Belgrade. The intrigues and favouritism introduced by the kings, Milan and Alexander, caused him to be placed on the retired list, but in the autumn following the military revolution of 1903 he was appointed general and chief of the general staff. In 1906 he succeeded General Gruič as minister of war, and again held that office in 1912, during the period when the military convention with Bulgaria was negotiated.

On the outbreak of war with Turkey Putnik was made *voivode* or marshal (being the first holder of that title) and commander-in-chief, and was responsible for the rapid success of the Serbian arms at Kumanovo, Prilep and Monastir. It was largely owing to his vigilance and foresight that the treacherous night attack by which the Bulgarians opened the second Balkan War (June 29, 1913) failed as it did. When the World War broke out, he was undergoing a cure at an Austrian watering place, and was at first placed under arrest, being later released by special order of the emperor Francis Joseph and conveyed to the Rumanian frontier. Despite impaired health he resumed the position of Serbian generalissimo and inflicted upon the forces of General Potiorek three successive defeats—on the Yadar (Aug. 16–20), the Drina (Sept. 8–19) and at Rudnik, which ended on Dec. 14, 1914 with an Austrian rout and the complete evacuation of Serbia. Putnik retained the supreme command during the triple invasion of Serbia in Nov. 1915, and shared the retreat of the Serbs through Albania. When, however, the exiled Government established itself at Corfu, he and most of his staff were placed on the retired list. He himself withdrew to France. He died on May 17, 1917, at Nice.

PUTTEE or **PUTTIE.** The name adapted from the Hindu *patti,* bandage (Skr. *patta,* strip of cloth), for a covering from the ankle to the knee, consisting of a long narrow piece of cloth wound spirally, and fastened by a tape, though straps may be used. For infantrymen, the winding commences at the ankle, but mounted men reverse the process as the rubbing against the horse causes the tape to come undone. Their advantages over leggings are that they are not "hard" on the legs, can be used as bandages or slings in case of need, and occupy less space when not in wear. Worn by most armies except the German in 1918, they have gradually disappeared in favour of short leggings.

PUTTENHAM, GEORGE (d. 1590), the reputed author of *The Arte of English Poesie* (1589). The book was entered at Stationers' Hall in 1588, and published in the following year. The writer of *The Arte of English Poesie* was educated at Oxford, and at the age of 18 he addressed an eclogue entitled *Elpine* to Edward VI. In his youth he had visited Spain, France and Italy, and was better acquainted with foreign courts than with his own. In 1579 he presented to Queen Elizabeth his *Partheniades* (printed in a collection of ms. *Ballads* by F. J. Furnivall), and he wrote the treatise in question especially for the delectation of the queen and her ladies. He mentions nine other works of his, none of which are extant. There is no direct evidence beyond Bolton's ascription to identify the author with George or Richard Puttenham, the sons of Robert Puttenham and his wife Margaret, the sister of Sir Thomas Elyot, who dedicated his treatise on the *Education or Bringing up of Children* to her for the benefit of her sons. Both made unhappy marriages, were constantly engaged in litigation, and were frequently in disgrace.

Many later "poetics" are indebted to this book. The original edition is very rare. Professor Edu-ard Arber's reprint (1869) contains a clear summary of the various documents with regard to the authorship of this treatise. The history of the Puttenhams is discussed in H. H. S. Croft's edition of Elyot's *Boke called the Governour. A* careful investigation brought him to the conclusion that the evidence was in favour of Richard. There are other modern editions of the book, notably one in J. Haslewood's *Ancient Critical Essays* (1811–15).

PUTTING THE SHOT, the modern form of stone putting, practised at the Irish Tailteann Games, began 1829 B.C. The adoption of a shot in preference to a heavy stone was suggested by the use of such a missile at military sports meetings which had access to an assortment of cannon-balls. The weight of the shot was first stabilized at 16 lb. at Dublin university sports in 1860, but a 14 lb. missile continued in use. The 16 lb. implement was known as a "weight," and the 14 lb. implement as a "stone." It is an event at which Irish athletes for many years were supreme, and in which the big man has an advantage Ralph Rose, U.S. whose 1909 world's record of 51 ft. stood until 1928, stood 6 ft. $5\frac{1}{2}$ in. and weighed 280 lb. J. Torrance, U S.A., holding the world's record of 57 ft. 1 in., is as tall and weighs about 330 lb. Other records are: Olympic, H. Woellke, Germany, 53 ft. $1\frac{1}{4}$ in., U.S.A., J. Torrance, 55 ft. 5 in.; English, R. L. Howland, 47 ft. $8\frac{1}{2}$ in.

For many years this event was practised from a 7ft square, the distance being measured from the first pitch of the shot to the front line of the square, or that line produced. Latterly, however, the square has been replaced by a 7ft. ring with a stop-board on the front half, the distance being measured from the pitch of the shot to the nearest point on the circle. The shot must be put from the shoulder with one hand only, without ever being brought behind the shoulder, and in which no part of the person of the competitor touches the top of the stop-board, the circle, or the ground outside the circle until the shot has touched the ground. The competitor rnay not leave the circle until his put has been marked, and he must then, from a standing position, leave the circle from the rear half.

The athlete, preparatory to making an attempt, takes up his position at the back of the circle. His weight is borne by his right leg: The shot is held on the centre joints of the fingers. The weight resting mainly upon the base of the middle two fingers;

the thumb and little finger support the shot at either side. The shot is held close to the neck in the hollow of the shoulder, with the elbow turned outward; the left foot, pointed forward, with toes resting on the ground, is separated from the right by some 18in. to 24in. The left foot is raised, the left leg is swung behind the right and is then kicked forward and up. At the same time the athlete hops, or glides, forward on his right foot so that it lands at the centre of the circle a fraction of a second before the left foot reaches the ground. During the glide the body is bent from the hips to the side of the hand holding the shot. As the feet take the ground the action is continued without any pause, but the body being fully extended. The drive comes from both legs, and the final effort is continued by the putting arm, and the wrist and fingers impart a final "flick" to the shot. The left leg provides a point of resistance. There must be a good follow through. After the shot has left the hand the position of the feet is quickly reversed, to help the athlete to retain his balance.

See F. A. M. Webster, *Athletes in Action* (1931); *Why—The Science of Athletics* (1936); Lawson Robertson, *Modern Athletics* (1932); Webster and Heys. *Exercises for Athletes* (1932); *Athletic Training for Men and Boys* (1933). (F. A. M. W.)

PUTTKAMER, ROBERT VON (1828–1900), Prussian statesman, was born at Frankfort-on-the-Oder on May 5, 1828. Puttkamer was the chosen instrument of the Clerical Conservative policy initiated by Bismarck when the growth of the socialist movement made it expedient to conciliate the Catholic Centre. As *Oberpräsident* of Silesia he had mitigated the rigour of the application of the "May laws," and as minister of public worship and of the interior he continued this policy. He was also the author of the ordinance of Jan. 2, 1880 on the simplification of German orthography. As minister of the interior Puttkamer's temper was in harmony with the view of Bismarck and the emperor William, and with their support he tried to re-establish the old Prussian system of rigid discipline from above. On his initiative, on Jan. 4, 1882, a royal ordinance required all officials to give the government their unconditional support at political elections. He also interfered with the liberty of public meetings, and attempted to suppress strike movements by force. This "Puttkamer régime" was intensely unpopular, and when the emperor Frederick III. succeeded to the throne Puttkamer was forced to resign (June 8, 1888). He was largely rehabilitated under William. He died at Karzin, in Pomerania, on March 15, 1900.

PUTTY. Originally tin oxide in a state of fine division used for polishing glass, granite, etc., now known as "putty powder" or "polisher's putty." The term is applied to cement composed of fine powdered chalk (whiting) or oxide of lead (white lead) mixed with linseed oil, either boiled or raw. It is used for fixing sheets of glass in frames, and for filling up nail-holes, etc., in woodwork. The oxidation of the oil hardens the putty and when it is required to dry quickly, boiled oil and sometimes litharge and other driers are used. Putty is also a fine lime cement employed by masons.

PUVIS DE CHAVANNES, PIERRE CÉCILE (1824–1898), French painter, was born at, Lyons or Dec. 14, 1824. His father was a mining engineer, the descendant of an old family of Burgundy. Pierre Puvis was educated at the Lyons College and at the Lycée Henri IV. in Paris, and was intended to follow his father's profession when a serious illness interrupted his studies. A journey to Italy opened his mind to fresh ideas, and on his return to France he went to study painting first under Henri Scheffer, and then under Couture. In 1852 he established himself in a studio in the Place Pigalle (which he did not give up till 1897), and there organized a sort of academy for a group of fellow students who wished to work from the living model. Puvis first exhibited in the Salon of 1850 a "Pietà." In 1852 and in the following years Puvis's pictures were rejected by the Salon, but the young painter was none the less warmly defended by Théophile Gautier and Théodore de Banville. His compositions at this early period show great variety, reflecting the influence of the Italian masters as well as of Delacroix and Couture. In 1859 Puvis reappeared in the Salon with the "Return from Hunting" (now in the Marseilles Gallery). But not till he produced "Peace" and "War" did he really impress his critics, inaugurating a vast series of decorative paintings. For these two works a second-class medal was awarded to him. In 1864 he exhibited "Autumn" and "Sleep." One of these pictures is now in the Lyons Museum, and the other at Lille. "Peace" and "War" were placed in the great gallery of the museum at Amiens, where Puvis completed their effect by painting four panels—a "Standard-Bearer," "Woman Weeping over the Ruins of her Home," a "Reaper," and a "Woman Spinning." Further decorations were ordered for the same building, and the artist presented to the city of Amiens "Labour" and "Repose." In 1865 a composition entitled "Ave Picardia Nutrix," allegorical of the fertility of the province, was added to the collection. In 1879 the city wished to complete the decoration of the building, and the painter executed the cartoon of "Ludus pro patria," exhibited in the Salon of 1881 and purchased by the state, which at the same time gave him a commission for the finished work. Meanwhile Puvis de Chavannes also painted easel pictures. To the Salon of 1870 he had sent a picture called "Harvest"; the "Beheading of John the Baptist" figured in the Great Exhibition of 1889; then followed "Hope" (1872), the "Family of Fisher-Folk" (1875), and "Women on the Seashore" (1879). Two paintings in the Palais Longchamp at Marseilles, ordered in 1867, represent "Marseilles as a Greek Colony" and "Marseilles, the Emporium of the East." After these, Puvis executed for the town-hall of Poitiers two decorative paintings of historical subjects: "Radegund," and "Charles Martel." The Pantheon in Paris also possesses a decorative work of great interest by this painter: "The Life of Saint Geneviève," treated in three panels. In 1876 the Department of Fine Arts in Paris gave the artist a commission to paint "Saint Geneviève giving Food to Paris" and "Saint Geneviève watching over Sleeping Paris," in which he gave to the saint the features of Princess Cantacuzene, his wife. At the time of his death—on Oct. 24, 1898—the work was almost finished. After completing the first paintings in the Pantheon, which occupied him for three years and eight months, Puvis de Chavannes undertook to paint the staircase leading to the gallery of fine arts in the Lyons Museum, and took for his subjects the "Vision of the Antique," a procession of youths on horseback, which a female figure standing on a knoll points out to Pheidias; the "Sacred Grove"; and two allegorical figures of "The Rhône" and "The Saône." It was in the same mood of inspiration by the antique that he painted the hemicycle at the Sorbonne, an allegory of "Science, Art, and Letters." At the Hôtel de Ville in Paris, Puvis decorated the grand staircase and the first reception-room These works occupied him from 1889 till 1893. In the reception-room he painted two panels, "Winter" and "Summer." The pictures in the Rouen Museum (1890–1892) show the artist's power of conceiving a scheme to decorate a public building with beautiful human figures and the lines of landscape. Puvis, as a rule, adhered to the presentment of the nude; here, however, in response to some critical remarks, he has clad his figures in modern dress. After prolonged negotiations, begun so early as in 1891, with the trustees of the Boston Library, U.S.A., Puvis de Chavannes accepted a commission to paint nine large panels for that building. These pictures, begun in 1895, were finished in 1898. In these works of his latest period Puvis de Chavannes soars boldly above realism. Puvis de Chavannes was president of the National Society of Fine Arts (the New Salon). His principal pupils are Ary Renan (d. 1900), Baudouin, J. F. Auburtin and Cottet.

See Marius Vachon, **Puvis** *de Chavannes* (1900); J. Buisson, "Puvis de Chavannes, Souvenirs Intimes," *Gazette des beaux-arts* (1899); L. Riotor, *Les Arts et les Lettres* (1901); A. Michel, *Puvis de Chavannes* (London 1912). (H. Fr.; X.)

PUY, a geological term used locally in Auvergne for a volcanic hill. Most of the puys of central France are small cinder-cones, with or without associated lava, whilst others are domes of trachytic rock, like the domite of the Puy-de-DBme. The puys may be scattered as isolated hills, or, as is more usual, clustered together, sometimes in lines. They probably became extinct in late prehistoric time. Puys are also found in the Eifel, on the Bay of

Naples, in the Swabian Alps of Wiirttemberg, and, as Sir A. Geikie has shown, in Scotland.

PUYALLUP, a city of Washington, U.S.A. It is served by the Chicago, Milwaukee, St. Paul and Pacific, the Great Northern, the Northern Pacific and the Union Pacific railways. Pop. (1920) 6,323 (87% native white); (1940) 7,889 by the federal census. It is famous for its berries and bulbs, and has three large fruit-canning and pre-cooling plants, besides several saw and shingle mills and veneer plants. It is the seat of the Western Washington agricultural experiment station of the state college and the annual Western Washington fair (attendance 264,000, 1940). A tablet across the river marks the site of the first blockhouse built in the valley. Puyallup was founded in 1853 by Ezra Meeker, and was incorporated in 1890, with Meeker as first mayor.

PUY-DE-DÔME, a department of central France, four-fifths of which belonged to Basse-Auvergne, one-sixth to Bourbonnais, and the remainder to Forez (Lyonnais). Area, 3,095 sq. miles. Pop. (1936), 486,103. It is bounded north by Allier, east by Loire, south by Haute-Loire and Cantal, and west by Corrkze and Creuse. The famous plain of the Limagne, watered by the Allier and its tributary, the Dore, has on its western flank the volcanic Puys and Monts Dore, while on its eastern side rises the largely granitic heights of the Forez (5,380 ft.). The Puys include a number of craters, now dead and often filled by lakes, which also occur behind lava dams in the valleys. The Puy de Sancy (6.188 ft.) is the highest crater, but the Puy de Dôme (4,806 ft.) gives its name to the department and has a meteorological observatory on its summit, once crowned by a Roman temple, the ruins of which still exist.

The climate of Puy-de-DBme is usually very severe, owing to its high level and its distance from the sea; the mildest air is found in the northern valleys, where the elevation is least. During summer the hills about Clermont-Ferrand, exposed to the sun, become all the hotter because their black volcanic soil absorbs its rays. On the average 25 or 26 in. of rain fall in the year; in the Limagne, around which the mountains arrest the clouds, rainfall is less. Nevertheless the soil of this plain, consisting of alluvial deposits of volcanic origin, and watered by torrents and streams from the mountains, makes it one of the richest regions of France. In the highest altitudes the rainfall attains 64 inches.

About two-thirds of the inhabitants of the Puy-de-Dôme are engaged in agriculture. The Limagne yields a variety of products and the vine flourishes on its hill-sides. The high mountains provide pasture for large flocks of cows and sheep, and cheese-making is an important industry. The intermediate region is cultivated mainly for cereals, the chief of which are wheat, rye, oats and barley. Potatoes are largely grown, and peas, beans, beetroot, colza and tobacco. The Limagne produces fruit of all kinds—apricots cherries. pears, walnuts and apples, yielding considerable quantities of cider. The department possesses considerable mineral wealth. There are important coal-mines at Brassac on the Allier, on the borders of Haute-Loire, at St. Eloy near the department of Allier, and at Bourg-Lastic on the borders of Corrèze. Peat, asphalt, bituminous schists, antimony, mispickel and argentiferous lead are also worked. Of the last named there are mines and foundries at Pontgibaud on the Sioule. Amethysts and other rare minerals are found, and there are numerous stone-quarries. Mont Dore, Royat and La Bourboule are watering places. The springs of St. Nectaire contain sodium and iron chlorides and bicarbonates. The waters of Châteauneuf (on the Sioule), also known to the Romans, contain iron bicarbonates; those of Châtelguyon, like the waters of Carlsbad and Marienbad, are also widely known, and there are many other mineral springs of varied character. Manufactures are grouped around Thiers, which produces a large amount of cheap cutlery, and Clermont-Ferrand, the capital The textile industry includes uool-carding and making of linen cloths, bunting, clothing manufactories for lace and for rubber (Clermont-Ferrand), sugar-works, manufactures of edible pastes and of fruit-preserves. The department exports grain, fruits, cattle, wines, cheese, wood, mineral waters, cutlery. etc. It is served by the Orléans and P.L.M. railways. Many thousands of the inhabitants, chiefly of the district of Ambert, leave it during winter and find work elsewhere.

The department comprises 4 arrondissements—Clermont-Ferrand, Issoire, Riom, Thiers—50 cantons and 473 communes. Clermont-Ferrand is the seat of the bishopric and the *académie* (educational division); court appeals are heard at Riom.

The chief towns are Clermont-Ferrand, Issoire, Thiers, Riom, Ambert, Mont-Dore-les-Bains, La Bourboule and Royat. Near Clermont-Ferrand is Mt. Gergovie (see GERGOVIA), the scene of the victory of Vercingetorix over Julius Caesar. Billom, Chamalières, Courpière, Orcival, St. Nectaire and St. Saturnin possess churches in the Romanesque style of Auvergne. There are interesting ruined feudal strongholds at Murols and Tournoël (near Volvic). Vic-le-Comte has a beautiful sainte-chapelle, and Aigueperse has a Gothic church of the 13th to the 15th century. Near Pontgibaud are the ruins (13th century) of the Carthusian abbey of Port St Marie.

PWLLHELI ("salt pit," or "pool"), a municipal borough, seaport and market town of Caernarvonshire, north Wales, 21 mi. S.W. of Caernarvon with station on the G.W.R. Pop. (1938) 3,578. Area 1.8 sq.mi. It has a sandy beach on the north side of Cardigan bay, on the shore of Tremadoc bay. The town was incorporated by Edward the Black Prince. Pwllheli commands a good view of the Merionethshire and Snowdon mountains.

PYANEPSIA, an ancient festival in honour of Apollo, held at Athens on the 7th of the month Pyanepsion (October). A hodge-podge of pulse was offered to Apollo. Another offering was the *eiresiōnē,* a branch of olive or laurel, bound with purple or white wool, round which were hung fruits of the season, pastries, and small jars of honey, oil and wine. Both are old pieces of rustic magic, for which many analogies can be found elsewhere. It was carried in procession to the temple of Apollo where it was suspended on the gate by a boy whose parents were both alive. The doors of private houses were similarly adorned. The branch was allowed to hang for a year, when it was replaced by a new one, since by that time it was supposed to have lost its virtue. During the procession a chant (also called *eiresiōnē*) was sung, the text of which has been preserved in Plutarch (*Theseus,* 22).

Aetiologists connected both offerings with the Cretan expedition of Theseus, who, when driven ashore at Delos, vowed a thank-offering to Apollo if he slew the Minotaur, which afterwards took the form of the *eiresiōnē* and Pyanepsia. His comrades on landing in Attica gathered up the scraps of their provisions which explains the origin of the hodge-podge.

See W. Mannhardt, *Wald- und Feldkulte,* ii., 214, for an exhaustive account of the *eiresiōnē* and its analogies; Sir J. G. Frazer, *Golden Bough,* vol. ii., pp. 48, 71; A. Mommsen, *Feste d. Stadt Athen,* p. 278. et seq.; J. E. Harrison, *Prolegomena to Greek Religion,* ch. iii.; L. R. Farnell, *Cults of the Greek States,* iv. 286.

PYAPON, a town in Burma, on the Pyapon river. Pop. (1931) 12,338. The district, formed in 1903, lies within the delta of the Irrawaddy. It is intersected by creeks and liable to inundation at high spring tides. The jungle is being reclaimed for rice, which is the sole crop. Area, 2,148 sq m.; pop. (1921) 288,994, showing an increase of 32,779 in the decade. The district has no railways and few roads, communication being by water. Other urban centres, which ship the rice to Rangoon, are Kyaiklat (9,224 in 1921), and Dedayè (5,568 in 1921).

PYAT, FELIX (1810–1889), French communard, was born at Vierzon (Cher) on Oct. 4, 1810, the son of a Legitimist lawyer. Called to the bar in Paris in 1831, he threw his whole energies into journalism. The violent personalities of a pamphlet entitled *Marie Joseph Chénier et le prince des critiques* (1844), in reply to Jules Janin, brought him a six months' sojourn in La Pélagie, in the cell quitted by Lamennais. In 1848 George Sand, whom he had introduced in 1830 to the staff of the *Figaro,* now asked Ledru-Rollin to make him commissary-general of the Cher. After three months' tenure of this office he was returned by the department to the Constituent Assembly, where he voted with the Mountain, and brought forward a motion for the abolition of the presidential office. About this time he fought a duel with Proudhon, who had called him the "aristocrat of the democracy." He joined Ledru-Rollin in the attempt of June 13, 1849, after which he sought refuge in Switzerland. Belgium, and finally in England. For a glorification of regicide at the time the Orsini attempt against Napoleon III. he was brought before an English court, but acquitted, and the general amnesty of 1869 permitted his return to France, but further outbursts against the authorities compelled his return to England. The revolution of Sept. 4 brought him back to Paris, and it was he who in his paper *Le* Combat displayed a black-edged announcement of the *pourparlers* for the surrender of Metz. After the insurrection of Oct. 31, he was imprisoned for a short time. In Jan. 1871, *Le Combat* was suppressed, only to be followed by an equally virulent *Vengeur*. Elected to the National Assembly, he retired from Bordeaux with Henri Rochefort and others until such time as the "parricidal" vote for peace should be annulled. He returned to Paris to join the committee of public safety, and, in Hanotaux's words, was the *âme ulcérée* of the Commune, but was blamed for the loss of the fort of Issy. He was superseded there by Delescluze, but he continued to direct the violent acts of the Commune, the overthrow of the Vendôme column, the destruction of Thiers's residence and of the expiatory chapel built to the memory of Louis XVI. He escaped across the frontier, and, though condemned to death in 1873, the amnesty of July 1880 permitted his return. He was elected to the Chamber of Deputies in 1888, but died at Saint-Gratien on Aug. 3, 1889.

PYATIGORSK, a town of Russia in the North Caucasus on the Podkoumok river and on a plateau 1,680 ft. above sea-level, hence its name ("five mountains"). Its sulphur springs, about 15 in number, vary from 75° to 96° F and are used for drinking and bathing and are bottled for export. The first buildings were erected in 1812 and a great impetus was given to the town when it was linked with the Rostov-on-Don to Baku railway. Its population in 1933 was 60,000. Its springs had long been known to the Circassians of the district who addressed a petition to Ivan the Terrible in 1551 asking for protection against the Crimean Tatars. The poet M. Y. Lermontov (1814–41) was killed here in a duel. In 1918 a skeleton, apparently Neanderthal, was reported.

See *Russ. Anthr. Journ.* (1922); "Caucasus: Ice Age," *Man,* vol. xxv. (1926).

PYCNOGONIDA, also known as Pantopoda or Podosomata, a small group of marine Arthropoda characterized by a very small body and disproportionately long legs. The facts that there are usually four pairs of legs and, typically, a pair of chelate or pincer-like appendages in front of the mouth, have led to the Pycnogonida being associated with the Arachnida in most systems of classification, but the relationship is not close.

The body is composed of an unsegmented anterior head region followed by three, rarely four, somites which may be free or more or less coalesced, and a minute terminal piece which bears the anus. The legs, as a rule, are exactly alike, and are attached, the first pair to the head region and the others to the following three (or four) somites. The triangular mouth-opening is at the end of a proboscis which may be as long or longer than the rest of the body. In the more typical genera, such as *Nymphon,* the head-region carries, in front of the first legs, three pairs of appendages, the chelate chelophores above and in front of the proboscis, followed by a pair of sensory palps and a pair of leg-like ovigers which get their name from the fact that they are nearly always used, in the male, to carry the eggs received from the female. Some or all of the appendages of the first three pairs may be reduced or absent in the adult, although they are probably always present in the young.

The internal structure is simple, with some peculiarities due to the reduced size of the body compared with the legs. The proboscis contains a suctorial pharynx, but the greater part of the digestive cavity is formed by the immensely long diverticula which extend from the alimentary canal into each of the legs. There is a tubular dorsal heart with two or three pairs of lateral ostia hut no definite blood-vessels. The nervous system consists of a supra-oesophageal ganglion or "brain" and a ventral chain of six to eight ganglia. The eyes, when present, are four in number, simple in structure, and elevated on a tubercle on the dorsal surface of the head. The gonads lie, to begin with, in the body, but send long diverticula into the legs, and the ripening eggs are lodged in the swollen fourth segments of these appendages. The genital apertures are on the second segments of the legs.

It is very characteristic of the Pycnogonida that the males take charge of the eggs as they are extruded by the females and carry them, cemented together in packets, on the ovigers. In a few genera, however, the egg-packets have never been seen and the mode of oviposition is unknown.

Not much is known of the habits of Pycnogonida. Most species are found clambering in ungainly fashion among the branches of hydroids or other coelenterates. Some are known to swim by beating the water with their long legs. Many species, perhaps all, feed upon the soft tissues of coelenterates which they suck into the mouth by dilating the pharynx. The distribution of the Pycnogonida extends to all seas, and in arctic and antarctic waters they sometimes occur in vast numbers. The affinities of the Pycnogonida are very obscure. (W. T. C.)

PYCNOSTYLE, the architectural term given by Vitruvius to the inter-columniation (*q.v.*) of a temple, when the distance between these columns was equal to 1½ times their diameter.

PYDNA, BATTLE OF (168 B.C.). The Roman operations in Greece having lingered on for some time, Lucius Aemilius Paullus, "one of the few Romans of that age to whom one could not offer money," was sent to hasten a decision. Arriving at Heracleum he at once seined the pass of Pythium, which compelled Perseus king of Macedonia to fall back on Pydna.

The serried ranks of the Macedonian phalanx astonished and terrified Paullus, who, however, disguised his anxiety from his men, and advanced towards his enemy. The Roman vanguard was dispersed and one cohort almost annihilated. Once again the sarissa (pike) carried all before it, the Roman legions being forced back until they reached the hill upon which stood their camp. Here, on account of the broken nature of the ground, the phalanx became somewhat disorganized. Paullus at once sizing up the situation "commanded his men, that wherever they should see the line of the enemy present openings, they should individually rush to these spots, and insinuating themselves like a wedge into such spaces, however narrow their extent, they should fight with impetuosity" (Livy). These tactics resulted in complete success, the phalanx being disjointed and broken up into a number of separated bodies. The II. legion then charged the disorganized mass of pikemen and routed it. Perseus and his cavalry fled the field leaving the infantry to be slaughtered—20,000 were killed and 11,000 made prisoners. This battle was the last fought by the phalanx. The whole campaign was only fifteen days. Thus perished the empire of Alexander the Great 144 years after his death.

See Livy *XLIV.; T.* Mommsen, *The History of Rome,* Book III. chap. x.; H. G. Liddell, *A History* **of Rome** (1855). (J. F. C. F.)

PYE, HENRY JAMES (1745–1813), English poet laureate, was born in London on Feb. 20, 1745, and educated at Magdalen college, Oxford. Of all he wrote his prose *Summary* of *the Duties* of *a Justice* of *the Peace out of Sessions* (1808) is most worthy of record; it is based on his own experience as a magistrate at Westminster. He was made poet laureate in 1790, perhaps as a reward for his faithful support of Pitt in the House of Commons. The appointment was looked on as ridiculous, and his birthday odes were a continual source of contempt. His most elaborate poem was an epic, *Alfred* (1801). He was the first poet laureate to receive a fixed salary of £27 instead of the historic tierce of Canary wine. He died at Pinner. Middlesex, on Aug. 11, 1813.

PYGMALION, (1) son of Cilix, and grandson of Agenor, king of Cyprus. He fell in love with an ivory statue he had made; Aphrodite granted life to the image, which he married (Ovid. *Metam.* x. 243). There is no ancient authority for the introduction of the name Galatea. (2) Brother of Dido (*q.v.*).

PYGMY, a term for a diminutive human being. Homer, in the *Iliad* (iii. 6) uses it of a race of tiny folk dwelling in a far southern land, whither the cranes fly when inclement winters and piercing frosts visit the northern shores. Fierce battles were often mentioned by later writers as occurring between the pygmies and cranes, and were even represented on their vases. On these the pygmies were depicted as dwarfs with large heads, negro features. close, curly hair, and sometimes armed with lances. Aristotle firmly believed in the existence of these pygmies, whom he characterized as a race of men of small stature inhabiting the marshes of upper Egypt towards the sources of the Nile. Herodotus (ii. 32), describes how five Nasamonians, while journeying through the African desert, came at last to a plain where fruit-trees grew. While gathering the fruit they were seized by some dwarfish men of strange speech, who led them to a town, where dwelt people of a similar appearance, and near which a great river flowed from west to east containing crocodiles. This river was probably the Niger, and the people referred to were no doubt the ancestors of the existing pygmies of equatorial Africa. Representations of pygmies are sculptured on the tombs at Sakkarah, the Vth Dynasty, *c.* 2500 B.C. They faithfully reproduce the racial characteristics of the present race of pygmies inhabiting the Ituri and Central forests.

BY COURTESY OF THE FIELD MUSEUM OF NATURAL HISTORY
BATAK PYGMY MAN AND WOMAN OF THE ISLAND OF PALAWAN, P.I.

Pliny mentions dwarfed races in both Asia and Africa, of the Catizi dwarfs in Thrace, and a similar race in Caria. Ctesias, a century after Herodotus, described a race of pygmies in the heart of India, as black and ugly, and only two *pygmai* in height. The Chinese author, Chao Fu-Kua, in the beginning of the 13th century, described a tribe of black pygmies dwelling in the Philippine Islands, called Hai-tan, small in size, with round, yellow eyes, curly hair, and with the teeth showing through their lips, no doubt the ancestors of the present Aetas. The existing pygmy races are divided into two groups: (a) the African pygmies, Negrillos, (b) the Asiatic pygmies, Negritos (*q.v.*).

PYLE, HOWARD (1853–1911), American artist and writer, was born at Wilmington (Del.), on March 5, 1853, He was a pupil of the Art Students' league, New York, and first attracted attention by his line drawings after the manner of Albrecht Diirer. His brilliant work as an illustrator made him one of the foremost of American artists, his drawings to illustrate American colonial life, particularly in New England and New Amsterdam, being especially noteworthy; and he published a number of books of fiction, written and illustrated by himself. He also became prominent in decorative painting, his works including "The Battle of Nashville" for the capitol at St. Paul (Minn.), and "The Landing of Carteret" for the Essex county court house, Newark (N.J.). At his home in Wilmington (Del.), he established a school of art, instruction being gratuitous, and many successful American illustrators were educated there. In 1907 Howard Pyle was elected a member of the National Academy of Design. He died in Florence on Nov. 9, 1911.

PYLOME, in zoology, is the name which is given to the principal opening (or openings) of the shell (theca, test) of various Protozoa. See FORAMINIFERA; RADIOLARIA.

PYLON, in architecture, originally a gate, but in modern usage reserved to the huge truncated pyramidal forms, crowned with cornices, that flanked the entrances to Egyptian temples. The term is also applied to any similar large masses of masonry, often decorated with sculpture or architectural forms, used to flank the entrance to an avenue, a plaza or a bridge—especially a suspension bridge. (See BRIDGES; EGYPTIAN ARCHITECTURE.)

PYLOS (mod. Navarino), a town and bay on the west coast of Messenia, noted chiefly for the part it played in the Peloponnesian War. The bay, roughly semicircular, is protected by the island of Sphacteria (mod. Sphagia), over $2\frac{1}{2}$ m. long. To the north lies the lagoon of Osman Aga. North of Sphagia is the rocky headland of Pylos or Coryphasium, called in modern times Palaea-Navarino or Palaeokastro, from the Venetian ruins on its summit. Most scholars have identified this with the Homeric Pylos, the home of Neleus and Nestor, and a cave on the north slope of Coryphasium is pointed out as that in which Hermes hid the stolen cattle of Apollo. But this view presents considerable difficulties, and Strabo (viii. 348, *sqq.*) argued that the Pylos of Nestor must be the place of that name in Triphylia, now known to have been an important prehistoric site. After the Dorian migration Pylos declined, and it is referred to by Thucydides (iv. 3) as a deserted headland in 425 B.C. In May of that year, the seventh of the Peloponnesian War, the Athenians sent an expedition to Sicily under command of Eurymedon and Sophocles. With them was the general, Demosthenes, who landed at Coryphasium with a body of Athenian troops and hastily fortified it. The Spartans, who were then invading Attica, withdrew their forces and attacked Pylos vigorously by sea and land, but were repulsed, and the Athenians were enabled by the arrival and victory of their fleet to blockade on the island of Sphacteria a body of 420 Spartiates with helots. Their resistance was overcome by a rear attack directed by a Messenian, who led a body of men by a difficult path along the cliffs on the east, and the 292 Spartan survivors laid down their arms 72 days after the beginning of the blockade. Their surrender made a deep impression on the whole Greek world, which had learned to regard a Spartan surrender as inconceivable. Though Pylos should have been ceded to Sparta under the peace of Nicias (421 B.C.) it was retained by the Athenians until the Spartans recaptured it early in 409 B.C. (Diodorus xiii. 64).

In the middle ages the name Pylos was replaced by that of Avarino (Ἀβαρῖνος) or Navarino, derived from a body of Avars who settled there; the current derivation from the Navarrese company, who entered Greece in 1381 and built a castle at this spot, cannot now be maintained (*Eng. Hist.* Review, xx. 307, xxi. 106; *Hermathena,* xxxi. 430 sqq.). From 1498 to 1821 Navarino was in the hands of the Turks, save at two periods when it was held by the Venetians, who named it Zonklon. (See NAVARINO, THE BATTLE OF.)

BIBLIOGRAPHY.—*See* W. M. Leake, ***Travels in the Morea,*** i. 398 ***sqq.*** (1830), and ***Peloponnesiaca,*** 190 ***sqq.*** (1846); *E.* Curtius, *Peloponnesos,* ii. 173 ***sqq.*** (Gotha, 1852); C. Bursian, ***Geographie von Griechenland,*** ii. 175 ***sqq.*** (Leipzig, 1868); Pausanias iv. 36, and the commentary in J. *G.* Frazer, *Pausanias's* ***Description of Greece,*** iii. 456 ***sqq., v.*** 608 ***sqq.*** (1898); *W.* G. Clark, *Peloponnesus,* 214 ***sqq.*** (1858); *W.* Vischer, Erin*nerungen* ***und*** *Eindrücke aus* ***Griechenland,*** 431 ***sqq.*** (Basel, 1857); G. Grote, ***History*** of ***Greece,*** pt. ii. ch. 52; G. Busolt, ***Griechische Geschichte,*** iii. 1086 ***sqq.;*** F. M. Cornford, ***Thucydides*** *mythistoricus,* 82 *sqq.* (1907). The operations at Pylos, described by Thucydides iv. 2–41, have been discussed on the basis of personal observation by Dr. *G.* B. Grundy ***(Journal of Hellenic Studies,*** xvi. 1 *sqq.; Classical* ***Review,*** x. 371 ***sqq.,*** xi. 155 ***sqq.,*** 448; ***J.H.S.,*** xviii. 232 ***sqq.)*** and Professor R. M. Burrows (*J.H.S.,* xvi. 55 *sqq.;* C.R. xi. 1 ***sqq.; J.H.S.,*** xviii. 147 ***sqq.,*** 345 *sqq.;* ***C.R.*** xix. 129 ***sqq.).*** Though differing on many points, they agree in thinking (1) that the island of Sphagia is the ancient Sphacteria, Palaeokastro the ancient Coryphasium or Pylos; (a) that in 425 B.C. the lagoon of Osman Aga was navigable and communicated by a navigable channel with the Bay of Navarino; **(3)** that Thucydides, if the ms. reading is correct, underestimates the length of the island, which he gives as 1j stades instead of 24 (nearly 3 m.), and also the breadth of the southern channel between it and the mainland. ***Cf. J.H.S.,*** xx. 14 ***sqq.,*** xxvii. 274 ***sqq.,*** and Frazer's summary **(ap.** *cit.* v. 608 ***sqq.).*** (M. N. T.; X.)

PYM, JOHN (1584–1643), English statesman, son and heir of Alexander Pym, of Brymore, Somersetshire, a member of an ancient family which had held this seat in direct male descent from the time of Henry III. He matriculated as a commoner at Broadgates Hall (now Pembroke College), Oxford, in 1599, and entered the Middle Temple in 1602. He became receiver-general of the king's revenue for Wilts., and was returned to parliament as member for Calne in 1614 and again in 1621. To the committee appointed to consider the state of religion he made his first great speech on Nov. 28, 1621; he spoke in defence of maintaining the disabilities of Roman Catholics on political grounds, and moved for a special commission for the suppression of recusancy. Pym was a chief promoter of the petition which incurred James's violent displeasure, and of the Commons' answer defending their privileges, which was afterwards torn from the records by the king's own hand. On the dissolution of parliament which immediately followed, Pym, with other "ill-tempered spirits," was arrested in Jan. 1622, and was confined first to his house in London, and then to Brymore. He associated himself with the party of Francis, 4th earl of Bedford, mas returned for Tavistock in 1624, and represented this borough in all the ensuing parliaments.

On May 8, Pyrn was manager of Buckingham's impeachment. In the third parliament of Charles I., in 1628, Pyrn overruled Eliot in deciding that Buckingham's impeachment should now be subordinated to the struggle on general grievances. He zealously pushed on the Petition of Right, resisting the clause added by the Lords to safeguard the king's "sovereign power," declaring that "he knew not what it was." He carried up to the Lords the impeachment of Roger Manwaring, and delivered a famous speech (June 9) in which he expounded the fundamental principles which guided his policy.

His name is not mentioned as actively resisting Charles's arbitrary government during the eleven years which followed the dissolution of 1629. It has not been proved that Pym, with Hampden and Cromwell, actually embarked for New England and was prevented from sailing by orders from the government. Pyrn himself was directly interested in the colonies, being patentee of Connecticut and Providence, and of the latter company also treasurer, and there can be little doubt that like other leaders of the opposition, he regarded America as a possible refuge.

Short Parliament.--On the assembly of the Short Parliament on April 13, 1640, Pym was the acknowledged leader. "Whilst men gazed upon each other," says Clarendon (*Hist.* ii. 68), "looking who should begin (much the greater part having never before sat in parliament), Mr. Pym, a man of good reputation . . . who had been as long in these assemblies as any man there living, broke the ice." On April 17 he spoke for nearly two hours on the national grievances, pointed out the practical injury inflicted on commerce and every sort of enterprise including colonial expansion by illegal and arbitrary taxation, and concluded by asking the Lords to join in finding out causes and remedies. His words made a deep impression. On April 27 he resisted the grant of supply, and when the Lords passed a resolution that supply should precede the discussion of grievances, Pym, as manager of the Commons on May 1, read them a severe lecture on the breach of privilege they had committed. Finally, on the 4th, it was resolved that Pyrn should next day petition the king to make terms with the Scots, to avoid which Charles summarily dissolved the parliament.

All the energies of Pyrn were now concentrated on obliging Charles to summon another parliament. He was the author of the petition of the twelve peers to the king for redress of grievances and for calling a new parliament, and he was the promoter of the petition signed by 10,000 citizens of London. In company with Hampden he rode through the provinces, rousing and organizing public opinion. Meanwhile Charles's attempt to implicate Pym in treasonable communications with the Scots failed.

Long Parliament.—When the king was forced to call the Long Parliament (Nov. 3), Pyrn was its acknowledged author and leader. On Nov. 7 he moved for a sub-committee to examine into Strafford's conduct in Ireland. The latter's sudden arrival at London on the 9th with the intention of instantly impeaching the popular leaders of treason was met by Pyrn with corresponding quickness and resolution. On the 11th, after a debate of four hours in the Commons, by his directions with locked doors, he carried up Strafford's impeachment to the Lords, and rendered him at once powerless.

On Dec. 6 he moved the impeachment of Laud. He was the chief promoter of the case against Strafford, while the attempts of the queen to gain him over were without result, and Jan. 28, 1641 he brought up to the Lords the list of charges. To the attainder, which was at this stage resolved upon, he was opposed (since he clung to the more judicial procedure by impeachment), but when overruled he supported it, at the same time procuring that the legal arguments should not be interrupted. He delivered his final speech on April 13, a great oratorical performance, when he again appealed to the Elizabethan political faith and to that of Bacon, who had so severely censured any action which divided the king from the nation. The man who violated this union was guilty of the blackest treason. "Shall it be treason," he asked, "to embase the King's coin though but a piece . . . of sixpence . . . and not to embase the spirits of his subjects: to set a stamp and character of servitude upon them?" Towards the end of his tremendous indictment of Strafford, Pyrn broke down, fumbled among his papers, and lost the thread of his argument. But his temporary failure did not diminish the force and effect of his words, all the more impressive because actually spoken in the presence of the sovereign. "I believe," wrote Baillie (Letters, i. 348) "the king never heard a lecture of so free language against his idolized prerogative."

Attempts were now once more made to gain over Pyrn to the administration. He had two interviews with the king, but without result, and Charles again determined to resort to force. On May 2 he endeavoured to get possession of the Tower. On the 3rd the Protestation, on Pym's motion, was taken by the Commons within closed doors, and afterwards circulated in the country, and on the 5th Pyrn disclosed the army plot. These incidents decided the struggle and Strafford's fate. Pyrn also took the lead in the religious controversy. During the dispute between the two houses on this question on Feb. 8–9, 1641, while supporting the London petition for the abolition of the bishops, he had declared his opinion that "it was not the intention of the House to abolish episcopacy or the Book of Common Prayer, but to reform both wherein offence was given to the people." This, no doubt, expressed his real intentions and policy. When, however, it became clear that the bishops were merely the nominees of the king to carry out "innovations in religion" and preach arbitrary government, Pyrn was easily persuaded to support their abolition, and voted in opposition to the moderate party for the Root and Branch Bill of May 1641, and again for taking away their votes in October. But in his "Vindication," published in March 1643, he especially states that his action with regard to the bishops in "no way concluded me guilty of revolt from the orthodox doctrine of the Church of England."

The first act in the great political struggle had ended in the complete triumph of Pym. His chief care now was to defend the parliament from violence, since this was the only method of retaliation left at the king's disposal, and on Nov. 22 he made a great speech on the Grand Remonstrance, of which he was the chief promoter, when he referred to plots "very near the king, all driven home to the court and popish party."

Charles returned on the 25th. He immediately substituted a force commanded by Dorset for the guard already placed at Westminster, but was compelled to withdraw it, and on Pym's motion the house appointed its own watch. Charles appointed Lunsford to the Tower, rejected the Grand Remonstrance and the Impressment Bill, and began to assemble an armed force. In consequence Pyrn urged, but unsuccessfully, on Dec. 30 the summoning of the train-bands to guard the parliament, and moved the impeachment of the bishops, who had declared the proceedings of the parliament to be sinful and illegal. At the critical moment, however, Charles wavered. He renewed his offer to Pyrn of the exchequer on Jan. 1, 1642, and on his refusal, he determined on the impeachment of the five members on Jan. 3. But these had been forewarned of the king's plans, and when on the 5th he entered the House of Commons with an armed band to seize them, they had removed themselves in safety. (See LENTHAL, WILLIAM.) Charles's first look on entering was for his great opponent, and he was greatly disconcerted at not finding him in his usual place. To his question "Is Mr. Pyrn here?" there was no answer, and nothing remained but to retreat with his mission completely unachieved. The second act in the great national drama had thus, as the first, ended in a victory for Pym. On the 11th, with the other members, he was escorted in triumph back to Westminster, and while the other four stood uncovered, Pym returned thanks from his place to the citizens.

Civil War.—When war broke out, Pym remained at headquarters in control of the parliament and executive, and on July 4 was appointed to the committee of safety which directed the movements of the parliamentary forces. His attitude was firm but moderate. He opposed the attempt to prevent Colepepper giving the king's message to the house on Aug. 27 when Charles declined to receive the petition of parliament and advanced on London Pym proposed (Oct. 20) the parliamentary covenant, and that those who refused it should be "cast out of the House." He succeeded in overcoming the opposition in the city to the heavy taxation now imposed. After repeated efforts to secure peace had failed, he proposed in order to carry on the war an excise, hitherto unknown in England, which met with the same violent hostility afterwards aroused by Walpole's scheme. In March he published a "Declaration and Vindication" of his public conduct, in which he threw the whole blame of the appeal to arms on the opposite party, and expressed his fidelity to the Church and constitution. In May he entered, together with the other leaders, into resultless negotiations with the queen, and on the 23rd he took up her impeachment to the Lords. In June he reported on Waller's plot, which exposed the insincerity of Charles's negotiations, and on June 26 wrote a "sharp letter" to Essex on his inaction. In July, after the defeat at Adwalton Moor, he prevented the house from again initiating negotiations for peace, which he declared "full of hazard and full of danger," and on Aug. 3, after having visited Essex at Kingston, persuaded him to separate himself from the peace propositions of the Lords and to march to relieve Gloucester. He thus incurred the hatred of the peace party, and on Aug. g a mob of women surrounded the house calling for Pym's destruction, and were not dispersed without some bloodshed.

Pym had already proposed (Jan. 3) to the house an alliance with the Scots, and the Royalist victories now induced parliament to consent to what had before been rejected. The establishment of Presbyterianism was accepted by Pym as a disagreeable necessity, and he was one of the first to take the covenant (Sept. 25). This alliance, which was afterwards destined to have so decisive an influence on the military campaign, and was the first occasion on which the two nations had united in public action, closes Pym's career. He was made master of the ordnance on Nov. 8, but died Dec. 8 at Derby House. He received a public funeral in Westminster Abbey, whence his body was ejected at the Restoration. A sum of £10,000 was voted by the parliament to pay Pym's debts and provide for his family. About 1614 Pym married Anne Hooke, or Hooker (d. 1620), by whom he had five children, including two sons, Alexander, who died unmarried, and Charles, who was created a baronet; this title, together with Pym's male line, became extinct in the person of Pym's grandson Charles in 1688, Brymore then passing to his sister Mary, wife of Sir Thomas Hales, Bart.

Character.—Pym had little of the Puritan in his character or demeanour. His good humour, humanity and cheerfulness in all circumstances, "his pleasant countenance and sweet behaviour," were marked characteristics; the aspersions, however, on his morals, as well as the accusations of bribery, are completely unsubstantiated and discredited. Pym's eloquence lay rather in the clearness of his expression and in the depth and solidity of his ideas than in the more showy arts of oratory.

The article on Pym by S. R. Gardiner, in the *Dict. Nat. Biog.* with its references to authorities, must be supplemented by the same author's *Hist. of England and of the Civil War*. Pym's life has also been ivritten at length by J. Forster in Lardner's *Cabinet Cyclopaedia, Eminent British Statesmen*, vol. iii., and by Wood in *Ath. oxon* iii. 72, who adds a list of Pym's printed speeches. His character, drawn by Clarendon, *Hist.* iii. 30 and vii. 409, is inaccurate and obviously prejudiced. See also J. Fosster's *Grand Remonstrance, Arrest of the Five Members, Life of Sir J. Eliot;* Verney's *Notes of the Long Parliament;* Whitelocke's *Memorials* (needing corroboration of other authorities); R. Baillie's *Letters; Eng. Hist. Rev.* xvii. 736; Rushworth's *Collections; Thomason Tracts, E* 153 (10), 63 (8), 172 (14), 164 (3), 200 (13) (26) (37) (49) (65), 199 (24) (49), 78 (13); *Somers Tracts* iv. 217, 355, 461, 466; *Affaniae* and *Death's Sermon*, by C. Fitzgeffrey; *Add. MSS*. Brit. Mus. 14,827; 11,692; *Lords and Commons Journals*. There are a large number of references to Pym in *Calendars of State Papers Dom.* 1619–1643, and *Colonial Series* 1574–1660, and in the *Hist. MSS. Comm. Series*; but the supposed notebook of Pym mentioned in *Rep.* x. app. vi. 82, has been shown by Gardiner to be that of another person (*Eng. Hist. Rev.*, Jan. 1895, p. 105).

PYORRHOEA is a term used to designate any one of a group of diseases (periodontoclasia or pyorrhoea alveolaris) which attack the gums and bone around the teeth. They include ulatrophia (recession of the gums), gingivitis (inflammation of the gums), alveolar resorption (wasting of the bony socket), pericementoclasia (pus pocket formation). Vincent's gingivitis, erroneously called Vincent's angina, also trench mouth, is an acute gingivitis caused by the fusiform bacillus and spirochaete of Vincent. It is the only type of periodontoclasia which is communicable. These diseases have a direct sequential relationship, although they do not always occur in the same order. A typical case may begin as recession associated with slight alveolar resorption: later it merges into gingivitis with advancing alveolar resorption; finally it develops a pus pocket (pericementoclasia), due to the detachment of the gum from the root, and still more advanced alveolar resorption. Unless checked by correct treatment this results in the loss of the tooth.

Knowledge as to the cause of periodontoclasia, while still incomplete, has advanced so far that rational treatment is now possible, and, in skilful hands, success is obtainable in nearly all cases. While infection plays a prominent part, the important factor is some influence which depresses the resistance of the tissues, thereby making infection possible. In a large percentage of cases the important depressant is an inequality of the biting surfaces of the teeth known as traumatic occlusion, resulting in unequal distribution of pressure when the jaws are brought together. Deposits of tartar, long regarded as the important factor, now only share the responsibility. Improper diet is regarded as important in the causation of periodontoclasia. This is apparently due to a failure to develop strong, resistant, supporting tissues for the teeth, because of dietary deficiencies. After the disease has become established dietary improvement is relatively ineffective.

Treatment includes the following, given in the order of their usual importance: equalizing functional stresses; raising local resistance by massage of the gums; removal of deposits of tartar, etc.; maintaining cleanliness; and building up general resistance by attention to nutrition. Preventive treatment follows the same lines, with special emphasis on stimulating the blood supply by tooth-brush massage. Orthodontic treatment, by helping to equalize functional stresses, helps in treatment and prevention.

Foci of infection may develop in the later stages of the disease, owing to the absorption of toxic material from the pus-pockets into the circulation. Also when the pocket extends to the end of the root, a typical abscess is produced. Advanced pyorrhoea or periodontal disease may usually be detected in the X-ray film, which registers the resorption of alveolar bone accompanying this disease. (J. O. McC.; P. R. S.)

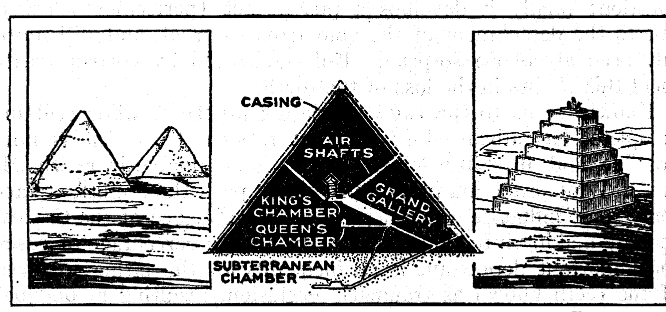
PYRAMID, the name for a class of buildings, first taken from a part of the structure,[1] and mistakenly applied to the whole of it by the Greeks, which has now so far acquired a more definite meaning in its geometrical sense, that it is desirable to employ it in that sense alone. A pyramid therefore should be understood as meaning a building bounded by a polygonal base and plane triangular sides which meet in an apex. (For figures of geometrical pyramids see CRYSTALLOGRAPHY, and for their mensuration see MENSURATION.) Such a form in architecture is best known in Middle Egypt, during the period from the IVth to the XIIth Dynasty (before 3000 B.C.)—having square bases and angles of about 50°. In other countries various modifications of the tumulus, barrow or burial-heap have arisen which have come near to this type; but these when formed of earth are usually circular, or if square have a flat top, and when built of stone are always in steps or terraces.

The origin of the pyramid type has been entirely explained by the discovery of the various stages of development of the tomb. In prehistoric times a square chamber was sunk in the ground, the dead placed in it, and a roof of poles and brushwood overlaid with sand covered the top. The Ist Dynasty kings developed a wooden lining to the chamber; then a wooden chamber free-standing in the pit, with a beam roof, then a stairway at the side to descend; then a pile of earth held in by a dwarf wall over it. By the IIIrd Dynasty this dwarf wall had

[1]The vertical height was named by the Egyptians *pir-em-us* (*see* E. Revillout, *Rev. Ég.*, 2nd year, 305–309), hence the Greek form *pyramis*, pl. *pyramides* (Herod.), used unaltered in the English of Sandys (1615), from which the singular *pyramid* was formed.

expanded into a solid mass of brickwork, about 280 by 150 ft. and **33** ft. high. This was the *ntastaba* type of tomb, with a long, sloping passage descending to the chamber far below it. This pile of brickwork was then copied in stonework early in the IIIrd Dynasty (Saqqara). It was then enlarged by repeated heightening and successive coats of masonry. And lastly a smooth casing was put over the whole, and the first pyramid appeared (Medum).

The pyramids were each begun with a definite design for their size and arrangement; this is plainly seen in the two largest, where continuous accretion (such as Lepsius and his followers propound) would be most likely to be met. Any section of these buildings shows how impossible it would have been for the passages to have belonged to a smaller structure (Petrie, 165). The supposition that the designs were enlarged so long as the builder's life permitted, was drawn from the compound mastabas of Saqqara and Medum; these are, however, quite distinct architecturally from true pyramids.



PYRAMID. LEFT: TWO AT GIZEH; CENTRE: SECTION, GREAT PYRAMID OF KHUFU, GIZEH, C. 3000 B.C.; RIGHT. ASSYRIAN

Around many of the pyramids peribolus walls may be seen, and it is probable that some enclosure originally existed around each of them. At the pyramids of Gizeh the temples attached to these mausolea may be still seen. As in the private tomb, the false door which represented the exit of the deceased person from this world, and towards which the offerings were made, was always on the west wall in the chamber, so the pyramid was placed on the west of the temple in which the deceased king was worshipped. The temple being entered from the east (as in the Jewish temples), the worshippers faced the west, looking towards the pyramid in which the king was buried.

The pyramid was never a family monument, but belonged—like all other Egyptian tombs—to one person, members of the royal family having sometimes lesser pyramids adjoining the king's (as at Khufu's); the essential idea of the sole use of a tomb was so strong that the hill of Gizeh is riddled with deep tomb-shafts for separate burials, often running side by side 60 or 80 ft. deep, with only a thin wall of rock between; and in one place a previous shaft has been partially blocked with masonry, so that a later shaft could be cut partly into it.

The usual construction of pyramids is a mass of masonry composed of horizontal layers of rough-hewn blocks, with a small amount of mortar; and this mass in the later forms became more and more rubbly, until in the VIth Dynasty it was merely a system of retaining walls of rough stones and mud, filled up with loose chips, and in the XIIth Dynasty the bulk was of mud bricks. There was always on the outside a casing of fine stone, elaborately finished, and very well jointed; and the inner chambers were of similarly good work. Indeed, the construction was in all cases so far sound that, had it not been for the spite of enemies and the greed of later builders, it is probable that every pyramid would have been standing in good order at this day. The casings were of massive blocks, usually greater in thickness than in height. Inside each pyramid, always low down, and usually below the ground level, was built a sepulchral chamber; this was reached in all cases by a passage from the north, sometimes beginning in the pyramid face, sometimes descending into the rock on which the pyramid was built in front of the north side. This chamber, if not cut in the rock altogether (as in Menkaura's), or a pit in the rock roofed with stone (as in Khafra's), was built between two immense walls which served for the east and west sides, and between which the north and south sides and roofing stood merely in contact, but unbonded. The gable roofing of the chambers was formed by great sloping slabs of stone, projecting from the north and south walls, on which they rested without pressing on each other along the central ridge; thus there was no thrust, though it had been provided for in the sloping form of the roof, so as to delay as long as possible the collapse of the chamber. This is best seen in the pyramid of Pepi (Petrie). opened from the top right through the roof. The roofing is sometimes of more than one layer; in Pepi's pyramid it is of three layers of stone beams, each deeper than their breadth, resting one on another, the thirty stones weighing more than 30 tons each. In the king's chamber (Gizeh) successive horizontal roofs were interposed between the chamber and the final gable roof, and such may have been the case at Abu Roash (Howard Vyse).

The passages which led into the central chambers have usually some lesser chamber in their course, and are blocked once or oftener with massive stones. In all cases some part, and generally the greater part, of the passages slopes downwards, usually at an angle of about 26°, *or* 1 in 2. These passages appear to have been closed externally with stone doors turning on a horizontal pivot, as may be seen at South Dahshur. This suggests that the interiors of the pyramids were accessible to the priests, probably for making offerings.

The pyramid of Medum was the first true pyramid. It was begun as a mastaba. This mastaba was then enlarged by heightening it and adding a coating, and this process, repeated seven times, resulted in a high stepped mass of masonry. Such had been made before, at the step pyramid of Saqqara; but for the first time it was now covered with one uniform slope of masonry from base to top, and a pyramid was the result. The chamber is peculiar for being entered by a vertical shaft in the floor. The great pyramid of Gizeh (Khufu's) is very different in its internal arrangements from any other. The pyramid covers upwards of 13 ac. and is about 150 ft. higher than St. Paul's cathedral. The greater number of passages and chambers, the high finish of parts of the work and the accuracy of construction all distinguish it. The chamber which is most normal in its situation is the subterranean chamber; but this is quite unfinished. The upper chambers, called the "king's" and "queen's," were completely hidden, the ascending passage to them having been closed by plugging blocks, which concealed the point where it branched upwards out of the roof of the long descending passage. Another passage, which in its turn branches from the ascending passage to the queen's chamber, was also completely blocked up. The object of having two highly-finished chambers in the mass may have been to receive the king and his co-regent (of whom there is some historical evidence) and there is very credible testimony to a sarcophagus having existed in the queen's as well as in the king's chamber. The accuracy of work is such that the four sides of the base have only a mean error of $\frac{6}{10}$ in. in length and 12" in angle from a perfect square.'

The second pyramid of Gizeh, that of Khafra, has two separate entrances (one in the side, the other in the pavement) and two chambers (one roofed with slabs, the other all rock-hewn); these chambers, however, do not run into the masonry, the whole bulk of which is solid so far as is known. This pyramid has a part of the original casing on the top; and it is also interesting as having the workmen's barracks still remaining at a short distance on the west side, long chambers capable of housing about 4,000 men. The third pyramid, that of Menkaura, was cased around the base with red granite for the 16 lowest courses. Its design has been enlarged at one bound from a small pyramid (such as those of the family of Khufu) to one eight times the size, as it is at present, the passages needed therefore to be altered. But there is no sign of gradual steps of enlargement: the change was sudden. The basalt

'With respect to the construction of this and other pyramids, *see* Howard Vyse; on measurements of the inside of the great pyramid and descriptions, *see* Piazzi Smyth; and on measurements in general mechanical means, and theories, *see* Petrie.

Place	King	Date B.C.	Base	Error	Angle	Height	Azimuth
Medum . . .	Sneferu	4750	5,682·0	6·2	51° 52′	3,619	24′ 25″ W.
Gizeh . . .	Khufu	4700	9,068·8	·6j	51° 52′	5,776	3′ 43″ W.
,, . . .	Khafra	4600	8,474·9	1'j	53° 10′	5,657	5′ 26″ W.
,, . . .	Menkaura	4550	4,153·6	3·0	51° 10′	2,581	14′ 3″ E.
Dahshur S. . .	?	?	7,459·0	3'7	{43° 5′, 55° 1′}	4,134	9′ 12″ W.
Dahshur Small .	?	?	2,064·6	1·1	44° 34′	1,017	10′ 12″ W.

sarcophagus of this pyramid was ornamented with the panel decoration found on early tombs, unlike the granite sarcophagi of the two previous pyramids, which are plain. Unhappily it was lost at sea in 1838.

Farther south are the pyramids of Abusir, described in the work of Col. Howard Vyse, and since excavated by the Germans. Next come those of Saqqara. The construction of the step pyramid or cumulative mastaba has been noticed above; its passages are very peculiar and intricate, winding around the principal chamber, which is in the centre, cut in the rock, very high, and with a tomb-chamber built in the bottom of it, which is closed with a great plug of red granite. A doorway faced with glazed tiles bearing the name of Ring Neter-khet of the IIIrd Dynasty existed here; the tiles were taken to Berlin by Lepsius. Beyond these come the pyramids of Dahshur, which are in a simple and massive style, much like those of Gizeh. The north pyramid of Dahshur has chambers roofed like the gallery in the great pyramid by successive overlappings of stone, the roof rising to a great height, with no less than 11 projections on each side. The south pyramid of Dahshur has still the greater part of its casing remaining, and is remarkable for being built at two different angles, the lower part being at the usual pyramid angle, while the upper part is but 43°. Beyond the Memphitic group are the scattered pyramids of Lisht (Senusert I.), Illahun (Senusert II.) and Howara (Amenemhat III.), and the earliest pyramid of Medum (Sneferu). Illahun is built with a framework of stone filled up with mud bricks, and Howara is built entirely of mud bricks, though cased with fine stone like the other pyramids.

The dimensions of the pyramids that are accurately known (as shown in table above) are in inches.

The first two closely agree to the proportion of 7 high on 11 base, approximately the ratio of a radius to its circle. And on dividing the base at Medum by 11 the modulus is 515·64, and the base of Khufu÷11 is 824·44. These moduli are 25 cubits of 20·625 and 40 cubits of 20·611; so it appears that the form was of the same type, but with moduli of 25 and 40 cubits respectively.

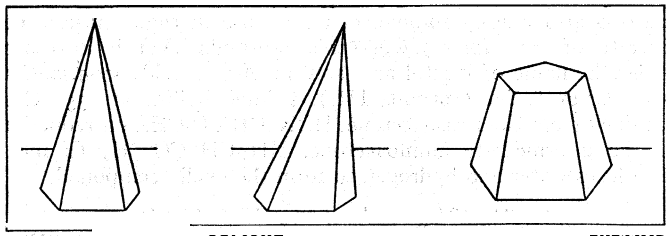
Beyond these already described there are no true pyramids, but we will briefly notice those later forms derived from the pyramid. At Thebes some small pyramids belong to the kings of the XIth Dynasty; the tomb-chamber is in the rock below. The size is under 50 ft. square. These are not oriented, and have a horizontal entrance, quite unlike the narrow pipe-like passages sloping down into the regular pyramids. (*See* Mariette, in *Bib. arch. trans.* iv. 193.) In Ethiopia, at Gebel Barkal, are other so-called pyramids of a very late date. They nearly all have porches; their simplicity is lost amid very dubious decorations; and they are not oriented. They are all very acute, and have flat tops as if to support some ornament. The sizes are very small, varying from 23 to 88 ft. square at Gebel Barkal and 17 to 63 ft. square at Meroe. The interior is solid throughout, the windows which appear on the sides being useless architectural members. (*See* Hoskin's *Ethiopia,* 148, etc.) The structures sometimes called pyramids at Biahmu in the Fayum have no possible claim to such a name; they were two great enclosed courts with sloping sides, in the centres of which were two seated statues raised on pedestals high enough to be seen over the walls of the courts.

Not one fragment of early inscription is known on the casing of any pyramid, either *in situ* or broken in pieces. Large quantities of travellers' "graffiti" doubtless existed, and some have been found on the casing of the great pyramid; these probably gave rise to the accounts of inscriptions, which are expressly said to have been in many different languages.

The mechanical means employed by the pyramid-builders have been partly ascertained. The hard stones, granite, diorite and basalt were in all fine work sawn into shape by bronze saws set with jewels (either corundum or diamond), hollows were made (as in sarcophagi) by tubular drilling with tools like our modern diamond rock-drills. (W. M. F. P.)

See Colonel Howard Vyse, *Operations at the Pyramids* (1840); Prof. C. Piazzi Smyth, *Life and Work at the Great Pyramid* (1867); W. M. Flinders Petrie, *Pyramids and Temples of Gizeh* (1883); M. D. Fraser, *The Pyramids* (Glasgow, 1894); H Borchardt, *Die Pyramiden* (1911); M. Edgar, *The Great Pyramid* (Glasgow, 1924).

PYRAMID, in geometry, a polyhedron of which one face, called the base, is any polygon and the other faces (the lateral faces) are triangles with one vertex in common. The intersections of the lateral faces are called the lateral edges of the pyramid, and their common vertex is called the vertex of the pyramid. The perpendicular distance from the vertex to the plane of the base is called the height or altitude of the pyramid. If the base is a regular polygon the centre of which coincides with the foot of the perpendicular from the vertex to the base, the pyramid is called a regular pyramid. As in the case of prisms (*q.v.*), pyramids are classified according to their bases. The portion of a



REGULAR PYRAMID, OBLIQUE PYRAMID, AND FRUSTUM OF PYRAMID

pyramid and a plane cutting all the lateral edges is called a truncated pyramid; and if the cutting plane is parallel to the base, the truncated pyramid becomes a frustum of a pyramid. The volume of a pyramid with base B and altitude a is $\frac{1}{3}aB$. The volume of a frustum of a pyramid with bases B and B' and altitude a is $\frac{1}{3}a(B+B'+\sqrt{BB'})$. *See* SOLIDS: *Geometric.*

PYRAMIDION (diminutive of "pyramid"), an architectural term for the copper-gilt casing covering the apex of an obelisk; also its upper termination of pyramidal form.

PYRAMUS AND THISBE, the hero and heroine of a Babylonian love story told by Ovid (*Metam.* iv. 55–465). Their parents refused to consent to their union, and the lovers used to converse through a chink in the wall separating their houses. At last they resolved to flee together, and agreed to meet under a mulberry tree near the tomb of Ninus. Thisbe was the first to arrive, but, terrified by the roar of a lion, took to flight. In her haste she dropped her veil, which the lion tore to pieces with jaws stained with the blood of an ox. Pyramus, believing that she had been devoured by the lion, stabbed himself. Thisbe returned to the rendezvous, and finding her lover mortally wounded, put an end to her own life. From that time the fruit of the mulberry, previously white, was always black.

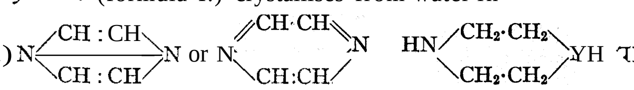
See G. Hart, *Die Ursprung und Verbreitung der Pyramus- und-Thisbesage* (1889–92).

PYRARGYRITE, a mineral consisting of silver sulphantimonite, Ag_3SbS_3, known also as dark red silver ore, an important source of the metal. It is closely allied to, and isomorphous with, the corresponding sulpharsenite known as proustite (*q.v.*) or light red silver ore. "Ruby silver" or red silver ore (Ger. *Rotgültigerz*) was mentioned by G. Agricola in 1546, but the two species were completely distinguished by J. L. Proust in 1804.

The colour of pyrargyrite is usually greyish-black and the lustre metallic-adamantine; large crystals are opaque, but small ones and thin splinters are deep ruby-red by transmitted light, hence the name, from Gr. πῦρ (fire) and ἄργυρος (silver). The streak is purplish-red, thus differing markedly from the scarlet streak of proustite and affording a ready means of distinguishing the two minerals. The mineral occurs in metalliferous veins with calcite, argentiferous galena, native silver, native arsenic, etc. The best crystallized specimens are from St. Andreasberg in the Harz, Freiberg in Saxony and Guanajuato in Mexico. It is not uncommon in many silver mines in the United States, but rarely as distinct crystals; and it has been found in Cornish mines.

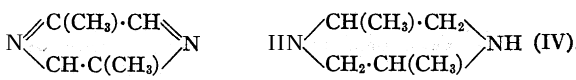
PYRAZINES, Piazines or Paradiazines, in organic chemistry, nitrogenous compounds containing a ring composed of four carbon atoms and two nitrogen atoms, the latter being at opposite ends of the ring in the so-called "para-position."

Pyrazine (formula I.) crystallises from water in

(I.)  (II.)

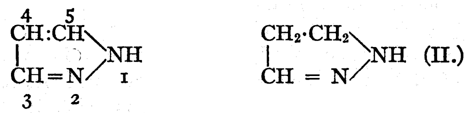
colourless prisms having a heliotrope odour; it melts at 55° C and boils at 115° C. In general the pyrazines are obtained by eliminating water and hydrogen from α-aminoaldehydes or α-aminoketones (2 molecular proportions in each case).

Piperazine (formula II.), the reduction product of pyrazine, is employed medicinally in gout and rheumatism. It is best prepared by condensing aniline and ethylene dibromide to diphenyldiethylenediamine, the dinitroso-compound of which hydrolyses to *p*-nitrosophenol and piperazine. It is a strongly basic compound melting at 104° C, boiling at 145° C, and soluble in water. Its urate is also readily soluble, hence its use in therapeutics. The tartrate of *$\alpha\gamma$-dimethylpiperazine* (formula IV.) is also used under the name of lycetol as a solvent of uric acid *$\alpha\gamma$-dimethylpyrazine* or *ketine* (formula III.), a liquid boiling at 153° C, is obtained from isonitrosoacetone, $HON:CH\cdot CO\cdot CH_3$, on reduction, as the intermediate aminoacetone, $NH_2\cdot CH_2\cdot CO\cdot CH_3$ (2 mol.) then loses water and hydrogen to form the cyclic compound.

(III.)  (IV).

A methyldiketopiperazine has been isolated from the hydrolysis of silk fibroin and shown to be identical with the synthetic compound from glycine and d-alanine.

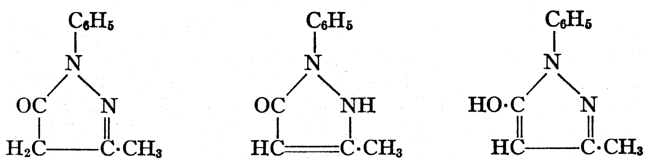
PYRAZOLES, in organic chemistry a series of compounds containing a five-membered ring with three carbon atoms united to two adjacent nitrogen atoms arranged as in formula (I.), which represents the structure of pyrazole itself.

(I.)  (II.)

The application in medicine of such pyrazole derivatives as antipyrine (*q.v.*) and pyramidone, and the production of synthetic dyes (*q.v.*) of the pyrazolone type, lends a special interest to this chapter of organic chemistry.

The simplest synthesis of pyrazole is effected by heating together acetylene and diazomethane (H. von Pechmann, 1897), this process corresponding with the synthesis of pyrrole (*q.v.*) from acetylene and ammonia. The earliest synthesis of pyrazole was accomplished by E. Buchner in 1889, who condensed ethyl diazoacetate with diethyl acetylenedicarboxylate, thus obtaining triethylpyrazole-3:4:5-tricarboxylate. The free pyrazoletricarboxylic acid on prolonged heating lost carbon dioxide and yielded pyrazole, which crystallises in colourless needles melting at 70° C (boiling point, 185° C), and giving well-defined salts with acids. Pyrazole has certain chemical properties in common with pyridine and benzene; it exhibits an aromatic character and can be sulphonated or nitrated. Its 4-nitro-compound can be reduced to 4-aminopyrazole, which resembles the aromatic bases; it gives a colour reaction with bleaching powder solution and its hydrochloride is readily diazotised. Pyrazole-4-diazonium chloride couples with phenols and naphthols to form azo-dyes after the manner of benzenoid diazo-compounds.

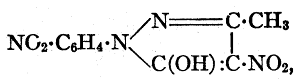
Pyrazoline or 4:5-dihydropyrazole (formula II.), is formed from acrolein and hydrazine hydrate and has also been obtained by the interaction of diazomethane and ethylene. It is a colourless liquid boiling at 144° C. The pyrazolines are unstable oxidisable substances resembling dihydrobenzene and its homologues; they are generally prepared by reducing the corresponding pyrazoles with sodium in alcoholic solution. On further reduction they yield pyrazolidines or tetrahydropyrazoles and when oxidised they develop blue or red colorations. This reaction, described by L. Knorr as the "pyrazoline reaction," is used for the detection of pyrazole and pyrazoline bases derived from phenylhydrazine. The *pyrazolones* (ketodihydropyrazoles), first prepared by Knorr in 1883, result from the elimination of the elements of alcohol from the hydrazones of β-ketonic acids. The most important member of this group is *1-phenyl-3-methyl-5-pyrazolone,* the parent substance of antipyrine and an intermediate in the manufacture of certain pyrazolone dyes (Eriochrome Red, etc.). 1-Phenyl-3-methyl-5-pyrazolone, prepared by condensing together phenylhydrazine and ethyl acetoacetate, crystallises in colourless prisms melting at 127° C, and although it is only known in this form, nevertheless it exhibits twofold tautomerism (see ISOMERISM) and behaves as if it had one or another of the three following structures



Methylene form — Imino-form — Phenolic form

When condensed with aldehydes, water is eliminated between aldehydic oxygen and the two hydrogens of the methylene group, thus indicating the mcthylene form. When methylated with methyl iodide in methyl alcohol to form the hydriodide of antipyrine (1-phenyl-2:3-dimethyl*iso*pyrazolone), the pyrazolone reacts in its imino form, the methyl group replacing the hydrogen of the imino group. Antipyrine (*q.v.*) and its therapeutically important derivatives and analogues are all constituted on the imino type. When in the production of synthetic dyes the pyrazolone is coupled with diazonium salts, it reacts in its third phenolic form, the diazo-group replacing the hydrogen of the CH residue adjacent to the hydroxyl-group.

Picrolonic acid,



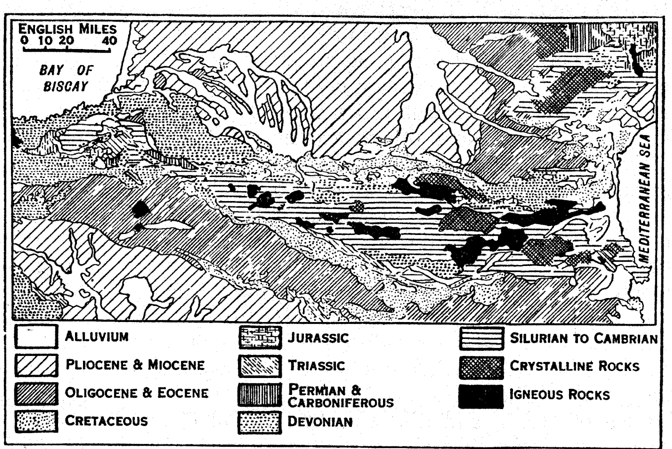
or 4-nitro-1-*p*-nitrophenyl-3-methyl-5-hydroxypyrazole, is also a pyrazolone of phenolic type. It closely resembles picric acid and is used to identify alkaloids and other bases owing to the formation of very sparingly soluble *picrolonates.* For benzopyrazoles, see INDAZOLES.

BIBLIOGRAPHY.—J. Schmidt, *A* Text Book of Organic *Chemistry* (translated by H. G. Rule) (1926); W. Meijer, Pyrazolones (1925); G. Cohn, Tabillarische *Übersicht* der Pyrazolderivate (Brunswick, 1897). (G. T. M.)

PYRENE, an aromatic hydrocarbon found with chrysene (*q.v.*) in the coal-tar distillate boiling above 360° C and also in "Stubb" fat, a by-product from the working up of mercury ores in Idria. It crystallises in pale yellow leaflets, melts at 148–149° and boils at 360° C. Chromic acid oxidises it successively to pyrenequinone and pyrenic acid; permanganate oxidises the latter substance to naphthalene-1:4:5:8-tetracarboxylic acid, which confirms the constitutional formula ascribed to pyrene $C_{16}H_{10}$.

BIBLIOGRAPHY.—A. E. Everest, *The* Higher Coal Tar Hydrocarbons (1927).

PYRENEES, a range of mountains in south-west Europe (Span. *Pirinéos,* Fr. *Pyrénées*), separating the Iberian Peninsula from France, and extending for about 240 m., from the Bay of Biscay to Cape Creus, or, if only the main crest of the range be considered, to Cape Cerbère, on the Mediterranean Sea. The main crest constitutes the Franco-Spanish frontier; except in the case of the valley of Aran, which belongs orographically to France but



GEOLOGICAL MAP OF THE PYRENEES

politically to Spain. The Pyrenees are conventionally divided into three sections, the central, the Atlantic or western, and the Mediterranean or eastern. The central Pyrenees extend eastward from Canfranc to the valley of Aran, and include the highest summits of the whole chain, Aneto or Pic de Néthou (11,168 ft.), in the Maladetta ridge, Posets (11,047 ft.), and Mont Perdu or Monte Perdido (10,997 ft.). In the Atlantic Pyrenees the average altitude gradually diminishes westward; while in the eastern Pyrenees, except for one break at the eastern end of the Pyrénées Ariégeoises, the mean elevation is maintained, till a rather sudden decline occurs in the extreme eastern portion, the Albères. This threefold division is only valid so far as the elevation of the Pyrenean chain is concerned, and does not represent its geological structure or general configuration. The southern versant of the mountains is the more important. It is recognized that the range must be regarded as an elevated part of the earth's crust, the culminating portion of which is composed of a series of chains, which do not coincide with the watershed, but cross it obliquely. Maps by Schrader and de Margerie (*Ann. du Club Alpin français,* 1891 and 1892) show the orderly arrangement of these chains. The primitive formations of the range are shown to be almost all continued diagonally on the Spanish side, and the central ridge thus presents the appearance of a series of wrinkles with an inclination (from north-west to south-east) greater than that of the chain as a whole. Other less pronounced wrinkles run from south-west to north-east and intersect the former series at certain points, so that it is by alternate digressions from one to the other series that the irregular crest of the Pyrenees acquires its general direction. Far from having impressed its own direction on the orientation of the chain at large, this crest is merely the resultant of secondary agencies by which the primitive mass has been eroded and lessened in bulk, and though its importance from a hydrographic point of view is still considerable, its geological significance is practically nil.

Geology.—The Pyrenees are divided into a number of longitudinal zones. The central zone (Central Massifs) consists of Primary rocks, Archaean, Cambrian, Ordovician, Silurian, Devonian and Lower Carboniferous (Dinantian) together with great masses of granite. It forms most of the higher summits, but west of the Pic d'Anie it disappears beneath an unconformable covering of Cretaceous deposits. On the French side the central zone is followed by (1) the zone of Ariège, consisting of Lower Cretaceous and Jurassic beds, together with granitic masses; (2) the zone of the Petites Pyrénées, Upper Cretaceous and Eocene; a thin outcrop of Jurassic; (2) the zone of Aragon, Eocene; and Primary rocks. On the Spanish side, from north to south, are (1) the zone of Mont Perdu, Upper Cretaceous and Eocene with a thin outcrop of Jurassic; (2) the zone of Aragon, Eocene; and (3) the zone of the Sierras, Trias, Cretaceous and Eocene. Although the number of zones is the same on the two flanks, they do not correspond. The zone of the Corbières has no equivalent in Spain, while in France there is no definite zone of Eocene like that of Aragon. The zone of the Petites Pyrénées, however, is clearly homologous with that of the Sierras. On the northern side granitic masses occur in the zone of Ariège amongst the Jurassic and Lower Cretaceous beds. On the southern side they are not found except in the axial zone, and the Jurassic and Lower Cretaceous deposits are reduced to a narrow band. In spite of these differences between the two flanks, the structure is to some extent symmetrical.

The tectonics of the Pyrenees are still only imperfectly understood. Some authorities consider the structure to be that of a "fan," whilst others have shown that the phenomena of *recouvrement* play an important part here. Large masses of rock have been brought forward upon thrust-planes over the edges of other beds with which they originally had no connection. Several cases have been described; but denudation has been carried further than in the Alps, and accordingly the masses overlying the thrust-planes have been more completely removed.

The Pyrenean axis was outlined by the Hercynian movement and folding took place along it at the close of the Dinantian epoch and again before the Permian. Later the chain was completely submerged until early Cretaceous times, when the earth movements which raised the present mountains commenced and continued into the Oligocene period. The uplift of the Pyrenees was therefore completed before that of the Alps.

The arrangement of the Pyrenees in chains gently inclined near the centre but longitudinal everywhere else, is illustrated by the courses of the streams which flow down towards Spain. On the French side most of the longitudinal valleys have disappeared, except at the eastern end. On the south the principal streams, after cutting their way through the highest zone at right angles to the general direction of the range, become involved half-way to the plains in great longitudinal folds, from which they make their escape only after traversing long distances.

The total area of the Pyrenees is estimated at 21,044 sq.m., two thirds of which is on the southern versant. The mean elevation is placed at 3,930 ft., whilst the highest summit Pic de Néthou, is 11,168 ft. above sea level. The passes show a greater altitude than those of the Alps.

Gaves.—Four features of Pyrenean scenery are the absence of great lakes, as in the Alps; the rarity and great elevation of passes; the large number of the mountain torrents locally called *gaves,* which often form lofty waterfalls, surpassed in Europe only by those of Scandinavia; and the frequency with which the upper end of a valley assumes the form of a *cirque.* The highest waterfall is that of Gavarnie (1,515 ft.), at the head of the Gave de Pau; the Cirque de Gavarnie, in the same valley, is perhaps the most famous example of the cirque formation. Low passes only occur at the two extremities of the range, where the principal highroads and railways run between France and Spain; a third railway (Pau to Jaca via the pass of Somport) was opened in 1928. In the mountains themselves there are only five passes practicable for motors—the Col de la Perche, Col du Pourtalet, Col de Somport, Roncevalles road and the road through the Baztan valley.

Projects for further railway construction, including the building of tunnels on a vast scale, have been approved by the French and Spanish governments (*see* SPAIN: *Communications*).

The metallic ores of the Pyrenees are not important. There are considerable iron mines at Vicdessos in Ariège and at the foot of Canigou in Pyrénées-Orientales. Coal deposits capable of being profitably worked are situated chiefly on the Spanish slopes and the French side has numerous beds of lignite. Mineral springs are abundant and specially noteworthy are the hot springs. The latter, among which those of Bagnères de Luchon and Eaux-Chaudes may be mentioned, are sulphurous and mostly situated high, near the margin of the granite. The lower springs, such as those of Bagnères de Bigorre (Hautes-Pyrénées,), Rennes (Aude) and Campagne (Aude), are mostly selenitic and not very warm. The use of hydro-electric power has been developed in recent years.

The amount of the precipitation, including rain and snow, is much greater in the western than in the eastern Pyrenees, causing a marked contrast between these sections of the chain in more than one respect. In the first place, the eastern Pyrenees are without glaciers, the quantity of snow falling there being insufficient. The glaciers are confined to the northern slopes of the central Pyrenees, and do not descend far down in the valleys, but have their greatest length in the direction of the chain. They form, in fact, a narrow zone near the crest of the highest mountains. Here, as elsewhere in Europe, there are evidences of a much wider extension of the glaciers during the Ice Age. The best known glacier is that in the valley of Argelks. The snow-line varies in different parts of the Pyrenees from 8,800 to 9,200 ft. above sea-level.

A more marked effect of the high rainfall in the west is seen in the vegetation. The lower mountains in the extreme west are very well wooded, but the extent of forest declines eastwards, and the eastern Pyrenees are peculiarly wild and naked, more so because here the granite massifs occur. There is a change, moreover, in the type of flora in passing from west to east. In the west the flora, at least in the north, resembles that of central Europe, while in the east it is distinctly Mediterranean in character. The Pyrenees are relatively as rich in endemic species as the Alps, and among the most remarkable instances of this is the occurrence of the sole European species of Dioscorea (yam), the D. pyrenaica, on a single high station in the central Pyrenees, and that of the monotypic genus Xatardia, only on a high pass between the Val d'Eynes and Catalonia. The genus most abundantly represented in the range is that of the saxifrages, several species of which are here endemic.

In their fauna also the Pyrenees present some striking instances of endemism. There is a distinct species of ibex (*Capra* pyrenaica) confined to the range, while the Pyrenean desman or water-mole (*Mygale* pyrenaica) is found only in some of the streams of the northern slopes of these mountains, the only other member of this genus being confined to the rivers of southern Russia. Among the other peculiarities of the Pyrenean fauna are blind insects in the caverns of Arihge, the principal genera of which are *Anophthalmus* and *Adelops.*

The ethnology, folk-lore, institutions and history of the Pyrenean region form an interesting study: see ANDORRA; ARAGON; BASQUE PROVINCES; BÉARN; CATALONIA; NAVARRE.

BIBLIOGRAPHY.—H. Béraldi, *Les Pyrtntes orientales et l'Ariège* (1904) and other works; P. Joanne, *Pyrénées* (1905); H. Belloc, *The Pyrenees* (3rd ed., 1923); A. Campagne, *Les forêts pyrénéennes* (1912); M. Sorre, *Les Pyrtntes* (bibl.) (1922); A. Oakley, *Hill-towns in the Pyrenees* (1924); R. O. Sawtell and I. Treat, *Primitive Hearths in the Pyrenees* (1927); for geology *see* also A. Bresson, *Études sur les formations des Hautes et Basses Pyrénées* (1903); L. Bertrand, *Sur la structure géol. des Pyrtntes*, etc. (1911); L. Carez, *Resumé de la géologie des Pyrtntes* (1912); on the climate and flora, T. Cook, *Handbook to the Health Resorts of the Pyrenees* (1905).

PYRÉNÉES-ORIENTALES, a department of south-western France, bordering on the Mediterranean and the Spanish frontier, formed in 1790 of the old province of Roussillon and of small portions of Languedoc and of Cerdagne. Population (1936) 233,347, including many Spaniards. Area, 1,600 sq.mi. The department is bounded north by Arihge and Aude, east by the Mediterranean, south by Catalonia and west by the republic of Andorra. Its borders are marked by mountain peaks, on the north by the Corbières, on the north-west and south-west by the eastern Pyrenees, on the extreme south-east by the Albères, which end in the sea at Cape Cerbera. The coast is low-lying, with large lagoons. In the lowlands the climate is Mediterranean, with mild winters, dry summers and short and sudden rain-storms. Amélie-les-Bains is much frequented on account of its mild climate and sheltered position. The temperature ranges from 85° to 95° F in summer, and in winter only occasionally falls as low as 26" or 27°. The mean rainfall is 27 in. on the coast, but increases towards the hills. The most common wind is the *tramontane* from N.N.W., as violent as the mistral of Provence and extremely parching. The *marinada* blows from the S.S.E.

On the Canigou massif to a height of 1,400 ft. are found the orange, the aloe, the oleander, the pomegranate and the olive; the vine grows to a height of 1,800 ft.; next come the chestnut (2,625 ft.), the rhododendron (from 4,330 to 8,330 ft.), pine (6,400), and birch (6,560); while stunted junipers grow to the summit. The cultivated land in Pyrénées-Orientales is devoted to wine-growing, market-gardening and fruit culture, the production of cereals being comparatively unimportant. The main source of wealth to the department is its wine, of which some kinds are strongly alcoholic and others are in request as liqueur wines (Rivesaltes, Banyuls). Early vegetables are grown in the irrigated lowlands, and fruit-growing is chiefly carried on in the river valleys. In iron Pyrénées-Orientales is one of the richest departments in France, the greater part of the ore being transported to the interior. Lignite and various kinds of stone are worked. The mineral waters are popular. Amélie-les-Bains has hot springs, chalybeate or sulphurous. In the arrondissement of Céret there are also the establishments of La-Preste-les-Bains, near Prats de Mollo, with hot sulphurous springs, and of Le Boulou, the Vichy of the Pyrenees. Near Prades are the hot sulphurous springs of Molitg, and a little north of Mont Canigou are the hot springs of Vernet, containing sodium and sulphur. In the valley of the Tet the sulphurous and alkaline springs of Thuès reach a temperature of 172° F.

The baths of Les Escaldas, near Montlouis, are hot, sulphurous and alkaline.

The chief route (Southern Railway) across the Pyrenees is from Perpignan through Montlouis, a fortified place, to Puigcerda, in the Spanish province of Gerona, through the pass of La Perche, skirting in the French department an enclave of Spanish territory. Three other roads run from Perpignan to Figueras through the passes of Perthus (defended by the fort of Bellegarde), Banyuls and Balistres, the last-named being traversed by a railway. The chief towns of the three arrondissements are Perpignan, Céret and Prades: there are 18 cantons and 234 communes.

The department constitutes the diocese of Perpignan under the archbishop of Albi, and is attached to the appeal court and the *académie* (educational division) of Montpellier and to the region of the XVI. army corps.

Perpignan, the capital town and a fortress of the first class, Amélie-les-Bains and Elne (*qq.v.*) are the chief towns.

Rivesaltes ([1936] 4,793) is the most populous town after Perpignan (64,100).

PYRETHRUM. The pyrethrum (family Compositae), now regarded as a section of the genus Chrysanthemum, flowers in the early summer months, and is remarkable for the great variety of colour which it presents.

The type form is the Caucasian species C. coccineum, a hardy perennial, with finely cut leaves and large flower heads, having a ray of deep rose-coloured ligulate florets surrounding the yellow centre or disk. They bloom during the months of May and June, as well as later, and are always most welcome ornaments for the flower borders, and useful for cutting for decorative purposes.

The powdered flower heads of *C.* coccineum and C. *anethifolium* are the source of Persian insect powder, and C. *cinerariaefolium* yields Dalmatian insect powder. Both are important insecticide ingredients, commonly called pyrethrum.

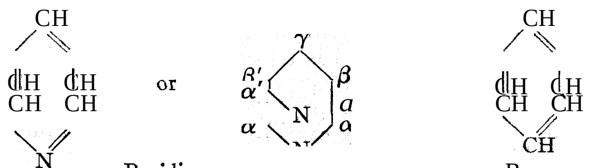
PYRGI, an ancient town of Etruria, Italy, on the southwest coast, g mi. W.N.W. of Caere. The name is Greek (πύργοι towers), and the place of considerable antiquity. Remains of its defensive walls exist in polygonal blocks of limestone and sandstone, neatly jointed. They enclosed a rectangular area some 200 yd. in width and at least 220 yd. in length, and there was a small harbour.

A rich temple of Leucothea here was plundered by Dionysius in 384 B.C. Later it became dependent on Caere, though it was not originally its harbour, for Alsium (*q.v.*) is a good deal nearer (5 mi. south). The Romans planted a colony here about 200 B.C.

PYRGOS, a town of Greece, in the province of Elis and Achaea, 43 mi. S.S.W. of Patras. It is connected with its harbour, Katakolon, $7\frac{1}{2}$ mi. distant. with Patras, Olympia and Kalamata by rail. It has frequently been injured by earthquakes. Pop. 22,500. Axis troops occupied it during World War II.

PYRIDINE, C_5H_5N, is a liquid organic base formed during the destructive distillation of a great variety of nitrogenous organic substances such as bone, coal, shale and lignite. It has been detected in crude petroleum and fusel oil, and is also a characteristic decomposition product of various alkaloids (*q.v.*) either heated alone or with zinc dust. Pyridine was discovered and isolated in a pure state by T. Anderson (1851) from bone oil, which, together with coal tar, is its chief commercial source, and which is obtained in the preparation of bone black or animal charcoal by distilling bones in a closed retort. For the extraction from coal tar or bone oil, the light oil boiling up to 120° C is taken and the basic constituents are extracted by washing with dilute sulphuric acid and removing the acid layer. The bases, which have dissolved in the acid, are liberated by the addition of excess of caustic soda and separate as a dark oily layer at the surface of the liquid After drying they are fractionally distilled in order to separate pyridine from its higher homologues which inevitably accompany it when obtained from these sources. Synthetically pyridine may be prepared by distilling allylethylamine over lead oxide; by passing acetylene and hydrocyanic acid through a red-hot tube; by heating pyrrole with sodium methoxide and methylene iodide; also by heating *iso*amyl nitrate with phosphoric oxide. These methods are of theoretical interest only. When required very pure, it is made by distilling nicotinic acid with lime.

Properties. — Pyridine is a colourless liquid with a penetrating sickly odour. It boils at 115° C, has a specific gravity of 0.9855 and a high refractive index. It is hygroscopic and miscible with water in all proportions, but is not soluble in strong caustic alkali or salt solutions. It is very stable towards the common chemical reagents. Nitric and chromic acids are without action upon it, whilst chlorine and bromine yield substitution products with difficulty. If bromine is added to a hydrochloric acid solution of pyridine, a crystalline unstable dibromide, C_5H_5N,Br_2, is precipitated, which can be used as a delicate reagent to brominate other compounds. It is because pyridine possesses this property of forming loose additive compounds on the nitrogen atom that it is a useful "carrier" in the halogenation of various materials. At high temperatures it reacts with sulphuric acid to form a sulphonic acid. As a base it combines with acids to form crystalline salts, such as the hydrochloride, which is very soluble in water. With many inorganic salts such as mercuric, auric and platinic chlorides, it forms double salts or addition compounds, many of which are highly crystalline and sparingly soluble in cold water. Pyridine combines with alkyl iodides to form pyridinium alkyliodides which are often highly crystalline and have definite melting points. Nascent hydrogen reduces pyridine to piperidine, $C_5H_{11}N$ (*see* p. 798), whilst hydriodic acid reduces it to n-pentane. Pyridine is a strong base; its aqueous solution turns red litmus blue. It is a tertiary amine possessing a ring structure that is expressed symbolically by the following formulae:



Pyridine Benzene

The resemblance in chemical behaviour found between the derivatives of benzene and pyridine indicates that these two substances must have a similar ring constitution, The above formulae also allow for the existence of all the known isomeric substitution products. Thus, when substituent groups are identical, six di-derivatives, six tri-, three tetra-, and one penta-derivative have been isolated. The five hydrogen atoms which can be replaced by a substituting group are represented by the Greek letters α, β, γ, β', and α', the positions α and α', β and β', being equivalent.

Uses.—Pyridine is used for asthma, and certain of its iodine derivatives for antiseptic purposes as well as for some protozoal diseases. In some countries pyridine is used as a denaturant for alcohol. As a catalyst it is applied in specific chemical reactions. Pyridine is one of the best organic solvents, readily dissolving a large number of technical products such as fats, mineral oils and rubber. It has also the remarkable property of dissolving many metallic salts such as silver nitrate and mercuric acetate. In the dye industry it is used as a solvent in the extraction of carbazole from crude anthracene. Pure pyridine is mainly used for the production of piperidine.

Derivatives.—Chloropyridines can all be obtained under varying conditions by the action of phosphorus pentachloride on pyridine or upon hydroxypyridines. The β-derivative is best prepared by the action of chloroform on potassium pyrrole. By heating with alcoholic ammonia, several of the higher chlorinated pyridines can be converted into amino-chloropyridines.

β-Pyridinesulphonic acid, $C_5H_4(SO_3H)N$, is formed when pyridine is treated with fuming sulphuric acid. The sodium salt on distillation with potassium cyanide yields β-cyanopyridine, which on hydrolysis gives nicotinic acid. On fusing the sulphonic acid with potash, β-hydroxypyridine is formed.

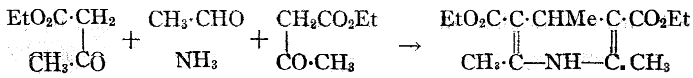
Nitration of the pyridine nucleus is only possible when amino-, hydroxy- or similar groups are present. Aminopyridines are obtainable by the action of ammonia upon the corresponding chloropyridine. The α-amino- and $\alpha\alpha'$-diamino-derivatives are formed by the action of sodamide on pyridine and subsequent treatment with water. The aminopyridines can be diazotised in the same way as aniline and can form azo-dyes.

Hydroxypyridines correspond to aminophenols in that they form salts with strong bases and acids. They are feebly basic in character and are readily soluble in water. They also exhibit keto-enol tautomerism (*q.v.*), derivatives of keto-dihydropyridine, or pyridone, being obtainable.

The carboxylic acids of pyridine are usually prepared by oxidizing the homologues of the base with potassium permanganate. Many of the alkaloids yield these acids upon energetic oxidation. When heated with strong hydrochloric acid the higher polycarboxylic acids give rise to the lower acids by loss of carbon dioxide. By heating with lime all the carboxyl groups are eliminated and pyridine is formed. The most important pyridine carboxylic acids are described in the following table:

Name	Formula	Position of substituent	Remarks
Picolinic acid	$C_5H_4N(CO_2H)$	α	M.p. 137° C. Easily soluble in water.
Nicotinic acid	$C_5H_4N(CO_2H)$	β	M. p. 228° C. An oxidation product of nicotine and berberine.
Quinolinic acid	$C_5H_3N(CO_2H)_2$	$\alpha\beta$	M.p. 190° C with decomposition into nicotinic acid. Formed on oxidation of quinoline.
n o meronic acid	$C_5H_3N(CO_2H)_2$	$\beta\gamma$	M.p. 266° C. Formed on oxidation of quinine, cinchonine and iso-quinoline.

Homologues.—The homologues of pyridine constitute that fraction of the crude bases from bone or coal-tar oil boiling between 120–230° C. They can be synthesized in various ways. One of the most important is A. Hantzsch's "collidine" synthesis, which consists in the condensation of two molecules of acetoacetic ester with one of aldehyde and one of ammonia:



The resulting dihydro-compound is oxidized with nitrous acid, the ester hydrolysed, and the acid heated with lime, when the trimethylpyridine is obtained. The α- and γ-alkyl-pyridines are also produced by heating the pyridinium alkyl iodides, a molecular rearrangement taking place. These homologues are of importance because of their relation to the alkaloids. A simple alkyl-pyridine is often the main product of distillation of an alkaloid with zinc dust or lime. They are liquids of an unpleasant odour resembling pyridine. The chief alkyl-pyridines are summarized in the following table:

Name	Formula	Position of substituent	Remarks
Picolines	$C_5H_4N(CH_3)$	a	Liquid, b. p. 129° C. Oxidizes to picolinic acid.
		β	Liquid, b. p. 142° C. Oxidizes to nicotinic acid.
		γ	Liquid, b. p. 143° C.
Lutidines	$C_5H_3N(CH_3)_2$	aa', αβ', ay , ββ', βγ	Six isomerides, all liquids, b. p. 140–165° C (approx.)
Collidines	$C_5H_2N(CH_3)_3$	aya'	Liquid, b. p. 171° C. Five other isomerides.

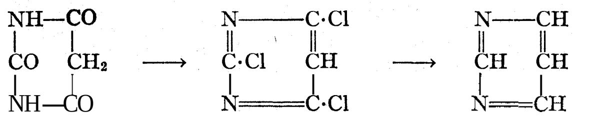
Piperidine, or hexahydropyridine, $C_5H_{11}N$, is a colourless liquid of peculiar odour slightly resembling that of pepper. It dissolves readily in water and alcohol, boils at 106° C, and has strongly basic properties. It occurs in pepper in combination with piperic acid as the alkaloid piperine. It is prepared by the reduction of pyridine with metallic sodium and alcohol. Upon oxidation it yields pyridine. Piperidine is a secondary amine and its imino-hydrogen atom is therefore replaceable by alkyl and acyl radicals. Benzoylpiperidine when heated with phosphorus pentachloride in sealed tubes yields benzonitrile and pentamethylene dichloride, showing that the piperidine ring is readily opened. When heated with fuming hydriodic acid it yields n-pentane and ammonia.

Piperidine is often used as a catalyst in synthetic organic chemistry. It was one of the first organic accelerators used in the vulcanisation of both synthetic and natural rubber, and certain of its derivatives are still used for this purpose. The hydrogen tartrate and other salts have been employed in medicine for urinary calculi and as uric acid solvents, of doubtful efficacy.

(J. RD.)

PYRIMIDINES, METADIAZINES or MIAZINES, a series of nitrogenous organic substances which play an important part in physiological processes. They possess a cyclic structure as shown in the formula (III.) of pyrimidine itself, and the group includes cyclic urea derivatives (ureides) and also compounds of the uric acid or purine group.

Pyrimidine is best prepared from barbituric acid (malonyl urea, formula I.) by the action of phosphorus oxychloride and by reduction of the resulting 2:4:6-trichloropyrimidine (formula II.).

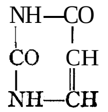


(I.) (II.) (III.)

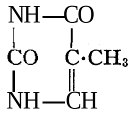
Pyrimidine is a crystalline base of narcotic odour and dissolves readily in water; it melts at 21° C and boils at 124° C. Derivatives of pyrimidine are of great physiological importance and take part in many fundamental life processes. They have been shown by Kossel (1893) to be present in the cell nucleus where synthetic changes associated with the growth of the cell are taking place.

Uracil (2:6-dioxypyrimidine, formula IV.), a white crystalline powder, sparingly soluble in cold but more readily soluble in hot water, melts with evolution of gas at 338° C. It was recognised as a hydrolytic product of nucleic acids from yeast in 1900 by A. Ascoli and was synthesised by E. Fischer and Roeder in 1901 by heating urea with acrylic acid. This condensation gave dihydrouracil which was successively converted into monobromo-derivative and uracil.

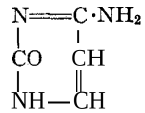
Thymine or 5-methyl-a:6-dioxypyrimidine (formula V.) is obtainable in large amount from animal and vegetable nucleins; it has also been synthesised by E. Fischer; it crystallises from water in colourless leaflets melting at 318–321° C.



(IV.)



(V.)



(VI.)

Cytosin (2-oxy-6-aminopyrimidine, formula VI.) was synthesised by H. Wheeler and Treat B. Johnson in 1903 and identified by Kossel and Neumann in 1894 as a hydrolytic product of thymonucleic acid. It crystallises from water in colourless, nacreous plates decomposing at 320–325° C. It is converted by nitrous acid into uracil (v. supra) and is oxidised by barium permanganate into oxalic acid and biuret. (See UREA.)

For methods of preparation and properties of numerous pyrimidine derivatives see T. B. Johnson, *Jour. Biol. Chem.*, 1906; Amer. *Chem. Journ.*, 1906; *Journ.* Amer. *Chem. Soc.*, 1911 et seq.

BIBLIOGRAPHY.—C. Oppenheimer, Handbuch der Biochemie, vol. i. (1924); E. Abderhalden, Biochemisches Handlexikon, vol. iv. (1911); vol. ix., Supplement, 1915; V. Meyer and P. Jacobson, *Lehrbuch der* Organischen Chemie, vol. ii. (1920).

PYRITE or **PYRITES,** a term applied to iron disulphide when crystallized in the cubic system. The original word pyrites (from Gr. πῦρ, fire) had reference to the fact that sparks might be elicited on striking the mineral violently, as with flint, so that πυρίτης λίθος meant a stone which struck fire. Hence the name seems to have been applied also to flint, and perhaps to emery and other hard stones. Nodules of pyrite have been found in prehistoric barrows and elsewhere under conditions suggesting their use as a primitive means of producing fire. Even in late historic time it was employed in some of the old wheel-lock guns. The compound FeS_2 is dimorphous, and the modern practice is to distinguish the cubic form as pyrite and the orthorhombic as marcasite (*q.v.*).

Iron pyrites, or pyrite, belongs crystallographically to the parallel-faced hemihedral class of the cubic system. Its common forms are the cube, the octahedron, and the pentagonal dodecahedron, or various combinations of them. It has a conchoidal fracture, and a very indistinct cubic cleavage. Its hardness is about 6, and its specific gravity 4.9 to 5.2, being rather more than that of marcasite. Moreover, the colour of pyrite is brass-yellow, whilst that of marcasite when untarnished may be almost tin-white. From copper-pyrites (chalcopyrite) pyrite is distinguished by its superior hardness and by its paler colour. On exposure to meteoric influences pyrite commonly becomes brown, by formation of ferric hydrate. Such a change is very common on the outcrop of mineral veins, forming what miners call "gozzan."

According to the formula FeS_2, pyrite contains theoretically 46.67% of iron and 53.33% of sulphur. Practically, however, it frequently contains other metals, such as copper, cobalt and nickel. Gold is often present, and in many gold-mining districts the precious metal is obtained mainly from auriferous pyrite. As pyrite, from its brass-yellow colour, is sometimes mistaken for gold, it has been vulgarly called "fool's gold." Traces of thallium, which are present in some pyrite, may be detected in the flues of the furnaces where the metal is roasted. Arsenic is an impurity which may be of serious consequence in some of the purposes to which pyrite is applied. The presence of copper, nickel and arsenic is possibly due in many cases to traces of kindred minerals, like chalcopyrite, pentlandite and mispickel.

DISTRIBUTION AND USES

Pyrite is a mineral of very wide distribution, occurring under varied conditions and probably originating in various ways. It is common in mineral-veins, usually associated with quartz, and is often known to miners as "mundic." It occurs crystallized, commonly in cubes, in schistose and slaty rocks, and less abundantly in the younger sedimentary deposits. In coal it not infrequently forms bands and nodules known as "brasses," and may also be finely disseminated through the coal as "black pyrites"; but much of the so-called pyrite of coal is really marcasite. Films of pyrite sometimes coat the joint-planes of coal. Pyritous shales have been largely used in the manufacture of alum, and are therefore known as "alum shales." Many fossils are mineralized with pyrite, which has evidently been reduced by the action of decomposing organic matter on a solution of ferrous sulphate, or perhaps less directly on ferrous carbonate dissolved in water containing carbonic acid, in the presence of certain sulphates. A similar action probably explains the origin of pyrite and marcasite in coal and lignite, in clay and shales, and in limestone like chalk.

Pyrite is largely worked for the sake of the sulphur that it contains, and has displaced sulphur in the manufacture of sulphuric acid. For this purpose its value depends on the proportion of sulphur present. Pyrite low in sulphur is incapable of sustaining its own combustion without the aid of an external source of heat, and 45% of sulphur is, for economic reasons, usually regarded as the lowest percentage admissible for sulphuric acid manufacture. It is also important for this purpose that the ore should be as free as possible from arsenic (see SULPHURIC ACID).

An extremely important variety of pyrite is that which is more or less cupriferous, and is commonly known commercially as "copper-pyrites" (*q.v.*), though distinct mineralogically from that mineral. It consists, indeed, mainly of pyrite, with a notable but variable proportion of copper, sometimes with silver and gold, and not infrequently associated with lead and zinc sulphides. The copper probably exists as disseminated chalcopyrite. Deposits of such cupriferous pyrite are widely distributed and are often of great magnitude. They are generally of lenticular form, and usually occur in or near the contact of eruptive rocks with schists or slates; the presence of the igneous rock being probably connected genetically with their origin.

The world's annual production of iron-pyrite is about 4,500,000 tons. The largest producer is Spain, with upwards of 2,000,000 tons, including the cupriferous pyrite. France yields about 200,000 tons, largely from the Sain Bel mines, department of the Rhône. Then follows Portugal, with its important output of cupriferous pyrites. In the United States the production of pyrite now reaches about 170,000 tons per annum. The State of Virginia is the chief producer, followed successively by Georgia, North Carolina, Colorado, Massachusetts, California, Missouri, New York, etc. From Indiana and Ohio a quantity of pyrite is obtained as a by-product in coal-mining. The United Kingdom yields but little pyrite, the annual output being not more than about 5,000 tons. Large quantities of "sulphur ore" were, however, formerly worked in the Vale of Avoca, County Wicklow, Ireland. Finely crystallized specimens of pyrite are obtained from many other localities, especially from Cornwall, Elba and Traversella, near Ivrea, in Piedmont.

PYRITZ, a town in the Prussian province of Pomerania, Germany, 16 mi. S.W. of Stargard by the railway to Cüstrin. Pop. (1939) 11,200. It became a town in 1150 and is still surrounded by walls with towers. Near the town was the spring in which Otto, bishop of Bamberg, baptized the first Pomeranian converts to Christianity in 1124.

PYROCATECHIN or **PYROCATECHOL:** *see* CATECHOL.

PYROGALLOL or PYROGALLIC ACID, a trihydroxybenzene, $C_6H_3(OH)_3=1:2:3$, first prepared by Scheele in 1786 by heating gallic acid. It is used as a photographic developer and also as an oxygen absorbent in gas analysis. It has antiseptic properties and is employed medicinally in the treatment of psoriasis. The process of manufacture is still based on Scheele's procedure. Gallic acid with half its weight of water is heated in an autoclave until the pressure reaches 12 atmospheres and the temperature registered is 175° C. Steam and carbon dioxide are then allowed to escape, leaving in sufficient water to keep the pyrogallol liquid. The cooled solution is decolorised with animal charcoal and evaporated down until the volatile pyrogallol has distilled over into flat iron receivers. The solidified material is purified by repeated distillation or sublimation. Pyrogallol crystallises in colourless leaflets or needles, melts at 133° C and is easily sublimed; it distils at 293° C under the ordinary pressure with partial decomposition. It dissolves in $2\frac{1}{4}$ parts of water at 13° C, and its aqueous solution develops a blue colour with ferrous sulphate containing a little ferric salt. Its alkaline solution, when exposed to air, rapidly becomes black, owing to the absorption of oxygen with the production of complex coloured substances. (G. T. M.)

PYROLUSITE, a mineral consisting essentially of manganese dioxide (MnO_2), of importance as an ore of manganese. It is a soft, black, amorphous mineral, often with a granular, fibrous or columnar structure, and sometimes forming reniform crusts. It has a metallic lustre, and a black or bluish-black streak, and readily soils the fingers. The specific gravity is about 4.8.

Supposed crystals of pyrolusite have been proved to be pseudomorphs after manganite; in fact the mineral often results by the dehydration and oxidation of manganite ($Mn_2O_3{\cdot}H_2O$), and for this reason it frequently contains a little water. True crystals of manganese dioxide are referred to the rare species polianite: they are tetragonal and isomorphous with cassiterite. Pyrolusite is an alteration product of other manganese minerals—manganite, rhodochrosite, rhodonite, etc. It occurs as irregular masses and nodules in the residual clayey materials resulting from the decomposition of various rocks, for example, limestone. That it is readily deposited from solution is shown by the frequent occurrence of black dendritic markings in the crevices of rocks, excellent examples of which are seen in mocha stone (*q.v.*) and in the lithographic stone of Solenhofen, Bavaria. It is deposited by some springs and manganiferous nodules are dredged from the floor of the deep sea.

As an ore pyrolusite is extensively mined at Ilmenau and other places in Thuringia, in North Wales, at several places in the United States (Vermont, Virginia, Arkansas, etc.), Nova Scotia, Brazil, India, etc. Together with the rather less important ore, psilomelane, it has various economic applications: it is extensively used for the manufacture of spiegeleisen and ferromanganese, and of various alloys, such as manganese-bronze; as an oxidizing agent it is used in the preparation of chlorine and disinfectants (permanganates); and when mixed with molten glass it oxidizes the ferrous iron to ferric iron, and so discharges the green and brown tints, hence the name pyrolusite, from Gr. πῦρ (fire) and λύειν (to wash). As a colouring material, it is used in calico printing and dyeing; for imparting violet, amber and black colours to glass, pottery and bricks; and in the manufacture of green and violet paints.

PYROMETER, an instrument for measuring high temperatures (Gr. πῦρ, fire, μέτρον, a measure). The term was first used by Musschenbroek to denote an instrument wherein the expansion of a metal rod measured the temperature. Discontinuous thermoscopes, depending on the fusion of a metal or salt, have also been employed. Prinsep prepared a series of alloys of silver and gold, and of gold and platinum, whose melting points, as determined by accurate instruments, covered a range of temperature from 954° to 1,775°, at intervals of from 25° to 30°. By placing ingots in a furnace and observing which one melted a fair idea of the temperature was obtained Carnelley and Williams employed certain salts of known melting point; whilst the Seger's cones, employed in porcelain manufacture, depend on the softening of small cones made of clay. The instruments employed today depend either on electrical effects produced in wires inserted in the furnace and so raised to its temperature, or upon measurements made on the radiation emitted by the furnace. (See also THERMOMETRY for scientific forms.)

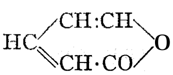
PYROMORPHITE, a mineral species composed of lead chloro-phosphate $(PbCl)Pb_4(PO_4)_3$, sometimes occurring in sufficient abundance to be mined as an ore of lead.

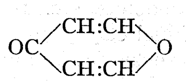
Crystals are common, and have the form of a hexagonal prism terminated by the basal planes, often with a barrel-like curvature, globular and reniform masses also being found. Between pyromorphite and the corresponding chloro-arsenate (mimetite, *q.v.*) the resemblance in external characters is so close that, as a rule, it is only possible to distinguish them by chemical tests, and they were formerly confused under the names "green lead ore" and "brown lead ore." The phosphate was first distinguished chemically in 1784, and it was named pyromorphite from Gr. πῦρ (fire) and μορφή (form), because when a fragment is fused the globule assumes a faceted form on solidifying. The colour is usually some bright shade of green, yellow or brown, and the lustre is resinous. The hardness is 3.5 and specific gravity 6·5–7·1. Pyromorphite has resulted from the alteration of galena in the oxidized portions of metalliferous veins, and is frequently met with in the upper levels of lead mines.

PYROMUCIC ACID (Furoic Acid): see FURFURAN.

PYRONES, in chemistry a group of heterocyclic compounds containing a six-membered ring composed of five carbon atoms and one oxygen atom. Substances containing the pyrone nucleus occur in nature; for example, coumarin, the odoriferous principle of the tonka bean, contains a pyrone, residue and so also do meconic acid, present in opium, and chelidonic acid, found in the celandine and white hellebore.

Two types of pyrones may be distinguished, the α-pyrones (I.), in which the oxygen atom is adjacent to a carbonyl group, and the y-pyrones (II.), where the oxygen atom and the carbonyl group are at opposite ends of the ring structure.

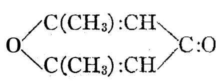
(I.) 

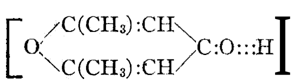
 (II.)

a-Pyrone or coumalin (I.) is derived from malic acid (*q.v.*). This acid on heating with strong sulphuric acid yields coumalic acid (α-pyrone-5-carboxylic acid) and on distilling the mecury salt of this intermediate acid in hydrogen, carbon dioxide is eliminated and α-pyrone is obtained as an oily liquid boiling at 206–209° C.

Phenylcoumalin or α'-phenyl-α-pyrone, colourless crystals melting at 68" C, is found in coto-bark. On heating with alkalis it yields benzoic acid and acetophenone. $\alpha'\beta'$-Benzo-α-pyrone is discussed under its other name, coumarin (*q.v.*). Like y-pyrone and dimethyl-y-pyrone (*v. infra*), coumarin has the property of forming salts with the acids (aurichloric, cobalticyanic, hydriodic and platinichloric acids). y-Pyrone or pyrocomane (II.) crystallises in colourless prisms melting at 32" C and boiling at 210–215° C. It is prepared from chelidonic acid γ-pyrone-2-6-dicarboxylic acid, m.p. 262° C. This acid on being heated loses carbon dioxide in two stages to form comanic acid, γ-pyrone-2-carboxylic acid, and finally y-pyrone. The elimination of carbon dioxide is facilitated by the addition of copper powder. Chelidonic acid can either be obtained from natural sources (v. *supra*) or prepared synthetically by condensing acetone with ethyl oxalate in presence of sodium ethoxide, when ethyl acetonedioxalate is produced, and this substance on boiling in alcoholic solution loses water to form ethyl chelidonate.

$\alpha\alpha'$-Dimethylpyrone (III.) is prepared by condensing carbonyl chloride with the copper derivative of ethyl acetoacetate, or by the action of concentrated hydrochloric acid on dehydracetic acid. It forms white monoclinic plates, melting at 132° C and boiling at 248° C/713 mm. It is readily soluble in water or alcohol to neutral solutions which have a bitter after-taste. Dimethylpyrone has the noteworthy property of giving well-defined crystallisable salts with hydrochloric, platinochloric and tartaric acids.

(III.) 

 (IV.)

The salts, which are considerably hydrolysed in aqueous solution, arise from a combination between one of the oxygen atoms (possibly the carbonyl one) and the hydrion of the acid. On the electronic theory of chemical combination either of these oxygens can furnish a pair of electrons to co-ordinate with the hydrion which has already given its single electron to the anion of the acid. Formula IV. represents the dimethylpyrone hydrochloride as having the hydrogen co-ordinated with the carbonyl oxygen. Dimethylpyrone was shown by A. Werner to combine in a similar way with cupric chloride to form the compound $C_7H_8O_2,CuCl_2$, the existence of which supports the hypothesis that the oxonium salts of the pyrones are co-ordination compounds arising from the operation of the subsidiary valencies of the oxidic or ketonic oxygen atoms. (G. T. M.)

PYROPHONE, the name of a curious kind of musical instrument invented by Georges Frederick Eugen Kastner (1852–82), son of the German composer and musical theorist, Jean Georges Kastner (1810–67). It consists of a set of tubes, from which the sound is produced, not by wind, but by jets of gas, picturesquely described by the author in a book which he published on the subject as "flammes chantantes."

PYROPHORIC ALLOYS, alloys which when filed or scratched give off bright sparks. Alloys containing about 15% iron and mixtures of rare-earth metals with small amounts of antimony, bismuth, copper and silicon are used in various lighters.

PYROPHORUS, a material which inflames spontaneously on contact with air. Homberg's pyrophorus (Gr. πῦρ, fire; *φέρειν*, to bear), one of the earliest known, was prepared by heating alum with finely divided carbon or organic material (lampblack, starch or flour) in a closed tube. The product, a mixture of potassium sulphide, aluminium sulphate and carbon, is spontaneously inflammable. The oxides of iron, cobalt or nickel when reduced by hydrogen at low red heat leave the metal in a state of such fine division that it becomes incandescent on exposure to air. Lead tartrate heated in a closed tube leaves a pyrophoric residue of finely divided lead. Liquid phosphine, P_2H_4, and organo-metallic compounds such as cacodyl, zinc diethyl, trimethylstibine, etc., are spontaneously inflammable liquids.

PYROPHYLLITE, a mineral species composed of hydrous aluminium silicate, $HAl(SiO_3)_2$. It occurs in two more or less distinct varieties, namely. as crystalline folia and as compact masses; distinct crystals are not known.

The folia have a pronounced pearly lustre, owing to the presence of a perfect cleavage parallel to their surfaces: they are flexible but not elastic, and are usually arranged radially in fanlike or spherical groups. This variety, when heated before the blowpipe, exfoliates and swells up to many times its original volume, hence the name pyrophyllite, from the Greek πῦρ (fire) and φύλλον (a leaf), given by R. Hermann in 1829. The colour of both varieties is white, pale green, greyish or yellowish; they are very soft (H.=1–2) and are greasy to the touch. The specific gravity is 2·8–2·9. The two varieties are thus very similar respectively to talc (*q.v.*) and its compact variety steatite, which is, however, a hydrous magnesium silicate. The compact variety of pyrophyllite is used for slate pencils and tailors' chalk ("French chalk"), and is carved by the Chinese into small images and ornaments of various kinds. Other soft compact minerals (steatite and pinite) used for these Chinese carvings are included with pyrophyllite under the terms agalmatolite and pagodite.

Pyrophyllite occurs in schistose rocks, often associated with kyanite, of which it is an alteration product. Pale green foliated masses, very like talc in appearance, are found at Beresovsk near Ekaterinburg in the Urals, and at Zermatt in Switzerland. The most extensive deposits are in the Deep River region of North Carolina, where the compact variety is mined, and in South Carolina and Georgia.

PYROTECHNY: see FIREWORKS.

PYROXENE, in mineralogy, an important group of rock-forming minerals very similar in chemical composition and general characters to the amphiboles (q v.). The name (from Gr. πῦρ, fire, and *ξένος*, stranger) was originally given by Haüy in 1796 to the augite (*q.v.*) of the lavas of Vesuvius, in the belief that the crystals had been caught up by the lavas that contained them; but next to the felspars the pyroxenes are the commonest constituents of igneous rocks, being especially characteristic of those of basic composition (basalt, gabbro, pyroxenite, etc.). Though crystallizing in three different systems, the pyroxenes all possess distinct prismatic cleavages, with an angle of about 87° between them. Usually the habit of these minerals is that of short prisms, but in the alkaline varieties long slender prisms are often characteristic, e g, acmite.

The pyroxenes are conveniently subdivided into three series according to the symmetry of their crystals. Chemically they are essentially metasilicates. The principal species are indicated in the table on p. 801.

Rhombic Series	
Enstatite	$Mg\,SiO_3$
Bronzite	$(Mg, Fe)\,SiO_3$
Hypersthene	$(Fe, Mg)\,SiO_3$
Monoclinic Series	
Clinoenstatite	$Mg\,SiO_3$
Diopside	$Ca\,Mg\,(SiO_3)_2$
Hedenbergite	$Ca\,(Mg, Fe)\,(SiO_3)_2$
Enstatite — Diopside or Magnesium Diopside	$m(Mg,Fe)SiO_3.\ nCa(Mg,Fe)(SiO_3)_2$
Augite	$Ca(Mg,Fe)(SiO_3)_2$ with $(Mg,Fe)SiO_3$ and $(Al,Fe''')_2O_3$
Acmite	$NaFe'''(SiO_3)_2$
Jadeite	$NaAl(SiO_3)_2$
Spodumene	$LiAl(SiO_3)_2$
Wollastonite	$CaSiO_3$
Pectolite	$HNaCa_2(SiO_3)_3$
Rosenbuschite	$Na_2Ca_3[(Si,Zr,Ti)O_3]_4$
Triclinic Series	
Rhodonite	$MnSiO_3$
Pyroxmangite	$(FeMn)\,SiO_3$
Bustamite	$(Ca,Mn)\,SiO_3$
Babingtonite	$Ca(Fe,Mn)\,(SiO_3)_2$ with Fe_2O_3 and SiO_2
Sobralite	$CaMgFe_2Mn_4\,(SiO_3)_8$
Hiortdahlite	$4Ca(Si, Zr)O_3.\ Na_2ZrO_2F_2$

Many of these species are described under their respective headings, to which reference should be made. Others not so treated are briefly mentioned below. *Clinoenstatite,* the monoclinic magnesium metasilicate, occurs in meteorites. It is the only stable metasilicate of magnesium prepared in the laboratory. It melts incongruently at 1,557° C with separation of forsterite. *Enstatite-diopside* or *magnesium diopside* is an isomorphous mixture of diopside with clinoenstatite, and as such is a characteristic pyroxene of the quartz-dolerite group of igneous rocks. *Hedenbergite* is a black or dark green pyroxene characteristic of metasomatically metamorphosed limestones or skams, and is often associated with andradite garnet. A fluorine-bearing diopside known as *mansjöite,* occurs at Mansjö Mt. in Sweden. The manganese and zinc-bearing monoclinic pyroxenes include *schefferite* $Ca(Mg,Fe,Mn)(SiO_3)_2$, and *jeffersonite,*

$$Ca(Mg,Fe,Mn,Zn),(SiO_3)_2,$$

both occurring at Franklin Furnace, New Jersey.

Jadeite is a white to grey pyroxene occurring in dense fibrous masses in association with serpentine, glaucophane schists or eclogites in Turkistan, Tibet, Burma and other places. It possesses a distinct ethnographic interest owing to its use by prehistoric man in the manufacture of images and utensils. *Pectolite* occurs as a secondary mineral in the form of radiating fibrous crystals in druses and veins of basic igneous rocks of the triclinic series of minerals classified as pyroxenes, *bustamite, fowlerite* and *pyroxmangite* are closely related to *rhodonite.* The two former occur at Franklin Furnace, New Jersey. *Sobralite* occurs with manganese-garnet in an eulysite from Sodermanland in Sweden. According to the most recent analyses, *babingtonite* contains alkalis and water as essential constituents. The mineral occurs in black crystals on felspar in the granite of Baveno, Italy, and also as a product of contact metamorphism in Japan and elsewhere. The rare zirconium-bearing silicates, *hiortdahlite* and the monoclinic *rosenbuschite,* occur in the nepheline-rich rocks of southern Norway and of the Los archipelago (Guinea). (C. E. T.)

PYROXENITE, a rock consisting essentially of minerals of the pyroxene group, such as augite and diallage, hypersthene, bronzite or enstatite. Names have been given to members of this group according to their component minerals, *e.g.,* pyroxenite (augite), diallagite (diallage), hypersthenite (hypersthene), bronzitite (bronzite), websterite (diallage and hypersthene). Closely allied to this group are the hornblendites, consisting essentially of hornblende. The term perknite (Gr. περκνός, dark) has also been used to designate the whole series.

PYRRHB OF ELHS (c. 360–270 B.C.), a Greek sceptic philosopher and founder of the school known as Pyrrhonism. Diogenes Laertius (ix. 61), quoting from Apollodorus, says that he was at first a painter, and that pictures by him were in existence in the gymnasium at Elis. Later he was diverted to philosophy by the works of Democritus. He studied in India under the Gymnosophists (*q.v.*) and under the Magi in Persia. Returning to Elis, he lived in poor circumstances, but highly honoured by the Elians and also by the Athenians, who gave him the rights of citizenship. His doctrines are known mainly through the satiric writings (Σίλλοι) of his pupil Timon of Phlius (the Sillographer). The main principle of his thought is expressed in the word *acatalepsia,* which implies the impossibility of knowing things in their own nature. Pyrrho concludes that, since nothing can be known, the only proper attitude is imperturbability *(ataraxia).* The impossibility of knowledge, even in regard to our own ignorance or doubt, should induce the wise man to withdraw into himself, avoiding the stress and emotion which belong to the contest of vain imaginings. *(See* PHILOSOPHY, HISTORY *OF.)*

PYRRHOTITE, a mineral species consisting of iron sulphide and crystallizing in the hexagonal system. The formula is Fe_nS_{n+1}, in which n may vary from 5 to 16; such a composition being explained by the "solid solution" of sulphur in ferrous sulphide (troilite). Small amounts of nickel and cobalt are often present; the mineral is of some importance as an ore of gold, and the nickeliferous pyrrhotite of Sudbury, Ontario, is by far the most important source of nickel.

Crystals have the form of hexagonal plates bounded at their edges by faces of a hexagonal prism and pyramids, which are deeply striated horizontally. More frequently, however, the mineral is massive, with a laminar or granular structure. It is magnetic, sometimes with polarity, and is therefore often called "magnetic pyrites." The colour is bronze yellow, the lustre metallic and the streak greyish black. The hardness is 4 and the specific gravity 4·58–4·64.

Pyrrhotite occurs in metalliferous veins, and as grains and plates disseminated through various rocks.

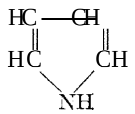
PYRRHUS *(c.* 318–272 B.C.), king of Epirus, son of Aeacides, and a member of the royal family of the Molossians. He claimed descent from Pyrrhus, the son of Achilles, and was also connected with the royal family of Macedonia through Olympias, the mother of Alexander the Great. He became king when still a boy, and fought for Demetrius Poliorcetes at Ipsus in 301. He was sent to the court of Ptolemy as a hostage by Demetrius, married Ptolemy's step-daughter Antigone, and became in his turn a thorn in Demetrius' side. For some time he occupied most of Macedonia under the terms of a truce, but in 286 Lysimachus defeated him at Edessa and drove him back into Epirus.

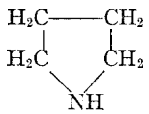
In 281 Tarentum, in southern Italy, asked his assistance against Rome. Pyrrhus went with some 25,000 men, and might, with more whole-hearted assistance from the Greek cities, have been a fatal obstacle to the growth of Rome, faced with Etruscans and Gauls in the north as well as this reinforced opposition in the south. Greeks and Romans met at Heraclea, and Pyrrhus, with the advantage gained by his cavalry and elephants, completely defeated the consul M. Valerius Laevinus, but at the cost of very heavy losses. This battle is the origin of the phrase "a Pyrrhic victory." He advanced on Rome through Latium, but the towns were all garrisoned, and though the senate were inclined to agree to terms, the speech of Appius Claudius the censor decided them against it. Cineas, Pyrrhus' minister, was sent back with a refusal to negotiate as long as Pyrrhus' troops were in Italy.

In 279 Pyrrhus won another victory at Asculum in Apulia. He then went to Sicily with the idea of driving the Carthaginians out; his military operations were successful, and Rome and Carthage united in an alliance against him, while his despotic methods alienated the Sicilian cities. He stayed three years in Sicily, and then returned to Italy, but the Greek cities now entirely failed to support him, and he was completely defeated at Beneventum in 275. He left Italy, saying "what a battlefield I am leaving to Rome and Carthage"—a remark of some insight. The rest of his life was passed in wars at home, including a victory over Antigonus Gonatas, and an unsuccessful expedition into Sparta at the invitation of Cleonymus in 273. He was killed in 272 in a night skirmish in a street in Argos. Pyrrhus wrote a history of the art of war, which is praised by Cicero, and quoted by Dionysius of Halicarnassus and Plutarch.

The chief ancient authority for the life of Pyrrhus is Plutarch; *see* also Polybius xviii. 11, and elsewhere; Dion. Halic. xviii. 1, xix. 6–9; Pausanias i. 13; Justin xviii. 1, 2, xxiii. 3, xxv. 4, 5. Modern monographs by G. F Hertzberg, "Rom und König Pyrrhus" (popular: in O. Jäger's *Darstellungen aus der römischen Geschichte,* 1870); R. von Scala, *Der Pyrrhische Krieg* (1884), with map of Roman garrison system in 281; R. Schubert, *Geschichte des Pyrrhus* (1894), with full list of authorities; also ROME: *History.*

PYRROLE, in chemistry a comparatively simple organic base containing four carbon atoms and one nitrogen atom, united to form a five-membered ring C_4H_5N (formula I.). Its tetrahydro-compound, *pyrrolidine,* has a similar cyclic structure (formula II.) but with four additional hydrogen atoms. Pyrrole and pyrrolidine are of great significance in connection with the chemistry of many complex substances found in living organisms both vegetable and animal. These two five-membered rings are patterns frequently

(I.) 

 (II.)

employed in the molecular structure of products arising from the vital activities of plants and animals. The tobacco alkaloids, nicotine and nicoteine contain pyrrole nuclei, whereas pyrrolidine residues are present in other alkaloids such as stachydrine, betonicine, hygrine and the solanaceous and coca alkaloids. Hydrolysis of protein materials often leads to the production of proline (pyrrolidine-2-carboxylic acid) or of hydroxyproline (4-hydroxypyrrolidine-2-carboxylic acid). Moreover, the researches of Willstatter and other investigators have shown that the pyrrole pattern is manifolded in chlorophyll (*q.v.*) and haemoglobin (*q.v.*), thus revealing an interesting relationship between the colouring matters of leaves and blood.

Pyrrole is a colourless liquid which becomes brown on exposure and smells like chloroform. It boils at 130–131° C/761 mm.; its specific gravity is 0·9752/12·5° C. Although readily soluble in ether or alcohol, it dissolves only sparingly in water. It is insoluble in aqueous alkalis and dissolves but slowly in acids. On keeping or on warming its acid solution a red precipitate known as pyrrole red separates, this characteristic reaction being accompanied by liberation of ammonia.

Pyrrole is present to a small amount in coal tar but is most readily obtained from bone oil (Dippel's oil) when the fraction boiling between 98° and 150° C is heated with solid caustic soda. The solid product, a sodium pyrrole, C_4H_4NNa, is hydrolysed by water and distilled in steam, when pyrrole passes over and is purified from its homologous methylated pyrroles by fractional distillation. It can be prepared synthetically by heating ammonium mucate (see MUCIC ACID) with glycerin, the mixture being then saturated with ammonia and distilled at 320–330° C. In pyrrole vapour a pine-wood splinter moistened with hydrochloric acid develops an intense carmine-red coloration, this reaction being employed as a delicate test for pyrrole.

Pyrrole has been obtained by passing acetylene and ammonia through a heated tube containing ferric oxide; it is also produced on heating succinimide (see SUCCINIC ACID) with zinc dust containing zinc hydroxide.

With zinc dust and mineral acid, pyrrole is reduced to its dihydro-derivative, *pyrroline,* a colourless liquid boiling at 90° C/748 mm., fuming in air and having a strongly alkaline reaction.

Pyrrolidine (formula II.) is obtained by reduction of either pyrrole or pyrroline with hydriodic acid and phosphonium iodide at 240–260° C, or with hydrogen at this temperature over a nickel catalyst. The reduction of ethylene cyanide leads to pyrrolidine together with tetramethylenediamine (putrescine, a ptomaine alkaloid). Pyrrolidine is a constituent of the tobacco alkaloids.

Although pyrrole itself has had no technical application, its iodo-derivative is an antiseptic. Iodine acts on potassium pyrrole to yield tetraiodo-pyrrole or *Iodole,* $C_4I_4{:}NH$, which crystallises in yellowish-brown prisms and decomposes at 140° C. This compound acts antiseptically like iodoform but has the advantage of being odourless.

BIBLIOGRAPHY.—J. Schmidt, *Die Chemie der Pyrrols und seiner Derivate* (1904); Ahrens' *Sammlung Chemischer und Chemisch-technischer Vorträge* (1912, vol. 17, p. 311); *Neue Studien in der Indol und Pyrrolgruppe,* by A. Angeli 1913; C. Hollins, *The Synthesis of Nitrogen Ring Compounds* (1924). (G. T. M.)

PYRUVIC ACID or **PYRORACEMIC ACID,** an extremely reactive organic acid employed in the synthesis of derivatives of aryl-cinchonic acids including phenylcinchonic acid (Acidum Phenylcinchonicum, U.S. Pharmacopoeia), which is also known as Phenoquin or Atophan, used in neuralgia, sciatica or for the elimination of uric acid in gout and rheumatic affections.

Pyruvic acid, $CH_3{\cdot}CO{\cdot}CO_2H$, is best prepared by heating together an intimate mixture of 6 parts of fused potassium hydrogen sulphate and 4 parts of tartaric acid at 210–220° C. The distillate is fractionated under reduced pressure when a 50–55% yield of the acid is obtained (O. Kamm, Organic Syntheses, J. Wiley and Sons, 1925, vol. v., p. 63). Pyruvic acid was first obtained by Berzelius in 1855 by the dry distillation of tartaric or racemic acid. Methods of academic interest are: (1) the acid hydrolysis of acetyl cyanide, $CH_3{\cdot}CO{\cdot}CN$, or of ethyl oxaloacetate, $Et{\cdot}O_2C{\cdot}CO{\cdot}CH_2{\cdot}CO_2{\cdot}Et$; (2) boiling $\alpha\alpha'$-dichloropropionic acid with moist silver oxide. As prepared by any of the foregoing methods pyruvic acid is a liquid boiling at 75–80°/25 mm. and at 165° C/760 mm. with partial decomposition; it may be solidified and then melts at 13·6° C. With phenylhydrazine it yields a well defined crystalline phenylhydrazone and it combines additively with prussic acid and with alkali bisulphites. It forms mercaptols with the mercaptans and is reduced successively to lactic and propionic acids. Its most characteristic reaction with aldehydes and aromatic amines (Doebner's reaction) leads to the production of aryl-cinchonic acids. With benzaldehyde and aniline it furnishes phenylcinchonic acid and with other aldehydes and β-naphthylamine it yields β-naphthylcinchonic acids of definite melting points which on heating lose carbon dioxide and give well-defined bases. The reactions serve to identify aldehydes (*q.v.*).

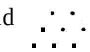
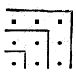
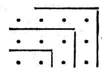
PYTHAGORAS (6th century B.C.), Greek philosopher, was a native of Samos and flourished about 532 B.C. He is said to have been a pupil of Pherecydes (*q.v.*). He left in Ionia the reputation of a learned and universally informed man. "Of all men," says Heracleitus, "Pythagoras, the son of Mnesarchus, was the most assiduous enquirer." The extensive travels attributed to Pythagoras are no doubt mostly apocryphal, but there is no intrinsic improbability in the statement of Isocrates (Laud. *Busir.* 28, p. 227 Steph.) that he visited Egypt and other countries of the Mediterranean. The historically important part of the career of Pythagoras begins with his migration to Croton, a Dorian colony in southern Italy, about the year 529. According to tradition, he was driven from Samos by the tyranny of Polycrates. At Croton Pythagoras became the centre of a widespread organization, which was, in its origin, a religious brotherhood or an association for the moral reformation of society rather than a philosophical school. The Pythagorean brotherhood had much in common with the Orphic communities which sought by rites and abstinence to purify the believer's soul and enable it to escape from the "wheel of birth." Its aims were those of a religious order rather than a political league. The new order did indeed establish for a time its supremacy over a considerable part of Magna Graecia, but this entanglement with politics led in the end to the dismemberment and suppression of the society. The first reaction against the Pythagoreans, led by Cylon, seems to have taken place in the lifetime of Pythagoras in connection with the victory gained by Croton over Sybaris in 510. Cylon was able to bring about the retirement of Pythagoras to Metapontium, where he remained until his death at the end of the 6th or the beginning of the 5th century. The order appears to have continued powerful in Magna Graecia till the middle of the 5th century when it was violently trampled out. The meeting-houses of the Pythagoreans were everywhere sacked and burned; mention is made in particular of "the house of Milo" in Croton, where 50 or 60 Pythagoreans were surprised and slain. Those who survived took refuge at Thebes and other places. Lysis went to Thebes, where he became the instructor of Epaminondas. Philolaus, too, who according to tradition wrote the first exposition of the Pythagorean system, lived at Thebes at the end of the 5th century. Philolaus, however, and some others were afterwards able to return to Italy, and thenceforth Taras (Tarentum) became the chief seat of the school. Here Archytas, the friend of Plato, lived; he ruled Taras for years and was never defeated in battle. As a philosophic school the Pythagoreans became extinct about the middle of the 4th century.

Aristotle in his accounts of Pythagorean doctrines never refers to Pythagoras but always to "the Pythagoreans" or "the so-called Pythagoreans" (*οἱ καλούμενοι*). Nevertheless certain doctrines may be traced to the founder. Foremost among these is the theory of the immortality and transmigration of the soul (*see* METEMPSYCHOSIS). Pythagoras's teaching on this point is connected with the primitive belief in the kinship of men and beasts, a view which Pythagoras also held. The Pythagorean rule of abstinence from flesh is thus, in its origin, a taboo resting on the blood-brotherhood of men and beasts; and a number of the Pythagorean rules of life which we find embodied in the different traditions appear likewise to be genuine taboos belonging to a similar level of primitive thought. The moral and religious application which Pythagoras gave to the doctrine of transmigration continued to be the teaching of the school. The view of the body (*σῶμα*) as the tomb (*σῆμα*) of the soul and the account of philosophy in the Phaedo as a meditation of death are expressly connected by Plato with the teaching of Philolaus; and the strain of asceticism and other-worldliness which meets us here and elsewhere in Plato is usually traced to Pythagorean influence.

Theory of Numbers.—The scientific doctrines of the Pythagorean school have no apparent connection with the religious mysticism of the society or their rules of living. Their discourses and speculations all connect themselves with the idea of number, and the school holds an important place in the history of mathematical and astronomical science. Aristotle tells us that the Pythagoreans "applied themselves to the study of mathematics and were the first to advance that science; insomuch that, having been brought up in it, they thought that its principles must be the principles of all existing things." Pythagoras is said to have attached supreme importance to arithmetic, which he advanced and took out of the region of commercial utility. He also made geometry a part of a liberal education, examining the principles of the science and treating the theorems from an immaterial and intellectual standpoint.

Pythagoras's greatest discovery was, perhaps, that of the dependence of the musical intervals on certain arithmetical ratios of lengths of string at the same tension, 2:1 giving the octave, 3:2 the fifth and 4:3 the fourth. This discovery could not but have powerfully contributed to the idea that "all things are numbers." According to Aristotle, the-theory in its original form regarded numbers, not as relations predicable of things, but as actually constituting their essence or substance. Numbers, he says, seemed to the Pythagoreans to be the first things in the whole of nature, and they supposed the elements of numbers to be the elements of all things, and the whole heaven to be a musical scale and a number (*Metaph.* A. 986 a). Later, *e.g.*, in the fragments of "Philolaus," things are spoken of, not as *being* numbers, but as having number and thereby becoming knowable.

The development of these ideas into a comprehensive metaphysical system was probably the work of Philolaus. The "elements of numbers" referred to by Aristotle were, according to the Pythagoreans, the Odd and the Even, which they identified with the Limit and the Unlimited. The Unlimited, and therefore the Limit also, was conceived as spatial. Numbers were thus spatially regarded, and "one" was identified with the point, which was thus a unit having position and magnitude; "two" was similarly identified with the line, "three" with surface, and "four" with solid. The Odd and Even and the Limit and Unlimited were the first two of a set of ten fundamental oppositions postulated by the Pythagoreans, the remaining eight being: one and many, right and left, male and female, rest and motion, straight and curved, light and darkness, good and evil, square and oblong. To the Pythagoreans the Universe was in a sense the realization of these opposites. The further speculations of the Pythagoreans on the subject of number rest mainly on fanciful analogies. Thus "seven" is called *πάρθενος* and *Ἀθήνη* because within the decade it has neither factors nor products; "five," on the other hand, is marriage because it is the union of the first masculine and the first feminine number (3+2, unity not being considered a number); "one" is identified with reason because it is unchangeable; "two" with opinion because it is unlimited and indeterminate; "four" with justice because it is the first square number, the product of equals.

Aristotle has the interesting remark that Eurytus, who was a disciple of Philolaus, used to assign numbers to all sorts of things such as horses or men, and imitated their shapes by arranging pebbles after the manner of those who bring numbers into the forms of triangles or squares (*Metaph.* N. 5, 1092 b 10). This brings us to figured numbers and the connection between numbers and geometry. The "holy tetractys," by which the later Pythagoreans used to swear, was a figure of this kind  representing the "triangular" number 10 and showing at a glance its composition as 1+2+3+4. To add a row of five dots gives the next "triangular" number with 5 as the side, and so on, showing that the sum of any number of the series of natural numbers beginning with 1 is a triangular number. The sum of any number of the series of odd numbers beginning with 1 is similarly seen to be a square; thus 3 and 5 added successively to 1 give a figure of this kind , and so on. If we take the series of even numbers, we see that the sum of any number of them beginning with 2 makes an "oblong" number .

The successive odd numbers after 1 were called "gnomons" because the addition of each of them to the sum of the preceding ones (beginning with 1) makes a square number into the next larger square. If the "gnomon" added to a square is itself a square number, *e.g.*, g, we have a square number which is the sum of two squares; thus $1+3+5+7=16$ or 4^2, and the addition of g $(=3^2)$ gives 25 or 5^2, that is, $3^2+4^2=j^2$. Pythagoras himself is credited with a general formula for finding two square numbers the sum of which is also a square, namely (if m is any odd number), $m^2+\left\{\tfrac{1}{2}(m^2-1)\right\}^2=\left\{\tfrac{1}{2}(m^2+1)\right\}^2$. This connects itself with the theorem of the square on the hypotenuse of a right-angled triangle, which tradition universally associates with the name of Pythagoras. This being a property of all right-angled triangles, consideration would show that, while some such triangles have their sides in the ratio of rational numbers, some, and in particular the isosceles, have not. In the case of the isosceles right-angled triangle the ratio of the hypotenuse to either of the other sides is what we write as V2, which is "irrational" in the sense that its value cannot be expressed exactly as a ratio between numbers. It was the Pythagoreans who discovered the irrationality of V2, and not only so, but they discovered the law of formation of the series of "side"?—and "diagonal" numbers (as they were called), which satisfy the equations $2x^2-y^2=+1$ and so enable us to find, as x and y increase, closer and closer approximations to the value of V2. The law depends on the proposition in Eucl. ii. 10 to the effect that $(2x+y)^2-2(x+y)^2=2x^2-y^2$, whence it follows that if x, y satisfy one of the above equations, then $2x+y$, $x+y$ is a solution in higher numbers of the other equation. From this we derive $\frac{1}{1}, \frac{3}{2}, \frac{7}{5}, \frac{17}{12}, \frac{41}{29}$ and so on ad *infinitum* as approximations to V2.

Contributions to Geometry.—Other contributions to geometry by the Pythagoreans comprise the following: (1) Pythagoras, we are told, himself formulated definitions in geometry. (2) The Pythagoreans proved that the sum of the three angles of any triangle is equal to two right angles; we have their proof, which, like Euclid's, uses the property of parallels; hence they knew the theory of parallels. (3) They discovered the powerful method in geometry of the "application of areas" (cf. Eucl. i. 44, 45), including application with "excess" and "defect" (*cf.* Eucl. vi. 28, 29) which amounts to the geometrical solution of any quadratic equation in algebra having real roots. (4) Pythagoras himself is said to have discovered the theory of proportion (for when Proclus says that he discovered the theory of irrationals, τῶν ἀλόγων, the reading should almost certainly be τῶν ἀνάλογον, of proportionab) and of the three means, arithmetic, geometric and harmonic. The arithmetic and harmonic means are shown in the middle terms of the proportion $a:\frac{a+b}{2}=\frac{2ab}{a+b}:b$, a particular case being $12:9=8:6$, from the terms of which the three musical intervals can be obtained. The Pythagorean theory of proportion was arithmetical (after the manner of Euclid, Book vii.) and did not apply to incommensurable magnitudes; it must not therefore be confused with the general theory due to Eudoxus which is expounded in Euclid < (5) Proclus also says that Pythagoras discovered the construction of the five regular solids. It was more probably Theaetetus who (as another scholium says) discovered the octahedron and the icosahedron; but the Pythagoreans were clearly acquainted with the pyramid or tetrahedron and the dodecahedron. The construction of the dodecahedron requires that of a regular pentagon, which again depends (as in Eucl. iv., 10, 11) on the problem of Eucl, ii. 11. about the division of a line "in extreme and mean ratio," a particular case of the "application of areas." The assumption that the Pythagoreans could construct a regular pentagon is confirmed by the fact that the "pentagram," the "triple interwoven triangle," or the star-pentagon, was used by the Pythagoreans as a symbol of recognition between the members of the school and was called by them Health. (6) The Pythagoreans discovered how to construct a rectilineal figure equal to one and similar to another rectilineal figure.

Summing up the Pythagorean geometry, we may say that it covered the bulk of the subject matter of Euclid's Books i., ii., iv., vi. (and probably iii.), with the qualification that the Pythagorean theory of proportion was inadequate in that it did not apply to incommensurable magnitudes.

Pythagorean **Astronomy.**—It remains to speak of the Pythagorean astronomy. Pythagoras was one of the first to hold that the earth and the universe are spherical in shape. He realized that the sun, moon and planets have a motion of their own independent of the daily rotation and in the opposite sense. It is improbable that Pythagoras himself was responsible for the astronomical system known as Pythagorean, which deposed the earth from its place in the centre and made it a "planet" like the sun, the moon and the other planets; for Pythagoras apparently the earth was still at the centre. The later Pythagorean system is attributed alternatively to Philolaus and to Hicetas, a native of Syracuse. The system may be thus described. The universe is spherical in shape and finite in size. Outside it is infinite void which enables the universe to breathe, as it were. At the centre is the central fire, called the Hearth of the Universe (among other names), wherein is situated the governing principle, the force which directs the movement and activity of the universe. In the universe there revolve round the central fire the following bodies: nearest to the central fire is the "counter-earth" which always accompanies the earth; next in order (reckoning from the centre outwards) is the earth, then the moon, then the sun, then the five planets and then, last of all, the sphere of the fixed stars. The counter-earth, revolving in a smaller orbit than the earth, is not seen by us because the hemisphere in which we live is always turned away from the counter-earth (the analogy of the moon which always turns the same side to us may have suggested this). This part of the theory involves the assumption that the earth rotates about its own axis in the same time as it takes to complete its orbit round the central fire; and, as the latter revolution was held to produce day and night, it is a fair inference that the earth was thought to revolve round the central fire in a day and a night, or in 24 hours.

The system amounts to a first step towards an anticipation of the Copernican hypothesis, and Copernicus himself referred to it as such. The curious thing in the system is the introduction of the counter-earth. Aristotle in one place says that its object was to bring the number of the revolving "bodies" up to ten, the perfect number according to the Pythagoreans; but elsewhere he hints at the truer explanation, when he says that eclipses of the moon were considered to be due sometimes to the interposition of the earth, sometimes to the interposition of the counter-earth, whence it would appear that the counter-earth was invented in order to explain the frequency of lunar eclipses as compared with solar.

For accounts of the sources and for further details reference may be made to the following works in addition to Zeller, *Die Philosophie der Griechen* (4th ed. 1892, etc.); Diels, *Doxographi Graeci* (1879) and *Die Fragmente der Vorzokratiker* (4th ed., 1922); A. Delatte, *Etudes sur la littérature Pythagoricienne* (1915) and *La vie de Pythagore de Diogine Laerce* (1922); Gomperz, *Griechische Denker,* vol. i. (Eng. trans., 1901), and especially Burnet, *Early Greek Philosophy* (3rd ed., 1920). For the mathematics *see,* besides other histories of mathematics, James Gow, *A Short History of Greek Mathematics* (1884); Sir T. L. Heath, *A History of Greek Mathematics,* vol. i. (1921); Eva Sachs, *Die fünf Platonischen Körper* (1917). (T. L. H.)

PYTHAGORAS, of Rhegium, a noted Greek sculptor of the 5th century B.C., a contemporary of Myron and Polyclitus, and their rival in making statues of athletes. One of these, that of the boxer Euthymus of Locri, can be dated at 472 B.C. He was born at Samos and migrated in his youth to Rhegium in Italy. He made a statue of Philoctetes notable for the physical expression of pain, an Apollo shooting the Python at Delphi, and a man singing to the lyre. His technical improvements went far to ending archaic stiffness. No existing work can be certainly attributed to him, but the "Apollo on the Omphalos" at Athens and the "Choiseul-Gouffier" Apollo in the British Museum have been identified as copies of his statue of Euthymus.

See Waldstein in *J.H.S.* i., 168; E. A. Gardner, *Handbook of Greek Sculpture* (London, 1915).

PYTHEAS, of Marseille (Massilia), Greek navigator and geographer, was probably contemporary with Alexander the Great; his work is lost, and we are left in the dark as to its form and character, but the various titles under which it is quoted (*e.g.,* Γῆς περίοδος, or Τὰ περὶ τοῦ Ὠκεανοῦ) point to a geographical treatise, in which Pytheas had embodied the results of his observations, rather than to a continuous narrative of his voyage.

Some modern writers supposed Pytheas to have been sent out, at public expense, by the republic of Massilia; but there is no ancient authority for this, and Polybius states that he had undertaken the voyage in a private capacity and with limited means. All that we know concerning the voyage of Pytheas is contained in a brief passage of Polybius cited by Strabo, according to which Pytheas had not only visited Britain, but had "travelled all over it on foot," and estimated its circumference at more than 40,000 stadia (4,000 geographical miles). To this he added the account of Thule (which he placed six days' voyage north of Britain) and the adjoining regions. After this he visited "the whole of the coasts of Europe" (*i.e.,* those bordering on the ocean) as far as the *Tanais.* Some modern writers suppose that he made two different voyages; but this is improbable; the expressions of Polybius imply that his explorations in both directions, first towards the north and afterwards towards the east, formed part of the same voyage.

The countries visited by Pytheas, were previously unknown to the Greeks and were not visited again for two centuries. Hence some of the later Greek geographers altogether disregarded his statements, and treated his voyage as a fiction. In modern times a critical examination has been more favourable and the tendency of modern critics has been to exaggerate the value of Pytheas's work. Speculation has dealt chiefly with his "Thule," believed differently to be Norway, Iceland, or the Shetlands; and "Cassiterides" (Tin islands, perhaps St. Michael's mount in Cornwall).

Pytheas had one special merit; he was a good astronomer, and was one of the first to fix latitudes. His calculations of the length of the longest day at four different points in the neighbourhood of Britain are probably based on native reports. If these figures (16, 17, 18 and 19 hours) are to be pressed, they would refer to, say, Ushant (48° N.), Flamborough Head (54°), Tarbet Ness in Ross (58°) and the northernmost Shetlands (61°). Pytheas was also the first among the Greeks to arrive at any correct notion of the tides, and to note their connection with the moon, and their periodical fluctuations. Other observations concerning the manners and customs of the inhabitants of remote northern regions prove that he had himself visited them. Among these are the gradual disappearance of various kinds of grain as one advanced northward; the use of fermented liquors made from corn and honey; and the habit of threshing out corn in barns, instead sf on open threshing-floors as in Greece and Italy.

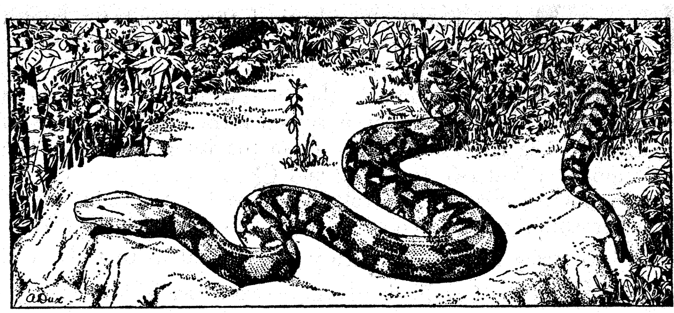
The fragments of Pytheas have been collected by Arvedson (Uppsala, 1824), and by Fuhr (*De Pythea massiliensi*, Darmstadt, 1835). Of the numerous treatises on the subject, *see* Ukert, "Bemerkungen über Pytheas," in vol. i. of his *Geog. d. Griechen u. Romer*, pp. 298–309, which contains an excellent summary of all that is known concerning Pytheas; Sir George C. Lewis, *Historical Survey of the Astronomy of the Ancients*, pp. 466–480 (London, 1862); Sir Edward H. Bunbury, *History of Ancient Geography*, vol. i. ch. xv. § 2 (1883); C. I. Elton, *Origins of English History*, *cf.* especially app. i. pp. 400, etc. (1882); Hugo Berger, *Geschichte der wissenschaftlichen Erdkunde der Griechen*, pt. 3 (2nd ed., Leipzig, 1903). An elaborate investigation of the subject will be found in Mullenhoff, *Deutsche Alterthumskunde*, i. 211–497 (1870). *See* also Sir Clements Markham's paper, "Pytheas, the Discoverer of Britain," in the *Geographical Journal* (June 1893); and H. F. Tozer, *History of Ancient Geography*, pp. 152–164 (Cambridge, 1897).

PYTMIAS, KNIGHTS OF, a fraternal and benevolent order of secret character, founded in Washington, D. C. Feb. 19, 1864 and chartered by a special act of Congress. In 1939 the order maintained j6 grand lodges or grand domains in the States of the United States and in provinces of Canada. There were also,about 5,000 local or subordinate lodges. Most of these (49 grand lodges and approximately 4.800 local lodges) are in the United States; in the Dominion of Canada there were in 1939 seven grand lodges and about 200 local lodges. The governing body is the Supreme Lodge. The organization supports 22 homes in as many States to take care of its dependent members and maintains a military department. There are three recognized auxiliary bodies, the Dramatic Order Knights of Khorassan, the Junior Order Princes of Syracuse, and the Order of the Pythian Sisters which, founded in 1888, is open to all women relatives of members of the Knights of Pythias.

PYTHIS or **PYTHIUS,** one of the most noted Greek architects of the later age. He cultivated the Ionic style, in which he constructed the temple of Athena at Priene. The dedicatory inscription, which is in the British Museum, records that the founder was Alexander the Great. Pythis also made a great marble quadriga which surmounted the Mausoleum.

PYTHON, a genus of snakes of the family Boidae. The snakes of this genus are very large and are found throughout the tropical regions of the Old World; they are distinguishable from the boas, with which they are often confused, by the presence of an extra bone in the skull above the eye, the supra-orbital. All the members of the genus possess long powerful teeth, but there is no poison apparatus. Killing is effected by constriction; coil after coil is thrown round the victim and these are slowly tightened. All snakes of whatever size are extraordinarily muscular so that the pressure exerted by a large python when constricting must be terrific; usually all the bones of the prey are broken and the whole animal is crushed into the shape of a sausage. This is then swallowed, head first, the head and body of the snake being literally drawn over the victim's body by the alternate forward motions of the right and left halves of the jaws; it is during this swallowing process that the large teeth are called into play, those of one side being dug in and giving a grip whilst the other side is pushed forwards. During the swallowing process much saliva is secreted and should the prey be disgorged, as it sometimes is if the snake is disturbed or frightened, it will be found to be covered with this secretion; this probably accounts for the origin of the fable that pythons cover their prey with saliva before swallowing it.

There is little doubt that a large python would be physically strong enough to kill almost any large mammal, but the stories of their killing and eating cattle and horses cannot be credited;



BY COURTESY OF THE N.Y. ZOOLOGICAL SOCIETY

RETICULATED PYTHON (P. RETICULATUS)

the prey must be swallowed whole and the mouth of even the largest specimens, wonderfully distensible though it is, could not be stretched to accommodate anything much larger than a small pig. Most species are semi-arboreal and prefer the neighbourhood of water, in which they often lie and soak. Reproduction is by means of leathery-shelled, oval eggs, of which there may be a hundred or more in a clutch; they are laid in a heap round which the mother coils herself and it has been found that the temperature of a female under such circumstances rises above that of the surrounding air so that there is, apparently, true incubation.

The largest species is the reticulated python (*P. reticulatus*) of the Indo-Chinese and Malayan regions; which may attain a length of 30 ft. Other well-known species are the Indian python (P. *molurus*) of India and Ceylon, the rock python (P. sebae) of tropical and South Africa, the West African python (P. regius) and the Australian carpet snake (*P. spilotes*). (H. W. P.)

PYTHQN, a huge serpent, nameless and female in the earliest account (Hymn. Homer iii. 300 et seq.), which was killed by Apollo at Delphi (older name Pytho), either because it would not let him come near the oracle,—in one version (Hyginus, *fab.* 140), it used itself to give oracles,—or because it persecuted his mother Leto during her pregnancy. It is generally said to be the child of Earth (Hyg., l.c.), and in all probability is to be connected with the reliable tradition (*e.g.*, Aesch., *Eumen.* 1–8) that there was an oracle of Earth at Delphi before Apollo came.

In Hellenistic belief, a python was a spirit which possessed certain persons and prophesied unknown to them through their mouths (Hesychius, *q.v.*).

See Farnell, *Cults of the Greek States*, iii. 9; iv. 180; also Preller-Robert, I., 239.

PYTNONOMORPHA, a group of large extinct, aquatic reptiles of Upper Cretaceous age. (See REPTILES.)

PYX, a term for various forms of receptacles (Gr. πυξίς, a box or chest). In ecclesiastical usage it is the sacred vase or tabernacle in which the Host is reserved. In the English Mint the pyx is the chest in which are placed one coin from every 15 lb. of newly coined gold and one from every 60 lb. of newly coined silver to await the "trial of the pyx" (see MINT). This chest was formerly kept in the Chapel of the Pyx in Westminster abbey.

Q This letter corresponds to Semitic φ (*koph*) and Greek ϙ (*koppa*). The form of the majuscule has been practically identical throughout its known history. In the form found on the Moabite Stone the vertical stroke extended to the top of the loop and the same is the case with an early form φ from the island of Thera. The Etruscan form was identical with the Greek. The letter did not occur in the Ionic alphabet. The Latin alphabet had two forms ϙ and Q.

In the minuscle form the stroke has moved to the right side of the letter owing to the speed of writing. This produced the cursive form q occurring in the 6th century A.D. Uncial writing also had the form q and the Carolingian form was practically identical.

In Semitic the sound represented by the letter was an unvoiced guttural pronounced further back than that represented by the letter *kaph*. In Greek the letter was largely redundant, and in the eastern alphabet was entirely superseded by *kappa*.

Name of Form	Approximate Date	Form of Letter
PHOENICIAN	B.C. 1.200	φ
CRETAN	1,100-900	φ
THERAEAN	700-600	φ
ARCHAIC LATIN	700-500	ϙ
ATTIC	600	9
CORINTHIAN	600	ϙ
CHALCIDIAN	600	Q
IONIC	403	Q
ROMAN COLONIAL	PRE-CLASSICAL AND CLASSICAL TIMES	Q
URBAN ROMAN		Q
FALISCAN		V 3
OSCAN		? 3
UMBRIAN		? Ɔ
CLASSICAL LATIN AND ONWARDS		Q

THE DEVELOPMENT OF THE LETTER "Q" FROM THE EARLIEST TIMES

In the Chalcidic alphabet it lingered and was taken over from this into Latin, where it became stereotyped for use only before the letter U in words in which the unvoiced labio-velar occurred, represented by the combination of these letters. The combination of these two letters holds to the present day, and in modern English Q is not used unless followed by U, even if, in words such as oblique, the sound is a simple velar and not a labio-velar. The most usual position of the sound is initial in words such as queen, *quick*. Q is used apart from U only very rarely in words of foreign origin, especially to represent a Semitic guttural, as in Qabala, 'Iraq. (B. F. C. A.)

QABES: see GABES.

QAIN is the administrative headquarters of the very extensive district of Qainat, the south-eastern portion of the province of Khurasan in Persia. This district has the province of Kerman on the south and extends eastwards to the frontier of Afghanistan The region in which Qain is situated consists mainly of a complicated system of hill ranges of mean elevation 4,000 ft. running north to south and sinking down in the south to the Seistan basin. It is without perennial rivers, the drainage flowing westward to the Dasht-i-Lut. The rainfall is greater than that of Kerman province, which has an average fall of 4.7 inches, and the population depend largely on deimi crops, *i.e.*, those which are not artificially watered. Great numbers of camels are reared and the principal products are grain, saffron, wool and opium; the assafoetida plant also grows very profusely.

The town of Qain is situated some 200 m. south of Meshed on the main road (passible for motors) to Duzdab, in a broad valley, in 33° 42′ N., 59° 8′ E., at an elevation of 4,500 feet. The population is variously estimated at 5,000–15,000; the town, surrounded by a mud wall with bastions in disrepair, appears to have considerably increased in size and importance in recent years, so that the houses of the wealthier inhabitants are found without the walls. The cultivation of saffron is a speciality of the immediate neighbourhood which supplies nearly the whole of Persia with this commodity. The chief industries are the making of felts and carpets, but the best Qaini carpets are made at Darakhsh north-east of Birjand. South-east of the town, on the summit of two hills rising 500 ft. above the valley, are the ruins of a great fort some 600 yards in length. Qain is undoubtedly a place of great antiquity and chequered history. The present town was built by Shah Rukh to replace an older town which he is said to have destroyed. After a time the Uzbegs took possession of and held the place until Shah Abbas I. (1587–1629) expelled them. In the 18th century it fell under the sway of the Afghans and was a dependency of Herat until 1851.

See P. M. Sykes, "A fourth journey in Persia, 1897–1901," *Geogr. J.* (1902) XIX., pp. 119–73; see also KHURASAN. (P. Z. C.)

QAIRWĀN, the sacred city of Tunisia, 36 m. south by west by rail from Susa, and about 80 m. due south from the capital. Qairwān is built in an open plain a little west of a stream which flows south to the Sidi-el-Hani lake. Qairwān, in shape an irregular oblong, is surrounded by a crenellated brick wall with towers and bastions and five gates. The city, however, spreads beyond the walls, chiefly to the south and west. Some of the finest treasures of Saracenic art in Tunisia are in Qairwān. The chief buildings are the mosques, which are open to Christians, Qairwān being the only town where this privilege is granted.

In the northern quarter stands the great mosque founded by Sidi Okba ibn Nafi, containing his shrine and the tombs of many Tunisian rulers. It was several times rebuilt; that which subsists dates from the period of the Aghlabites (3rd century of the Hegira, 9th century of the Christian era). Like the primitive mosques of Islam, it consists of a rectangular hypostylar hall preceded by a courtyard surrounded by porticoes on all sides. It is reached through numerous gateways; that on the N.E., named the gate of Lella Rejana, is preceded by a beautiful square porch, decorated with ancient columns. In the middle of the northern side of the courtyard rises a massive square minaret.

The mosque of Sidi Okba is the prototype of many other notable mosques. (See MOSQUE.) Of greater external beauty than that of Sidi Okba is the mosque of the Three Gates. Cufic inscriptions on the façade record its erection in the 9th and its restoration in the 15th century A.D. Internally the mosque is a single chamber supported by sixteen Roman columns. One of the finest specimens of Moorish architecture in Qairwān is the *zawia* of Sidi Abid-el-Ghariani (d. c. A.D. 1400), one of the

Almoravides, in whose family is the hereditary governorship of the city. The entrance, a door in a false arcade of black and white marble, leads into a court whose arches support an upper colonnade. The town contains many other notable buildings, but none oi such importance as the mosque of the Companion (*i.e.,* of the Prophet), outside the walls to the north-west. This mosque is specially sacred as possessing what are said to be three hairs of the Prophet's beard, buried with the saint, who was one of the companions of Mohammed. (This legend gave rise to the report that the tomb contained the remains of Mohammed's barber.) The mosque consists of several courts and chambers, and contains some beautiful stained glass.

The suks of Qairwiin are interesting but less important than those of Tunis The town is the centre of fairly active trade and industry, especially in leather goods and carpets. The town has a population of (1936) 23,000.

The legend says that Okba in A.D. 671 (A.H. 50) determined to found a city as a rallying-point for the followers of Mohammed in Africa. He led his companions into the desert, and having exhorted the serpents and wild beasts, in the name of the Prophet, to retire, he struck his spear into the ground exclaiming "Here is your Qairwiin" (resting-place), so naming the city. In the 8th century Qairwān was the capital of the province of Ifrikia governed by amirs appointed by the caliphs. Later it became the capital of the Aghlabite princes, thereafter following the fortunes of the successive rulers of the country. (See TUNISIA: History.) After Mecca and Medina Qairwān is the most sacred city in the eyes of the Mohammedans of Africa, and constant pilgrimages are made to its shrines.

See Murray's Handbook to Algeria end Tunis, by Sir R. L. Playfair (1895); H. Saladin, Tunis et *Kairouan* (1908); Georges Marcais, *Manuel d'art Mussulman,* Tome I. (1926).

QAIS, an island in the Persian gulf lying about 10 m. off the mainland of Persia in 54° E ; it is the site of a trade emporium of great importance in former times. The island measuring 10 m. by 5 m., rises 120 ft. above sea level to a plateau and is bare of vegetation except for small patches of cultivation and a few date groves and stunted herbage. It is surrounded by a reef and pearl banks. The normal population is estimated at about 2,000 chiefly Arabs of the Al Ali tribe, who largely engage in pearl fishing.

Qais is an arabicized form of the Persian Kish; and is the Kataia of Arrian. In the Mohammedan period it formed a part of the province of Fars, but it was only in the later middle ages that the place attained importance, when a prince of South Arabian origin obtained possession of it, built a fleet there, and gradually extended his power. He captured Siraf (modern Tahiri 27° 40' N., 52° 20' E.) which was then the principal emporium of the Persian-Indian-Chinese trade. Siraf gradually—in the first half of the 11th century—became more and more deserted under the suzerainty of the princes of Qais, as they diverted the very considerable trade from the captured Persian sea-port to their own island, and finally Qais supplanted Siraf.

At its period of greatest power, the dynasty of Qais also ruled over the district of Oman on the opposite Arabian shore. The Rabbi Benjamin of Tudela visited Qais between A.D. 1164–73, and noted the rich market of the island whose chief business was the exchange of Persian, Mesopotamian, Arabian and Indian manufactures and produce. The site of the old city is marked by the ruins known as Harira on the north coast. Qais in turn lost its importance—for what reason is not precisely known—somewhere in the 14th century, and its trade passed to Hormuz.

See W. Ouseley, Travels in various *countries* of the East, vol. i. (1819); A. W. Stiffe, "Ancient trading centres of the Persian Gulf. Kais." *Geogr.* J., 1896, VII.; A. T. Wilson, The Persian Gulf (1928). (P. Z. C.)

QARAITES or **KARAITES** (Hebr. Bend *Miqrā',* sons of the Scripture), a mediaeval Jewish sect claiming to return to primitive Judaism by restoring the Scriptures to their rightful place now usurped by tradition (the Oral Law). Neither historically nor spiritually have they any connection with the Sadducees, the Samaritans or with Schechter's Jewish Sectaries of Damascus. Karaism was an anti-Rabbinic religious innovation prompted by politics, but the Raraites have always endeavoured to prove their antiquity and to trace their origin to former sects that had existed and decayed before Karaism arose. The founder, Anan ben David of Baghdad, in 760 claimed to succeed Isaac Iskawi his uncle as Exilarch, but the *Geōnim* (see GĀON) ultimately chose Anan's younger brother Josiah, whose appointment was confirmed by the Caliph al-Manṣūr. Anan proclaimed himself as anti-exilarch and succeeded in enlisting the support of various sects such as the Isawites, the Yudganites and the Shadganites. This act on the part of a *dhimmi* in Islam was treasonable. In 767 Anan was arrested but saved from execution by the advice of a fellow-prisoner, the famous Abu Hanifa. Anan pleaded that his was a new religion which venerated Islam and followed Muslim law in many ways, *e.g.,* in fixing the calendar by observation instead of by calculation. In 770 he published his code (*Ṣēfer ham-Miçwōth*). Ultimately he led his followers to Jerusalem, whence they spread over Egypt, Syria and S. Russia. They have never been numerous and now number about 14,000.

The chief points of difference with the Rabbanites were the calendar, Sabbath and marriage laws. Karaism had a great effect on the body of Judaism. polemics stimulated learning. Sa'adya of Fayyum was one of the notable scholars who challenged Karaite exegesis. The Karaites possessed a number of scholars of considerable distinction, especially in the direction of Hebrew philology, biblical exegesis (*e.g.,* Yepheth ibn 'Ali) and philosophy of religion (*e.g.,* Isaac b. Abraham Troki, 1533–1594, author of the Hizzziq *'emūnah*). Their liturgy is jejune, being composed almost entirely of scriptural excerpts and possessing practically no hymns. Nevertheless this constitutes no general reflection on Karaite intellectualism. No movement can be considered barren from the literary standpoint that has produced writers such as Benjamin Nahawandi (c. 850), Abu Yusuf al-Qirqisani (tenth cent.) and his contemporaries Sahl ibn Maçliaḥ, Solomon ibn Yeroham, Yusuf ibn Nuh, Aaron ben Elijah of Nicomedia (b. 1300), Elijah ben Moses Bashyazi (1420–90), Caleb Afendopouio (end of 15 cent.) and, latterly, Abraham Firkovitch (1786–1874). The latter dimmed his splendid reputation for scholarship and lowered the value of his enormous archaeological activity by partisan conduct. He discovered in the Crimea very many mss. and tombstones of considerable antiquity but he tampered with the dates and colophons to prove the age of the Karaites and their claims to represent true Judaism. Largely owing to his efforts, the Karaites were exempt from the religious persecution from which the Russian Jews (Rabbanites) suffered. A notable controversy arose in consequence of his discoveries, which were more or less categorically impugned by H. L. Strack and A. Harkavy (lit. *s.v.* Firkovitch in Jew. *Enc.*) but upheld (with reservations) by D. Chwolson (*Corp. Inscrip.* Hebr., St. Petersburg, 1882). The recent Masoretic researches of Paul Kahle (e.g., Masoreten d. *Westens,* Stuttgart, 1927: Hebr. *Bibelhand*-schriften *aus* Babylonien, Giessen, 1928) incline to the latter view.

BIBLIOGRAPHY.—*See* the various articles in Jew. *Enc.* and Hastings' E.R.E. and articles in Jew. Quart. Rev.

QARO (or CARO), **JOSEPH BEN EPHRAIM** (1488–1575), codifier of Jewish law, whose code is still authoritative with the mass of Jews, was born in 1488. As a child he shared in the expulsion from Spain (1492), and like most prominent Jews of the period was forced to migrate from place to place. In 1535 he settled in Safed, Palestine, where he spent the rest of his life. Safed was then the headquarters of Jewish mysticism. Qaro's mysticism did not take the form of a'revolt against authority, but was rather the spiritual flower of pietism. It is, however, as a legalist that Qaro is best known. In learning and critical power he was second only to Maimonides in the realm of Jewish law. He was the author of two great works. In the earlier and greater book, in the form of a commentary (entitled Beth Yoseph) on the *Turim* (see 'ASKER BEN YEHIEL) designed exclusively for specialists, Qaro shows an astounding mastery over the Talmud and the legalistic literature of the middle ages. He felt called upon to systematize the laws and customs of Judaism in face of the disintegration caused by the Spanish expulsion. But the Beth *Yoseph* is by no means systematic. Qaro's real aim was effected by his second work, the *Shulḥan 'Arukh* ("Table Prepared"). Finished in 1555, this code was published in four parts in 1565. The work gradually became the almost unquestioned authority of the whole Jewish world. Its influence was to some extent evil. It "put Judaism into a strait-jacket." Independence of judgment was inhibited, and the code stood in the way of progressive adaptation of Jewish life to the life of Europe. But its good effects far outweighed the bad. It was a bond of union, a bar to latitudinarianism, an accessible guide to ritual, ethics and law. It sanctified the home, it dignified common pursuits. When, however, the era of reform dawned in the 19th century, the new Judaism assumed an attitude of hostility to Qaro's code.

See Graetz, *Geschichte der Juden,* vol. ix. (English trans. vol. iv.); Ginzberg, in *Jewish Encyclopedia,* arts. "Caro" and "Codification"; Schechter, *Studies in Judaism,* second series, pp. 202 *seq.*

QENA, a town of Upper Egypt on a canal about a mile E. of the Nile and 380 mi. S.S.E. of Cairo by rail. Pop. (1937) 34,431. Qena, the capital of a province of the same name, was called by the Greeks Caene in distinction from Coptos, 15 m. S., to whose trade it eventually succeeded. That its modern name should be derived from a purely Greek word seems to point to Qena having originated in a foreign settlement in connection with the Red Sea trade. It is a flourishing town, specially noted for the manufacture of the porous water jars and bottles used throughout Egypt. Its trade in grain and dates with Arabia is all that is left of the extensive commerce formerly maintained between Upper Egypt and India and Arabia.

QISHM, styled by the Arabs as *Jazirat-at-Tawilah* or Long Island, the Oarakta of the ancients, the largest island in the Persian gulf, is situated in the Strait of Ormuz and separated from the mainland of Persia by Clarence strait, 2 to 15 m. in width. The island has an extreme length of 68 m. and average breadth of 10 m. and is composed of table-topped hills rising to 560 ft. with one peak attaining 1,300 ft. The range on the south is largely composed of rock-salt, which is quarried at Namakdan and other places and forms one of the main products. In general aspect the island is parched and barren, but there are fertile patches of cultivation near the villages, producing grain, grapes, dates and melons. The climate is trying to Europeans from May to October.

The total population, mainly of Arab origin, is estimated at 15,000. The chief town is Qishm (pop. 3,000) on the north-eastern point, a well-built Arab village which was partially destroyed by earthquake in 1898. It carries on a small coasting trade which (including that of Hanjam island) amounted to 6,300 tons in 1925–26, mainly in fish, fruit and salt. Borings for oil were made by the Anglo-Persian Oil Company during the years 1914–1922 but without result. A light buoy with a flashing light is moored about a mile east of the Portuguese fort, now in ruins. The administration is in the hands of a *shaikh,* an Arab of the Bani Ma'in, who has executive powers under the Persian authorities.

Basidu, known to British sailors as "Bassadore" is on the north-western extremity of Qishm, exposed to all winds. The site was ceded to the British Crown in 1817, having been selected, after the suppression of piracy, as a base for the naval squadron responsible for keeping order in the Persian gulf and protecting trade. The station was abandoned in 1823.

QOSEIR, EL, a port on the west coast of the Red sea, just north of latitude 26° north. Not only is this place opposite the region in which the Nile comes nearest to the Red sea but between the Nile and El Qoseir is the Wadi Hammamat, with more water than have the valleys farther south. This district (anciently Rohanu) is rich in diorite, which was quarried for building the great monuments of ancient Egypt and, at least from the days of the 18th dynasty, a caravan route (about 120 m.) left the Nile at Qubti (Coptos), afterwards superseded by Qus and then by Qena, north of Thebes, making for the Red sea where the port of Tuâu (the old El Qoseir) was in use at first, but was later superseded by Sav (El Qoseir) 3 m. to the south-east. It was thence that Egypt sent its ships to Punt for spices, perfumes, gold, incense, ivory, skins, scented woods and precious stones. The town stands on a beach with a coral reef in front giving shelter to small craft; larger ships have to anchor outside.

QUACKERY, the pretensions or practice of a boastful pretender to skill which he does not possess, especially medical skill. Although this dictionary definition does not attach the condition that the quack practises for gain, such is usually the fact.

The existence of quackery pre-supposes four factors (1) an evil, usually an obstinate disease, (2) a sufferer from such an evil, (3) a person—the quack—who claims special knowledge or power to cure the particular evil, (4) a person—the orthodox medical practitioner—who holds out little or no hope of cure. Inasmuch as the sufferer has no knowledge whether the quack or the orthodox practitioner is more justified in his statement and is anxious to leave no stone unturned to be rid of his trouble, there is small cause for wonder that the quack has a great following. Other factors play a part, the desire for cheapness, for the quack medicine or treatment can be obtained—at all events in the first instance—at a relatively low price; rebellion against authority especially when authority gives an unpleasant decision; the hope which, as in the old fable, lies at the bottom of Pandora's box of human ills; the element of mystery which the quack usually employs; the natural repugnance to surgical operation when such is the only remedy recognized by the orthodox practitioner; the desire for secrecy particularly in respect of venereal disorders. It may be imagined from the foregoing that such diseases as cancer, venereal diseases, kidney and bladder complaints, diseases of the skin and respiratory tract, chronic rheumatism, chronic indigestion supply the largest proportion of the quack's clientèle; still, no common disease is free from a fringe of quackery.

The agents employed by quacks in various ages repeat themselves. In the case of cancer, the same chemical substances, the same corrosives have been employed, the same articles of diet have been inculpated over and over again. And though the agents have been shown repeatedly to be useless—even injurious—they come daily under the notice of those whose duty it is to investigate suggested cures and causes of cancer. Other agents are vegetable substances often derived from distant and little occupied parts of the world, called by local names, and for the most part unrecognizable by botanists. The tendency to repetition is unjustifiably taken by the public as a sign of their efficacy in the face of medical antagonism, whereas the truth is that the agents lend themselves to the secrecy which is one of the characteristics of the cancer curer and to the production of a medicine or ointment which can be sold at a price. It is a common story that the "cure" has been handed down from parent to child through many generations and often that it has been imparted to the present owner in return for some remarkable service.

Besides the use of chemical and vegetable substances the quack often turns to profitable account the current scientific tendency of the day. With the advance in knowledge of electricity he builds up what he terms a special form of electrical treatment and though his apparatus may be of the crudest kind and unable to generate electricity in appreciable quantity, the mystery attaching to his method of treatment and the pseudo-scientific language which he employs are not without effect upon the mind of the patient who is already more than half convinced in his favour. Similarly, with the discovery of radium, so-called radium treatments were devised for many complaints in which the amount of radium concerned was in the region of the limit of detectability. In the case of chronic rheumatism "magnetic belts," which give no more than a barely detectable electric current, have been recommended widely, as well as radium plasters which in all contained perhaps a thousandth of a milligram of radium. When it is recognized that the commercial value of such an amount of radium at current prices would be under twopence, the profitable side of such a variety of treatment becomes obvious.

The quack relies largely upon advertisement in newspapers and magazines and most publications of repute exercise scrupulous care in the admission or total exclusion of such advertisements. He is aided, too, by the reluctance of those who have consulted him with disadvantage to acknowledge their action and by the magnification of his successes or apparent successes. Moreover, his powers of diagnosis are negligible and upon strict examination a case of cancer, for example, reported to have been cured always fails because there is no evidence, either that the case was truly cancer or else that it was truly cured. The one requires microscopical evidence, the other the lapse, according to medical standards, of a period of years — three, five or more.

Quackery flourishes in certain parts more than others. In respect of cancer the mining districts of Northumberland, Durham and South Wales, South Africa, Australia and to a less extent Canada are the source of the greater number of so-called "cancer cures" met with in England, but the proportion is trivial compared with what occurs in Prussia, where it is said that there is one quack to every three orthodox medical practitioners. Recourse to quackery is not the foible of any particular class of society and is compatible with a high level of general intellect. In the case of the wealthy and intelligent it is difficult to feel sympathy for the sufferer in his action, but for the poor and ill-educated who often waste time and money only to find themselves at the end in a hopeless condition, sympathy is great. Yet it is difficult to see how they can be safeguarded. Legislation with regard to quacks and their medicines varies in different countries. In England they are liable if they hold themselves out to be recognized medical practitioners or if death occurs in a person whom they are treating. On the other hand the law considers that a person consults a quack at his own risk; it does not actually forbid the quack from giving advice though he cannot charge for that advice; as a result the financial side is represented by the sale of ointments, apparatus, etc. Elsewhere (*e.g.* in Prussia) legislation has been tried and has failed. The real remedy lies in advancement of medical knowledge and in education.

A word may be said on patent medicines the sale of which is great in all countries. In England they pay a duty but otherwise their sale is unrestricted though limits are imposed upon their composition. The British Medical Association for years has made a practice of analysing patent medicines and attaching to the report of their composition a statement as to the cost of the ingredients; all return to the proprietor a very large margin of profit. Copies of the reports issued from time to time are published under the authority of the Association. Many of these patent medicines are harmless, some are useful; actual fraud, as a rule, is absent. This cannot be said for the quack and his wares. (W. S. L.-B.)

In the United States the outstanding quacks are located in the large cities; mail-order quackery, like the mail-order house has grown tremendously and it requires a large staff of agents of the post office to make even the slightest inroads on this form of fraud. After some four years of battling in the courts the post office may issue a fraud order against such concerns denying them the use of mails, whereupon they dispose of their wares over the counters of drug stores, and promote them through advertising in the press. Although leading newspapers refuse to carry fraudulent advertisements of cancer and tuberculosis cures, they still carry all sorts of nostrum advertising for coughs, colds, rheumatism and similar complaints.

The use of the testimonial is fundamental to quackery and its advertising. Testimonials, obtainable at a price, have become a current feature in the trade.

In the headquarters of the American Medical Association is a bureau of investigation which carefully investigates the claims made for all new methods of medical treatment. Here is a card index containing 125,000 cards cross-indexing the various forms of quackery practised in the United States. In each of the 48 States there are different laws regulating the practice of medicine; hence quackery varies in each State according to the limits permitted by law. In some States quackery is limited almost entirely to the sale of medicines of secret composition and with claims not justified by the content. In other States quackery is rampant, including not only the sale of patent medicines but the operation of healing institutions conducted by quack doctors, all of the 40 or 50 forms of religious and faith healing, healing by conjuring and by charms, the practice of systems of healing such as chiropractic, naturopathy, naprapathy and similar methods. (M. Fi)

QUACK-GRASS (*Agropyron repens*), a perennial grass of the barley tribe (Hordeae), called also couch-grass or quitch-grass. It is native to Europe, common in northern Europe and widely naturalized in North America. Quack-grass has bright-green, smooth, stiffly erect stems, 1 to 4 ft. high; leaves with flat or inrolled blades; and terminal flowering spikes, 2 to 6 in. long, composed of numerous, usually five-flowered spikelets, which often bear short awns. Sometimes it is grown for forage, but it is better known as a troublesome weed in cultivated fields, especially on rich soil, spreading rapidly by its extensively creeping greenish-yellow rootstocks. The best method to eradicate it is to plow the land, after it has been left in sod two or more years, just after the flowers appear and harrow at weekly intervals for about 6 weeks.

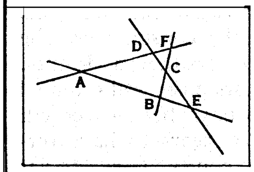
BY COURTESY OF THE IOWA GEOLOGICAL SURVEY

QUACK-GRASS (AGROPYRON REPENS)

QUADRATRIX: see CURVES, SPECIAL.

QUADRATURE (from Lat. *quadratura*, a making square), in astronomy, that aspect of a heavenly body in which it makes a right angle with the direction of the sun; applied especially to the apparent position of a planet, or of the moon at first and last quarters. In mathematics, quadrature is the determination of a square equal to the area of a curve or other figure. Integration by quadratures means calculation by a step-by-step process when no analytical expression for the integral is available.

QUADRILATERAL, in geometry, a figure formed by four straight lines. It is said to be plane or skew according as the four lines do or do not lie in one plane. Quadrilateral is also a military term applied to a combination of four fortresses mutually supporting each other. The most famous military quadrilateral was that of the four fortified towns of north Italy — Mantua and Peschiera on the Mincio, and Verona and Legnago on the Adige. This quadrilateral gave Austria a firm hold on Lombardy.



Let us consider the plane figure bounded by four lines terminated at the vertices. A line joining a pair of opposite vertices is called a diagonal. The area of such a quadrilateral is half the product of the length of one diagonal by the sum of the perpendiculars drawn to this diagonal from the other two angular points. The sum of the squares of the four sides of such a quadrilateral is equal to the sum of the squares of its diagonals increased by four times the square of the line joining the midpoints of the diagonals. If the vertices of such a quadrilateral lie on a circle, the product of the diagonals is equal to the sum of the products of the opposite sides.

It is in projective geometry that the quadrilateral plays its most interesting rôle. If A, B, C, D are four points in a plane no three of which are collinear, then the lines AB, BC, CD, DA, each taken to be of indefinite extent, form a quadrilateral. These sides intersect in pairs not only in the four given points (called vertices) but also in a point E on both AB and CD, and in a point F on both BC and AD. The points E and F are also called vertices. Then each side of the quadrilateral contains three vertices. Two vertices not on the same side are called opposite. A line joining two opposite vertices is called a diagonal. The configuration so described is called a complete quadrilateral. The dual figure is called a complete quadrangle. These figures are of fundamental importance in projective geometry (*q.v.*).

QUADRILLE, the name of a game of cards and of a dance. The game, played by four persons with a pack of forty cards, was a variation of the Spanish game of ombre and superseded it in popularity about 1725, to give way in turn to whist. The dance is of French origin and is usually danced by four couples in square. In the 18th century the *contredanse* was introduced into the ballet, and groups of four, eight or twelve dancers dressed alike performed different figures; these were first called *quadrilles* des *contre-danses,* later shortened to *quadrilles.* Later the dance became popular outside the ballet, and its figures, five in number, with a finale, bore the names of the different contredanses, Le *Pantalon, l'Été,* La *Poule,* La *Trénitz,* La *Pastourelle.*

QUAESTOR (Lat. quaerere, to investigate), a Roman magistrate whose functions, in the later times of the republic, were principally financial, although he was originally concerned with criminal jurisdiction. The quaestorship was probably instituted in 509 B.C. simultaneously with the consulship. The number of quaestors, originally two, was successively increased until Julius Caesar raised it to 40 (45 B.C.); Augustus reduced it to 20, which remained the regular number under the empire. When the number was raised from two to four in 421 B.C., the office was thrown open to the plebeians.

The quaestorship was the lowest of the great offices of State, and hence it was the first sought by aspirants to a political career (*cursus honorum*). The candidate was bound to have completed his 30th year before he entered office, but Augustus lowered the age to 25. Quaestors were elected by the comitia tributa (see COMITIA) under the presidency of a consul or another of the higher magistrates. They held office for one year, but, like the consuls and praetors, they were often continued in office. Indeed, it was a rule that the quaestor attached to a higher magistrate should hold office as long as his superior; hence, when a consul presided over the city for one year and afterwards as proconsul governed a province for another year, his quaestor also held office for two years. A peculiar burden laid on the quaestors, as a sort of fee exacted from all who entered on the political career, was the paving of the high roads, for which the Emperor Claudius substituted the exhibition of gladiatorial games.

Various classes of quaestors may be distinguished:—

The Urban **Quaestors.**—Originally the duties of the quaestors, like those of the consuls, were undefined; the consuls were the superior magistrates of the republic, the quaestors their assistants. From a very early time, however, the quaestors possessed criminal jurisdiction; political crimes only seem to have been excepted. The criminal jurisdiction of the quaestors appears to have terminated only when trial by permanent courts (*quaestiones perpetuae*) was extended to criminal cases.

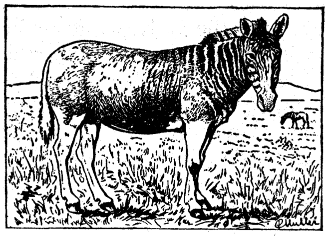
The quaestors had also charge of the public Treasury (*aerarium,* q.v.) in the temple of Saturn, and this was in later times their most important function. They kept the keys of the Treasury and had charge of its contents, the coin and bullion, the military standards, and a large number of public documents, which comprised all the laws as well as the decrees of the senate. Their functions as keepers of the Treasury were withdrawn from urban quaestors by Augustus and transferred to other magistrates.

The Military **Quaestors.**—These were instituted in 421 B.C. and were clearly distinguished from the urban quaestors by the fact that a non-urban quaestor was assigned as an assistant or adjutant to every general in command, whose name or title the quaestor usually added to his own. Originally they were the adjutants of the consuls only, afterwards of the provincial praetors, and still later of the proconsuls and propraetors. The governor of Sicily had two quaestors; all other governors and commanders had but one. Between the quaestor and his superior, a close personal relation existed, and was not severed when their official connexion ceased. The duties of the military quaestor, like those of the Treasury quaestor, were primarily financial. Moneys due to a provincial governor from the State Treasury were often, perhaps regularly, received and disbursed by the quaestor; the magazines seem to have been under his charge; he coined money, on which not infrequently his name appears alone. But, though his duties were primarily financial, the quaestor was the chief assistant or adjutant of his superior in command, and invested with a certain degree of military power. When the general left his province before the arrival of his successor, he usually committed it to the care of his quaestor, and, if he died or was incapacitated from naming his successor, the quaestor acted as his representative.

The Italian **Quaestors.**—The subjugation of Italy occasioned the institution (267 B.C.) of four new quaestors, who appear to have been called quaestores classici because they were originally intended to superintend the building of the fleet (classis); their functions, however, are very imperfectly known.

See Mommsen, Staatsrecht; A. H. J. Greenidge, Roman Public *Life* (1901); J. E. Sandys, *Companion to* Latin *Studies* (1921); W. E. Heitland, *The Roman Republic* (1923).

QUAGGA, an animal of the genus *Equus* (E. Quagga), allied to Burchell's zebra, formerly met with in vast herds on the great plains of South Africa between the Cape Colony and the Vaal river, but now extinct. The colour of the head, neck and upper parts of the body was reddish-brown, irregularly banded and marked with dark brown stripes, stronger on the head and neck, and gradually becoming fainter until lost behind the shoulder. There was a broad dark median dorsal stripe. The under surface of the body, the legs, and tail were nearly white, without stripes. The crest was high, surmounted by a standing mane, banded brown and white. The name is an imitation of the shrill barking neigh of the animal. (See HORSE and ZEBRA.)



THE QUAGGA (EQUUS QUAGGA), OF SOUTH AFRICA CLOSELY ALLIED TO THE ZEBRA; NOW EXTINCT

QUAHOG: see CLAM.

QUAIL, a bird well known throughout Europe, Asia and Africa. The common quail (*Coturnix coturnix*) is variable in colour, but in general is reddish-brown above, marked with dark brown and buff and pale buff below, passing into white on the belly. Essentially migratory, quails breed on the ground, laying 9 to 15 yellowish white eggs, spotted with dark brown. They are very good table birds and immense numbers are netted during the autumn migration across the Mediterranean. Quail is now very rare in Britain, but the numbers fluctuate. It is much the smallest British game bird. It feeds largely on weed seeds, but also eats insects, and is decidedly a beneficial species. Allied species include the rain-quail (*C. coromandelica*) of India; the Australian stubble-quail (C. *pectoralis*); the North American "Bob White" (*Colinus virginianus*); and the Californian tufted quail (Lophortyx *californica*).

The button-quails (*Turnix*) are a somewhat different group, lacking the hind toe in most species. One, T. *sylvatica*, inhabits Barbary and southern Spain; all are confined to the Old World.

QUAIN, SIR RICHARD, BART (1816–1898), Irish physician was born at Mallow-on-the-Blackwater, Co. Cork, on Oct. 30, 1816. After a brilliant career as a student at University college, London, he became assistant physician at the Brompton hospital for diseases of the chest. He served this hospital until his death (March 13, 1898) as full physician (1855–75), and then as consultant. He became physician-extraordinary to Queen Victoria in 1890, and was created a baronet in the following year. Quain's name is remembered by the Dictionary of Medicine, the preparation of which occupied him from 1875 to 1882 (3rd ed., 1902).

QUAKERS, originally a cant name applied in derision to the members of the Society of Friends, but now used without any contemptuous significance. It was used as early as 1647, and arose from the physical manifestations of religious emotion characteristic of many early Friends. (See FRIENDS, SOCIETY OF.)

QUAKERTOWN, a borough of Bucks county, Pennsylvania, U.S.A., 38 m. N. of Philadelphia; served by the Quakertown and Bethlehem and the Reading railway,. Pop. (1930) 4.883 and 5,150 in 1940. It is in an agricultural region, and has a number of factories making stoves, hosiery, silk, clothing, church organs.

QUALITIES. Primary qualities of matter are, mainly, the spatio-temporal ones, such as shape or motion; secondary ones are the sensible qualities, such as colour or smell. "Tertiary qualities" is a new and convenient term, introduced by Bosanquet, among others, to designate what are commonly called the ultimate values, beauty, goodness, truth.

Primary and Secondary Qualities.—The distinction between primary and secondary qualities is given officially for

British philosophy by Locke (*Essay*, Bk. ii., ch. viii. secs. g, 10). "Qualities thus considered in bodies are First, such as are utterly inseparable from the body in what estate soever it be; such as, in all the alterations and changes it suffers, all the force can be used on it, it constantly keeps; and such as sense constantly finds in every particle of matter which has bulk enough to be perceived, and the mind finds inseparable from every particle of matter, though less than to make itself singly be perceived by our senses." Locke enumerates: "solidity, extension, figure, motion or rest and number." Secondly, "Such qualities, which in truth are nothing in the objects themselves, but powers to produce various sensations in us by their primary qualities, *i.e.*, the bulk, figure, texture and motion of their insensible parts, as colours, sounds, tastes, etc., these I call secondary qualities." Locke adds that there is a third set of qualities, which are powers to produce changes in other bodies, not merely sensations in us. The distinction of primary and secondary qualities does not originate with Locke. It occurs in Greek philosophy in the doctrine of Democritus: "Sweet and bitter exist by law or convention" (that is, are relative to us); "what exists in reality are the atoms and the void." The atoms, which possess shape and other "primary" qualities, themselves by their density account for such qualities as heavy or hard; but other qualities are the effect upon us of the atoms. Aristotle makes the distinction on a quite different basis, and probably the more valuable one. He distinguishes (De *Anima*, ii., 5) the special sensibles, like colour or taste, which are apprehended by only one sense, from the common sensibles, apprehended by all the senses alike, motion, rest, etc. For modern philosophy, the distinction of primary qualities from secondary ones, in much the same form as Locke's, begins with Galileo, who goes so far even as to say that secondary qualities are but names which we give to things because they excite certain sensations in us (Hoeffding, *Hist. Phil.*, vol. i., p. 183). Locke derived his statement of the distinction from Descartes who, in a famous passage of the *Meditations*, points out how a piece of melting wax changes its colour but always retains extension. Extension he therefore regarded as an essential quality of matter, the sensible qualities being due to us or subjective. Locke puts the matter naïvely in the form, that ideas of figure or motion exactly resemble their original in real things, whereas colour and taste have nothing like themselves in things, and are the work of the mind. As thus drawn, the distinction corresponds to the practice of science and the tradition of the so-called mechanical theory of the world, which has been of such enormous practical value for scientific procedure.

Locke's statement implies that the primary qualities are real and the secondary ones subjective or mental, that is, have no existence apart from the mind; and secondly that the primary qualities are prior in the order of importance and fact to the secondary ones, for the secondary qualities are due to the impingement, however indirect, upon our sense-organs of the primary qualities of the microscopic constituents of matter. Two fundamental questions are therefore raised for philosophy: the relation of the two sets of qualities in respect of reality; are they unequally real, the one independent of the mind and the other dependent on the mind; and secondly their relative status, which of the two is prior in rank in the world of ideas to which they both belong. It is not strange, therefore, that the formulation of the difference between them raises vital questions of philosophy as a whole.

The first question was the immediate interest of Locke's successor, Berkeley, who declared them both to be upon the same level of reality, both being dependent on the mind, or being ideas, that is mental objects. Berkeley had little difficulty in showing first of all that the primary qualities are as much subject to variation with the condition of the observer as the secondary ones; and secondly that the primary ones cannot be experienced apart from the secondary ones—extension must be seen or touched to be experienced. If, then, the secondary ones are mental, so also are the primary ones Berkeley's contention that both sets are on the same level of reality has been generally accepted by all who have been content to regard both of them as sensible objects. When, as with Kant, a distinction has been readmitted it has been on the ground that extension, for instance, is not a sensible but an a *priori* form of all external sensibles. Granted, however, that they are both on the same level of reality, the primary qualities may still be the more important. But the significance of Berkeley's result for present philosophy lies in this that it leads directly to the question, are the two sets of qualities alike because both are dependent on mind, or because both are equally independent of mind? Now suppose, as simple realism supposes, that what the mind directly experiences is not its ideas but real objects themselves; that instead of holding its objects to be ideas we hold the so-called ideas to be objects themselves; it is still true that primary and secondary qualities are equally real, this time because both are equally independent of mind.

The general metaphysical difficulties of such an idealism as Berkeley's cannot be fully discussed here. But the idealism which has replaced his still declares that reality is experience and even sentient experience (Bradley); and accordingly there is some impatience expressed in either camp when it is asked if secondary qualities are not real. The question still remains whether they are both dependent on mind, or both independent of it. That secondaries are still dependent upon us is maintained even by those realists who urge that, at any rate, they depend if not upon our minds at least upon our bodies, that there would not be colours except there were eyes. The answer made by those realists who maintain that secondaries are as much as primaries independent of mind, is that the bodily organs are instrumental to perception, but are not constitutive, even in part, of the perceived. It is one thing to hold that objects cannot be known without a mind to know them, and another to hold that they owe their existence to mind. The doctrine of behaviourism, which has acquired such strength in American psychology, rests upon the belief that what are called mental acts are nothing but bodily reactions of certain specific sorts to stimulation from objects, and are thus instances of the wider field of organic vital reactions. And some, like the present writer, have expressed the situation for philosophy by saying that in sensation a bodily reaction which is conscious takes place in response to a physical object and that in such action an object or sensum, *e.g.*, a colour, is revealed to the mind. What the exact character of the object in question is may for the moment be deferred.

According to this, secondary and primary qualities alike are independent of mind. An entirely different complexion is put upon the matter in the theory of "neutral monism" advocated by several present philosophers both American (*e.g.*, Holt) and English (*e.g.*, Bertrand Russell). Upon this view the stuff of things is neither material nor mental but neutral; as Bertrand Russell puts it, the mental is more like matter and the material more like mind than is commonly supposed. This doctrine descends from William James who said that physical objects and the ideas of them are but the same thing considered in different relations as, for instance, the same fire may physically destroy a house and mentally suggest the danger of its inhabitants. It is plain that secondary qualities are real on such a view, and that there is no point in asking if they are subjective or objective. Into the grounds of this doctrine there is no space to enter. We may note, however, that it is far closer in its general tendency to idealism as represented by Bradley than it is to any realism which declares that we apprehend objects directly and that we discover what they are in virtue of the specific reactions which the body-mind makes towards them. Without examining neutral monism further we may observe that it stands or falls with its initial statement of experience. When we see a patch of red, it is held that the experience is completely described in the words, a red patch occurs. Is this exact, or must we rather say, I am aware, or there is awareness, of a red patch?

This question must be left, in order to turn to the second question of the order of priority between primary and secondary qualities. No one has ever suggested that the two sets of qualities are upon the same level in this respect. But it is noticeable that in the more recent English philosophy the old priority of the primaries seems to give way to the priority of the secondaries.

Granted that both are equally real, different ways have been adopted of stating their difference. One way is that of G. F. Stout (Proceedings of the Aristotelian Society, N.S. vol. iv., 1903–4, p. 153) that "the difference lies in their respective relation to the interaction of material things." The executive order of the material world can be expressed only in terms of the primary and not in terms of the secondary properties of matter. In Bergson's doctrine (Matter and Memory, ch. iv.) red differs from the corresponding vibrations in the tempo at which the experience is taken by the mind: what at a slower rhythm of *durée* may be apprehended as mechanical vibrations at a faster rhythm is condensed into colour.

But in the important recent philosophy of A. N. Whitehead, although the relative position of the two sets is not discussed as such, the traditional priority of the primaries would seem almost to be reversed in favour of the secondaries. The secondaries are, of course, real. In a happy phrase Whitehead has effectually destroyed the "representationism" inherited from Locke and Descartes by "protesting against the bifurcation of nature into two systems of reality," the one physical, which is not directly known, and the other "which is the byplay of the mind" (Concept of Nature, 1920). The world in this philosophy is a world of events, and the simplest events into which the total event which is "the passage of nature" can be resolved are described as "situations" into which "eternal objects," like red or sweet, which are not events, make "ingression." The perception of sense-objects implies a multiple relation into which enter the "percipient event" which is a bodily state, the "situation," the "eternal object" and the surrounding conditions (p. 152). (Compare his Science and the Modern World, pp. 99–102.)

The reality of secondary qualities is here not in doubt. The relative position of the primaries and secondaries is not so clear. For space and time on this doctrine are relational, relations between events as thus fully qualified by ingression of eternal objects; and accordingly constructions are framed to describe in terms of concrete events such conceptions as points, areas, volumes, etc.; and the great merit of this procedure is that it starts from concrete events instead of from conceptual entities like points. It is possible thus to define a point by means of all the sets of concrete extensions (*e.g.,* red patches) by which we can approach it. Now, to come to the present question, since space and time are relations between events, they are logically posterior in rank to the events themselves; and it would seem to follow that primary qualities such as geometrical figures, which are enumerated under the head of eternal objects (Science and *the* Modern World, p. 146), are posterior to the secondary qualities which are situated in the events. At least the two sets of qualities appear to be on a different footing.. This is, however, not the author's statement but an inference of the writer's, which may be mistaken. We may add that the omission of any analysis or explanation of the vague conception of "relation" makes the whole subject obscure.

A different though allied doctrine, that of the writer (Space, *Time* and Deity), leaves the primary qualities with their traditional priority, while at the same time raising difficulties of its own. According to this view the stuff of the world is space-time itself, that is, pure events, and the qualities or objects, which on Whitehead's doctrine are ingredient into events from the beginning, are said to emerge historically as the web of events within the whole space-time assumes certain complexities of configuration. Primary qualities, such as shapes or numbers, arise within space-time at the earliest level of existence. Subsequently these spatio-temporal configurations assume a certain complexity and we have matter or at least sub-matter. At a higher level of complexity there "emerge" certain material or submaterial configurations, complexes in the end of space-time, which are those conditions of bodies of which we have become aware as colour or taste. The notion of Emergence (*q.v.*) indicates the fact that at certain critical points in the development of the spatio-temporal world, new qualities appear, which are based upon the lower level of existence, and while also equivalent to the lower-level complex are qualified by a new character. So, to take an example from a higher stage of history, a certain complex of chemical and mechanical processes is endowed with the quality life; in the same way as a certain complex of purely spatio-temporal configurations becomes submaterial. Emergence is a term applied by this writer to the large critical novelties only; by Lloyd Morgan it is applied more freely to any change that can be called a change of character. (Whitehead uses the term differently. Since events from the outset are characterized by qualities through the ingression of objects, he speaks naturally of the emergence not of a new quality or "eternal object" but of a new thing through the ingression of a fresh complex of eternal objects.) On this second view, then, secondary qualities emerge from primary ones when those primary qualities, as in material or submaterial things, reach a certain degree and kind of complexity—*e.g.,* when certain motions occur in the body which are propagated in the form of light waves. The grave difficulties, which need not be concealed, in this general doctrine lie in its basis, in its use of the notion of pure event without quality, and its assumption without investigation of geometrical ideas such as point and line.

The Tertiary Qualities or Values raise similar problems, but it may well be doubted whether it is altogether happy to suggest, as the name does, that values belong to things in the same sense as the primary and secondary qualities do. Beauty is the only one of them which belongs directly to things; for truth attaches to propositions, and goodness to actions; and it will be convenient to speak principally of it. It has been held that beauty belongs to the beautiful object itself, a statement which, plausible enough when made of works of art, seems at first only the obvious one to make of a beautiful sunset or any form of natural beauty. Beauty, according to this view, is real and objective like shape or colour. In like manner goodness is held by some to belong to the person or act which is good; and it may be noted that even a writer like Kant treats good as objective though belonging to the intelligible or supra-phenomenal world. The statement that beautiful things have beauty apart from mind is, however, difficult to accept, because in a work of art beauty depends so largely on characters imputed to the work by the artist or the spectator. Thus dead marble looks alive and full of character, or in a picture stable forms are seen, aesthetically, to be in motion, for instance, to be dancing; and in a poem, the words are chosen not merely to describe but to endow: "two voices are there, one is of the sea, one of the mountains," though neither sea nor mountains have voices. There is so far always an element of illusion in art, a character being imputed to the material which it does not possess of itself. Even in natural beauty, the beauty may be seen to depend on selection on our part, or it may be addition; for instance, we may select in the sunset the shades which harmonize, or in the landscape the features which suit our own mood.

It would seem to follow that beauty is really dependent on the mind, and would not exist either in art or nature except for our interference. And it is not difficult to carry this line of reflection further and maintain that goodness and truth are human constructions, as, with respect to goodness, was held by Spinoza. Truth is not so obviously a human invention, but it is, in fact, different from reality itself, though it is guided and controlled by reality. Truth as in science is really a semi-artistic product in which the seeker blends himself with reality and does so by selection. His difference from the artist is that, though he imputes and interprets, he imputes nothing that he cannot verify in the reality. The artist introduces himself into his art giving the work characters which it only has so far as seen with the aesthetic eye. The enquirer who attains truth possesses reality for himself, but he keeps his human imputations out of the product.

The same thing may be concluded from observing that beauty satisfies a specially human impulse which has to make the object which is to satisfy it. Animals, including men, live by using the food which they find; but the impulse to beauty is a creative impulse, which the present writer (Art and Instinct, 1927) identifies as the impulse of constructiveness (such as animals and bees or ants also have) but used without regard to a practical purpose. In the same way truth appeals to an impulse of curiosity, and goodness to a social impulse. The values accordingly possess value because they satisfy these special impulses, and bring a peculiar satisfaction.

Such a conception of beauty and the other values has been held by some critics to be incbnsistent with the view that the secondary qualities are independent of mind. If beauty is so dependent, why not colour? The question is really irrelevant, for the same explanation does not necessarily apply to situations which may seem superficially similar. And, as has been indicated, the action in virtue of which we discover colour is entirely different from the creative action by which we become aware of beauty and goodness and truth.

The values therefore rest on a different basis from primary and secondary qualities. Men produce works of art and good societies and true knowledge. But these products have these qualities only on sufferance from their makers. Remove men, and beauty would disappear. But red would remain; though, unless there are creatures with the appropriate organs, it would not be perceived.

At the same time in declaring the values to be qualities only of the new realities which are held upon human tenure, we do not declare them to be mere figments of men. On the contrary, goodness belongs, in the sense described, to acts which bring out what is best in human nature, and true knowledge, being controlled throughout by reality, admits us to the secrets of that reality. And art embodies, in stone or sound, the constructive visions of men and reveals the deeper relations between us and nature.

The separation of tertiary qualities from those which do not depend on human interference helps us to set in a clearer light the quality of things which is their "worshipfulness" and becomes, when considered as abiding in them, the object of religion. It is commonly spoken of as a value along with beauty, goodness, and truth, and may consistently be so regarded, if value is thought to be inherent in what is valuable. If, however, the above considerations are valid, it would be treated, whether under the name of deity, or worshipfulness, or as Otto calls it (in *The Idea of the Holy*, Eng. trans., 1923), "numinousness," not as a value or tertiary quality at all, but, just because it belongs to its possessor intrinsically, without need of human intervention, as a quality, on the line of the primary and secondary qualities, independent of man and actually belonging to the world of things, which world includes, of course, man and man-made values. This topic is, however, raised here only for completeness, and it falls beyond the scope of this article to examine further the nature of deity and its possessor. (S. A.)

QUANTICS, the study of homogeneous algebraic functions of two or more variables which generally contain only positive integral powers of the variables. *See* ALGEBRAIC FORMS.

QUANTITY THEORY OF MONEY. A summary form of expression for two allied but distinct propositions relating to the causes of changes in the value of money. The broader proposition referred to is that, other things being equal, changes in the value of money are dependent upon changes in the quantity of money. The narrower proposition is that changes in the value of money, other things being equal, are *directly* proportional to changes in the quantity of money: so that, if, say, the quantity of money is either halved or doubled, all other things remaining the same, the value of money will be doubled or halved; that is (since the price level is an expression of changes in the value of money) prices will rise or fall in strict proportion to a given change in the quantity of money, all other things being supposed to remain unchanged. It will be clear from what has been said that the narrower proposition cannot be true if the broader proposition is not, but that it by no means follows that the untruth of the broader proposition can be proved by disproving the truth of the narrower.

The controversies to which these propositions have given rise are amongst the most celebrated in political economy. Before approaching them, it must be pointed out that the issues involved are irrelevant for any theory of money which asserts that money is only a symbol *expressing* values, but itself incapable of *possessing* value. Any such theory must reject not only the quantity theory in any form, but also the view (which historically is very important) that the value of money is based upon the cost of production of the precious metals. It must reject the latter alternative by arguing that, though the given form of money may be made from gold or silver, which may possess value, it is not *this* fact which is relevant in deciding whether the coin so made is money or not; the important fact is the denomination of units of value expressed and these are independent of the material out of which money is made. But. though some "symbolistic" theories of money reject the quantity theory, others are so worded as to admit of some form of it; and, in any case, the "quantity theory" and the "cost of production theory" are capable of reconciliation; for it may be argued, as, for example, by J. S. Mill, that "cost of production would have no effect on value if it could have none on supply." Thus a lowering of the cost of production of gold lowers the value of gold and therefore raises prices, because under these circumstances more gold will be produced.

It must be pointed out, further, that the truth of any form of the quantity theory cannot be established purely by an appeal to facts. This is so, not merely because, in practice, other things never are equal—so that, in the real world, changes in the quantity of money are always accompanied by changes, not only in the price level, but in other things—but also because mathematical or statistical equivalences between quantities are incapable of throwing any light upon causal sequence. In other words, assuming that changes in the price level always do accompany changes in the quantity of money, this fact, if it is a fact, does not tell us which change depends upon which. It must be shown, if any form of the quantity theory is true, why changes in the price level are dependent upon changes in the quantity of money. Otherwise it might be argued that changes in the quantity of money are dependent upon changes in the price level, or that changes in the price level and changes in the quantity of money are co-effects of remoter causes.

Though the truth of the quantity theory is not denied by a majority of economists, the formulation of the theory has undergone profound modifications. A distinction must be drawn between the "older" and the "newer" quantity theories. In what follows we shall deal first with the older and traditional theory, and then with its formulation in recent years.

The Older Theory.—The older view, which received its most complete expression at the hands of Irving Fisher in his *Purchasing Power of Money* before the World War (1911), ultimately rests upon the following assumptions. The dynamic consequences of the theory flow from the fact that additional supplies of money *constitute an incentive to additional spending.* Additional supplies of money drive prices up, because (the supply of goods being assumed constant) there will be more to spend and competition among spenders is a cause of rising prices. The additional supplies of money, secondly, *will be spent* because money possesses no intrinsic power of yielding satisfactions; the satisfactions arising from the possession of money can be realized only by acquiring goods and services which possess a direct power of satisfying wants. Now, given these two assumptions, it follows almost as a matter of course not only that prices will rise as the quantity of money rises, but that the price-rise will be in proportion to the increase in the quantity of money. For, given a certain increase in the volume of money and a *disproportionate* alteration of prices, disequilibrium will prevail until the price level is in direct relation to the new total quantity of money. If prices have risen less than in proportion to money, goods will seem unusually cheap to consumers and this will stimulate further consumption of them. If prices have risen more than in proportion to the increased quantity of money, consumers will, in spite of additional quantities of money, find prices unusually high and will check their consumption, with the result that prices will fall. If, but only if, prices alter in exact correspondence to changes in the quantity of money, everyone will find himself in the same position as formerly, with the same real income of satisfaction, but with higher prices on the one hand, and larger money supplies available on the other.

The quantity theory, in the course of its evolution, gradually acquired complexity of exposition. Three separate points have to be noted in this connection. The first is the modification introduced when changes in the volume of goods are taken into account. Changes in production may be increasing the supply of goods contemporaneously with the increased monetary supply and the latter may even exert some stimulating effect upon production. Other things in this case will not be equal, so that the price level will be forced upwards or downwards according as the influence of increased supplies of money or of goods exerts the preponderating influence; so that the quantity theory is usually expressed in the form that prices move directly with the supply of money and inversely with the supply of goods. Further, it is not the volume of physical goods but the volume of goods *and services* which must be contrasted with the supply of money: an increase in the number of *separate transactions* associated with production works, in this connection, as a price reducing factor, because, in fact, transactions represent services rendered in connection with physical supply. Next, the theory has to take account of the fact that, during a given period of time, each unit of money, passing from hand to hand, necessarily plays a part in the number of transactions, the number depending upon the rapidity of its circulation. Given a certain number of monetary units, an increase in their *velocity of circulation* is equivalent in effect to increasing the supply of units acting as money during the period of time considered, so that an increase in the velocity of circulation, other things being equal, raises prices, whilst a decrease in the velocity reduces prices. Lastly, the quantity theory has to take account of credit instruments of various kinds. Here two solutions are possible. One is to treat these instruments as *additional* to the supply of metallic money and bank and government notes, so that an increase in the supply of credit instruments raises prices in exactly the same way as an increase of money would have done. The second alternative is to regard credit instruments as a *substitute* for ordinary forms of money, which are replaced in a certain number of transactions by credit instruments, so that, *in relation to transactions,* the supply of money rises and prices rise in correspondence.

The **New** Formulation of the Quantity Theory.—The theory fashionable in pre-war days had two great defects. By contrasting money as a whole with transactions as a whole, it was unable adequately to take account of the individual process of revaluation which is implied in a change in the price level. Secondly, the facts of inflation during the war threw grave doubt on the view that prices were altered proportionately to changes in the quantity of money, the fact being that prices rose much more rapidly in the later stages of inflation, and appreciably less rapidly in the early stages of inflation, than the theory warranted. The new formulations have no difficulty in dealing with these points.

The modern quantity theory starts from the fact that each independent individual or other economic unit requires to keep on hand at all times a certain stock of money. At any moment, of course, money may be passing out of one stock into another, but this does not invalidate the fact that considerations of convenience and habit dictate the keeping of a certain stock on hand. This stock of money on hand or, as Hawtrey calls it, "The unspent margin," is as much required as a stock of clothes or a stock of food, if the economic system is to function adequately. The aggregate demand for money, then, is derived from the sum of individual demands for stocks, just as the demand for houses is derived from the individual demands of those who desire to occupy them. An increase in demand for money is equivalent to an unwillingness to reduce the stock actually held and a desire to add to it. If the supply of money is fixed, this must mean that money acquires a higher value, that is, prices will fall, because people can add to their stocks only by parting with goods or services in order to increase the stock they hold and, since the total stock of money is assumed to be fixed, this can only be at the expense of other stocks held by other individuals. If there is a general desire to decrease stocks on hand, prices must rise, in spite of the total supply of money being fixed, because if there is a general alteration in the desire to hold money, holders can only get rid of what they have by offering it more cheaply, that is, at a lower price in goods to the taker. But this is equivalent to a rise of prices.

When the supply of money alters, the effect produced upon prices depends upon the effect alterations in the supply have upon the willingness to hold stocks. At first the effects of increasing supplies upon the price level, when spent by the issuer, are not in any case likely to be very great. If, at such a time, people's willingness to increase their stocks extends, the rise in the price level will not be in proportion to the increase in the output of money. But if this output increases continuously, the rise in the price level will tend to be more and more rapid and to outstrip the increase in the quantity of money, and that for two reasons. The larger the stock already held, the lower must be the price at which additional amounts must be offered to holders in order to induce them to take more. It may be argued that, as prices rise, individual holders need to hold more, because otherwise the stock held will be inconveniently small in view of the new price level. This is so, but it by no means follows that in the course of the process of adaptation, individuals have not altered their ideas as to what a convenient stock is; in fact, the rise of prices shows that they must have done so. In any case, if the supply of money goes on increasing and prices go on rising, anticipation of the future value of money begins to play an important part. Just as individuals will refuse to add to their stocks of cotton at a time when they believe that cotton will continue to fall in value, so they will refuse to add to their stocks of money at a time when that is falling in value, and unwillingness to add to their stocks is in itself a cause why the fall in the value of money should proceed more rapidly.

It makes no essential difference to the new formulation whether credit is regarded as a form of money or not. If it is so regarded, then the demand for stocks must be regarded as a demand for so much cash plus so much credit. It is thus that the position is treated by Keynes and Hawtrey. If credit is regarded as a substitute for cash, as it is by Cannan, then the demand for cash will fall off if credit arrangements are regarded as more convenient, and in the absence of appropriate arrangements for withdrawing superfluous cash, prices will rise, since part of the stock of cash will have become redundant.

See also Inflation and Deflation; Money; Banking and Credit; Currency. (T. E. *G.)*

QUANTUM THEORY, THE. As recently as the opening years of the present century the vast majority of physicists still regarded Newton's dynamical laws as something established for all time. And they were not without solid grounds for this faith. Many phenomena were indeed known, chiefly those which may be classed under the heading radiation, *e.g.,* black body radiation and line spectra, which refused to accommodate themselves to any sort of theory founded on Newtonian principles; but it was generally believed that such phenomena would, sooner or later, be completely accounted for without any departure from the classical principles of physics. Even the theory of relativity developed by Lorentz, Einstein, Minkowski and their successors was regarded only as a widening or generalization of the Newtonian basis of physics. It was the culmination of classical physical theory. These phenomena we now believe, cannot be accounted for on the basis of the classical physical theory, whether Newtonian or Einsteinian. The first act of sacrilege was committed by Max Planck, until recently professor of theoretical physics in the University of Berlin, about the end of the year 1900, when he initiated the quantum theory. One of the problems engaging the attention of physicists during the closing years of last century was that of the radiation from a blackbody; a body, the surface of which absorbs all the radiation of any wave-length whatever that may fall on it. The radiation emitted by a black body at some definite temperature is like that inside a vacuous enclosure the walls of which are at this definite temperature. (The terms *vacuous* and *empty* as used in this article mean *not containing atoms or molecules.)* The character of black body radiation is determined solely by the temperature of the walls of

FIG. 1.—THE FULL LINE REPRESENTS THE WAY IN WHICH THE ENERGY E, IS DISTRIBUTED AMONG THE VARIOUS WAVE-LENGTHS, λ; THE BROKEN LINE REPRESENTS THE LAW OF DISTRIBUTION ACCORDING TO RAYLEIGH'S FORMULA

the enclosure, and is independent of the nature of the materials of which they are made. Now the feature of this type of radiation which puzzled the physicists of the period immediately preceding the present century was the way in which the radiant energy was distributed among the different wave-lengths. The actual law of distribution is illustrated by the full line in fig. 1. The distribution deduced from Lord Rayleigh's formula is shown by the broken line in fig. 1. The figure illustrates the wide divergence of the theoretical from the actual distribution in the region of very short waves.

Planck convinced himself that Rayleigh's deduction, confirmed by J. H, Jeans, was sound, and he therefore drew the inference that the premises on which it was based, *i.e.*, Newtonian dynamical principles, were faulty. In the year 1896, W. Wien, then a professor in Wurzburg, found a formula which represented the observational data very well for small values of the product of wave-length and absolute temperature. Planck had for his guidance the formulae of Rayleigh and Wien, and also the ideas of Ludwig Boltzmann about the relation between entropy and probability. His first success was the discovery by a method of trial and error, of a formula which interpolated between those of Rayleigh and Wien, and which represents the facts of black body radiation exceedingly well for all ranges of wave-lengths and temperatures over which observations have been made. A little later he succeeded in giving this formula a theoretical basis and it is here where the first mention of the quantum theory appears.

FIG. 2.—THE RELATION BETWEEN THE DISPLACEMENT OF THE BOB OF A PENDULUM AND THE CORRESPONDING MOMENTUM

The essential feature of the innovation which Planck introduced may be described with the aid of a simple illustration. Let us consider a pendulum, the bob of which is vibrating in a vertical plane, with not too large an amplitude. The centre of gravity of the bob will move backwards and forwards along a short arc of a circle. Represent its distance at any instant from the central position by the letter q and the momentum of the bob, *i.e.*, the product of its mass and velocity, by the letter p. If we exhibit the relation between p and q graphically (fig. 2) we obtain a closed curve, on account of the periodicity of the motion. Newton's laws of motion require the shape of this curve to be an ellipse, and further, that the energy of the pendulum bob shall be equal to the product of the area of the ellipse and the frequency, *i.e.*, the number of complete oscillations made by the pendulum in the unit time. Therefore

$$E=A\nu \tag{1}$$

where E is the energy, A is the area of the ellipse and ν is the frequency. We are assuming, of course, that the pendulum is not subjected to damping influences and after being set in motion is not further interfered with. The constant A is called the *action* of the pendulum corresponding to its period of motion and has the dimensions of the product of energy and time. It seems self-evident that, provided we keep within a certain upper limit, the action A may have any value whatever. It merely depends on the energy with which the motion is initiated, and Newton's laws of motion impose no restrictions on the values of the constant A.

Planck's Theory.—It is just here where the theory of Planck steps in. According to Planck, a vibrating system, like the pendulum with a small amplitude of oscillation, will normally behave as if it were not interfered with and will obey the classical laws, *but the constant A is restricted to be an integral multiple of a small universal constant h called the Quantum of Action.* The energy is therefore expressed by

$$E=nh\nu \tag{2}$$

where n is a positive integer or zero. While this normal behaviour continues, the system is said to be in one of its *stationary states,* and the corresponding value of the energy is termed an *energy level.* Energy can only be gained or lost by a transition from one stationary state to another. Such transitions do not conform to classical laws and their nature is still obscure. In the case of a simple harmonic vibration, of which the motion of the pendulum described above is an instance, the integer n can only change by unity in a single transition. The reason for this will be explained later. The universal constant h turns out to be very small, being equal to

$$6\cdot55\times10^{-27}\ \text{ergs}\times\text{seconds},$$

so that, when applied to a thing on as big a scale as an ordinary pendulum, Planck's theory makes no practical or observable difference. But it makes a profound difference when applied to things on the scale of atoms. The classical theory (if under this term we include the theory of relativity) is quite competent to deal with microscopic phenomena, and it has always been, in fact, a guiding principle in the development of the quantum theory to make it coalesce with the classical theory when applied to large scale phenomena.

In his later work Planck modified his earlier hypothesis. Possibly he may have felt that he had laid hands on the doctrines of Newton with more violence than was necessary, since the later modifications conceded that a vibrating system might absorb energy after the classical fashion

Black Body Radiation.—The following description of the theory of black body radiation (*see* **BLACK BODY**), or full radiation as it is now more usually termed, while embodying the essentials of Planck's theory, differs from it in immaterial details. The radiant energy in a vacuous enclosure is associated with aether vibrations of all wave-lengths from zero upwards. The sort of picture we must form of a vibration of a definite frequency (or wave-length) is very like that of the vibration of the column of air in a cylindrical resonance tube or, better still, the transverse vibration of a stretched cord (Melde's experiment). Let us consider such a stretched cord, fixed at both ends. Its possible states of vibration will be such that it is divided into a number of intervals, each of the length of half a wave, terminated by nodes, or points where the cord is not in motion. In such a case we have the relation

$$l=n\frac{\lambda}{2}, \tag{3}$$

where l is the length of the cord, λ is the length of the wave torresponding to the frequency of the vibration and n is the number of intervals. If v represents the velocity with which transverse waves of frequency ν travel along the cord, we have the well known relation,

$$v=\lambda\nu, \tag{4}$$

so that equation (3) becomes

$$l=\frac{nv}{2\nu},\ \text{or}\ n=\frac{2l\nu}{v}. \tag{5}$$

It is clear, therefore, that the total number of possible vibrations of all frequencies from the lowest possible one up to ν will be represented by n in equation (5), and, therefore, the number corresponding to the narrow range of frequencies between ν and $\nu+d\nu$ will be represented by

$$\frac{22}{v}\,d\nu. \tag{6}$$

Strictly speaking this represents the number of vibrations when the motions of the cord are all parallel to one another, or all in one plane. The most general sort of motion of a point on the cord can be regarded as made up of two independent motions in directions at right angles to one another, and, therefore, the expression (6) should be multiplied by 2 to give the number of independent vibrations. We are concerned, however, with a slightly more complicated problem than that of the vibrations of a stretched cord. We wish to find an expression for the number of aether vibrations in unit volume of the enclosure and in the range of frequencies between ν and $\nu+d\nu$. The same sort of method as that just described leads to the result

$$\frac{4\pi\nu^2d\nu}{C^3}, \tag{7}$$

where C is the velocity of aether waves (light waves) in empty space. Or when we take account of the fact that aether waves are transverse like those along the cord, and that therefore, the displacements in such waves can be regarded as compounded of two independent motions at right angles to one another, we must multiply the expression (7) by 2, so that we get the final result

$$\frac{8\pi\nu^2 d\nu}{C^3}. \tag{8}$$

We shall get a formula for the energy per unit volume associated with the vibrations of this range of frequencies if we multiply formula (8) by the average energy of a vibration. The classical kinetic theory of matter requires that the average energy of a vibration shall be two-thirds of the average kinetic energy of translation of a molecule of a gas at the temperature in question. It must therefore be equal to

$$kT, \tag{9}$$

where T is the absolute temperature and k is the "gas constant" reckoned for one molecule. If, however, we adopt Planck's hypothesis and make use, as he did, of Boltzmann's notions of the relation between entropy and probability, we get the expression

$$\frac{h\nu}{\epsilon^{h\nu/kT}-1}, \tag{10}$$

where h is the universal constant already described and ϵ is the base of natural logarithms. Combining (8) and (9) we have Rayleigh's formula,

$$\frac{8\pi\nu^2 kT}{C^3}d\nu, \tag{11}$$

and from (8) and (10) we get Planck's formula,

$$\frac{8\pi h\nu^3}{C^3(\epsilon^{h\nu/kT}-1)}d\nu. \tag{12}$$

The expressions (11) and (12) represent, according to the classical theory and the quantum theory respectively, the energy of full radiation per unit volume and within the range of frequencies between ν and $\nu+d\nu$. If we remember that the product of wave-length and frequency is equal to the velocity of the waves, in this case

$$\lambda\nu = C$$

it is easy to see that these expressions are equivalent to

$$\frac{8\pi kT}{\lambda^4}d\lambda \tag{11a}$$

and

$$\frac{8\pi Ch}{\lambda^5(\epsilon^{Ch/k\lambda T}-1)}d\lambda \tag{12a}$$

respectively, either of which represents the energy per unit volume associated with the range of wave-lengths between λ and $\lambda+d\lambda$, the former according to Rayleigh and the latter according to Planck. Planck's formula fits the observed facts of black body radiation extraordinarily well (see HEAT), and it is easily verified that it approaches Rayleigh's formula in the limiting case of large values of the product λT.

Law of Dulong and Petit.—It is well known that the product of specific heat and atomic weight is very nearly the same, about 6 in the usual units, for many solid elements, *e.g.*, copper, iron, zinc, etc. This is the law of Dulong and Petit. There are many exceptions to the law, notably among elements of low atomic weight, such as boron and carbon (graphite, diamond). (See HEAT.) It should be pointed out that the specific heat of a solid is usually measured under the condition of constant pressure and that we are concerned here with the specific heat measured under the condition of constant volume. The latter is nearly always less than the former, and never greater. Let us examine the law from the point of view of the classical theory. We should expect the heat energy, expressed in mechanical units (ergs), in a gram atom of a solid element to be

$$3NkT, \tag{13}$$

where N is the number of atoms in a gram atom (or the number of molecules in a gram molecule), since the energy of a single atom in a solid element may be regarded as associated with three independent vibrations in mutually perpendicular directions and must therefore be equal to 3kT according to the classical theory. The atomic heat at constant volume, *i.e.*, the amount of heat required to raise the temperature of a gram atom one degree will be therefore

$$3Nk \text{ ergs per degree.} \tag{14}$$

To express it in the usual units, we divide by the mechanical equivalent of heat, *i.e.*, by $4{\cdot}2\times10^7$ ergs per calorie, and so we get

$$\frac{3Nk}{4\cdot2\times10^7} = \frac{3R}{4\cdot2\times10^7}, \tag{15}$$

where $R=8{\cdot}315\times10^7$ ergs per degree is the gas constant for one gram molecule of a gas. It is easily verified that the quantity (15) is very nearly equal to 6. The elements which deviate from the law of Dulong and Petit at ordinary temperatures conform to it more and more closely as the temperature is raised, and conversely, those which agree with the law at ordinary temperatures deviate from it more and more the lower the temperature at which the measurements are taken. We have here an illustration of the competence of the classical theory to deal with phenomena on a sufficiently macroscopic scale.

Planck's theory was first applied to the problem of atomic heats or specific heats by Einstein, and later and more completely by Debye. Debye assumed that the heat energy of a solid element is the energy of elastic vibrations of all frequencies from very low values to a certain upper limit which was fixed by the consideration that, as we have already seen, the theory must asymptotically approach the classical theory when the energy involved is very great (or the temperature very high). This upper limit is low enough (or the corresponding lengths of the elastic waves big enough) to justify us in regarding the material as uniform and to ignore in the calculation the fact that it is made of atoms and therefore granular in structure. The problem is closely analogous to that of black body radiation. The difference lies mainly in the fact that here we are dealing with the vibrations of a material and not with aether vibrations only. The number of vibrations in the frequency range from ν to $\nu+d\nu$ will now be

$$\frac{8\pi\nu^2 d\nu}{v_t^3}+\frac{4\pi\nu^2 d\nu}{v_l^3} \tag{16}$$

per unit volume, where v_t is the velocity of transverse waves in the solid and v_l that of longitudinal waves. This formula is based on the fact that we may have both transverse and longitudinal waves in a solid material and it should be compared with formula (8) above. Each of these vibrations has the average energy expressed by formula (10), so that we get for the total energy in the unit volume the expression

$$\int_0^{\nu m} 4\pi\left\{\frac{2}{v_t^3}+\frac{1}{v_l^3}\right\}\frac{h\nu^3}{(\epsilon^{h\nu/kT}-1)}d\nu, \tag{17}$$

the upper limit being fixed in accordance with the principle referred to above. Strictly speaking we ought to take into account the aether vibrations as well as those of the material; but the additional energy is negligible by comparison with that given by (17). The reason for this is that the velocities v_t and v_l are very small compared with C the velocity of aether waves. Since formula (17) must reduce to the corresponding classical one at high temperatures, we must fix ν_m so that the total number of vibrations is equal to 3N where N is the number of molecules in the unit volume, or

$$3N = 4\pi\left(\frac{2}{v_t^3}+\frac{1}{v_l^3}\right)\int_0^{\nu m}\nu^2 d\nu,$$

and therefore

$$4\pi=\left(\frac{2}{v_t^3}+\frac{1}{v_l^3}\right)=\frac{9N}{\nu_m^3}. \tag{18}$$

When we substitute this result in (17) we get for the energy in the unit volume of the material,

$$\frac{9N}{\nu_m^3}\int_0^{\nu m}\frac{h\nu d\nu}{(\epsilon^{h\nu/kT}-1)}. \tag{19}$$

If we agree that N in formula (19) shall represent the number of atoms in a gram atom of the element, instead of the number in the unit volume, then (19) will give the heat energy in a gram atom at the temperature T.

Since ν_m can be calculated from the velocities of transverse and longitudinal waves in the solid element (equation 18), it follows that the heat energy in a gram molecule and therefore also the atomic heat (the heat required to raise the temperature of a gram atom by unity) can be found from a knowledge of the elastic moduli, Young's modulus and the modulus of rigidity of the material.

If we use the letter E for the energy of a gram atom, and abbreviate by representing $h\nu/kT$ by β, which amounts to replacing v by $\frac{kT\beta}{h}$, formula (19) will take the shape

$$E=T\cdot\frac{9Nk}{\beta_m^3}\int_0^{\beta_m}\frac{\beta^3d\beta}{(e^\beta-1)};\tag{20}$$

or, expressed in words, the energy is equal to the product of the absolute temperature and a certain function (the same for all elements) of the quantity β_m. This may be written concisely,

$$E=Tf(\beta_m).\tag{21}$$

The atomic heat is, of course, $\frac{dE}{dT}$, and when we differentiate $Tf(\beta_m)$ with respect to T and write $f'(\beta_m)$ for $\frac{df(\beta_m)}{dT}$, we get since

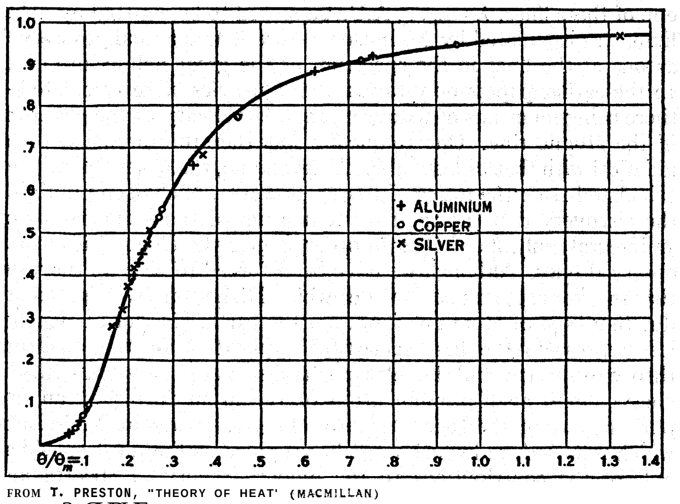
$$\frac{d\beta_m}{dT}=-\frac{\beta_m}{T},$$

$$\frac{dE}{dT}=f(\beta_m)-\beta_m f'(\beta_m),\tag{22}$$

The significance of (22) is that the atomic heat (as usually measured, *i.e.*, in terms of the centigrade degree) is the same function of β_m for all solid elements. Now $\beta_m=\frac{h\nu_m}{kT}$, or

$$\frac{1}{\beta_m}=\frac{T}{\frac{h\nu_m}{k}}=\frac{T}{\theta},\tag{23}$$

and therefore $\frac{1}{\beta_m}$ is the temperature of the element expressed in terms of the unit θ, which is called its characteristic temperature. We may say then finally, that the atomic heat of a solid element (measured in terms of the centigrade degree, or in terms of the same unit for all elements) is the same function of the temperature (now measured in terms of the characteristic temperature of the particular element as a unit) for all solid elements.



FROM T. PRESTON, "THEORY OF HEAT" (MACMILLAN)

FIG. 3—CURVE SHOWING THE VARIATION OF ATOMIC HEAT WITH TEMPERATURE

Reference to fig. 3 will show how well this theoretical result is supported by the facts. The atomic heats are given in terms of $3NK$, *i.e.*, to get the actual atomic heats the ordinates must be multiplied by 5.96. Debye's theory has been improved and extended by Born and Kármán, who have taken the crystalline structure of the solid into account.

The Constants of Planck and **Boltzmann.**—The universal constants h and k which have appeared in the formulae of the theories of full radiation and the specific heats of solid elements are appropriately named after Planck and Boltzmann. The data provided by investigators of full radiation enable us to assign to them the values,

$$h=6\cdot55\times10^{-27}\text{ erg seconds}$$

$$k=1\cdot37\times10^{-16}\text{ ergs per °C.}$$

These values do not differ materially from those originally computed by Planck.

The question now arises: What are the physical meanings of these constants? There is no difficulty in answering the question so far as k is concerned. It enters the theory of radiation as a factor correlating the entropy associated with the state of a thermodynamical system and the probability of that state, and is, therefore, sometimes termed the entropy constant. It appeared, more or less disguised in the kinetic theories of Maxwell and Boltzmann and in the statistical mechanics of Willard-Gibbs long before Planck began his investigations, and it happens to be identical with the quotient of the gas constant,

$$R=\frac{pv}{T}$$

of an ideal gas by the number of molecules in the gas; *i.e.*,

$$k=\frac{R}{N}.$$

Now R has the value $8\cdot315\times10^7$ ergs per degree centigrade for a gram molecule, therefore we get for N, the number of molecules in a gram molecule, $6\cdot06\times10^{23}$. This result, which differs only very slightly from that obtained by Planck, is in good agreement with the number obtained by later and quite different methods and it is very remarkable that it can be arrived at in this way. The quantity of electricity carried by a gram atom of hydrogen or other univalent element in electrolysis is found to be $2\cdot895\times10^{14}$ e.s.u., and when we divide by $6\cdot06\times10^{23}$, the number of atoms in a gram atom, we get for the charge on an ion $4\cdot77\times10^{-10}$ e.s.u. Planck arrived at the result $4\cdot67\times10^{-10}$ e.s.u., which may be said to be the earliest reasonably accurate estimate of the elementary ionic charge.

In the early days of the quantum theory, the question: What is the physical meaning of the constant h? was often asked. The question then really meant: What is the interpretation in terms of more familiar physical concepts of the type of atomicity symbolized by h? If the question is put in this way the answer is that h has no physical meaning. The fact is that the weird type of atomicity which finds its expression in Planck's constant is itself a ***new*** physical fact, first disclosed in the early development of the quantum theory and is something which can no more be expressed solely in terms of the older concepts of physics than can the dimensions of, say, a dielectric constant be expressed in terms of those of length, mass and time.

Photo-electricity.—The phenomena of photo-electricity exhibit two main features. (See article PHOTO-ELECTRICITY.) (1) No emission of electricity from the illuminated body occurs at all unless the frequency of the incident radiation reaches or exceeds a certain lowest value (the threshold frequency), and (2) the maximum kinetic energy of the ejected electrons depends only on the frequency of the incident radiation and not on its intensity. If a metal plate is exposed to homogeneous X-rays, *i.e.*, X-rays of one definite frequency; then, provided there is no electric field or other circumstance to affect the energy of the electrons, experiment shows that the maximum kinetic energy of the individual electrons emitted is quite independent of the distance of the plate from the source of X-rays (though of course the number emitted per second is inversely proportional to the square of the distance between the plate and the source). On the other hand, however distant the illuminated body may be from the source of light or X-rays, in other words, however low the intensity of the radiation the well-known phenomenon of interference characteristic of waves can still be produced. The reconciliation of these two aspects of the phenomenon, namely the independence of the energy of the ejected photo-electrons of the intensity, on the one hand, and the wave character of the radiation on the other, constitutes one of the most formidable problems which physical science has ever encountered. The former of these features seems to require that the radiation is corpuscular in character, while the latter seems to require that it is undulatory and spreads out continuously in all directions.

Recent developments of the quantum theory, more especially the wave mechanics of de Broglie and Schroedinger, suggest the solution of this problem, but meanwhile we shall confine our attention to the historically important explanation of photo-electric phenomena which we owe to Einstein, who about the year 1905 suggested that light is propagated through space in the manner of a corpuscular radiation, each corpuscle (or light quantum) having the energy $h\nu$. While this hypothesis frankly ignores those phenomena, such as interference, which have an indubitably undulatory character; it has the merit of explaining the facts of photo-electricity and allied phenomena. When a light quantum falls on a metal plate, the whole of its energy $h\nu$ may be given up to an electron. Part of this energy, 4, is used up in dragging the electron away from the metal and the rest is retained by the electron as kinetic energy; so that

$$\tfrac{1}{2}mv^2 = h\nu - \phi. \tag{24}$$

The quantity ϕ is called the work function and is characteristic of the illuminated material. If the incident radiation has a frequency ν_0, such that the energy $h\nu_0$ is just sufficient to drag the electron out, so that its kinetic energy is zero, then

$$0 = h\nu_0 - \phi,$$

and therefore equation (24) becomes

$$\tfrac{1}{2}mv^2 = h\nu - h\nu_0; \tag{24a}$$

with lower frequencies than ν_0 it is clear that no electrons can be ejected at all. Equation (24) has been verified experimentally and the constant h contained in it found to be identical with the h in Planck's radiation formula within the limits of experimental error. When very high frequencies are involved, *e.g.*, those of X-radiation hv is so large that equation (24) becomes practically

$$\tfrac{1}{2}mv^2 = h\nu;$$

and if we consider the converse phenomenon, *i.e.,* the excitation of X-rays by bombarding a metal with electrons, we should expect the highest frequency of the excited X-rays to be given by this equation, or by

$$Ve = h\nu \tag{25}$$

if V represents the drop of potential between the cathode and anti-cathode and e the electronic charge. This has been verified by Duane. X-radiation of lower frequency than that given by (25) can in general be excited, because the colliding electron may lose part of its energy in causing changes in the electronic constitution of the atoms with the consequent emission of X-radiation characteristic of the material bombarded.

The Compton Effect.—When ordinary light or X-radiation falls on a body there are in general, in addition to a possible photo electric emission, if the wave-length is short enough, two further observable consequences: (1) part of the incident beam is scattered by the body, *i.e.*, a radiation, the character of which is identical with or very closely similar to the incident radiation proceeds from the irradiated material, and (2) the atoms of the material may be excited to emit a radiation characteristic of the material (Barkla's characteristic or *fluorescent* radiation). While the classical theory requires that the scattered radiation (1) should be exactly similar to, *i.e.*, should have the same frequency and in other respects should be a replica of the incident radiation, the light-quantum hypothesis of Einstein leads us to expect the scattered radiation to have a slightly lower frequency (longer wave-length) than the incident radiation. This was first deduced and observed by the American physicist, A. H. Compton, and is named after him the Compton effect. We regard the light-quantum or photon, as it is sometimes called, as a sort of corpuscle possessing the energy hv or h/τ, where v and τ are respectively the frequency of the vibration associated with the corpuscle and the corresponding period. We further suppose the corpuscle to have the momentum h/λ, where λ is the wave-length of the fight. Since $\lambda\nu = C$, the momentum will also be equal to $\frac{h\nu}{C}$. The application of the principles of conservation of energy and momentum leads to a simple solution of the problem of the collision between a photon or corpuscle and an electron as explained in the article COMPTON EFFECT. Indeed, in the simple case where the electron is supposed to be at rest before the collision, it is obvious. without entering into mathematical details, that the effect of the collision will be to reduce the energy of the photon, since the electron must acquire some energy. Therefore hv will be less than $h\nu$ and consequently ν' will be less than v.

Theory **of** Spectra.—Regularities in the spectrum of hydrogen were discovered as early as 1885 by Balmer and much further progress of this kind was made subsequently by Rydberg, Ritz and others. The first to calculate wave-lengths successfully from an assumed dynamical model of the emitting atom appears to have been J. W. Nicholson, whose work is published in a valuable series of papers on the spectra of nebulae and the solar corona in 1911 and 1912. He ascribed certain nebular and coronal spectral lines, which could not at that time be associated with known terrestrial elements, and which did not apparently exhibit the types of regularity of series spectra, to hypothetical elements nebulium and protofluorine, the atoms of which he supposed to have a structure like that suggested by Rutherford to explain the laws of the scattering of α particles by matter. (See ATOM.) He applied mathematical methods very similar to those employed by Clerk-Maxwell in his study of the motion of the rings of Saturn, and from the dynamical properties of these atoms of hypothetical elements he calculated the wave-lengths of a very large number of coronal and nebular lines by identifying the frequencies of the radiation emitted by them with those of the small vibrations of the electrons perpendicular to and also in the plane of the circle on which they were situated.

The differencebetween the calculated and observedwave-lengths was probably in no case as great as 4 Angstrom units and at least one of these lines, $\lambda = 4{,}353$ Å.U., supposed to be emitted by nebulium, was calculated by Nicholson before it was actually observed as one of the lines in the spectrum of the great nebula in Orion. In the earlier papers only ratios of frequencies were calculated—there being no means of fixing the angular velocity of the electrons in the atomic ring. One frequency was therefore assumed to be identical with that of a suitable observed line, the others being then calculated from the ratios. In 1912, however, Nicholson published the discovery that the angular momentum of the atom has to be an integral multiple of $h/2\pi$ in order to give the frequencies of the observed lines. Although we have been forced to give up the view that the coronal and nebular lines which Nicholson investigated are due to a type of atom not found on the earth, his work nevertheless represents the first successful application of the quantum theory to spectra, and the relations he discovered between Planck's constant and angular momentum of the atom furnished an important part of the foundation for the great work of Niels Bohr which followed, and which must be regarded as the most considerable of the contributions to the modern theory of spectra and atomic structure. The earliest of Bohr's papers involving the quantum theory appeared in 1913 and contains two basic principles. (See ATOM.)

(1) The first of these, which we shall term Bohr's postulate, connects (we might say identifies) the spectral terms (see SPECTROSCOPY) with the energy levels or the energies of the emitting atom in its different stationary states. The frequencies (or wave numbers) of all the lines of series spectra can be expressed as dif-

ferences of certain quantities called spectral terms (combination principle of Ritz). Bohr supposed each spectral term to be identical, numerically, with the energy of the emitting atom in a corresponding stationary state divided by Planck's constant

$$\text{Spectral term} = \frac{\text{Energy}}{h}.$$

It is to be observed that in this connection we are dealing with spectral terms for calculating frequencies properly so called, *i.e.*, the number of waves emitted per second. Since the waves emitted during a second are spread over a distance of C centimetres (C= velocity of light) the *wave* number, *i.e.*, the number of waves in a centimetre, will be obtained by dividing the frequency by C. For the calculation of wave numbers we have therefore

$$\text{Spectral term} = \frac{\text{Energy}}{Ch}.$$

(2) The second basic principle is the connection discovered by Nicholson between angular momentum and Planck's constant. Bohr employed this relation to fix the stationary states of the sort of atom he contemplated. In this early form of the quantum theory he considered the simplest atoms of the Rutherford type, consisting of a positively charged nucleus of relatively small dimensions and large mass M, with a charge equal to Ze, where Z is a positive integer and e is the elementary unit of charge, $4\cdot774\times10^{-10}$ e.s.u.. and 3 single planetary electron with a mass m and the same numerical charge e. The simplest kind of motion of such a system is that in which the nucleus and electron (A and B in fig. 4) travel in circular orbits, the radii of which we shall represent by R and r respectively, with the atomic centre of gravity as their common centre. In V and v are the respective velocities of nucleus and electron, and if T represents the total kinetic energy of the system, we get the following equations from the principles of conservation of energy and momentum and the inverse square law of force:

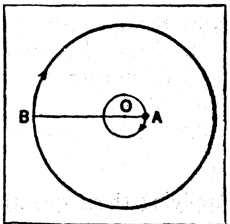


FIG. 4.—TWO CIRCLES REPRESENTING THE ORBITS OF THE NUCLEUS, A, AND THE ELECTRON, B, WITH O THE CENTRE OF GRAVITY OF THE SYSTEM AND THE COMMON CENTRE OF BOTH CIRCLES

$$\frac{m}{M} = \frac{V}{v} = \frac{R}{r} = s, \text{ a small constant,} \tag{26}$$

$$2T = mv^2(1+s) = \frac{mv^2}{\epsilon} = \epsilon\frac{Ze^2}{r}, \tag{27}$$

where ϵ has been written for $\frac{1}{1+S}$. We now fix the stationary states by Nicholson's angular momentum relation, which is expressed by

$$2\pi mvr + 2\pi MVR = nh,$$

or if we eliminate M, V and R by equations (26),

$$2\pi mvr(1+s) = nh$$

or

$$2\pi mvr = \epsilon nh. \tag{28}$$

If we now eliminate r and v by means of equations (27) we get

$$T = \frac{2\pi^2 m\epsilon Z^2 e^4}{n^2h^2} \tag{29}$$

To fix the arbitrary constant in the energy of the atom we shall adopt the convention which assigns the value zero to the potential energy of the system when the electron and nucleus are separated by an infinite distance. The potential energy W will then be expressed by

$$W = -\frac{Ze^2}{r+R} = -\epsilon\frac{Ze^2}{r} \tag{30}$$

It will be seen from (27) that $2T = \epsilon\frac{Ze^2}{r}$,

and therefore $2T + W = 0$,

or, since the energy $E = T + W$,

$$T + E = 0. \tag{31}$$

Now combining this last result with that given in equation (29) we get

$$E = -\frac{2\pi^2 m\epsilon Z^2 e^4}{n^2h^2}. \tag{29a}$$

Bohr's postulate then gives us for a spectral term

$$\frac{E}{h} = -\frac{2\pi^2 m\epsilon Z^2 e^4}{h^3}\cdot\frac{1}{n^2}, \tag{32}$$

or

$$\frac{E}{h} = -Z^2R\cdot\frac{1}{n^2}, \tag{33}$$

and for the frequencies of the spectral lines

$$\nu = Z^2R\left(\frac{1}{n^2} - \frac{1}{n'^2}\right), \tag{34}$$

where R (Rydberg's constant) is defined by

$$R = \frac{2\pi^2 m\epsilon e^4}{h^3}. \tag{35}$$

In equation (34) v represents frequencies properly so called, but if we define R by

$$R = \frac{2\pi^2 m\epsilon e^4}{Ch^3}, \tag{35a}$$

the equation (34) will give wave numbers.

A hydrogen atom was supposed by Bohr to be of the type described, with the integer Z (the atomic number) equal to unity. A helium atom he supposed to have a doubly charged nucleus, $Z=2$, and in its neutral state two electrons, so that the atomic model just described, with $Z=2$ represents an ionized helium atom, $Z=3$ represents an ionized lithium atom and so on. Putting $Z=1$ and $n=2$ in equation (34), we have Balmer's formula. The value of R calculated by (35a) is in entire accord with the observational value. By substituting the known values of m, h, e and C in (35a) and taking the approximate value unity for ϵ we find R to lie between 109,000 cm.$^{-1}$ and 110,000 cm.$^{-1}$. Spectroscopic data furnished the value 109,677·6 cm.$^{-1}$ in the case of hydrogen.

The deduction of equation (34) was one of Bohr's greatest triumphs. It rendered a complete account of Balmer's formula and predicted other spectral series of hydrogen. Four of these are now known observationally, namely, the

Lyman series, $n=1$, $n'=2$, 3, 4, . . .
Balmer series, $n=2$, $n'=3$, 4, 5, . . .
Paschen series, $n=3$, $n'=4$, 5, 6, . . .
Brackett series, $n=4$, $n'=5$, 6, 7, . . .

In the case of the (singly) ionized helium atom (34) becomes

$$\nu = 4R\left(\frac{1}{n^2} - \frac{1}{n'^2}\right)$$

For example if we put $n=4$ we have the series of lines,

$$\nu = 4R\left(\frac{1}{4^2} - \frac{1}{n'^2}\right) = R\left\{\frac{1}{2^2} - \frac{1}{\left(\frac{n'}{2}\right)^2}\right\}.$$

This series may be regarded as a superposition of two series, one in which n' is even and another in which n' is odd. If n' is even it follows that $\frac{n'}{2}$ is equal to an integer n'' and we have the series

$$\nu = R\left(\frac{1}{2^2} - \frac{1}{n''^2}\right),\ n''=3, 4, \cdots$$

If n' is odd we have $\frac{n'}{2} = n'' + \frac{1}{2}$ where n'' is again an integer, and we have the series

$$\nu = R\left\{\frac{1}{2^2} + \frac{1}{(n''+\frac{1}{2})^2}\right\},\ n''=2, 3, \ldots$$

The former of these is Balmer's series, which Bohr thus showed could be emitted by helium as well as by hydrogen. The latter series was observed by Pickering in the spectrum of the star ζ Puppis in 1896 and was naturally, but erroneously thought to be due to hydrogen. We must notice, however, that R is slightly different for hydrogen and helium, because the number ν, though always near unity is a little greater in the case of helium. Equation (35) gives us

$$\frac{R_{\text{helium}}}{R_{\text{hydrogen}}}=\frac{\epsilon_{\text{helium}}}{\epsilon_{\text{hydrogen}}}$$

or

$$\frac{R_{\text{helium}}-R_{\text{hydrogen}}}{R}=\frac{\epsilon_{\text{helium}}-\epsilon_{\text{hydrogen}}}{1}$$

approximately. Now the mass of a helium nucleus is known to be about 3·97 times the mass of a hydrogen nucleus and the difference between Rydberg's constant for helium and for hydrogen is found from spectroscopic observations to be about 44.5 cm.$^{-1}$, therefore

$$\frac{44\cdot5}{109700}=\frac{1}{1+\dfrac{m}{3\cdot97M}}-\frac{1}{1+\dfrac{m}{M}}=\frac{m}{M}\left(1-\frac{1}{3\cdot97}\right)$$

approximately, where M is the mass of a hydrogen nucleus or practically the mass of a hydrogen atom. Therefore

$$\frac{M}{m}=1840 \text{ approximately.}$$

This result is in excellent agreement with that obtained by more direct methods.

GENERAL QUANTUM THEORY

So far we have been concerned with systems possessing only one degree of freedom, actually or virtually, and consequently only one quantum number to fix a stationary state. In 1915 W. Wilson and A. Sommerfeld succeeded, independently of one another, in finding appropriate rules or conditions for fixing the stationary states of systems of more than one degree of freedom. These quantum conditions may be illustrated by the aid of the type of atom we have already studied. For the sake of simplicity we shall ignore the motion of the massive nucleus and regard the centre of mass of the atom as situated in the nucleus itself—an assumption which in any case is very near the truth. The electron has, of course, three co-ordinates. Since, however, its orbit lies in a plane, we can choose our system of reference so that one of the three is a constant and we need pay no further attention to it. We have then a system which has virtually two degrees of freedom. The principle of energy gives us the equation

$$\tfrac{1}{2}mv^2-\frac{Ze}{r}=E, \tag{36}$$

where the same convention as before is used in fixing the arbitrary constant in the energy and where the symbols have again the same meaning, except that r, the distance of the electron from the attracting nucleus, is not in general the radius of a circular orbit. In polar co-ordinates, r and θ, the equation becomes

$$\tfrac{1}{2}m\left(\frac{dr}{dt}\right)^2+\tfrac{1}{2}mr^2\left(\frac{d\theta}{dt}\right)^2-\frac{Ze^2}{r}=E, \tag{36a}$$

and if we express the velocities in terms of the corresponding momenta, p_r and p_θ defined by

$$p_r=m\left(\frac{dr}{dt}\right)$$

$$p_\theta=mr^2\left(\frac{d\theta}{dt}\right),$$

we obtain

$$\frac{p_r^2}{2m}+\frac{p_\theta^2}{2mr^2}-\frac{Ze^2}{r}=E. \tag{36b}$$

When E is negative, the orbit of the electron is elliptical or circular and each of the integrals,

$$\left.\begin{aligned}J_1&=\oint p_r dr\\ J_2&=\oint p_\theta d\theta\end{aligned}\right\} \tag{37}$$

extended over the period of motion of the electron, is a definite constant depending on the energy and angular momentum of the system. It is convenient to represent the constant angular momentum by Ω, so that $p_\theta=\Omega$ and

$$J_2=2\pi\Omega. \tag{38}$$

From (36b) we have $p_r=\sqrt{\left(2mE+\dfrac{2mZe^2}{r}-\dfrac{\Omega^2}{r^2}\right)}$;

whence we obtain $J_1=2\pi\left(\dfrac{mZe^2}{\sqrt{-2mE}}-\Omega\right)$. (39)

Equations (38) and (39) enable us to express the constants E and Ω in terms of the Js. We have

$$\left.\begin{aligned}E&=-\frac{2\pi^2mZ^2e^4}{(J_1+J_2)^2}\\ \Omega&=\frac{J_2}{2\pi}\end{aligned}\right\}. \tag{40}$$

Now the quantum conditions of Wilson and Sommerfeld make each of the phase integrals, J_1, J_2 etc., equal to the product of a positive integer (which may sometimes be zero) and Planck's constant, h:

$$\left.\begin{aligned}J_1&=n_1h\\ J_2&=n_2h.\end{aligned}\right\}. \tag{41}$$

Applying these quantum conditions in equations (40) we get

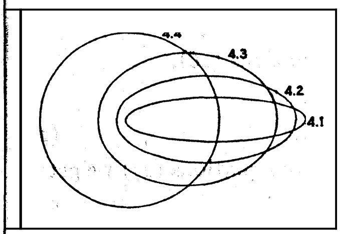
$$\left.\begin{aligned}E&=-\frac{2\pi^2mZ^2e^4}{n^2h^2}\\ \Omega&=\frac{n_2h}{2\pi}\end{aligned}\right\}, \tag{40a}$$

where n means n_1+n_2. The expression for the energy (40a) is in agreement with that originally given by Bohr (29a). The absence of the factor ϵ is due to our ignoration of the motion of the massive nucleus which is equivalent to making ϵ equal to unity. The validity of equations (40a) is not now confined to circular orbits, but extends to orbits which are elliptical in shape. The quantum conditions (41) restrict the eccentricities of the ellipses to those expressed by the formula

$$(1-\epsilon^2)^{\frac{1}{2}}=\frac{n_2}{n_1+n_2},$$

where ϵ is the eccentricity. The integers n_1 and n_2 are called the radial and azimuthal quantum numbers respectively. It is easy to show that for a given energy, or a given value of the total quantum number $n=n_1+n_2$, all the possible ellipses in which the electron may travel have a major axis of the same length.

In fig. 5 are illustrated the ellipses for which the total quantum number is 4. For instance, the ellipse 4.3 has a radial quantum number $n_1=1$, and an azimuthal quantum number $n_2=3$. Bohr prefers to characterize an orbit by specifying its total and azimuthal quantum numbers. He employs the letter k for the latter number and his general symbol for an orbit is n_k. The orbit 4·3 for example would be described by Bohr as a 4_3 orbit. The orbit for which n_2 or k is zero is obviously not one of those in which the electron is permitted to travel, since it is a straight line through the nucleus. It may be remarked that the quantum conditions (41) are in agreement with Planck's hypothesis for a simple harmonic oscillator, since the area of the closed curve in fig. 2 is given by $\oint pdq$.



FROM E. N. DA C. ANDRADE, "STRUCTURE OF THE ATOM" (G. BELL & SONS)

FIG. 5.—POSSIBLE ELLIPTIC ORBITS OF THE ELECTRON WHEN THE TOTAL QUANTUM NUMBER IS 4

We are now in a position to give a more general description of the quantum theory, or at any rate that part of it which is based on the quantum conditions (41). We shall denote the coordinates of a dynamical system by q_1, q_2, q_3, . . . and so, as is usual, the corresponding generalized momenta by $p_1, p_2, p_3, \ldots$. If it happens, as it does in many important cases, that the system is conservative from the point of view of classical dynamics, or sufficiently nearly so to be treated as such, and if the coordinates can be so chosen that p_1 is a function of q_1 only, p_2 a function of q_2 only and so on, the variables then being said to be separable, it can be shown that each q librates between definite limits and associated with each libration is a dehnite fundamental frequency of libration ν_1 of the coordinate q_1, ν_2 of q_2 and so on. Such systems are said to be conditionally periodic. Each of the phase integrals

$$J_1=\oint p_1dq_1,$$
$$J_2=\oint p_2dq_2,$$
$$\cdot \quad \cdot \quad \cdot \quad \cdot$$

where, in each case, the integration is extended over the complete range of values of the corresponding q and back to its original value again, is a constant and we can express the energy of the system E, and also the other constants of integration, as functions of the J's, just as we did in the simple example described above;

$$E=\text{function }(J_1, J_2, \ldots)$$

where, in general, there are as many J's as the system has degrees of freedom. The stationary states are now fixed by equations (41). We thus obtain an expression for the energy of a stationary state in terms of quantum integers of the constant h and of constants which are inherent in the system, such as electronic charge and mass, etc., and we are in a position to calculate frequencies of radiation by applying Bohr's postulate.

According to the principles of classical dynamics the fundamental frequencies of libration are given by

$$\left.\begin{aligned}\nu_1&=\frac{\partial E}{\partial J_1}\\ \nu_2&=\frac{\partial E}{\partial J_2}\end{aligned}\right\};\qquad (42)$$
$$\cdot \quad \cdot \quad \cdot$$

and the general expression for the frequencies of the radiation which such a system would emit if the classical *theory* were true, would be

$$\nu=\frac{\partial E}{\partial J_1}s_1+\frac{\partial E}{\partial J_2}s_2+\cdots,\qquad (43)$$

where s_1, s_2, etc., are integers. It sometimes happens that the number of independent fundamental frequencies is less than the number of degrees of freedom, *i.e.*, one or more of the frequencies calculated by (42) can be expressed in terms of the remaining frequencies. In such a case the motion is said to be degenerate. The Bohr atom described above is an instance of this. If we differentiate E in (40) with respect to J_1, we get for the frequency of the radial motion of the electron,

$$\nu=\frac{4\pi^2mZ^2e^4}{(J_1+J_2)^3},$$

and we obtain precisely the same value for ν_2 the frequency of revolution of the electron in its orbit when we differentiate with respect to J_2, so that in this case $\nu_1=\nu_2$.

Let us write the change in energy AE due to a transition from one stationary state to another in the following form,

$$\Delta E=\Delta E_1+\Delta E_2+\cdots,$$

where ΔE_1 is the change in energy associated with ΔJ_1, the change of J_1, due to the transition, and ΔE_2 is the change in energy associated with ΔJ_2 and so on. Obviously

$$\Delta E=\frac{\Delta E_1}{\Delta J_1}\cdot\Delta J_1+\frac{\Delta E_2}{\Delta J_2}\cdot\Delta J_2+\cdots;$$

Now we must necessarily have

$$\Delta J_1=s_1h,$$
$$\Delta J_2=s_2h,$$

where $s_1, s_2, \ldots$ are integers positive or negative including zero, therefore

$$\Delta E=\frac{\Delta E_1}{\Delta J_1}s_1h+\frac{\Delta E_2}{\Delta J_2}s_2h+\cdots.$$

If we divide both sides by h, the left hand member will be the frequency of the emitted (or absorbed) radiation according to Bohr's postulate, and therefore

$$\nu=\frac{\Delta E_1}{\Delta J_1}s_1+\frac{\Delta E_2}{\Delta J_2}s_2+\cdots.\qquad (43a)$$

Correspondence **Principle.**—It will be noticed that there is a close similarity between (43) and (43a), and, in fact, when J_1, J_2, etc., are individually very big compared with ΔJ_1, A J_2, etc., the two formulae (43) and (43a), the former giving frequencies of radiation calculated from the classical theory and the latter those given by the quantum theory, become identical. If the quantum theory is to represent the facts this asymptotic approach to the classical theory, when large energies are involved, is essential, as has already been pointed out. Now one of the striking facts about spectra is that while the frequency (or wave number) of any spectral line is equal to the difference of two spectral terms (combination principle), the converse is not always true. That is to say the difference between a pair of spectral terms does not in every case represent an observed frequency (or wave number). Using the language of the quantum theory we may say that the atom is not at liberty to make any transition it likes from one stationary state to another.

Certain restrictions have to be placed on the values of the integers, s_1, s_2, etc., in (43a). These restrictions have found their expression in the past in the form of selection rules (Rubinowicz, Sommerfeld and others), mostly deduced from the principle of conservation of angular momentum. They were superseded by the comprehensive correspondence principle of Bohr. According to this principle the integers s_1, s_2, etc., in (43a) must have the same values as those of the classical formula (43). In simple harmonic motion (the type of motion of the pendulum described above when the amplitude is small), the energy associated with a stationary state is equal to nhw, if ω is the frequency of oscillation, and according to Bohr's postulate

$$\nu=(n-n')\omega,$$

where ν is the frequency of the radiation emitted when a transition from a stationary state corresponding to a higher to one of a lower energy level takes place, *i.e.*,

v=SW,

where s is an integer. Now according to the classical theory s is restricted to the value 1 and the correspondence principle requires that we must adopt this value in applying the quantum theory. When applied to our simple Bohr atom the correspondence principle requires that s_2 (the change of the azimuthal quantum number n_2, or Bohr's k) during a transition must be $+1$ or -1 (unless the atom is under the influence of an external field). If we were concerned only with this special type of atom and neglect, as we have done, relativistic refinements, this would not be of the slightest consequence, since the frequency of the emitted radiation is determined by the change of $n=n_1+n_2$ and is not, therefore, affected (for a given change of n) by the changes in the individual integers.

If, however, we turn to a more complicated sort of atom, *e.g.*, a neutral sodium atom, it becomes of great importance. According to Bohr this atom consists of a nucleus having a charge of 11 units of positive electricity, with 10 electrons travelling in orbits arranged relatively closely round it and a more isolated electron travelling in an orbit which we may regard as roughly elliptic. A sodium atom therefore resembles the simple hydrogen atom. Indeed, if we were to imagine the 10 inner electrons to be very close indeed to the nucleus, the outer electron would behave in almost exactly the same way as the electron in the hydrogen atom, since we have an atom consisting of a small but massive inner structure, with a net charge of one positive unit. In consequence, however, of the fact that the inner orbits do extend out from the nucleus, the outer electron may, if n_2 or k is small, have its perihelion (or perinucleon) actually within the boundary of the inner system of orbits. If k is large the orbit of the outer electron may be quite outside this boundary. In these circumstances the energy of the outer electron is not determined by the sum $n=n_1+n_2=n_1+k$, but by the individual values of n_1 and k. For a given n the energy is least (numerically greatest, if we remember the sign of E) when $k=1$ and increases progressively with k. We shall have a set of spectral terms for which $k=1$, another set for which $k=2$ and so on. Bohr supposes $k=1, 2, 3, 4 \ldots$ for S, P, D, F terms respectively. The circumstance that k changes by $+1$ or -1, and not by zero or any other number, corresponds to the spectroscopic fact that we have combinations of S and P, P and D, or D and F terms, but not for instance combinations of S and D, or S and F terms.

Fine Structure of Spectral Lines.—In generalizing the quantum theory Sommerfeld made a very important application of it in an investigation of the fine structure of the lines of the spectra of hydrogen and helium. He took into account the fact that the mass of an electron (or of any particle) according to the theory of relativity, depends on its velocity. The effect of this dependence is to make the kinetic energy equal to

$$m_0C^2\left\{\frac{1}{\left(1-\frac{v^2}{C^2}\right)^{\frac{1}{2}}}-1\right\},$$

instead of $\frac{1}{2}mv^2$, where m_0 is the mass of the electron when at rest or in slow motion and C is the velocity of radiation in empty space. The expressions for the momenta differ from those in the ordinary theory by having m replaced by $m_0/\sqrt{(1-v^2/c^2)}$. The expression for the energy of a stationary state becomes for a hydrogen atom approximately

$$E=-\frac{Rh}{n^2}\left\{1+\frac{Rh}{2m_0C^2n^2}\left(1+4\frac{n_1}{n_2}\right)\right\}. \tag{44}$$

The $H\alpha$ line for example is due to transitions from states where $n=3$ to states where $n=2$. There are apparently six different sorts of transitions by which $H\alpha$ radiation may be emitted, since there are 3 states for $n=3$ and two states for $n=2$. These are shown in the following table.

THE STATIONARY STATES OF A HYDROGEN ATOM CORRESPONDLUG TO $n=3$ AND $n=2$, AND THE PERMITTED TRANSITIONS.

$n=3$		$n=2$	
n_1	n_2	n_1	n_2
0	3	0	2
1	2	1	1
2	1		

The integer n_2 cannot be zero, because this would correspond to a rectilinear motion through the nucleus. We have seen, however, that n_2 must change by $+1$ or -1 and in no other way according to the correspondence principle, and therefore the number of possible transitions is reduced to three. H_α then consists of three lines all close together. Two of the three are so very close to one another that the system is practically a doublet. The separation is approximately that of the two terms corresponding to $n=2$ namely $0{\cdot}365\text{cm.}^{-1}$. How small this is can be judged by comparison with the separation of the D lines of sodium, which is $17{\cdot}18\text{cm.}^{-1}$. It is easy to see that the correspondence principle requires that each line of Lyman's series is associated with only one kind of transition, and is therefore single.

This theory of the fine structure of spectral lines is in excellent accord with the observations made before and soon after its development; but the improved photometric methods developed in quite recent times have given the problem quite a different character—without impugning the accuracy of the relativistic formulae in Sommerfeld's theory. There is no doubt that the spectrum of hydrogen must be classed with the spectra of the alkali metals, lithium, sodium, etc., and in the present state of the theory H_α, for example, has seven components, two pairs of which, however, coincide, so that there are five distinct components instead of the *three* of the older theory.

Stark Effect.—In the year 1913 Johannes Stark discovered that each of the Balmer lines of hydrogen, which, for the purposes of this paragraph, may be considered to be single lines, since the effect we are about to study is of a much bigger scale of magnitude than that of the fine structure of the individual lines, splits up into a group of lines symmetrically situated with regard to the original line when the emitting atoms are subjected to a strong external electric field. The complete explanation of this phenomenon is one of the greatest successes of the quantum theory and was given independently by Epstein and Schwarzschild. The mathematical problem involved was actually solved by the German mathematician, Jacobi, in the earlier half of the last century. It is only possible to give the barest outline of it here. We may neglect the motion of the massive nucleus and suppose it provisionally to be at the origin of rectangular coordinates. The applied electric field we shall take to be in the direction of the X-axis. If ρ represents the perpendicular distance of the electron from the X-axis, the proper coordinates to use in order that the variables may be separated in the sense explained above are ξ, η and ϕ, where

$$x=\frac{\xi^2-\eta^2}{2},\quad \rho=\xi\eta,$$

and where ϕ is the azimuthal angle about the X-axis. Epstein and Schwarzschild showed that the energy of the system is given by

$$E=-\frac{2\pi^2mZ^2e^4}{J^2}-\frac{3}{8}\,\frac{J(J_\xi-J_\eta)}{\pi^2mZe}F, \tag{45}$$

where F is the intensity of the applied field, $J=J_\xi+J_\eta+J_\phi$, and the terms involving squares and higher powers of F have been ignored. The quantitizing formulae (41) give us

$$E=-\frac{2\pi^2mZ^2e^4}{n^2h^2}-\frac{3}{8}\,\frac{n(n_\xi-n_\eta)}{\pi^2mZe}F, \tag{45a}$$

as the general expression for the energy of a stationary state, where $n=n_\xi+n_\eta+n_\phi$. The correspondence principle indicates that n_ϕ changes by $+1$, -1, or 0 during a transition from one stationary state to another, and that when $\Delta n_\phi=0$ the emitted radiation is polarized with its vibrations parallel to the direction of the field and in the other cases perpendicular to the field. Kramers has successfully applied the correspondence principle to explain the observed relative intensities of the components. Finally it may be added that Bohr has worked out the problem of the Stark phenomenon by the method of secular perturbations, much used by astronomers. Essentially this consists in making use of the fact that the motion of a planet round the sun or of an electron round the nucleus is to a first approximation elliptical, but we can get a more accurate result by studying the small perturbations of this elliptic motion by the external disturbing bodies or by the applied external field.

Zeeman Effect.—When a source of light such as a sodium flame or a discharge tube is placed in a sufficiently intense magnetic field, we find on observing the spectrum with apparatus of suitable resolving power that each original spectral line is replaced by a number of lines. (See ZEEMAN EFFECT.) The energy equation (40) of a simple Bohr atom has to be modified in the following way when the atom is subjected to a uniform magnetic field of intensity H:—

$$E=-\frac{2\pi^2mZ^2e^4}{(J_1+J_2+J_3)^2}\pm\frac{eH}{4\pi mC}J_3, \tag{46}$$

where terms involving H^2 and higher powers are ignored. In this equation the definitions of the phase integrals J (37) have been extended by replacing the mechanical momentum p by a more general momentum which is the vector sum of p and the product $-eA$ of the charge on the electron and the electromagnetic vector potential. This extension, which was suggested by W. Wilson in 1921, plays an important part in recent developments of the quantum theory. J_3 above is the phase integral associated with the azimuthal angle about the axis of the magnetic field. The application of the classical method (42) indicates that the motion of the electron in the presence of the magnetic field is that which would result if we were to superpose on its motion in the absence of a field a rotation or precession about the axis of the field equal to $\frac{eH}{4\pi mC}$ revolutions per second (Larmor's theorem).

The quantum theory was first applied to the phenomenon by Debye and by Sommerfeld in 1916. Their methods were equivalent to fixing the stationary states in the way already described (equations [41]); using the extended integrals, and then applying Bohr's postulate. This leads, with the help of the correspondence principle, to the result given by the classical theory and only succeeds in explaining what is known as the normal Zeeman effect. In fact the last term in equation (46) becomes

$$+(n_3-n'_3)\,\frac{eH}{4\pi mC};$$

and the correspondence principle indicates, just as in the Stark effect, that n_3-n'_3 must be $+1$, -1, or 0. The anomalous phenomenon (observed when the magnetic field is not too intense) may be concisely described in the following way: the "magnetic" term in (46) has to be put in the form

$$g\cdot n_3\cdot\frac{eH}{4\pi mC},$$

instead of simply $n_3\frac{eH}{4\pi mC}$.

The factor g, called the splitting factor (Aufspaltungsfaktor), is characteristic of the spectral term, and n_3 is not always an integer, but may differ from an integer by &. The splitting factor is always expressed by

$$g=1+\frac{j(j+1)+s(s+1)-l(l+1)}{2j(j+1)},$$

where j is a quantum number characteristic of the term, s is a number which is supposed to represent the angular momentum of spin of the electron in terms of the unit $h/2\pi$, or the resultant momentum if more than one electron is involved. Where a single electron is involved $s=\$$. The quantum number l is equal to k – I where a single electron is involved. For example the sodium D_2 line is due to a transition from a P term for which $j=\frac{3}{2}$ to an S term for which $j=\frac{1}{2}$. For the former term $l=1$, since $k=2$, and for the latter $l=0$. Therefore g is equal to $\frac{4}{3}$ for the P term and 2 for the S term. The number n_3 has the values,

$$j,\ j^{-1},\ \ldots,\ -(j-I),\ -j;$$

i.e., in the case of the P term mentioned,

$$n_3=3/2,\ \tfrac{1}{2},\ -\tfrac{1}{2},\ -\tfrac{3}{2},$$

and in the case of the S term

$$n'_3=\tfrac{1}{2},-\tfrac{1}{2}.$$

Only such transitions are permitted for which $n_3-n'_3=+1$, 0, or -1, and the same rules determine the polarization as in the case of the normal effect.

Miscellaneous. — The principles of the quantum theory have been applied with great success to the study of X-ray emission and absorption spectra and the disentangling of the very complicated features of band spectra (see BAND SPECTRUM) has been greatly facilitated by, and indeed would hardly have been possible without, the indications which the theory has provided. The main features of these spectra can be ascribed to changes in the rotational and vibrational energy of molecules. The kinetic energy of a rotating body is expressed by

$$E=p^2/2K, \qquad (47)$$

where p is its angular momentum, and K the corresponding moment of inertia, and since p is restricted to the values $n\ h/2\pi$, where n is an integer, we must have

$$E=\frac{n^2h^2}{8\pi^2K}. \qquad (47a)$$

As a matter of fact the newer developments of the quantum theory (see "Wave Mechanics" below), as well as the actual facts of band spectra, show that in some cases the energy of rotation is given by

$$E=\frac{n(n+1)h^2}{8\pi^2K} \qquad (47b)$$

A similiar remark applies to the energy of a simple harmonic vibration which is expressed by $(n+\frac{1}{2})h\nu$ instead of n hv.

The energy of gas molecules is very largely kinetic energy of rotation, and therefore equation (47b) has played an important part in the theory of the specific heats of gases and their dependence on the temperature.

An electron orbit, constituting, as it does, an electric current, possesses a magnetic moment, and the existence of stationary states involves the consequence that the magnetic moment of an electron orbit must be an integral multiple of a certain smallest value or unit. It is easy to establish that this unit of magnetic moment is $\frac{eh}{4\pi mC}$. It is called the Bohr rnagneton. (See MAGNETISM.)

Elementary considerations show that the mutual energy of a magnet and an external field is equal to $M_H{\cdot}H$, apart from a constant which we may take to be zero, where M_H means the component of the magnetic moment of the magnet in the direction of the field and. H is the intensity of the field. If now we turn to equation (46) and remember that $J_3=n_3H$, where n_3 is an integer, we see that the mutual energy of an electron orbit and a magnetic field is

$$n_3\cdot\frac{eh}{4\pi mC}\cdot H, \qquad (48)$$

and therefore the component of the magnetic moment in the direction of the field is

$$n_3\frac{eh}{4\pi mC}, \qquad (48a)$$

an integral multiple of a Bohr magneton. We must infer from this that the angle between the axis of the electron orbit and the applied field cannot vary continuously, but is restricted to certain quite definite values. If,for example, the total magnetic moment of the orbit were one Bohr magneton, then its axis must be directed along the external field, or along the opposite direction, or at right angles to the field according to the simple theory we have given. This kind of restriction is sometimes called spatial quantization and has received remarkable confirmation in the experiments of Gerlach and Stern. (See MAGNETISM.) More direct confirmation of the hypothesis of stationary states is furnished by the extensive investigations of critical potentials of gases and vapours.

NEW QUANTUM THEORY

So far we have been describing a theory which, broadly speaking, consists of two not very coherent parts, namely, Einstein's light-quantum theory and the theory based on stationary states and Bohr's postulate. Although as we have seen, it has been very successful, it does suffer from certain serious defects— quite apart from its logical weaknesses and obscurities. The chief of these are: —

1. It fails to meet the dilemma of the corpuscular and undulatory behaviour of light.

2. It fails to render any adequate account of those magnetic phenomena which are usually termed "anomalous," such as the Zeeman effect and the gyromagnetic effect.

3. The presence in the formulae of the Zeeman effect and band spectra of half quanta, *i.e.,* of multiples of h which are half integers, finds no explanation in the "classical" quantum theory. This difficulty would obviously still remain, even if a new quantum equal to $h/2$ were introduced.

There is a certain parallelism between the advance from the older or classical quantum theory to the newer theory and that from the old elastic solid theory of light to the later and much more adequate electromagnetic theory of Clerk Maxwell, and, no doubt, we shall long continue to use the language of the older quantum theory, and the fairly simple pictures it provides of atomic phenomena, just as we still use that of the elastic solid theory of light. The new theory has developed along two different lines, which, however, lead invariably to the same mathematical consequences, so that they are almost certainly just different aspects of one and the same theory. One of these aspects, known as wave mechanics, and historically the earlier and more interesting, was initiated by Louis de Broglie and further developed by E. Schroedinger. L. de Broglie's immediate objective was the solution of the dilemma (1); the other line of development is due to W. Heisenberg. He was inspired by a scientific outlook very prevalent among German physicists since the time of the Austrian philosopher, Ernst Mach, who insisted on the rigorous observance of the Newtonian principle of the avoidance of all hypotheses—"hypotheses seu *metaphysicae,* seu *physicae,* seu *qualitatum* occultarum, *seu mechanicae,* in *philosophia experimentali locum* non *habent*" (Newton, *Principia* Liber *tertius* p. 530, editio tertia).

Wave Mechanics.—The similarity of the laws of classical mechanics and geometrical optics was known long ago and forgotten or overlooked in modern times. The laws of reflection and refraction, it will be remembered, were subsumed by Fermat in the statement that the path selected by a ray of light in travelling from a point A to a second point B is that which takes a minimum time. (See LIGHT.) To be quite accurate we ought to say that the path of a ray of light is always one which occupies a minimum or a *maximum* time, with, of course, the intermediate possibility exemplified by the behaviour of curved mirrors and lenses, that all paths within wide limits may occupy the same time. The time taken by any point on a wave front to travel a short distance dq in a direction normal to the wave front is obviously dq/u, where u is the velocity of the wave (the phase velocity). The whole time occupied between two points A and B is made up of the sum of such elements dq/u and is written

$$\int_A^B dq/u.$$

Fermat's principle of minimum (or maximum) time may therefore be expressed by

$$\delta\int_A^B dq/u=0. \tag{49}$$

The symbol 6 is used to indicate that the expression in (49) represents the difference between the value of the integral (the time) measured along the actual path of the ray and that measured along a neighbouring path. It is important to note that the frequency v (or the period τ) is taken to be the same for both paths. Remembering this and that the velocity $u=\lambda/\tau$, where λ is the length of a wave, we see at once that an alternative statement of Fermat's principle is

$$\delta\int_A^B dq/\lambda=0 \tag{49a}$$

or the path of the ray of light is the one which contains the minimum (or maximum) number of waves.

In 1744 de Maupertuis, president of the Prussian Academy in the reign of Frederick the Great, enunciated the principle of least action which subsumes the laws of classical mechanics in a single statement, just as Fermat's principle does for geometrical optics. The naïve belief of de Maupertuis that his principle was based on the attributes of the Supreme Intelligence was not inappropriate, for it has turned out to be deeper and wider in its scope than any other in the whole range of physical science. For a system with one degree of freedom it may be stated in the form

$$\delta\int_A^B p\,dq=0, \tag{50}$$

where q is the positional coordinate and p the corresponding momentum. The symbol 6 represents a small variation *for* a given energy, E, just as in (49) it represents a small variation for a given period τ. If we adopt the *corpuscular* theory of light, still held in the time of de Maupertuis. it is not difficult to show that (50) actually coincides with Fermat's principle. In order to appreciate the wave mechanics of de Broglie and Schroedinger it is very important to realize that classical mechanics rests on the principle expressed by equation (50) or a simple generalization of it, namely

$$\delta\int_A^B \Sigma p\,dq=0 \tag{50a}$$

when we are concerned with systems with several degrees of freedom, in just the same way as geometrical optics rests on equation (49) or better (49a). It will be noticed that p and $1/\lambda$ are analogous things in the two formulae. The principle of action can be expressed in other ways besides that of de Maupertuis, The most important of these alternative forms is that due to Sir W. Hamilton and known as Hamilton's principle. We shall only remark about Hamilton's principle that it brings out a parallelism between E, the energy of a particle and $1/\tau$ in the corresponding optical problem, of precisely the same kind as we have found between p the momentum of the particle and $1/\lambda$.

De Broglie supposed every ultimate particle to be the manifestation of some kind of "phénomène périodique" and to be associated with a wave or a group of waves of a narrow range of frequencies. There is a well known distinction between the velocity with which a group of waves travels and the phase velocity or the velocity of the crests and troughs of the individual waves. According to de Broglie the velocity v of the particle should be identified with that of the group. This view is supported by the circumstance that the velocity of a group is given by

$$v=\frac{d(1/\tau)}{d(1/\lambda)}. \tag{51}$$

The parallelism we have recognized between E and $1/\tau$ and between p and $1/\lambda$ suggests that we should investigate the quotient $\frac{dE}{dp}$, and we find, in fact, on substituting $\frac{1}{2}mv^2$ for E and mv for p,

$$\frac{d(\frac{1}{2}mv^2)}{d(mv)}=v.$$

This is also the result we arrive at if we use the more elaborate relativistic expressions for E and p.

We now reach the crux of the wave mechanics. The way in which classical mechanics, and classical physical theory generally breaks down when we have to deal with sufficiently small scale phenomena, is just like the way in which geometrical optics fails when applied to paths which are not long compared with the wavelength of the light.

By way of illustration we shall study the case of a rigid body spinning about a fixed axis and not in a field of force. It will help us if we think of it as a thin uniform ring of mass m turning about an axis through the centre of the ring and perpendicular to its plane. Apart from a constant, the energy of the ring is identical with its kinetic energy t. We shall use the letter q to represent the distance a mark on the ring has travelled from some chosen zero position, and R to represent the radius of the ring which is, of course, constant. In this example the energy E and the momentum p of the ring remain constant during its motion, and the simplest kind of de Broglie wave we can associate with it may be expressed in the form

$$\psi=A\cos 2\pi\left(\frac{t}{\tau}-\frac{q}{\lambda}\right), \tag{52}$$

where A, λ and τ are constants. We shall postpone the enquiry about the significance of ψ. This equation represents a wave of ψ, travelling in the direction of increasing q with a velocity λ/τ and it may be written in the form

$$\psi=A\cos\frac{2\pi}{h}\left(\frac{h}{\tau}t-\frac{h}{\lambda}q\right), \tag{52a}$$

where, so far, h may be any quantity, but if we agree that it shall be identical with Planck's constant, and remember the parallelism between E and $1/\tau$ and between p and $1/\lambda$ we are almost forced to adopt the hypothesis $E=h/\tau$ and $p=\frac{h}{\lambda}$ and so we have

$$\psi=A\cos\frac{2\pi}{h}(Et-pq) \tag{52b}$$

Now it is clear that if q is increased by $2\pi R$, *i.e.*, if the ring is turned once round, the original condition of things is reproduced and we must, therefore, demand that the value of ψ, or more precisely the part of it depending on q, is unaltered. Therefore the increase of the argument of the cosine, namely, $\frac{2\pi}{h}p\cdot 2\pi R$ numerically, must be equal to $2\pi n$ where n is an integer, or $p\cdot 2\pi R=nh$. We recognize in this equation a case of the familiar quantizing conditions (41) which enter wave mechanics quite naturally and have not to be imposed in the arbitrary and ad *hoc* manner of the older theory. Since the kinetic energy $\tau=p^2/2m$ we have, just as in the earlier theory,

$$\tau=\frac{n^2h^2}{8\pi^2mR^2}=\frac{n^2h^2}{8\pi^2K},$$

where $K=mR^2$ is the moment of inertia of the ring about the axis of spin.

In the case of a rigid body which is not in a field of force and can turn freely about a fixed point, we have two coordinates, q_1 and q_2, and their corresponding momenta, and the problem is much more complicated. It will suffice to say here that the demand that ψ must be one-valued now leads to the formula

$$\tau=\frac{n(n+1)h^2}{8\pi^2K},$$

which, as we have pointed out before, is actually required by spectroscopists to explain the phenomena of bands and which the older quantum theory is wholly unable to produce.

In order to utilize the wave theory of mechanics to the fullest extent, we must resort, as we do in optics, to the differential equation of the state of undulation. Turning again to the example of the rigid body spinning about a fixed axis, the appropriate differential equation is

$$\frac{\partial^2\psi}{\partial q^2}=\frac{1}{u^2}\frac{\partial^2\psi}{\partial t^2}. \tag{53}$$

This is the type of equation which represents plane waves travelling in the direction q with the constant velocity u, or the type of equation which represents the vibrations of a cord. The appropriate solution, in the case of a cord fixed at both ends, for example, consists of a sum of particular solutions so chosen as to satisfy the given initial or boundary conditions. The solution represents the motion of the cord as a superposition of vibrations consisting of a fundamental one and harmonic overtones, the frequencies of which are integral multiples of the fundamental one. The difference between this old-fashioned problem and the one we have in hand lies, not in the differential equation or its solution, but in the character of the "boundary" conditions which have to be satisfied and which, in this case, lie in the requirement that #must be a one-valued function of q. Since $u=E/p$ and $p^2=2m(E-V)$, where V is the potential energy—the part of the energy not dependent on the velocity and which in this example is constant, we have

$$\frac{\partial^2\psi}{\partial q^2}=\frac{2m(E-V)}{E^2}\frac{\partial^2\psi}{\partial t^2}. \tag{54}$$

This is called the Schroedinger equation of the problem and the "boundary" conditions require that E–V in the particular solution shall have one of the values:

$$\frac{1^2h^2}{8\pi^2K},\ \frac{2^2h^2}{8\pi^2K},\ \frac{3^2h^2}{8\pi^2K},\text{ etc.}$$

It follows from $E=h/\tau=h\nu$, if we denote the constant $\frac{V}{h}$ by ν_0, that the state of undulation is a superposition of vibrations with the frequencies:

$$\nu_0,\ \nu_0+\frac{1^2h}{8\pi^2K},\ \nu_0+\frac{2^2h}{8\pi^2K},\text{ etc.}$$

Let us now examine the simple Bohr atom in the light of wave mechanics. It is convenient to start out by representing the position of the electron by rectangular coordinates for which we shall use the letters x, y and z instead of q_1, q_2 and q_3. For simplicity we shall ignore the motion of the nucleus, as we have done already, and suppose it to be situated at the origin. The wave equation is now

$$\frac{\partial^2\psi}{\partial x^2}+\frac{\partial^2\psi}{\partial y^2}+\frac{\partial^2\psi}{\partial z^2}=\frac{1}{u^2}\frac{\partial^2\psi}{\partial t^2} \tag{55}$$

The same process which led to equation (54) may be applied here, and so we get for the wave equation

$$\frac{\partial^2\psi}{\partial x^2}+\frac{\partial^2\psi}{\partial y^2}+\frac{\partial^2\psi}{\partial z^2}=\frac{2m\left(E+\frac{Ze^2}{r}\right)}{E^2}\frac{\partial^2\psi}{\partial t^2} \tag{55a}$$

where we have replaced V, the potential energy, by $\frac{-Ze^2}{r}$, r being the distance of the electron from the nucleus or origin. If E is negative, that is if the electron is travelling in an elliptic orbit, the requirements that ψ must be a one-valued function of position and finite restricts E to the values

$$E=-\frac{2\pi^2mZ^2e^4}{n^2h^2},$$

where n is an integer, and the state of undulation round about the nucleus consists of a superposition of vibrations the frequencies of which are expressed by

$$\nu_n=\frac{2\pi^2mZ^2e^4}{h^3}\cdot\frac{1}{n^2}.$$

We recognize here the spectroscopist's spectral terms. The function ψ is usually written in a form equivalent to

$$\psi=a_1\epsilon^{i(2\pi\nu_1t-\delta_1)}+a_2\epsilon^{i(2\pi\nu_2t-\delta_2)}+\text{etc.}, \tag{56}$$

where $i=\sqrt{-1}$ and all the other quantities are real. If we employ $\bar\psi$ to represent a corresponding expression in which $\sqrt{-1}$ is replaced by $-\sqrt{-1}$ it will be seen that the product $\psi\cdot\bar\psi$ may be expressed in the following form

$$\psi\cdot\bar\psi=A+A_{12}\cos\{2\pi(\nu_1-\nu_2)t-D_{12}\}+\text{etc.} \tag{57}$$

Therefore $\psi\cdot\bar\psi$ represents a state of undulation, in the region surrounding the atom, which is a superposition of vibrations the frequencies of which are *differences* of spectral terms. This state of undulation must be identified with light waves or vibrations, and Schroedinger has made the suggestion that the value of $\psi\cdot\bar\psi$ at any place is identical with the electric density at that place. This, of course, involves giving up the old picture of an electron revolving in an elliptic or other orbit about the nucleus in favour of one which depicts a complicated distribution of negative electricity, the density of which falls off asymptotically to zero at great distances from the nucleus. This new picture of an atom has the great advantage of close conformity to Clerk Maxwell's electromagnetic theory of light. It also provides us with a means of fixing what has hitherto been indeterminate about the function ψ. We must lay down that the quantity e which we have hitherto described as the charge on the electron, shall be identical with

$$\int\psi\bar\psi\,dv, \tag{58}$$

where dv is a small element of volume and the summation indicated by the symbol $\int$ is extended over all space. It must be pointed out, however, that there is another interpretation of ψ which has much to be said for it, and which does not require us to give up the picture of an electron in orbital motion, namely, one which regards the value of $\psi\cdot\bar\psi dv$ at any given time as a measure of the probability that the electron is within the volume dv at that time.

We cannot, in this article, deal with the manner in which problems connected with polarization, intensity, etc., are dealt with by the wave mechanics. It will suffice to say that the new theory accomplishes all that the older quantum theory does, and in a manner which is much more coherent and complete, and that it goes far beyond it. In quite recent times it has received remarkable confirmation from observations of Davison and Germer, G. P. Thomson and others, on the scattering and diffraction of electrons. These observations are, in the main, just what the theory predicts. A stream of electrons, each having a definite momentum p, constitutes, according to the theory, a beam of waves with the wave length $\lambda = h/p$, and the investigations mentioned entirely bear out this prediction.

Matrix Mechanics.—This originated independently of wave mechanics, but its character can be described most conveniently with the help of the relationships between the two. We shall confine our attention to systems with one degree of freedom for which the classical equations of motion are:

$$\frac{dp}{dt} = -\frac{\partial H}{\partial q}, \qquad \frac{dq}{dt} = \frac{\partial H}{\partial p}, \tag{59}$$

provided the energy H is expressed as a function of p, q and t. We are concerned with the case where the system is conservative, so that H is a function of p and q only. For example, in the case of a particle in simple harmonic motion

$$H = \frac{p^2}{2m} + \frac{\mu}{2}q^2,$$

where m is the mass of the particle and μ is the restoring force per unit displacement. These equations of Hamilton (59) are retained in matrix mechanics; but the quantities involved in them, q, p, H are replaced by matrices. A matrix is a set of numbers arranged like the constituents of a determinant (*q.v.*). The product of two matrices is the matrix in which the constituent in the mth row and nth column is obtained by multiplying each constituent of the mth row of the first matrix by the corresponding constituent in the nth column of the second matrix, and adding the resulting products. This rule gives two products which are not, in general, identical, *i.e.*, the constituent in the mth row and nth column of one product is not generally the same as that in the corresponding place in the other product. The very essence of matrix mechanics is bound up with this ambiguity. (See DYNAMICS.)

We have next to explain what sense is to be attached to the operations $\frac{\partial}{\partial q}, \frac{\partial}{\partial p}, \frac{d}{dt}$ as applied to matrices. The mn constituent of a typical matrix in the new mechanics is represented:

$$x_{mn} = a_{mn}\epsilon^{2\pi i\nu_{mn}t}, \tag{60}$$

where $i = \sqrt{-1}$ and ν_{mn} is that frequency which, in the language of the older theory, is associated with a transition from the state m to the state n. The operation $\frac{d}{dt}$ is carried out on a constituent in the ordinary way; therefore

$$\frac{dx_{mn}}{dt} = 2\pi i\nu_{mn}x_{mn}. \tag{61}$$

Turning to wave mechanics, we find Schroedinger's function ψ in the particular solutions of the wave equation has the property

$$\frac{\partial\psi}{\partial q} = \pm\frac{2\pi ip}{h}\times\psi \tag{62}$$

If we adopt the + sign this equation means that the operation $\frac{\partial}{\partial q}$ when *performed* on ψ, is equivalent to multiplying it by $\frac{2\pi ip}{h}$, *i.e.*,

$$\frac{\partial}{\partial q} \equiv \frac{2\pi ip}{h}, \tag{63}$$

where $\equiv$ expresses equivalence. We shall not discuss the significance of the ambiguity of sign beyond saying that it cancels out in virtue of the corresponding ambiguity in the product of two matrices. We have further

$$\frac{\partial}{\partial q}x\psi = \frac{\partial x}{\partial q}\times\psi + x\frac{\partial\psi}{\partial q},$$

or

$$\frac{\partial}{\partial q}x\psi - x\frac{\partial}{\partial q}\psi = \frac{\partial x}{\partial q}\times\psi,$$

which means

$$\frac{\partial}{\partial q}x - x\frac{\partial}{\partial q} \equiv \frac{\partial x}{\partial q}; \tag{64}$$

or, remembering (63) we get

$$\frac{2\pi i}{h}(px - xp) \equiv \frac{\partial x}{\partial q}, \tag{65}$$

which is an expression of the equivalence of two operations when carried out on the function ψ. This last equation, or equivalence, is used to define the "differential quotient" of a matrix x with respect to the matrix q, the expressions px and xp being identified in an appropriate way with the two products of the matrices p and x. With the help of the Hamiltonian equations (59) we easily find that

$$\frac{2\pi i}{h}(Hx - xH) \equiv \frac{dx}{dt} \tag{66}$$

and

$$\frac{2\pi i}{h}(xq - qx) \equiv \frac{\partial x}{\partial p}. \tag{67}$$

Briefly, we may say that matrix mechanics simulates Hamiltonian dynamics, but instead of numbers we have matrices or "q" numbers, as they are sometimes called, and instead of ordinary differentiation we have the processes defined by (65) (66) and (67).

If a matrix y in the new mechanics is "constant," *i.e.*, if $\frac{dy}{dt} = 0$, it can be shown that it is a diagonal matrix. The constituents y_{mn} for which m is different from n are all zero. The matrix H itself must therefore be such a diagonal matrix. Now the rule for multiplying matrices (or determinants) makes the mn constituent of the product AB of two matrices A and B equal to the sum

$$\sum_k A_{mk}B_{kn}$$

therefore the mn constituent of the product Hx is equal to

$$H_{mm}x_{mn}$$

on account of the property of H, which has just been explained. Similarly the mn constituent of the other product xH is equal to

$$x_{mn}H_{nn},$$

therefore equation (66) is equivalent to

$$\frac{2\pi i}{h}(H_{mm} - H_{nn})x_{mn} = \frac{dx_{mn}}{dt}$$

or since $\frac{dx_{mn}}{dt} = 2\pi i\nu_{mn}x_{mn}$, (see equation 61) we have

$$\frac{H_{mm} - H_{nn}}{h} = \nu_{mn}. \tag{68}$$

This is, of course, Bohr's postulate, and we learn that the constituents of the diagonal matrix H are identical with the energy levels of the older theory.

It will be observed that if we replace x in equation (65) by q we have

$$\frac{2\pi i}{h}(pq - qp) \equiv 1 \tag{69}$$

where the right hand side means a matrix (the unit matrix) the diagonal constituents of which are all equal to unity and the others zero. Equation (69) occupies a position in matrix mechanics corresponding to that occupied in the older theory by the Wilson-Sommerfeld conditions (41).

Much has been written in recent times about the irrational character of the quantum theory. This irrationality is simply an expression of the difficulty—perhaps of the impossibility—of a coordination of quantum phenomena in the old-fashioned causal space-time manner. It seems possible to retain the notion of elementary particles, electrons, photons, etc., located in space and time—or more probably in a 5-dimensional continuum. If we do this it would appear that the de Broglie-Schroedinger undulations become merely a mathematical implement for computing probabilities, and cannot be regarded as physical entities in the ordinary sense of that term. There appears to be no determination in small scale events, except such of a statistical kind, and the very sharply-defined extrinsic causality of the macroscopic world has its being in the fact that probabilities may be so great as to be practical certainties.

BIBLIOGRAPHY.—M. Planck, *Theorie d. Wärmestrahlung* (Leipzig), Eng. trans. by Masius; E. N. da C. Andrade, *Structure of the Atom;* H. S. Allen, *The Quantum;* Reiche, *The Quantum Theory;* Sommerfeld, *Atomic Structure and Spectral Lines;* J. H. Jeans, *Report on Radiation and the Quantum Theory* (Physical Society of London, 1924); E. P. Adams, *The Quantum Theory* (Bulletin of the National Research Council, Washington, D.C., 1923); M. Born, *Mechanics of the Atom* (1927); *Probleme der Atomdynamik* (Berlin); A. Haas, *Materiewellen u. Quantenmechanik* (Akad. Verlagsgesellschaft, Leipzig); O. W. Richardson, *Presidential Address to Physical Society of London* (1927); G. Birtwistle, *The Quantum Theory of the Atom;* the *New Quantum Mechanics* (Cambridge Press).

The works of Allen, Andrade and Birtwistle contain numerous references to original papers. The historical papers of Planck are: "Ueber das Gesetz der Energieverteilung im Normalspektrum," *Ann. der Phys.*, vi. p. 553 (1901) and "Ueber die Elementarquanta der Materie und der Elektrizitat," *Ann. der Phys.* iv. p. 564 (1901). Schroedinger's chief contributions to Wave Mechanics have been published collectively under the title *Abhandlungen zur Wellenmechanik* (Leipzig).

(W. WI.)

QUARANTINE, a term originally applied to the old sanitary preventive system of detention of ships and men, unlading of cargo in lazarets, fumigation of susceptible articles, etc., which was practised at seaports on account of the plague, in connection with the Levantine trade. It is now a thing of the past in Great Britain and in the majority of other states. But, in common usage, the same word is applied to the sanitary regulations which are the modern substitutes for quarantine. *See* PLAGUE.

QUARE IMPEDIT, in English law, a form of action by which the right of presentation to a benefice is tried. It is so called from the words of the writ formerly in use, which directed the sheriff to command the person disturbing the possession to permit the plaintiff to present a fit person, or to show cause "why he hinders" the plaintiff in his right. The action was one of the few real actions preserved by the Real Property Limitation Act, 1833, and survived up to 1860. The effect of the Common Law Procedure Act, 1860, s. 26, was to assimilate proceedings in *quare impedit* as far as possible to those in an ordinary action. It is now brought against a bishop to try the legality of his refusal to institute a particular clerk. Except when a person presented is refused on the ground of doctrine or ritual, *quare impedit* became obsolete on the passage of the Benefices Act, 1898. (*See* BENEFICES.) In the United States, owing to the difference of ecclesiastical organization, the action is unknown.

QUARITCH, BERNARD (1819–1899), English bookseller and collector, was born at Worbis, Germany, on April 23, 1819. He went to London in 1842, and was employed by Bohn the publisher. In 1847 he started a bookseller's business off Leicester square, becoming naturalized as a British subject. In 1848 he started to issue a monthly *Catalogue of Foreign and English Books.* About 1858 he began to purchase rare books, one of the earliest of such purchases being a copy of the Mazarin Bible, and within a period of forty years he possessed six separate copies of this rare and valuable edition. In 1860 he removed to Piccadilly. In 1873 he published the *Bibliotheca Xylographica, Typographica et Palaeographica,* a remarkable catalogue of early productions of the printing press of all countries. He became a regular buyer at all the principal book-sales of Europe and America, and from time to time published a variety of other catalogues of old books. Amongst these may be mentioned the *Supplemental Catalogue* (1877), and *General Catalogue* of *Old Books and Manuscripts* (12 vols., with supplements, 1887–8). By this time Quaritch had developed the largest trade in old books in the world. He died at Hampstead on Dec. 17, 1899, leaving his business to his son.

QUARLES, FRANCIS (1592–1644), English poet, was born at Romford, Essex, and baptized there on May 8, 1592. He was entered at Christ's college, Cambridge, in 1608, and subsequently at Lincoln's Inn. He was made cupbearer to the Princess Elizabeth, Electress Palatine, in 1613, remaining abroad for some years; and before 1629 he was appointed secretary to Ussher, the primate of Ireland. About 1633 he returned to England, and spent the next two years in the preparation of his *Emblems.* In 1639 he was made city chronologer, a post in which Ben Jonson and Thomas Middleton had preceded him. At the outbreak of the Civil War he took the Royalist side, drawing up three pamphlets in 1644 in support of the king's cause. He died on Sept. 8, in that year. Quarles married in 1618 Ursula Woodgate, by whom he had eighteen children.

Of the numerous works of Quarles the only one which has importance is the *Emblems,* originally published in 1635, with grotesque illustrations engraved by William Marshall and others. The forty-five prints in the last three books are borrowed from the *Pia Desideria* (Antwerp, 1624) of Herman Hugo. Each "emblem" consists of a paraphrase from a passage of Scripture, expressed in ornate and metaphorical language, followed by passages from the Christian Fathers, and concluding with an epigram of four lines. The *Emblems* was immensely popular but little esteemed by critics.

An edition of the *Emblems* (Edinburgh, 1857) was embellished with new illustrations by C. H. Bennett and W. A. Rogers. These are reproduced in the complete edition (1874) of Quarles included in the "Chertsey Worthies Library" by Dr. A. B. Grosart.

QUARRYING, the art of winning or obtaining from the earth's crust the various kinds of stone used in construction, road building and the various manufacturing processes for which rock minerals are employed, the operation being, in most cases, conducted in open workings. There are two distinct types of quarrying, one being that employed in the quarrying of what is constantly referred to as "building stone," for which purpose the stone must be obtained in large unshattered blocks or masses, and the other, the quarrying of stone in rough irregular shapes for road building, concrete aggregate, fluxing and various manufacturing processes, for which purposes it must be broken up, crushed or pulverized in preparing it for utilization. The quarrying of stone in blocks for use in construction may be further divided, as will be described later, into the several types of quarrying processes that are employed by reason of the character and physical properties of the different types of rock used for "building stone."

Building Stone.—According to their general character and composition, building stones are broadly classed as granites, sandstones, limestones, marbles and slates. Under the first of these heads is included a number of crystalline rock species, of igneous origin such as granite, syenite, gneiss, schist, etc., which to the geologist are quite distinct, but which in commerce are all spoken of as granite. They are chiefly composed of one or more minerals of the felspar group mingled with one or more of the micas or with hornblende and usually contain quartz. Sandstones are sedimentary rocks chiefly composed of fragments of quartz consolidated by pressure or cemented into solid rock by silica and oxide of iron. Of these there are many varieties, including bluestone and flagstone used for foot-pavements. Thoroughly cemented sandstones are termed quartzites. Limestones are rocks also of sedimentary origin and consist principally of carbonate of lime or of a combination of the carbonates of lime and magnesia. Their chief variations are the crystalline form known as marble and the deposit from mineral springs known as Mexican onyx.

The type of limestone used principally for building stone is the oolitic variety, a calcareous-sand rock made up of shells and shell fragments on the sea floor consolidated into a solid mass or in layers and later uplifted to become a part of the land. Slates are mudstones or shales hardened by heat and pressure and rendered fissile by the latter agent. Chemically they consist chiefly of hydrous silicate of alumina. Theoretically, the sedimentary rock, sandstone, limestone and slate are of a layered formation, although certain limestones and sandstones are massive in character, while all granites are massive, and have no bedding or stratification like sandstones and limestones; but all rock masses are usually found to be more or less affected by movements of the earth's crust which occur as a result of its constant readjustment to the cooling and shrinking interior, so that the rocks are divided by cracks or fissures, which are commonly known as joints. In the massive granites these joints, which usually occur in two or more planes at right angles to one another, are of the greatest importance to the quarryman, as they enable him to separate masses of stone with approximately parallel faces In gneisses the parallel arrangement of the minerals usually coincides with a direction of easy cleavage known to quarrymen as the "rift"; at right angles to this direction is usually one less easy parting, known as the "grain." Sandstones and limestones being stratified rocks which have been formed as sediments in bodies of water, whether their beds are found in the normal position of horizontality, or whether they have been tilted and folded by earth movements, the direction of easiest separation is coincident with the original planes of sedimentation and parallel to them. Strictly speaking, the term rift applies only to massive crystalline rocks, the term bedding-plane being a better one to apply to sedimentary rocks.

In gneisses, sandstones and limestones, joints also occur; and while frequently convenient for the division of the beds into masses of useful size, they may be a detriment, as when they occur so close together as to fall within the limits of a block suitable or economically usable for commercial purposes. In commerce the various kinds of building stone are usually designated by the name of the locality or region in which the quarry is situated. In the case of the more important varieties this geographic name usually conveys to the architect or builder sufficient information concerning colour, texture and other properties of the material.

Methods of Quarrying. — The methods of quarrying vary with the composition and hardness of the rocks, their structure, cleavage and other physical properties; also with the position and character of the deposits or rock-masses. In the quarrying of building stone, the general purpose of the work is to separate the material from its bed in masses of form and the size best adapted to the intended use. Cutting the stone to accurate dimensions, dressing, moulding and finishing by tooling, rubbing or polishing are subsequent operations not involved in quarrying. Crushing all kinds of hard, durable stone to angular fragments for macadam type roads and for concrete aggregate is also an operation subsequent to quarrying.

The practice of quarrying consists in uncovering a sufficient surface of the rock by removing superficial soil, sand, clay, or overborder of overlaying waste rock by some suitable process or by sinking a shaft or slope, and then with proper tools or explosive, detaching blocks of form and size adapted to the purpose in view. Frequently the exposed outer portion of the rock has been either cut up and eroded away in fissures or has been affected by the action of various atmospheric agencies, until it has become discoloured or softened by decay. This weathered material must be removed before stone can be obtained for economic use in the production of dimension stone. .

The separation of blocks of building or dimension stone is ordinarily carried on by some specific variation of one of the two general present-day methods of quarrying known respectively as the "blasting" and "channeling" process. Blasting is used for the harder rocks that do not tend to shatter and channeling for most other kinds of rock. The blasting process consists of drilling holes along the outlines of the block to be removed, and then, by exploding blasting-powder in the holes, exerting sufficient force to overcome the cohesion of the rock and rend it asunder. In many quarries it is found most convenient to separate a large mass and afterwards divide it into blocks of the required size, by drilling holes for further charges of blasting powder, or by driving wedges into these to split the rock. When the rock is stratified, or has an easily determined rift, the holes are drilled at right angles to the plane of separation.

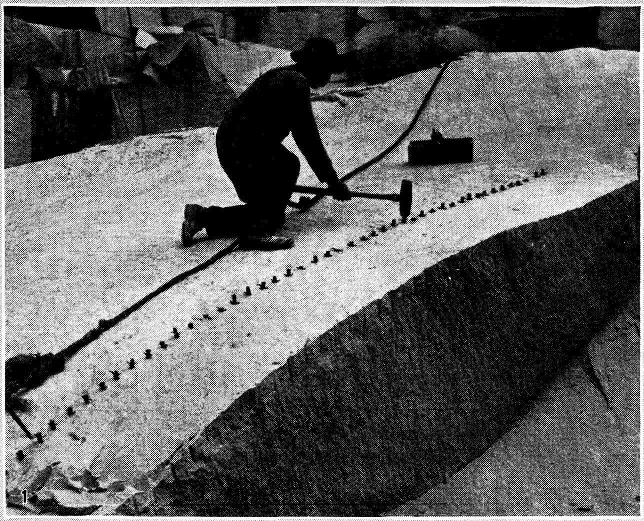
When there is no stratification or rift, or these natural planes of separation are too far apart, or when the position of the joints is not advantageous, a row of horizontal holes must be drilled into the face or breast of the quarry, along which separation is effected either by blasting or the use of wedges. At certain American quarries, in a granite which has no rift or direction of ready cleavage, compressed air has been brought into service to effect the separation of extensive layers. A hole is drilled as deep as the desired thickness of the layer to be separated, and a small charge of dynamite is exploded at the bottom of it. This develops a cavity in which a small charge of powder is next exploded, producing a crack or crevice parallel to the surface of the rock, A pipe for conveying compressed air is now sealed into the opening, and gradually increasing pressure is introduced. This results in the gradual extension of the crevice developed by the explosion of the powder. In the absence of compressed air, water under pressure may be used and also small powder charges exploded at intervals of a few days.

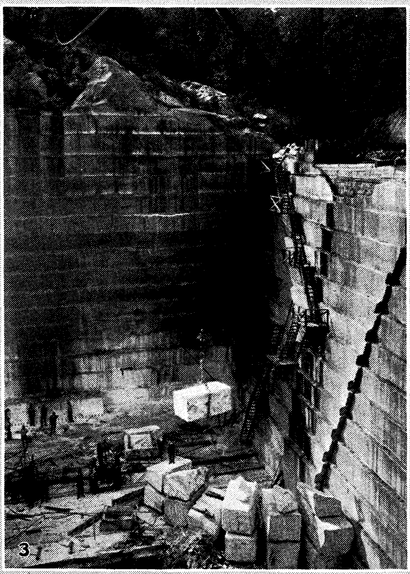
Crushed-stone Quarrying. — A very large and important branch of the quarry industry has recently come into existence, since the era of improved highways and the extensive use of Portland and other hydraulic cements; this is distinguished from "building or dimension stone" quarrying and is generally referred to as crushed-stone quarrying. The object of crushed-stone quarrying is to drill, blast with high explosives and remove or excavate the stone in the cheapest possible manner from either hillside or pit quarries, so that it may be loaded with power shovels and then be fragmented by crushing and grinding machinery of various types to commercial sizes for aggregate, or pulverized to be manufactured into cements. The quarrying of stone for flux in manufacture of steel and glass, for burning into lime and for various other mineral industries also falls in this category. Commercial sizes for crushed stone will vary from 5 to 6 in. in greatest dimension (limestone fragments for lime kilns or blast furnaces) to dust, which has many commercial uses. The commonest and largest uses of crushed stone are for surfacing highways and for use as aggregate with bituminous binders or Portland cement to make concrete. Most commercial crushed-stone quarry operations differ in no essentials from open-pit mining. There are also numerous underground quarry-mining operations for the purpose of winning crushed stone for similar purposes.

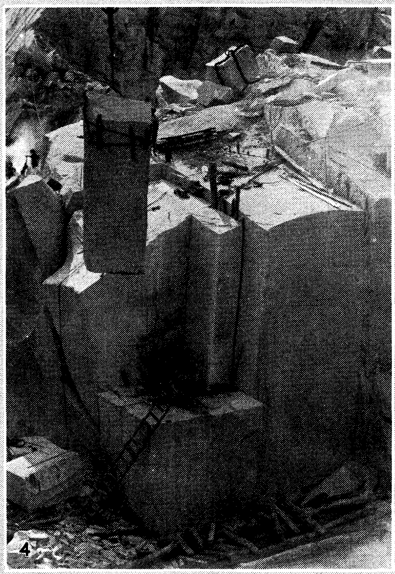
In thinly bedded sandstone, where vertical joints are frequent, it is often possible to separate the desired slabs and flagstones with crowbars and wedges, without drilling or the use of explosives. When blasting is necessary, some form of gunpowder is generally used, rather than a violent explosive like dynamite, in order to avoid shattering the rock. This, however, applies only to dimension stone. When the production of broken stone for road-making, concrete or similar purposes is the sole end in view, violent explosives are preferred.

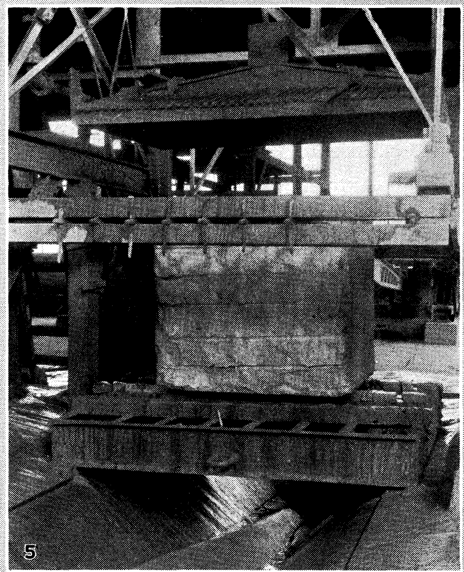
Channeling Machines. — In limestones and marbles and in the softer sandstones, the channeling process is almost invariably employed. Channeling machines, driven by steam, compressed air, electricity, or a combination of these are used, by which vertical or oblique grooves or channels can be cut with great rapidity to a depth of from 8 to 12 feet. A level bed of rock is cleared, and on this are laid rails, along which the machine moves opposite to the bottom of the channel cut. After the channels are cut and a row of holes drilled perpendicular to the channel — opposite the bottom of the channel cut — wedges are driven and the required blocks or cuts of stone are separated from the ledge. These cuts, frequently of great size, running 60 to 80 ft. in length, by 10 to 12 ft. in depth and 4 to 5 ft. in width in some limestone quarries, are then with the aid of the derrick power turned over on the side, after which they are drilled and split up into blocks of convenient sizes for transportation and handling. These are called mill blocks, and are usually from 3 to 4 ft. by 3 to 5 ft. in cross-section and 6 to 12 ft. in length.

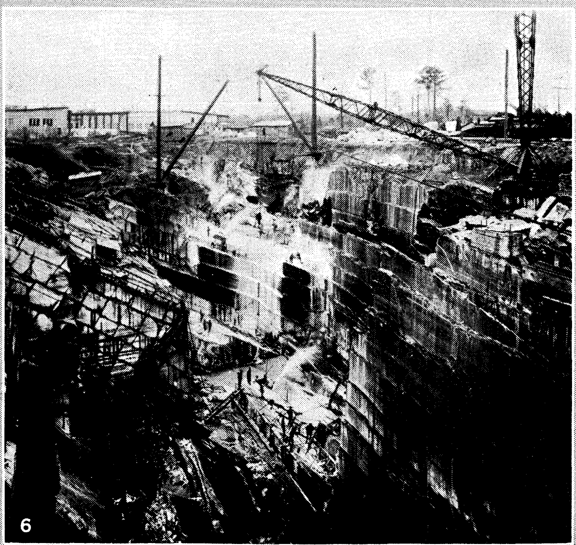
When the beds of stone to be quarried are comparatively thin, with heavy overburden, or when to remove the whole of the overlying mass of earth or rock would be too expensive, it has been found convenient to treat the quarry as if it were a mine, and to rely upon methods similar to those practised in mining,

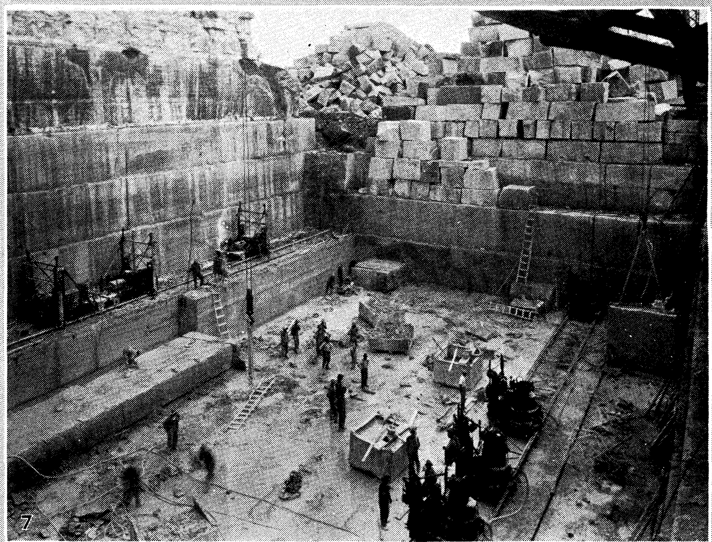












BY COURTESY OF (1, 4) THE ROCK OF AGES CORPORATION, (2, 7) THE INDIANA LIMESTONE COMPANY, (3, 5) THE GEORGIA MARBLE COMPANY, (6) THE ALABAMA POWER COMPANY

OPEN–CUT QUARRYING

1. **Open-cut** method of excavating Vermont granite by hand. 2. Turning over a large cut of limestone in an Indiana quarry. 3. Georgia marble quarry. Depth at time photograph was made, 80 feet. Weight of block being hoisted, 14 tons. 4. **Hoisting** blocks of granite from a Vermont **quarry.** 5. Gang-saw used for sawing marble. The cutting tool, a steel saw-blade aided by the abrasive action of a mixture of sand and water, cuts the blocks into the required thickness. 6. Marble quarry in Alabama, showing large cranes used for hoisting. 7. General scene at a **Bedford,** Ind., quarry. The large cut is shown "turned over" at the left, and being split up into smaller blocks before hoisting to railroad cars

Since great advances have been made in both the quarrying and working of building stone during recent years, few articles will be found that are really up to date. As a supplement to the following references the reader is referred to the more recent articles on the subject of quarrying that have appeared in trade press and technical publications of this industry as the most reliable source of additional information.

See Institution of Quarry Managers, *Quarrying* (Conway, 1924); G. C. Mance, *Power Economy and the Utilization of Waste in the Quarry Industry of Southern Indiana* (Indiana Univ. Studies, 1917), also the *Quarry Managers' Journal* (Conway). (F. J. H. M.)

QUARTER DAYS, the days that begin each quarter of the year; in England, March 25 (Lady day), June 24 (Midsummer day), Sept. 29 (Michaelmas day) and Dec. 25 (Christmas day). They are the days on which it is usually contracted that rents should be paid and houses or lands entered upon or quitted. In Scotland there are two legal terms, May 15 (Whitsunday) and Nov. 11 (Martinmas); these, together with the two conventional terms, Feb. 2 (Candlemas) and Aug. 1 (Lammas), make up the Scottish quarter days. In the Scottish burghs, however, the removal terms are May 28 and Ncv. 28. In the United States the quarter days are, in law, the 1st of January, April, July and October.

QUARTERMASTER, a commissioned officer of a unit whose chief duty is the care of the stores, rations, equipment, etc. Quartermasters were mentioned as early as 1447, and were found on the regimental lists of the Army in Ireland in 1660. The former title was "harbinger's clerk," the quartermaster-general being styled the Harbinger. Early quartermasters were usually warrant officers (unless holding a separate combatant commission), except in the Household Cavalry, where they were always commissioned officers. Cavalry regiments usually had a quartermaster to each troop but infantry never had more than one to a battalion. In the British service the rank is reserved for warrant officers and N.C.O.'s of exceptional ability and continuous exemplary conduct. *(See* OFFICERS.) In the U.S.A. there is a Quartermaster Corps which performs the duties comparable to the quartermaster-general's branch of the British service. In the French service similar duties are carried out by the *intendance,* the executive branch of which is officered by *officiers d'administration* recruited from *sous-officiers* (warrant officers and sergeants). (T. J. E.)

Naval quartermasters are petty officers in rank or, in smaller vessels, are selected leading seamen or able seamen, who in harbour perform, under the officer of the watch or officer of the day, duties comparable to those of a night-watchman during the dark hours, while during working hours they assist the duty officers by attending to the details of the routine, the good order of the quarter deck, the employment of the duty boats and the general curriculum of the ship's company. At sea the quartermaster is stationed at the wheel and either steers himself, under the orders of the officer of the watch or navigating officer, or closely supervises the seaman who is steering, to ensure that he keeps a good course and promptly and quickly obeys any orders given for the movements of the helm.

In a big ship the quartermasters are usually assigned for service in four watches. In smaller ships they may also combine the duties of boatswain's mate. The term is also used in the mercantile marine, where a quartermaster's duties are similar to those on a man of war. In old navy days the quartermaster's duties are described as being to supervise "stowing the ballast and provisions in the hold, coiling the cables in the platforms, overlooking the steerage of the ship, keeping the time by the watch glasses, and in turn overlooking the purser's steward in his delivery of provisions, etc." (E. A.)

QUARTER SESSIONS, COURT OF, in English law, the name for the justices of the peace of any county, riding, parts, division or liberty of a county, or of any county of a city or county of a town, in general or quarter sessions assembled; it includes the court of the recorder of a municipal borough having a separate court of quarter sessions. The word "general" in this context is contrasted with "special" or "petty." The court is a local court of record having a limited criminal jurisdiction, and also to some extent civil jurisdiction. As a court of record it has, in addition to its other jurisdiction, power to punish summarily without the assistance of a jury contempts committed in its presence, such as insults to the justices or disturbance of its proceedings. At the present time the whole of England and Wales is within the local jurisdiction of some court of quarter sessions.

The court derived its name from the direction in a statute of 1388 that the "justices shall keep their sessions in every quarter of the year at the least." By s. 22 of the Criminal Justice Act 1925, general quarter sessions for any county must be held at such times within the period of 21 days immediately preceding or immediately following March 25, June 24, Sept, 29 and Dec. 25 in every year as may be fixed. The justices are free to sit oftener by adjournment of the quarterly sessions to another time, and even to another place, in their county, or to hold additional sessions. All the sessions thus held are "general," though not all may be "quarter" sessions. The Assizes and Quarter Sessions Act 1908 gave the useful power of dispensing with the holding of quarter sessions if there is no business to transact, and under the Criminal Justice Act 1925 there is power to dispense with the grand jury where all persons committed have pleaded guilty.

In all the counties, except that of London, the justices in the commission elect a chairman and vice-chairman, neither of them necessarily a lawyer, to preside at the sittings of the court, In the county of London there are a paid chairman and deputy chairman, who must be barristers of at least ten years' standing, and are appointed by the Crown. Under the Quarter Sessions Act 1858 the court may sit in two divisions of at least two justices at the same time and place, but not simultaneously in separate parts of the same county.

The jurisdiction of the court of quarter sessions of a borough does not depend upon the commission of the peace, but upon the Municipal Corporations Act 1882. Before the Municipal Corporations Act 1835, many boroughs had criminal jurisdiction under their charters. Under that Act and the Act of 1882 a grant of quarter sessions to a city or borough is made by the Crown in council on petition of the town council. The recorder (*q.v.*), a barrister of not less than five years' standing appointed by the Crown, is sole judge of the court.

The city of London is not subject to the Municipal Corporations Act 1882, and its court of quarter sessions is created by the city charters, and is held before the mayor and aldermen with the recorder. It does not now sit to try indictments, which all go to the Central Criminal Court.

Criminal Jurisdiction.—Courts of quarter sessions in counties and boroughs have both original and appellate jurisdiction depending on the commission of the peace and on legislation beginning in 1344. This jurisdiction is derived in counties from the commission of the peace. The jurisdiction of quarter sessions is governed chiefly by the Quarter Sessions Act 1842, and they are forbidden to try the following offences: treason or misprision of treason; murder, capital felony or any felony (except burglary) which is punishable on a first conviction by penal servitude for life; offences against the king's title, prerogative, person or government, or against either House of parliament; offences against the Official Secrets Acts 1911 and 1920; offences subject to the penalties of praemunire; blasphemy and offences against religion, and composing or publishing blasphemous, seditious or defamatory libels; and various other offences prohibited by statutes. But their jurisdiction has been extended by the Criminal Justice Act 1925 and certain offences under the Perjury and Forgery Acts and other statutes and the so-called "long firm" frauds are cognisable by quarter sessions. Trials before the court with a jury are governed by the same procedure as trials on indictment in a court of assize. Under the Vagrancy Act 1823 and amending Acts, they have special powers of sentencing incorrigible rogues sent to them by courts of summary jurisdiction.

An appeal lies to quarter sessions from convictions by a court of summary jurisdiction only where such an appeal is expressly given by statute. *(See* SUMMARY JURISDICTION)

Civil Jurisdiction.—By legislation in and since 1888 most of the administrative powers and duties of justices in general and quarter sessions have been transferred to the incorporated and elective councils of counties, boroughs and urban and rural districts. But the justices still possess certain original, civil or quasi-civil jurisdiction with respect to licensing and as to closing highways. Most of the civil jurisdiction of quarter sessions is now appellate, *i.e.,* with reference to orders made by justices.

Rating appeals, although they are still made to quarter sessions, are heard by a committee of the justices of the county appointed by such sessions (Rating and Valuation Act 1925). The procedure as to each form of appeal depends partly on the statute by which it is given and partly on the general provisions of the Summary Jurisdiction Acts. Decisions on law may be reviewed by the High Court (king's bench division) by means of certiorari, mandamus or prohibition. Convictions on indictment before courts of quarter sessions are within the provisions of the Criminal Appeal Act of 1907, except convictions on indictments for obstruction or non-repair of a public bridge, highway or river, from which an appeal lies to the court of appeal in the same way as in the case of civil actions tried at assizes. Persons dealt with as incorrigible rogues are also within the Act of 1907. Quarter sessions can state a case on a point of law on an appeal to them against a conviction by a court of summary jurisdiction, and if they decline to do so may be ordered to state a case by the High Court (Criminal Justice Act 1925). (W. F. C.; W. DE B. H.)

United States.—There is no court of quarter sessions in the United States. Courts of other names, differing in the various jurisdictions, perform its functions.

QUARTER SQUARES. Among the labour-saving devices for multiplying is one which seems to be of Hindu origin and which may be stated as follows: to find the product of two numbers, take the difference between a quarter of the square of their sum and a quarter of the square of their difference. For example, $9\times8=\frac{1}{4}(9+8)^2-\frac{1}{4}(9-8)^2=\frac{1}{4}(289-1)=72$. It depends upon the algebraic identity, $ab=\frac{1}{4}(a+b)^2-\frac{1}{4}(a-b)^2$. If the computer has a table of squares sufficiently large, the method has considerable value, and this is more evident if he has a table of quarter squares. The plan is given in various Arabic works, as in al-Karkhî's *al-Kâfî fî'l-Hisâb* (c. 1020).

See J. Blater, Table des Quarts de *carrés* de *tous les* nombres *entiers* de 1 *à* 200000 (1888). For a discussion of the subject, with a bibliography and a description of related methods see H. Mehmke, *Numerisches Rechnen*, in W. F. Meyer, *Encyklopädie* der mathematischen Wissenschaften, Band I., pp. 944–952.

QUARTER-STAFF. A staff of wood from six to nine feet in length, used as a means of attack and defence; originally no doubt it was the cudgel or sapling with which many heroes are described by early writers as being armed. The quarter-staff attained great popularity in England in the middle ages. It was usually made of oak, the ends often shod with iron, and it was held with both hands, the right hand grasping it one quarter of the distance from the lower end (whence the name) and the left at about the middle.

Egerton Castle (Schools and Masters of Fence) says that the staff was the "foil," or practice-substitute for the long sword or two-hander. In earlier times it may also have been used as a practice weapon for the spear and bill. In the prints illustrative of the life of Richard Beauchamp, earl of Warwick (1382–1439), reproduced in Joseph Strutt's Manners, Customs, Arms, Habits, etc. of *the Inhabitants* of England, may be seen a combat between two knights after they have splintered their lances and dismounted, in which both are fighting with pointed staves about as long as a quarter-staff and held in the same manner. In the 17th century the staff was still popular in England.

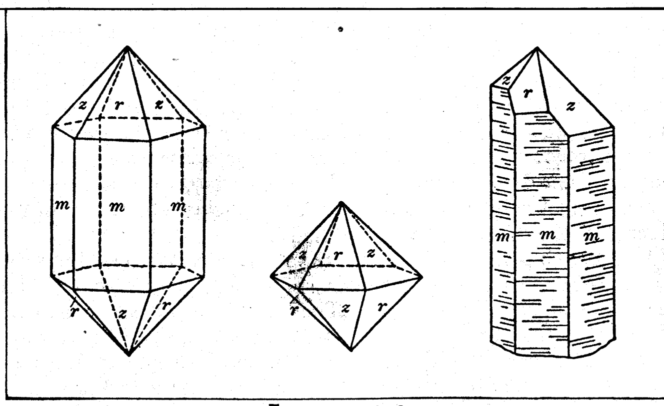
At the present time the quarter-staff is used to a limited extent in military circles as a school for bayonet play. (See FENCING.) (A. R. H.)

QUARTER TONES, in music. Although the semitone, or half tone, was formerly defined as "the smallest interval recognized in music" much smaller intervals have always been employed in oriental music (see INDIA), and in recent years attempts have been made by various musicians to introduce similar intervals, such as quarter tones, in Western music. Foremost among these has been the Czech composer and theorist, Alois Haba, who has written a number of works based on the quarter-tone system, though so far, it must be said, without securing for them much appreciation even at the hands of the best disposed listeners. To the contrary, the opinion expressed has usually been that the effect was too closely akin to that of instruments playing out of tune to be agreeable, although it may be that with further experience of the music it might produce a more favourable impression. Another who theorized on the subject, and considered incidentally the possibility of employing even smaller intervals than quarter tones, was the eminent pianist and composer Busoni, while John Herbert Foulds, an English composer, has done the like. (See HARMONY.)

QUARTZ, a widely distributed mineral species, consisting of silicon dioxide, or silica, SiO_2. It is the commonest of minerals, and is met with in a great variety of forms and with very diverse modes of occurrence. The various forms of silica have attracted attention from the earliest times, and the water-clear crystallized variety was known to the Greeks as *κρύσταλλος* (clear ice), being supposed by them to have been formed from water by the intense cold of the Alps; hence the name "crystal," or more commonly rock-crystal, applied to this variety. The name quartz is an old German word of uncertain origin used by G. Agricola in 1529.

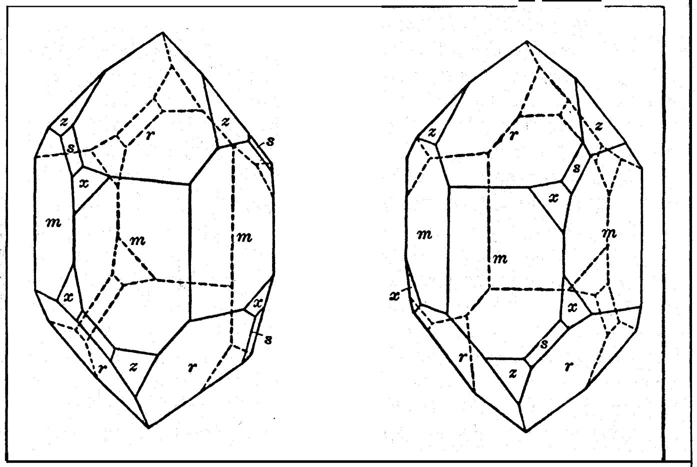
Quartz is a mineral which is put to many uses. Several of the varieties are cut into gems and ornaments, balance weights, pivot supports for delicate instruments, agate mortars, etc.; or used for engraving, for instance, cameos and the elaborately carved crystal vases of ancient and mediaeval times. Clear transparent rock-crystal is used for optical purposes; fused quartz is also used for the construction of lenses and laboratory vessels, and is drawn out into the finest elastic fibres and used for suspending mirrors, etc., in physical apparatus; for striking fire, flint is used even to the present day; and buhrstone, a cellular variety of chalcedonic quartz from the Tertiary strata of the Paris basin, is largely used for millstones. Quartz is a valuable grinding and polishing material, and is used for making sandpaper and scouring-soap, also in the manufacture of glass and porcelain, "silver sand" being a pure quartz sand.

Crystallography.—Quartz crystallizes in the trapezohedral class of the rhombohedral division of the hexagonal system. Crystals of this class possess neither planes nor centre of symmetry, but only axes of symmetry; perpendicular to the principal triad axis there are three uniterminal dyad axes of symmetry. Usually, however, this lower degree of symmetry is not indicated by the faces developed on the crystals. The majority of crystals of



FIGS. 1, 2 & 3

quartz are bounded only by the faces of a hexagonal prism $m\{2\bar{1}\bar{1}\}$ and a hexagonal bipyramid (fig. 1), though sometimes the prism is absent (fig. 2). Frequently the faces are of different sizes (fig. 3): mis-shapen crystals are common and sometimes very puzzling, but they can always be orientated by the aid of the very characteristic striations on the prism faces, which serve also to distinguish quartz from other minerals of similar appearance. These striations (fig. 3) are horizontal in direction, being parallel to the edges of intersection between the prism and pyramid faces, and are due to the frequent oscillatory combination of these faces. The apparent hexagonal bipyramid is really a combination of two rhombohedra, the direct rhombohedron *r*{100} and the inverse rhombohedron *z*{$22\bar{1}$}. The faces of these two rhombohedra exhibit differences in surface characters, those of *r* being usually brighter in lustre than those of *z;* further, the former often predominate in size (figs. 4 and 5), and the latter may sometimes be completely absent. When both the prism and the rhombohedron *z* are absent, the crystals



FIGS. 4 AND 5

resemble cubes in appearance, since the angles between the faces of the rhombohedron are 85° 46'. The additional faces *s* and *x* (figs. 4 and 5), which indicate the true degree of symmetry of quartz, are of comparatively rare occurrence except on crystals from certain localities. The six small faces *s*{$41\bar{2}$} situated on alternate corners at each end of the crystal, are called the "rhomb" faces, because of their shape; if extended they would give a trigonal bipyramid. The "trapezohedral," or "plagihedral," faces *x*{$4\bar{1}\bar{2}$} belong to a trigonal trapezohedron. The two crystals shown in figs. 4 and 5 are enantiomorphous, *i.e.,* they are non-superposable, one being the mirror reflection of the other: they are left-handed and right-handed crystals respectively. The faces *s* are striated parallel to their edge of intersection with r; this serves to distinguish *r* and *z,* and thus, in the absence of *x* faces, to distinguish left- or right-handed crystals. Numerous other faces have been observed on crystals of quartz, but they are of rare occurrence. The basal plane, so common on calcite and many other rhombohedra1 minerals, is of the greatest rarity in quartz, and when present only appears as a small rough face formed by the corrosion of the crystal. Faces of prisms other than *m* are also small and of exceptional occurrence. Etched figures, both natural and artificial (in the latter case produced by the action of hydrofluoric acid), on the faces of the crystals are in accordance with the symmetry, and may serve to distinguish left- and right-handed crystals.

Twinned crystals of quartz are extremely common, but are complex in character and can only be deciphered when the faces *s* and *x* are present which is not often the case. Usually they are interpenetration twins with the principal axis as twin-axis; the prism planes of the two individuals coincide, and the faces r and *z* also fall into the same plane. Such twins may therefore be mistaken for simple crystals unless they are attentively studied; but the twinning is often made evident by the presence of irregularly bounded areas of the duller *z* faces coinciding with the brighter *r* faces. In a rarer type of twinning, in which the twin-plane is {$52\bar{1}$} (a plane truncating the edge between *r* and z), the two individuals are united in juxtaposition with their principal axis nearly at right angles (84° 33'). A few magnificent specimens of rock-crystal twinned according to this law have been found at La Gardette in Isère, and in Japan they are somewhat abundant.

Electrical and Optical Characters.—The pyro-electric characters of quartz are closely connected with its peculiar type of symmetry and especially with the three uniterminal dyad axes. A crystal becomes positively and negatively electrified on alternate prism edges when its temperature changes. A similar distribution of electric charges is produced when a crystal is subjected to pressure; quartz being thus also piezo-electric. Use is made of this property in detecting extremely minute changes of pressure in the depth-sounding apparatus of submarines and in the resonators of radio-detectors.

In its optical characters, quartz is also of interest, since it is one of the two minerals (cinnabar being the other) which are circularly polarizing. This phenomenon is connected with the symmetry of the crystals, and is also shown by the crystals of certain other substances in which there are neither planes nor centre of symmetry. A ray of plane-polarized light traversing a right-handed crystal of quartz in the direction of the triad axis has its plane of polarization rotated to the right, while a left-handed crystal rotates it to the Ieft. A section 1 mm. thick, cut perpendicular to the principal axis of a quartz crystal, rotates the plane of yellow (D) light through 22°, and of blue (G) light through 43'. Such a section when examined in the polariscope shows an interference figure with a coloured centre, there being no black cross inside the innermost ring (this is not shown in very thin sections). Superimposed sections of right- and left-handed quartz, as may sometimes be present in sections of twinned crystals, exhibit Airy's spirals in the polariscope. The indices of refraction of quartz for yellow (D) light are $\omega=1{\cdot}5442$ and $\epsilon=1{\cdot}5533$; the optic sign is therefore positive.

Other Characters.—Quartz has a hardness of 7 (being chosen as No. 7 on Mohs' scale), and it cannot be scratched with a knife; its specific gravity is 2.65. There is no distinct cleavage; though an imperfect cleavage may sometime* be developed parallel to the faces of the rhombohedron *r* by plunging a heated crystal into cold water. The glassy conchoidal fracture is a characteristic feature of the crystallized mineral. A peculiar rippled or "thumb-marked" fracture is sometimes to be seen, especially in amethyst (*q.v.*), and is due to repeated intergrowths of right- and left-handed material. The mineral is a non-conductor of electricity; it is unattacked by acids with the exception of hydrofluoric acid, and is only slightly dissolved by solutions of caustic alkalis. It is infusible before the gas blowpipe, but in the oxyhydrogen flame fuses to a clear colourless glass, which has a hardness of 5 and specific gravity 2.2.

When heated, quartz undergoes a series of remarkable changes. At 575° C it passes over into β-quartz, with a change in the degree of crystal-symmetry from rhombohedral-trapezohedral to hexagonal-trapezohedral and an alteration of the various physical properties. At 870° this 8-quartz changes over into β-tridymite, and this again at 1,470° to β-cristobalite, the inaterial finally melting at about 1,710°.

Many peculiarities of the growth of crystals are well illustrated by the mineral quartz. Thus in "ghost quartz," in which one crystal is seen inside another, the stages of growth are marked out by thin layers of enclosed material. In "capped quartz" these layers are thicker, and the successive shells of the crystal may be easily separated. "Sceptre quartz," in which a short thick crystal is mounted on the end of a long slender prism, indicates a change in the conditions of growth. Crystals with a helical twist are not uncommon. Enclosures of other minerals (rutile, chlorite, haematite, goethite, actinolite, asbestos and many others) are extremely frequent in crystals of quartz. Cavities, either rounded or with the same shape ("negative crystals") as the surrounding crystal, are also common; they are often of minute size and present in vast numbers. Usually these cavities contain a liquid (water, a saline solution, carbon dioxide, or petroleum) and a movable bubble of gas. The presence of these enclosed impurities impairs the transparency of crystals. Crystals of quartz are usually attached at one end to their rocky matrix, but sometimes, especially when embedded in a soft matrix of clay, gypsum, or salt, they may be bounded on all sides by crystal faces (figs. 1 and 2). In size they vary between wide limits, from minute sparkling points encrusting rock surfaces and often so thickly clustered together as to produce a drusy effect, to large single crystals measuring a yard in length and diameter and weighing half a ton.

The characters as given above apply more particularly to crystals of quartz, but in the various massive and compact varieties the material may be quite different in general appearance. Thus in the microcrystalline chalcedony the lustre is waxy, the fracture fibrous to even, and the external form botrysidal or stalactitic: flint and chert are compact and have a splintery fracture: jasper is a compact variety intermixed with much iron oxide and clay and has a dull and even fracture. Further, these varieties may be of almost any colour, whereas transparent crystals have only a limited range of colour, being either colourless (rock-crystal), violet (amethyst), brown (smoky quartz) or yellow (citrine).

Occurrence.—Quartz occurs as a primary and essential constituent of igneous rocks of acidic composition such as granite, quartz-porphyry and rhyolite, being embedded in these either as irregularly shaped masses or as porphyritic crystals. In pegmatite (graphic granite) and granophyre it often forms a regular intergrowth with felspar. It is also a common constituent, as irregular grains, in many gneisses and crystalline schists, a quartz-schist being composed largely of quartz. By the weathering of silicates, silica passes into solution and quartz is deposited as a secondary product in the cavities of basic igneous rocks, and in fact in the crevices and along the joints of rocks of almost all kinds. Extensive veins of quartz are especially frequent in schistose rocks. Vein-quartz, often of economic importance as a matrix of gold, may, however, in some cases have been of igneous origin. In mineral veins and lodes crystallized quartz is usually the most abundant gangue mineral; the crystals are often arranged perpendicular to the walls of the lode, giving rise to a "comby" structure. In limestones of various kinds it occurs as nodules and bands of chert and flint, being in this case of organic origin. Quartz being a mineral very resistant to weathering agencies, it forms the bulk of sands and sandstones; and when the sand grains are cemented together by a later deposit of secondary quartz a rock known as quartzite results. Pseudomorphous quartz, *i.e.*, quartz replacing other minerals, is of frequent occurrence, and as a petrifying material replacing organic remains it is often met with. As a deposit from hot springs, quartz is much less common than opal. Crystals of quartz may be readily prepared artificially by a number of methods; for example, by heating glass or gelatinous silica with water under pressure.

For particulars respecting the special characters, modes of occurrence and localities of the more important varieties of quartz, reference may be made to the following articles: AGATE, AMETHYST, AVENTURINE, BLOODSTONE, CAIRNGORM, CARNELIAN, CAT'S-EYE, CHALCEDONY, CHRYSOPRASE, FLINT, JASPER, MOCHA-STONE, ONYX, SARD AND SARDONYX. For other forms of silica see OPAL and TRIDYMITE[1]. (L. J. S.)

Recent research on the physical chemistry of silica has shown that at 870° C under atmospheric pressure quartz inverts to tridymite, which again at 1,470° C changes to cristobalite. These changes are, however, exceedingly slow in coming about, and in actual practice, as in the manufacture of silica bricks for furnace linings, the temperature actually employed has to be considerably above 870° C if the change is to be reasonably complete, a point of much practical importance, owing to the large volume-change during the inversion (about 15%). Cristobalite, on the other hand, has nearly the same volume as tridymite, so that it does not matter much which is present in the finished brick.

For details see C. N. Fenner, *Amer. Journ. Sci.*, vol. xxvi., 1913, pp. 331–348, or for a short summary, R. H. Rastall, *Physico-Chemical Geology*, 1927, pp. 216–220. (R. H. RA.)

QUARTZITE, in petrology, a sandstone which by the deposit of crystalline quartz between its grains has been compacted into a solid quartz rock. As distinguished from sandstones, quartzites are free from pores and have a smooth fracture, since when struck with the hammer they break through the sand grains, while in sandstones the fracture passes through the cementing material and the rounded faces of the grains are exposed, giving the broken surface a rough or granular appearance. The conversion of sandstone into quartzite is sometimes the work of percolating water under ordinary conditions. In the Reading beds of England, which are for the most part loose sands, there are often many large blocks of quartzite which weather out and are exposed at the surface, being known as grey-wethers. The silicification of these rocks must have taken place at no great depth and under ordinary pressures. Most quartzites, however, are found among ancient rocks, such as the Cambrian or Pre-Cambrian and are products of metamorphism.

A normal quartzite has in microscopic section its clastic structure well preserved; the rounded sand grains are seen with patches of new quartz in the interspaces, and the latter is often deposited in crystalline continuity, so that the optical properties of the grains are similar to those of the material which surrounds them: a line of iron oxides or other impurities often indicates the boundary of the original sand grain. As might be expected, however, many of the oldest quartzites have been crushed by folding movements and the quartz consists in large part of a mosaic of small crystalline fragments of irregular shape with interlocking margins; these are called "sheared quartzites," and when they contain white mica in parallel crystalline flakes they become more fissile and pass into quartz-schists. Where sandstones are altered by intrusive rocks they are often converted into pure quartzite, the heat evidently occasioning the deposit of interstitial quartz.

The commonest minerals in quartzite, in addition to quartz, are felspar (microcline, orthoclase, oligoclase), white mica, chlorite, iron oxides, rutile, zircon and tourmaline. Except felspar they are usually present only in small quantity; the less frequent accessories include hornblende, sillimanite, garnet, biotite, graphite, magnetite and epidote. In colour quartzites are often snowy white; they frequently have a fine angular jointing and break up into rubble under the action of frost. Quartzites are too hard and splintery to be used as building stones to any large extent: they furnish a thin and very barren soil, and because they weather slowly tend to project as hills or mountain masses. (J. S. F.)

QUARTZ-PORPHYRY, in petrology, the name given to a group of hemi-crystalline acid rocks containing porphyritic crystals of quartz in a more fine-grained matrix which is usually of micro-crystalline or felsitic structure. In the hand specimens the quartz appears as small rounded, clear, greyish, vitreous blebs, which are crystals (double hexagonal pyramids) with their edges and corners rounded by resorption or corrosion. Under the microscope rounded enclosures of the ground-mass or fluid cavities are often seen; these are frequently negative crystals with regular outlines resembling those of perfect quartz crystals, and many of the latter contain liquid carbonic acid and a bubble of gas which may exhibit vibratile motion under high magnifying powers. In addition to quartz there are usually phenocrysts of felspar, mostly orthoclase, though a varying amount of plagioclase is often present. The felspars are usually cloudy from the formation of secondary kaolin and muscovite throughout their substance; their crystals are larger than those of quartz and sometimes attain a length of two inches. Not uncommonly scales of mica are visible as hexagonal plates. Other porphyritic minerals are few, but hornblende, augite and bronzite are sometimes found; the augite and hornblende are in most cases green, and are frequently decomposed into chlorite, but even then can usually be identified by their shape. A colourless rhombic pyroxene (enstatite or bronzite) occurs in a limited number of the rocks of this group and readily weathers to bastite. Apatite, magnetite, and zircon, all in small but frequently perfect crystals, are almost universal minerals of the quartz-porphyries.

Structure. — The ground-mass is finely crystalline and to the unaided eye Bas usually a dull aspect resembling common earthenware; it is grey, green, reddish or white. Often it is streaked or banded by fluxion during cooling, but as a rule these rocks are not vesicular. Two main types may be recognized by means of the microscope — the felsitic and the microcrystalline. In the former the ingredients are so fine-grained that in the thinnest slices they cannot be determined in this way. Some of the rocks show perlitic or spherulitic structure; such were probably originally glassy (obsidians or pitchstones), but by lapse of time have slowly passed into a very finely crystalline state. This change is called devitrification; it is common in glasses, as these are

[1]Still another form of silica is known as cristobalite (named after San Cristobal, its locality in Mexico), which, like tridymite, is of rare occurrence in nature as minute crystals in the cavities of certain lavas.

essentially unstable.

A large number of the finer quartz-porphyries are also in some degree silicified or impregnated by quartz, chalcedony and opal, derived from the silica set free by decomposition (kaolinization) of the original felspar. This re-deposited silica forms veins and patches of indefinite shape or may bodily replace a considerable area of the rock by metasomatic substitution. The opal is amorphous, the chalcedony finely crystalline and often arranged in spherulitic growths which yield an excellent black cross in polarized light. The microcrystalline ground-masses are those which can be resolved into their component minerals in thin slices by use of the microscope. They prove to consist essentially of quartz and felspars, which are often in grains of quite irregular shape (micrographic). In other cases these two minerals are in graphic intergrowth, often forming radiate growths of spherulites consisting of fibres of extreme tenuity; this type is known as granophyric. There is another group in which the matrix contains small rounded or shapeless patches of quartz in which many rectangular felspars are embedded; this structure is called micro-poikilitic, and though often primary is sometimes developed by secondary changes which involve the deposit of new quartz in the ground-mass. As a whole those quartz-porphyries which have microcrystalline ground-masses are rocks of intrusive origin. Elvan is a name given locally to the quartz-porphyries which occur as dikes in Cornwall; in many of them the matrix contains scales of colourless muscovite or minute needles of blue tourmaline. Fluorite and kaolin appear also, and these minerals as a whole are due to pneumatolytic action by vapours permeating the porphyry after it had consolidated but probably before it had entirely cooled.

Older Forms.—Many of the older quartz-porphyries which occur in Palaeozoic and Pre-Cambrian rocks have been affected by earth movements and have experienced crushing and shearing. In this way they become schistose, and from their felspar minute plates of sericitic white mica are developed, giving the rock in some cases very much of the appearance of mica-schists. If there have been no phenocrysts in the original rock, very perfect mica-schists may be produced, which can hardly be distinguished from sedimentary schists, though chemically somewhat different on account of the larger amounts of alkalis which igneous rocks contain. When phenocrysts were present they often remain, though rounded and dragged apart while the matrix flows around them. The glassy or felsitic enclosures in the quartz are then very suggestive of an igneous origin for the rock. Such porphyry-schists have been called porphyroids or porphyroid-schists, and in America the name aporhyolite has been used for them. They are well known in some parts of the Alps, Westphalia, Charnwood (England), and Pennsylvania. The *hälleflintas* of Sweden are also in part acid igneous rocks with a well-banded schistose or granulitic texture.

The quartz-porphyries are distinguished from the rhyolites by being intrusive rocks. All Tertiary acid lavas are included under rhyolites. (J. S. F.)

QUASSIA, the generic name given by Linnaeus to a small tree of Surinam (Quassia amara), superseded for medical purposes in 1809 by the bitter wood or bitter ash of Jamaica, Picrasma excelsa, which has similar properties and can be obtained in larger pieces. Since that date this wood has continued in use in Britain under the name of quassia to the exclusion of the Surinam quassia, which, however, is still employed in France and Germany. Picrasma excelsa is a tree 50 to 60 ft. in height, and resembles the common ash in appearance. It is found also in other West Indian islands, as Antigua and St. Vincent. Quassia amara is a shrub or small tree belonging to the same natural order as Picrasma, viz. Simarubaceae, but is readily distinguished by its large handsome red flowers arranged in terminal clusters. It is a native of Panama, Venezuela, Guiana and northern Brazil. Jamaica quassia is imported into England in logs several feet long and often nearly one foot thick. The wood is nearly white, has a pure bitter taste, and is without odour or aroma. It is usually met with as turnings or raspings, the former being obtained in the manufacture of the "bitter cups" which are made of this wood. The chief constituent is a bitter neutral principle known as quassin. It exists in the wood to the extent of about $\frac{1}{10}\%$. It forms crystalline needles soluble in alkalis, chloroform and 200 parts of water. There is also present a volatile oil. The wood contains no tannin, and for this reason quassia, like chiretta and calumba, may be prescribed with iron. The infusion is useful as a bitter tonic—a group of substances of which calumba is the type—and is also a very efficient anthelmintic for the thread-worm (*Oxyuris vermicularis*). It is a substitute for hops.

QUATERNARY, in geology, the time-division which comprises all the time which has elapsed from the end of the Pliocene to the present day. The term was proposed by J. Desnoyers in 1829. The Quaternary is thus the fourth of the great time-divisions in the geological scale—the Primary or Palaeozoic, the Secondary or Mesozoic and the Tertiary or Cainozoic being the first three—but it represents relatively such a small space of time that some geologists hesitate to give it equal rank, and regard it merely as a subdivision of the Tertiary. Broadly, as the Tertiary may be called the Age of Mammals, the Quaternary may be called the Age of Man. Although man or his ancestors were evolved during the Tertiary, it is in the Quaternary that man becomes the dominant animal. Two divisions of the Quaternary period are usually recognized:—

1 Pleistocene
2 Recent or Holocene

In England many extinct species of animals and mollusca occur in the lower but not in the upper division.

General History of the Quaternary Period.—The faunas of the later Pliocene indicate a definite lowering of temperature and with the opening of the Pleistocene both fauna and flora begin to assume a definitely arctic character. A period of intense cold then ensued—usually known as the Glacial period (*q.v.*) or the Great Ice age. The greater part of the British Isles north of a line from South Wales to the mouth of the Thames came under the influence of ice action. As a belt circling the North Pole, there were several ice-caps, similar to the one that covers most of Greenland at the present day, and the various ice-caps or ice-centres waxed and waned in relative importance in such a way that the same district was sometimes affected by ice from one centre, sometimes by ice from another centre. Finally climatic conditions were ameliorated and the ice retreated. It left in its wake not only great stretches of purely glacial deposits such as boulder clay, but the waters derived from the melting of the ice gave rise to torrents spreading over the still frozen ground and depositing great fans of gravel and sand. After the retreat of the ice a broad tract of cold desert or tundra encircled the Northern Hemisphere. This seems to have given place to a broad belt of wind-swept steppeland where great clouds of fine dust filled the air and were deposited as a mantle of loess. With the increase of humidity, forests sprang up and clothed the greater part of Europe north of the Mediterranean region, and it is in this Forest period that we are still living. This general sequence of events was interrupted by minor cycles which are adequately discussed by C. E. P. Brooks in his book The Evolution of Climate. It will be obvious that the ice-sheets were the controlling factors in Pleistocene times. Very few animals or plants, if any, could live in the regions actually covered by ice; in consequence the glacial deposits are devoid of fossils. Round the margins of the ice extensive floras and faunas existed; they migrated under the influence of fluctuations in the intensity of the cold. One finds thus at least three sets of Pleistocene deposits: (a) glacial deposits without fossils; (b) contemporaneous extra-glacial deposits such as river gravels and cave deposits with mammalian and other land or fresh-water fossils, and indications of the presence of man (artefacts or implements, etc.); (c) contemporaneous marine deposits with fossils. The great problems of Quaternary geology centre around the correlation of the different sets of deposits and of the sequence of events they indicate.

At least five chronological scales have been instituted for Quaternary deposits: (a) that based on a study of marine faunas where, unfortunately, each province has its own history, and those best known are the Baltic, North sea and Mediterranean;

(b) that based on a study of mammalian faunas; (c) that based on a study of human cultures, specially as exemplified by artefacts; (d) that based on a study of the sequence of plant formation in peat mosses; (e) that based on the history of continental deposits—glacial, fluvio-glacial, lacustrine and fluviatile, with their fossils, if any. In addition, a most important method of study of the Quaternary sequence is that of land forms—the rising or falling of the level of the sea relative to the land; the cutting of valleys by rivers and the formation of successive terraces; the formation of successive shore lines by seas and lakes.

Marine Faunas of the Period.—In the Mediterranean three stages are distinguished. The Sicilian has occasional rare forms, such as *Cyprina islandica* and *Buccinum undatum,* no longer living in the Mediterranean, but found in colder seas. Deposits of this age are found in the basin of Palermo, Sicily, hence the name. The Tyrrhenian has no longer any extinct species, but several living now in warmer seas. At this period the level of the Mediterranean seems to have been about 50 to 100 ft. above its present level. The third stage is that of the present-day fauna of the Mediterranean. In the Baltic sea a detailed succession has been worked out in connection with the complex history of the area—at times a fresh-water lake, at times a sea salter than at the present day. It was in the Swedish lakes left after the retreat of the ice that De Geer worked out his famous chronology, by which the duration of the stages of the Pleistocene in years can be calculated.

Mammalian Faunas of the Period.—The Quaternary mammals fall into four groups: (a) tundra species such as the lemming, arctic hare, arctic fox, reindeer and musk-ox; (b) steppe species, such as jerboa, steppe marmot, horse, etc.; (c) a group of southern species—a warm fauna—including some extinct and embracing rhinoceros (several species), cave lion and cave hyena; (d) a group of extinct species including Elephas antiquus, (early Pleistocene), and *Elephas primigenius* (the mammoth, late Pleistocene). It is not easy to trace the movement of Quaternary faunas, but there were living in the British Isles and Europe before the oncoming of the Ice age a number of southern and extinct species (*Elephas* antiquus) which appear to have retreated to the continent with the oncoming of the cold. In this connection it may be noted that the Strait of Dover was probably not cut through till the close of the Glacial period. Other animals, including man, retreated to caves within the British Isles (cave lion, cave bear, cave hyena). Associated with the cold conditions are the arctic animals such as the mammoth and reindeer, followed as the ice retreated by the gradual re-establishment of the modern fauna.

Human Culture of the Period.—This subject is discussed elsewhere. Older Palaeolithic man (Strepian, Chellean and Acheuléen cultures) lived in the open river valleys (River Drift man) before the oncoming of the cold; newer Palaeolithic man (Mousterian, Aurignacian, Solutrian and Magdalenian culture) lived in caves. Neolithic man, with his polished stone implements, was post-Glacial and belongs to the Holocene rather than the Pleistocene.

History of the Continental Deposits.—These deposits are discussed in the article GLACIAL PERIOD. Special interest attaches to the succession of river terraces, such as the famous series of the Thames or Somme. The First terrace of the Thames lies about 130 ft. above the present level of the river and has remains of mammoth. The Second or High (Swanscombe) terrace lies about 100 ft. above the Thames. It has implements of Chellean and Acheuléen and possibly Mousterian types, remains of mammoth and *Elephas* antiquus and a number of extinct mollusca (*Unio* littoralis and *Neritina grateloupiana*). The Third or Middle terrace lies about 50 ft. above the Thames and has Palaeolithic "floors" with Mousterian implements. Nearly all the Mollusca are still living but mammals include the mammoth. The South or Low terrace embraces the low-lying gravels of Kew, Richmond, etc., lying 10 to 25 ft. above sea-level. The Buried Channel represents a period when the level of the river must have been lower than at present. The latest deposits are the extensive stretches of alluvium (Holocene).

Turning to the coastal deposits, in pre-Glacial or early Pleistocene times the sea seems to have been higher than at present and hence there is frequently a pre-Glacial raised beach round the coasts of Britain. With the oncoming of the Glacial period the sea rose still higher and during the retreat of the glaciers the 100 ft. raised beach, 50 ft. raised beach and 25 ft. raised beach respectively were formed, especially in Scotland. At a later date the sea sank below its present level and this is the age of the Neolithic submerged forests and buried channels. For convenience one refers to the movement of the sea relative to the land; actually the change may have been of the land in relation to the sea-level. See also GLACIAL PERIOD.

BIBLIOGRAPHY.—Among general accounts may be noted W. B. Wright, *The Quaternary Ice Age* (London, 1914); C. Depéret, "Essai de co-ordination chronologique des temps quaternaires" (C. R. *Acad. Sci.,* Paris, March 1918–July 1920); K. Olbricht, "Die Eiszeit in Deutschland" (*Naturwiss. Wochenschrift,* Band 21, No. 27, July, 1922); F. Wahnschaffe and F. Schucht, *Geologie und Oberflächengestaltung des Norddeutschen Hachlandes* (Stuttgart, 1921); H. F. Osborn and Chester A. Reed, "Old and New Standards of Pleistocene Divisions in relation to the Prehistory of Man in Europe" (*Bull. Geol. Soc. America,* vol. 133, 1922); M. Boule, *Les Hommes Fossiles* (Paris, 2nd ed. 1922); G. Dubois, "Recherches sur les terrains quaternaires du Nord de la France" (*Mem. Soc. geol. Nord.* viii. 1924). In these works will be found references to classical authorities. Reference should also be made to the writings of E. Anteos in America.
(L. D. S.)

QUATERNIONS is the algebra of vectors—quantities, like force, velocity and acceleration, that have both magnitude and direction. Ordinary numbers (scalars) have merely magnitude. All positive numbers (integral, fractional or irrational) may be represented by the points of a straight line lying on one side of some point O which we conceive as corresponding to zero, as if the straight line were the indicator of a thermometer (fig. 1). If the line be horizontal, then the positive numbers are usually represented by the points to the right of O, the zero-point, and the negative numbers correspond to the points to the left of O (temperatures below zero). The totality of numbers corresponding to the points on this line are called real numbers. Thus far, the numbers introduced represent magnitude only and there is no direction implied by a number except the distinction between backward and forward.

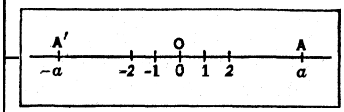


FIG. 1

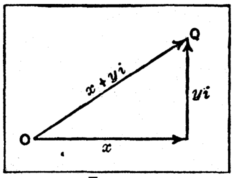


FIG. 2

Vectors in a Plane.—If we wish to have numbers which indicate direction in a plane as well as distance we can use ordinary complex numbers (see COMPLEX NUMBERS). To do this, we note that, since $(-1)\,a=-a$, then multiplication of any number by negative one rotates the line segment OA representing a through two right angles. But, since $\sqrt{-1}\,\sqrt{-1}=-1$, this shows that multiplication by $\sqrt{-1}$ must rotate OA through one right angle. Thus we can represent any point in the plane of this page by a number $x+yi$ where x and y are real numbers and where i is written for $\sqrt{-1}$. Better still, (fig. 2) we can think of the number $x+yi$ as representing the directed line segment OQ, or vector as we say (see VECTOR ANALYSIS).

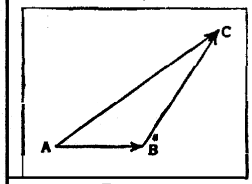


FIG. 3

One of the most familiar examples of a vector is position of a point with respect to some other point, *e.g.,* the position of a building is four blocks south and two blocks east of the city hall. Other examples are displacement through a certain distance in a certain direction, velocity, acceleration, momentum, force, rotation. Vectors are contrasted with ordinary numbers or scalars, examples of which are distance, time, temperature, volume, mass, work, energy (figs. 3 and 4).

Since the displacement AB followed by the displacement BC has the same effect as the single displacement AC, then the sum of the two vectors AB and BC is the vector AC. The multiplication of any number $a+bi$ by the number $x+yi$ means performing on the vector $OP=a+bi$ the same operation which changes the vector OU= 1 into the vector $OQ=x+yi$, and hence is a rotation of the vector OP through the angle 8, followed by a stretching in the ratio of ρ to 1 where ρ is the length of OQ (shrinking, if ρ be less than 1) and thus obtain the vector OR. Multiplication of ordinary complex numbers obeys the commutative law—that is, if u and v be any two complex numbers, then $uv=$ vu; and it also obeys the associative law—that is, if u, v and w be any three complex numbers, then $(uv)w=u(vw)$. (See the articles COMMUTATIVE and ASSOCIATIVE LAWS, respectively.) These two laws are so familiar that we have taken them for granted, but we shall have to discard one of them when we come to quaternions. Thus the field of ordinary complex numbers is the algebra of distances and directions in a plane. (See LINEAR ALGEBRAS.)

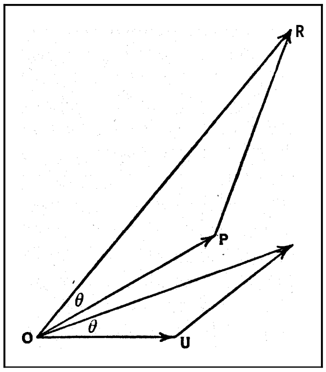


FIG 4

Vectors in Space.—When Sir W. R. Hamilton (1805–1865) tried to invent an algebra for vectors in space, he discovered some peculiarities which at first seemed disconcerting. By analogy with the algebra of vectors in a plane, he tried to represent every vector in space in the form $x+yi+zj$ where 1, i and j denote unit vectors in three mutually perpendicular directions (fig. 5a). This seems natural, inasmuch as any vector (displacement, force, etc.) in space is compounded of a vector in a north-and-south direction, a vector in east–west direction and a vector in an up-and-down direction. Now in the field of complex numbers multiplication obeys, (1) the commutative law, and (2) the associative law, while (3) division—the inverse of multiplication—is uniquely possible when the divisor is not zero. Hamilton, however, discovered that for space it is impossible to define an algebra which possesses all three of these properties. He tried to invent an algebra of vectors for space which should possess the second and third properties and discovered that there is no such algebra in which ij is expressible in the form $x+vi+zj$. Accordingly, he was forced to assume that the algebra was of order four instead of order three; and thus every quaternion is of the form $yi+zj+wk$ where i, j, k denote unit vectors in three perpendicular directions and where the product of two vectors is of the form $a+bi+cj+dk$. That is, although the algebra of vectors in a plane has only two units, the algebra of vectors in space has four units. This discovery of Hamilton makes one realize that man cannot invent law; he can only discover the primordial laws of the universe.

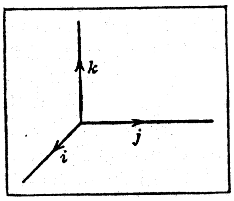


FIG. 5A

Quaternions.—When x, y, z, w are real numbers and i, j, k are the above unit vectors, any number of the form $q=x+yi+zj+wk$ is called a (real) quaternion. A vector is simply a quaternion with $x=0$ and a scalar is a quaternion with $y=z=w=0$. To make it concrete, we shall think of i as the unit vector toward the south, j as the unit vector to the east and k as the unit vector up. In the diagram, the plane of the page represents a vertical east–west plane viewed from the south; the vectors j and k are in this plane and i points to the south. As for vectors in a plane, multiplication by a vector of length p is equivalent to a stretching in the ratio of p to 1 compounded with a rotation in the counter-clockwise direction. Multiplication of any vector in the east–west vertical plane by i (on the left) is equivalent to a rotation in that plane through a right angle in a counter-clockwise direction as seen from the south. Similarly, multiplication by j or k is a rotation through a right angle in the direction indicated in the diagram. Since rotation through two right angles in the same plane reverses the direction, then $i^2=-1$ and also $j^2=-1=k^2$. From this (see fig. 6) we see that i rotates j into k and thus $ij=k$, whereas j rotates i into k reversed and thus $ji=-k$. Similarly, $jk=-kj=i$ and $ki=-ik=j$. Substituting these values for the products, we see that the product of any two quaternions $q=x+yi+zj+wk$ and $Q=X+Yi+Zj+Wk$ is $qQ=a+bi+cj+dk$ where $a=xX-yY-zZ-wW$, $b=yX+xY-wZ+zW$, $c=zX+wY+xZ-yW$, $d=wX-zY+yZ+xW$. Any quaternion q and its conjugate $q'=x-yi-zj-$ wk satisfy the quadratic equation $\omega^2-2x\omega+N(q)=0$ where $N(q)=qq'=x^2+y^2+z^2+w^2$ is the norm of q. Note that this gives a factorization of $x^2+y^2+z^2+w^2$, which cannot be factored in the field of complex numbers.

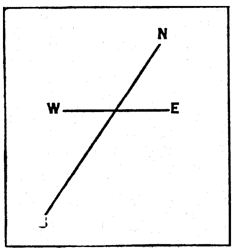


FIG. 5B

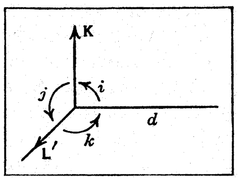


FIG. 6

From the above, it follows that the product $\alpha\beta$ of any two vectors has the form $-\alpha\,.\,\beta+\alpha\times\beta$ where $a\cdot\beta=ab\cos\theta$, where a and b are the magnitudes of α and (3, respectively, and θ is the angle through which a has to be rotated in order to make it extend in the same direction as (3; and α it $\beta=ab(\sin\theta)\gamma$ where γ is the unit vector perpendicular to a and β as indicated in the diagram (fig. 6). When we use $\alpha\cdot\beta$ and $\alpha\times\beta$ separately, we are using *vector* analysis (*q.v.*, due to J. W. Gibbs). The amount of work done by a force F acting through the displacement β is $F\,.\,\beta$. The area swept out by the vector a through displacement β is $\alpha\times\beta$ which means that we have to regard area as a vector. Theorems in geometry can be easily proved with quaternions (vector analysis), sometimes with great brevity; but its most important use is in mathematical physics.

"Ausdehnungslehre," due to H. Grassmann (1809–1877), is like quaternions in that it is an algebra in which some of the elements or numbers are vectors; but it is unlike quaternions in that the fundamental element is the point and the product of two elements of the same kind is an element of a different kind. Moreover, Ausdehnungslehre is not associative and applies to space of any number of dimensions.

BIBLIOGRAPHY.—Sir W. R. Hamilton, Lectures on *Quaternions* (1853). This is the classic on the subject; the long introduction is most interesting and suggestive to a layman. P. Kelland and P. G. Tait, Introduction to Quaternions (1873, 3rd ed. 1904). An excellent text-book; does not use calculus until the last quarter of the book; contains many applications and exercises. E. B. Wilson, Vector Analysis (1901), an expansion of a short pamphlet on the Elements of Vector *Analysis* (1881–84), by J. W. Gibbs. This book pre-supposes a knowledge of trigonometry and the elements of the calculus; it contains many applications to geometry and physics; the first two chapters, however, do not use calculus. J. B. Shaw, Vector Calculus (1922). A text-book on quaternions, with applications to physics; intended for those familiar with the elements of calculus; mature; many exercises. H. Grassmann, *Die Ausdehnungslehre* (Leipzig 1878–96). This is the classical work on this subject, but is highly technical. E. W. Hyde, *Grassmann's Space Analysis* (4th ed. 1906). A primer on Grassmann's work; does not use calculus but requires more intellectual maturity than Gibbs-Wilson. (O. C. H.)

QUATORZAIN, the term 'used in English literature, as opposed to "sonnet," for a poem in 14 rhymed iambic lines closing (as a sonnet strictly never does) with a couplet. The distinction was long neglected, because the English poets of the 16th century had failed to apprehend the true form of the sonnet, and called Petrarch's and other Italian poets' sonnets quatorzains, and their own incorrect quatorzains sonnets. Almost all the so-called sonnets of the Elizabethan cycles, including those of Shakespeare, Sidney, Spenser and Daniel, are really quatorzains. They consist of three quatrains of alternate rhyme, not repeated in the successive quatrains, and the whole closes with a couplet.

QUATRAIN, sometimes spelt *Quartain,* a piece of verse complete in four rhymed lines. The length or measure of the line is immaterial. This form has always been popular for use in the composition of epigrams, and may be considered as a modification of the Greek or Latin epigram.

QUATREFOIL or **QUARTERFOIL,** in architecture, a decorative form of four lobes or cusps, usually of approximately the shape of a four-leafed clover, and frequently with the whole surrounded by an enclosing circle.

QUAVER, in music, a note representing an eighth part of a semibreve, wherefore it is known as an eighth note in America and an *Achtelnote* in Germany.

QUEBEC. The northeastern province of Canada bounded on the southwest and west by part of Ontario, James bay and Hudson bay, on the north by Hudson strait and Ungava bay, on the east by the coast of Labrador and the Gulf of St. Lawrence, on the south by the Bay of Chaleur, New Brunswick, Maine, New Hampshire, Vermont, New York and part of Ontario. Its greatest extent is from the U.S. border, 45° N., to Cape Wostenholme, about 62° 30' N., and from Hudson bay, at a point 80° W. to Anse Sablon about 57° W. The total area is 594,534 sq.mi., or about one-sixth the total area of Canada. The area includes 71,000 sq.mi. of fresh water.

Climate. — There are wide variations in temperature, from arctic to semi-tropical, isotherms curving northeastward. The maximum and minimum temperatures at Quebec city in 1940 were: January max. 29° F., min. −15° F.; July max. 85° F., min. 49° F. Higher and lower temperatures are not uncommon. Movement of large cold air masses is generally from west to east. Cold fronts usually move rapidly from west to east; warm fronts from southwest to northeast. The climate of the eastern section is much affected by the Atlantic. Precipitation decreases from south to north *e.g.,* in 1940 30 in. rain, 151 in. snow in the south (Quebec) decreasing to 17 in. rain, 79 in. snow in the north (Mistassini).

Population. — The 1941 census was 3,331,882, of which about 85% were French-Canadians. English-speaking people are mainly centred in the larger cities, in Pontiac and Abitibi counties, where there are many new Canadians, the Saguenay and St. Maurice industrial areas, Gaspé and the eastern townships north of the New Hampshire and Vermont border.

Physiography and Geology. — The most recent physiographical studies divide the province into three main regions: Canadian Shield, St. Lawrence, Appalachian. The Canadian Shield region includes all territory north and northeast of an irregular line between the Lake of Two Mountains on the Ottawa river and Cap Tourmente on the St. Lawrence a few miles northeast of Quebec. Most of the area is bedded on Laurentian and Pre-Cambrian rock (chiefly granite and granite gneisses); the southern section, north of Montreal and Quebec, is mainly Pre-Cambrian schist and granite; the western central section, around the Canadian National railway near the Ontario border, is Pre-Cambrian.

The main physiographic feature is the Laurentian mountains which form the south section of the Canadian Shield; irregular rocky hills, oldest on the continent, few of the summits now being over 2,000 ft. above sea level; the total area is about equal to that of the American Rockies. These hills are studded by thousands of lakes, cut by river valleys so deep that voyages without too many portages can be made by canoe or small boat through and across the ranges. The most remarkable of these valleys is that of the Saguenay which, after a swift descent from the Lake St. John reservoir, falls into a vast chasm running from west to east, in places almost 2,000 ft. above and 300 fathoms below sea level. Hundreds of rivers, large and small, flow southward and northwestward ensuring to Quebec a huge potential water power which, with the forests covering the hills and valleys, preserving and preserved by this water supply, constitute an enormous reservoir of resources.

One sub-region, Abitibi, on both sides of the Canadian National main line and reaching the Ontario border, is heavily mineralized; both Abitibi and the level region surrounding Lake St. John have soils suitable for cultivation, the former largely clay covered by other soils of varying nature, the latter also clay with a lighter topsoil. The rest of the area has a light moraine soil supporting both softwood and hardwood forests, but not otherwise fertile.

The St. Lawrence region includes (1) an area divided by the river, narrowing from about 60 mi. breadth at Montreal to about 20 mi. breadth at Quebec; (2) an area on the south side of the river only, stretching about 300 mi. northeast from Quebec and 6 to 10 mi. in depth. This region has been divided into three sub-regions, the Montreal Plain, the St. Lawrence Valley between Montreal and Quebec and the South Shore (Cote Sud) below Quebec. The Montreal plain is low, 250 ft. or less above sea level. The surface slopes evenly and very slowly down to the river on both sides and also downward from northeast to southwest, *i.e.,* against the direction of the river. The basement is of Ordovician rock broken near Montreal by the Monteregian hills, remnants of considerable volcanic mountains now almost completely eroded. The soil consists of clay and sand from the Champlain sea with more recent deposits and is in most places good, although large parts have become sour. Considerable areas are covered by newly formed peat. The St. Lawrence Valley basement is likewise Ordovician rock; a mixed soil lies on a clay bed, much deeper on the south than on the north shore. The South Shore is comparatively level, lying on Ordovician rock with many outcrops. At its centre a subsidiary range, about 40 mi. in length, separates the river from the arable land. The soil is mainly sandy, although there are considerable areas of black vegetable deposit, in one section already turned to peat, and is strewn with glacial boulders.

The rest of the province constitutes the Appalachian region, mainly Ordovician with lesser amounts of Cambrian and Devonian dotted with granite, and serpentine hills, well weathered and largely tree-clad, rising in the centre of the region to about 3,000 ft. The Gasp6 peninsula in the east has a central axis of Devonian rocks with considerable traces of oil ending in a high, narrow and precipitous promontory (Cape Gaspé). On the north side are the Shickshock mountains, much folded and faulted. On the south side is another range, with red sandstone and conglomerate along the western end of the Bay of Chaleur. At the east end of the south shore of the peninsula is a much eroded shoreline of rocks filled with fossil shells from which a one-time peninsula, Perce rock, has comparatively recently been cut.

History. — Prior to its cession to Britain most of the present province of Quebec and also a vast ill-defined area stretching from the far west to the Alleghenies and from the Great Lakes to the Gulf of Mexico, as well as the French territories on the North Atlantic, were subject to the crown of France under the name of New France; the district in the St. Lawrence and watershed area was called Canada. Government was held closely in the hands of the crown at Paris; the governor, advised by a "Sovereign Council," had some powers of initiative but he was called to task if he overstepped and was rivalled by the bishop. His chief financial adviser, the intendant, was responsible to Paris for economic control. Except for elections of churchwardens, very few official traces of democratic government existed. "Canada" was by 1750 the home of about 65,000 French Canadians, descendants of settlers who had been arriving during a century and a half. They had a quasi-manorial system of land tenure: *Seigneurs* received grants of about six miles frontage and generally greater depth on the St. Lawrence and like areas in the interior. These were parcelled out to *habitants* who paid annual dues, mostly in kind, to the seigneur as well as making special payments on transfers of property. Traces of the system are only now (1943) disappearing. There were about 15,000 bourgeois in Quebec, Montreal and Trois Rivières where the seigneurial system also existed. There was a complete system of land registration and a notarial system for land transfers, marriage contracts, gifts, etc., which were unchanged at the cession and which, modernized, still remain. Births, marriages and deaths were recorded in the church of one or both of the persons concerned. These French Canadians who had become completely differentiated from the French (now mainly officials and soldiers), calling themselves Canadiens and not French, attributed vast importance to all these customs, to the civil law and to their religion.

After the victory of Wolfe at Quebec, a British military government carried on very satisfactorily, making no important changes. By the treaty of Paris, Feb. 10, 1763, New France passed formally to Britain. This treaty followed in one respect the terms of the capitulation of Quebec in 1759, which had provided *inter alia* that the French Canadians were to retain their houses, goods, effects *and privileges* and that the Catholic Church was to be preserved. The treaty also provided for the maintenance of the Catholic Church but subject to the laws of Britain (under which Catholics were debarred from almost all offices). The "privileges" of the capitulation, taken as meaning French civil law and customs, were maintained, but English law was to be followed so far as compatible with them. This to most judges meant that the common law of Britain prevailed and as no French Canadians knew what that law was there was great confusion.

The province of Quebec as a governmental and geographical entity first appeared under the name of The Government of Quebec in a proclamation made by the crown of Great Britain (in virtue of the somewhat dubious royal prerogative right to legislate for newly conquered territory) on Oct. 7, 1763. This proclamation reached Quebec Aug. 10, 1764. The "Government" included the St. Lawrence valley, except for what is now the Ontario section, and the Ottawa valley, bounded on the north by a line from Lake Nipissing to Lake St. John. The governor and captain general was authorized to, and did, set up a council to make laws and ordinances replacing the "Sovereign Council." The governor in council was also authorized to, but did not, set up a popular assembly. The confusion as to law and religion resulting from the proclamation, as well as the wish of the British government to curb the American settlers to the south, brought about the Quebec Act of 1774 which set up the "Province of Quebec" including most of the area now in the United States west of the Alleghenies. This act guaranteed the maintenance of French civil law and customs and freedom of worship. An executive and a legislative council, both nominated by the crown, were set up and both still exist, although the executive council, under fbe same name, has become a provincial cabinet.

The French Canadians were used to bureaucracy and were well enough pleased with the Quebec act to fight the invading Americans in 1775, and not at all concerned when the treaty of Paris in 1783 set the southern boundary west of the Quebec-Maine mountains back to the 45th parallel. In 1791, by the Constitutional act (enacted June 10, 1790), a government was set up for "Upper Canada" west of the Ottawa (except for a small triangle at the junction of the Ottawa and St. Lawrence) and "Lower Canada" extended by the act over the Magdalen islands, Anticosti and Quebec Labrador. The act provided for Lower Canada an appointive legislative council (15) and an elective assembly (50). The appointive council was at first all-powerful and there were many abuses of power, but there was little complaint until after the War of 1812, in which the French Canadians again fought, and, in Lower Canada, defeated the Americans. The revolutionary ideas inspired "liberals" (French- and English-speaking) in the assembly; the struggle for responsible government and judges independent of the government which ensued culminated in the "rebellion" of the "patriotes" in 1837.

The Union act (July 23, 1840) became law on July 23, 1841, uniting Lower and Upper Canada as Canada East and Canada West, with one council and one assembly in which the two sections had equal numbers, the French language being for the first time recognized although only for debate. After a conflict with the governor responsible government, in the modern sense, came into effect in 1841. The union was never much more than nominal, since the practice was to require a majority of the representatives from each section to pass any act while many acts referred to one section alone. The powers of self-government vested in the colonial parliament gradually increased, judicial reform was obtained, the French language was accepted for all purposes in 1849. In 1867, at confederation, the province of Quebec reappeared with its own lieutenant governor, legislative council and assembly. French-Canadian control of Quebec was assured but the rights of the powerful and rich English-speaking minority were carefully safeguarded, particularly their control over their own education. They (1943) constitute only about 15% of the population, but the growing French-Canadian majority has scrupulously regarded its obligations.

The boundary of Quebec on the north at confederation was the height of land north of the St. Lawrence valley. This was extended to the Eastmain and Hamilton rivers in 1898 and to Hudson strait in 1912. The boundary between Quebec and Labrador (as an adjunct of Newfoundland) was decided by the Labrador Act (1825). The boundary was placed as a line due north from Anse Sablon, and for over a century Newfoundland was presumed to have jurisdiction only over the coastal strip of Labrador, not over the interior (practically unknown). Exploration and the prospect of development raised dispute as to the boundary and in 1927 a decision of the privy council awarded to Newfoundland all of interior Labrador draining to the Atlantic (110,000 sq.mi.). The period after confederation left the government of Quebec practically unchanged; parliamentary procedure and democratic practice follow British precedent even more than that of most other provinces but the French-Canadian majority is quite firmly in the saddle. Quebec is a French-speaking island in North America owing allegiance to a king who for it (and perhaps correctly) is king of Canada, interpreting the Atlantic Charter as confirming its right to its own religion, laws and language.

Government.—The king is represented by the lieutenant governor, appointed for a renewable term of years by the governor general in council. The legislative council has 24 members, each sitting for a geographical district, appointed for life by the lieutenant governor in council (Quebec is the only province with such a body). The legislative assembly has 87 members, each elected for a constituency. Rural constituencies are larger but far less populous than urban. The distribution of powers between the three sections is identical with that between king, lords and commons in Britain, the assembly having complete control of taxation and finance. Treasury bills issued under orders-in-council must be covered by appropriate votes. All private and some public bills are discussed in and reported by appropriate committee sessions at which persons affected may appear personally or by legal representative before passage. Otherwise the formalities duplicate those of the parliament at Westminster. The premier leads in the assembly, and a leader named by the government, generally also a minister without portfolio, in the council. The executive council is the provincial cabinet; its members must, as a rule, hold seats in the assembly, thus ensuring maintenance of the representative principle. Members are premier, provincial treasurer, provincial secretary, attorney general, ministers of roads, public works, colonization, game and maritime fisheries, lands and forests, trade and commerce and municipal affairs, health and welfare, labour and mines, each of whom has one or more deputies while the premier has a "chef du cabinet" ranking as a deputy minister. There are generally a number of ministers without portfolio, of whom the leader of the council is generally one. Elections are governed by the Provincial Elections act, substantially in accord with British practice. There are two parties, Liberal and National Union; a local organization of each usually selects a candidate prior to an election. Independents may run if nominated. Municipal government is carried on by 76 county municipalities and rural and urban municipalities generally under the Cities and Towns act and municipal code, although there are many special charters and acts which demand much parliamentary time for their enactment and revision.

Agriculture.—In 1941 there were 154,184 occupied farms, an increase of 13.5% in 10 years. Main products and values (1940 figures): Spring wheat 522,000 bu., $473,000; oats 44,290,000 bu., $19,254,000; barley 3,888,000 bu., $2,219,000; spring rye 103,000 bu., $84,000; peas 318,000 bu., $794,000; beans 153,000 bu., $375,000; buckwheat 2,144,000 bu., $1,278,000; husking corn 183,000 bu., $168,000; mixed grains 4,502,000 bu., $2,373,000; flax 140,000 bu., $347,000; potatoes 13,125,000 bu., $10,416,000; turnips, beets, etc. 5,957,000 bu., $2,455,000; hay and clover 5,223,000 bu., $46,373,000; fodder corn 552,000 bu., $2,472,000; alfalfa 57,000 bu., $618,000. Quebec's place among the provinces (1940) was as follows: Acreage fifth, with 6,104,000; value of crops fourth, with $89,531,000; value per acre third, $44; total value of farms second, $901,213—about 20% of the Canadian total.

The main features of Quebec agriculture are (1) Family farming: on most farms most of the work is done by the farmer and his family, eliminating most of farm labour costs. (2) Farm arts and crafts—mainly in eastern section where most of the wool produced is woven locally. (3) Co-operation increasing very rapidly: In 1940 there were 364 co-operatives (against 167 in 1936) with 26,790 members; of these 214 were butter and cheese producers, 196 were purchasing agencies, 92 livestock sales agencies. Total sales were $14,389,622.72 (against total revenue of $213,116,000). Total purchases $12,582,847.02. (4) Farm credits (under Revised Statutes of Quebec 194 Chap. 113): A farmer whose debts exceed 65% of the value of his farm may borrow 75% thereof, provided his creditors accept this in full payment. A farmer establishing a new farm may borrow 75%. Interest is 3% per annum, plus 2.714% amortizing loan in 25 years. Total outstanding loans Dec. 31, 1941, were $43,602,262.

The department of agriculture includes director of services, chairman of council of services, head of administrative service (secretary of council), heads of agricultural economics. animal husbandry, horticultural service, each with subdivisions. The province is divided into 20 districts, in each of which there is a district agronomist with a staff of one agronomist for each county and a number of assistant and special agronomists with demonstration farms, etc. The province assists agricultural colleges.

Education.— Education in Quebec has three main branches (1) formal school system; (2) college and university system; (3) technical and special schools. There is a growing system of adult education.

(1) Formal system—under control partly of government, partly of committees. Superintendent of education (appointed by the government) is chairman of a council of education which does not sit as such but is divided into a Catholic and a Protestant committee, each with its secretary (a deputy minister). The Catholic committee includes all Roman Catholic bishops, an equal number of laymen, and some additional members. The Protestant committee has half the number of members and a number of associate members. In virtue of sec. 93 of the B.N.A. act the Protestant committee has sole control of the curriculum in, and recommends all government grants to, Protestant schools. The Catholic committee deals likewise with Catholic schools. Under jurisdiction of the committees are (a) Catholic elementary, complementary, intermediate and high schools, colonization area schools, and Catholic high schools; (b) Protestant elementary, intermediate and high schools. With the universities each committee controls normal schools. There are a few private schools (English-speaking). In school municipalities (erected and divided by the government), commissioners are elected by majority (Protestant or Catholic) and trustees by minority. In large cities there are two sets of commissioners. These finance schools and pay teachers.

(2) The college and university system is independent of government control except where agreements exist: (a) 32 classical colleges (Roman Catholic) with about 10,000 pupils give an 8-year arts and science course leading to a university *baccalaureat.* Convent schools train a large number of girls. Sir George Williams college (Y.M.C.A.) gives a degree course; (b) McGill university (non-sectarian), Montreal and Ste. Anne de Bellevue, have arts and science, professional and graduate faculties. Three Protestant theological colleges are affiliated. Bishops' university (Anglican) at Lennoxville, mainly residential, gives several degree courses. Laval university, Quebec, and Montreal university, with several affiliated schools, provide many branches of professional training.

(3) Technical and Special Schools. Under the department of the provincial secretary, affiliated to universities for standards and degrees, are the School of Higher Commercial Studies, Montreal, with a theoretical and practical curriculum; schools of fine arts at Montreal and Quebec; Polytechnic school, Montreal (university level); School of Tourism. Also, not affiliated, 9 technical schools, 70 schools of arts and manufactures, 1 school of furniture, 5 deaf, dumb and blind schools, 1 school for mental cases. Under the department of agriculture are 3 superior, 5 intermediate, 5 juvenile (orphan) schools, 1 dairy school, 201 domestic science schools. Departmental schools exist for mines, fisheries, forestry, domestic arts (statistics for 1940–41).

(4) Adult Education is carried on in 5 housekeeping schools, 90 night schools, 66 dressmaking schools, by McGill university in Montreal and rural areas, by department of education and Canadian Legion educational services.

Forests.—Quebec forests are the most important asset of the pravince. By a 1939 calculation the net value of Quebec forest products was $101,755,803 out of a Canadian total of $271,723,416.

The total forest area covers about 262.300 sq.mi. of which 153,231 sq.mi. are still in the hands of the crown. Of the balance, 75,369 sq.mi. are leased and 26,580 sq.mi. are privately owned. Varieties are spruce, balsam fir, white pine, red pine, jack pine, hemlock, cedar (white and red), tamarack, birch, maple, basswood, elm, ash, white birch, aspen, poplar, oak (white, red, burr), butternut, cherry, beech, walnut, hickory. Control is by the department of lands and forests.

Mineral Production.— Mineral production is characterized by very rapid recent growth owing to the rediscovery of copper (known to the Indians and described by them to Jacques Cartier in 1535) in Abitibi and the finding of gold in the same district. The region as known stretches about 120 mi. east from the Ontario border about the northern line of the Canadian National railway and varies from 10 to 40 mi. in width. A considerable group of modern cities and towns (Rouyn, Noranda, Amos, Val d'Or, Duparquet, LaSarre, etc.) has developed in consequence. As a world producer Quebec takes first place in one article only, asbestos of the serpentine type which exists throughout the Appalachian region. The main production is concentrated southeast of Montreal (Thetford, Black Lake, Asbestos). In 1940 the production was 346,805 tons valued at $15,619,815, about 60% of the world total, mainly shipped to the United States as raw material. In value gold was in 1940 of first importance accounting for $39,122,257 out of a total mineral production of $86,418,934.

Power and Manufactures.— The development of manufactures has marched with that of hydro-electric power, now probably the most extensive per capita of population, having increased from 2,165,445 h.p. on Jan. 1, 1928, to 4,837,343 h.p. on Jan. 1, 1943. The Shipshaw plant near Arvida on the Saguenay is designed to add 1,000,000 h.p. in 1943. Partly because of this power supply, and partly because of favourable labour conditions, manufacturing returns grew from $158,287,994 in 1901 to $1,045,757,585 in 1939 when the main products and receipts were pulp and paper $103,564,981, nonferrous metals $86,005,322, cottons $49,176,421 (70% of Canadian total), tobacco, etc. $39,986,847 (85% of Canadian total), factory clothing $79,366,964, meat packing $36,007,706, petroleum products $33,329,907.

Transportation and Communication.— The St. Lawrence waterway forms a section of the shortest route between Europe and the central United States, furnishing deep water communication to Quebec's main ports, Montreal, Sorel, Three Rivers, Quebec and (via the Saguenay) Port Alfred. Montreal is one of the most important rail-water-air connecting points in North America and Quebec manufactures are largely based on transportation facilities. The development of aviation should not change the situation since Quebec is at the centre of a web of potential great-circle flying trade routes to areas of economic importance (*e.g.,* North and Central Africa). Air: Canadian Pacific Air lines provide local facilities along the north shore of the St. Lawrence (Montreal to Bagotville and Lake St. John points and to Blanc Sablon, north from Lake St. John and north from Seneterre) total about 1,500 mi. Other lines. Trans Canada Air lines, Montreal to Maritime provinces, Newfoundland, Ontario and west; Canadian Colonial airlines to New York; North Eastern Air lines to Boston. Montreal airport, headquarters of R.A.F. ferry command became of vital war importance in 1941. Rail: Canadian Pacific 1,629.6 mi. (total rail, Canada and U.S., 21,005 mi., total air and water under normal conditions about 180,000 mi.); Canadian National 2,901.3 mi. (total Canada and U.S. 23,556 mi.); Alma and Jonquieres 10.6 mi.; Canada and Gulf Terminal (east from Mont Joli) 38.1 mi.; Napierville Junction (connection to U.S.) 27.1 mi.; Nipissing Central (west from Rouyn-Noranda) 26.7 mi.; Quebec Railway Light and Power (east from Quebec) 25.4 mi.; Roberval & Saguenay 29.0 mi.; St. Lawrence and Adirondack (New York Central) 46.5 mi.; Temiscouata (south from Rivière du Loup) 69.4 mi. Water: Seagoing lines: (1939) Canadian Import, Canadian National, Canadian Pacific, County lines (German lines), Elder Dempster, Furness Withy, Hudson's Bay, Imperial Oil, American Pioneer, Constantine, Norwegian-American, Ellerman, Head, Scandinavian-American. Inland lines: Canada steamships, Clarke steamships, Paterson lines, and many small vessels. Roads: 1st class, 6,645 mi. built and maintained by the provincial government (department of roads), 2nd class, 11,098 mi.; 3rd class, 20,843 mi. built and maintained by the provincial and local authorities. After many years of experiment, difficulties caused by weather extremes have been largely overcome. The Quebec countryside has retained a picturesque and old-world aspect and this with its remarkable scenery makes the province a tourist centre.

Communications. Canadian Pacific, Canadian Northern and Canadian government telegraphs (latter designed for navigation messages in lower St. Lawrence), Bell telephone west of Quebec and a number of small connecting telephone companies. Through service is very good but local connections east of Matane are somewhat irregular. Marconi transatlantic beam terminals are at Yamachiche and Drummondville. Private short wave sets are under normal conditions used for messages to mines and other outlying points. Air mail is carried by Canadian Pacific Air lines to the north shore of the St. Lawrence below Quebec.

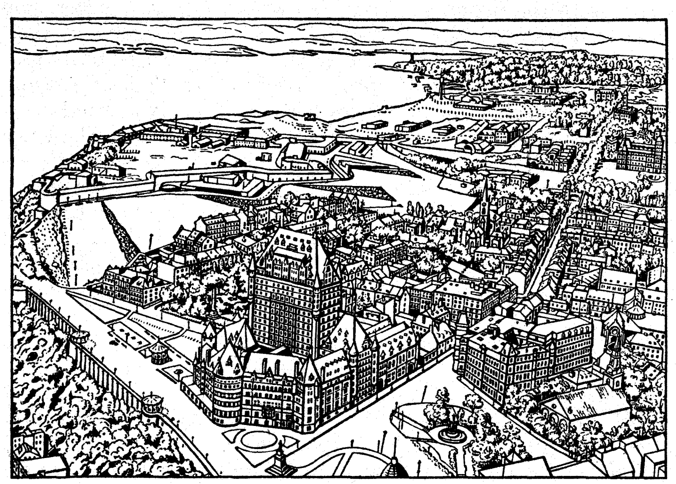
BIBLIOGRAPHY.—Canadian Census (decennial); *Canada Year Book;* Provincial Annual Reports of Departments. General works: J. C. Sutherland, *The Province* of *Quebec* (1922); Wilfrid Bovey, *The French Canadians Today* (1938). (W. BY.)

QUEBEC, the capital of the Canadian province of the same name, situated on the north bank of the river St. Lawrence, at its junction with the St. Charles, about 300 mi. from the gulf of St. Lawrence and 180 mi. by river northeast of Montreal, in 71° 12′ 19.5″ W. and 46° 48′ 17.3″ N. The origin of the name Quebec has been much disputed, but it is apparently the Algonkin word for a strait, or sudden narrowing, the river at its junction with the St. Charles being about 2,500 yards wide, but narrowing opposite Cape Diamond to 1,314 yards. Pop. (1941) 150,757.

Quebec is built on the northern extremity of an elevated tableland which forms the left bank of the St. Lawrence for a distance of 8 mi. The highest part of the headland is Cape Diamond, 333 ft. above the level of the water, and crowned by the citadel; towards the St. Lawrence it presents a bold and precipitous front, while on the landward side and towards the St. Charles the declivity is more gradual.

The harbour of Quebec is spacious and deep enough for the largest ships, the new wharves near Wolfe's cove add much to the present accommodation afforded by the Louise basin; the harbour is closed by ice only three or four months in the year. Quebec has the largest dry dock in the world.

Quebec consists of an upper and a lower town, the two connected by steep, winding streets and by an elevator. Much of the lower town still recalls the older portions of such French provincial towns as Rouen or St. Malo; the streets, with one or two exceptions, are narrow and irregular, but it remains the principal business quarter of the city. In the upper town, where the streets are wider and well paved, are the better-class dwelling houses and public buildings, most of the churches, public parks and many retail shops. Beyond the citadel are the historic Plains of Abraham, now become the National Battlefields Park, where the British army in Canada in 1849 marked the spot where Wolfe fell by a simple, high column. In the Governor's Garden is the famous monument dedicated to the two generals who fell in the battle, Wolfe and Montcalm. A point of much interest in the upper town is Dufferin Terrace, a magnificent promenade overlooking the St. Lawrence, 1,400 ft. long and 200 ft. above the level of the river.



BY COURTESY OF THE CANADIAN PACIFIC RAILWAY

QUEBEC. SHOWING A VIEW OF THE UPPER TOWN

The old town, which resembles a French provincial town, lies below. The citadel, 333 ft. above the river, is seen to the left on the river front. In the foreground is the modern Dufferin Terrace with the Hotel Frontenac built in the style of a French Chateau

Part of this terrace occupies the site of the old Château St. Louis, which was destroyed by fire in 1834. Near by, and in full view of the river, is the Château Frontenac, erected by the Canadian Pacific railway on the model of an old French chateau. Nothing remains of the fortifications erected under the French régime. The present walls and the citadel, which covers an area of about 40 acres, were built in 1823–32. Since then several of the gates have been destroyed, and others rebuilt, but in other respects the walls are practically intact, and, though obsolete as fortifications, add greatly to the picturesqueness of the city. Between 186j and 1871 three forts were built on the Lévis side of the river, but were neither manned nor armed. Quebec's natural position still makes it one of great military strength, though depending on naval control of the sea and of the gulf of St. Lawrence.

Churches and Institutions. — Although almost nine-tenths of the population are Roman Catholics, there are several Protestant churches, among them the Anglican Cathedral, built in 1804. Of the numerous Roman Catholic churches the most noteworthy is the Cathedral, the Basilica, founded in 1647 and enlarged at various times, containing some valuable paintings and relics. Fire destroyed this in 1922, but it has since been rebuilt on the original model. Perhaps the most interesting, historically, is a church in the lower town, the Notre Dame des Victoires, erected in 1688, and named in honour of the defeat of Phips in 1690 and the shipwreck of Sir Hovenden Walker in 1711. Laval university, which receives its name from the first bishop of Quebec, who founded in 1663 a seminary for the training of priests, is under Roman Catholic control. It was instituted in 1852 by royal charter from Queen Victoria, and in 1876 received a charter from Pope Pius IX. It includes faculties of theology, law, medicine and arts, a library of over 130,000 volumes, a museum and a picture gallery. The Ursuline Convent, founded in 1641, possesses some good paintings and a number of relics, among them the skull of Montcalm. High schools and numerous academies are supported by Protestants under the dual system of education in the province. The Literary and Historical Society, founded by Lord Dalhousie in 1824, is the oldest chartered institution of the kind in Canada. The principal benevolent institutions are the Marine Hospital, the Hôtel Dieu, founded in 1639 by the Duchess of Aiguillon, and the asylum at Beauport controlled by the Grey Nuns. The provincial parliament buildings erected in 1878–1892, are set in extensive grounds and finely ornamented with statues. The seat of the lieutenant-governor is at Spencerwood, outside the city.

Commerce, Industries, etc.—Quebec owes its electric light, electric tramcars, and industrial plants to a plentiful supply of power from Montmorency Falls (268 ft. in height) and Shawinigan Falls. The climate is severe, but bracing, the mean temperature in winter being 10° and in summer 68°. The city returns three members to the Provincial House of Assembly and four to the House of Commons. Economically, Quebec was long the chief port of Canada; then followed years of reverses when Montreal became the shipping port. Recently increased railway facilities at Quebec, greater difficulty for larger ships reaching Montreal, the development of vast water powers near Quebec, all contribute to an improved commercial and industrial position for that city. The Quebec bridge, connecting the north and south shores of the St. Lawrence river at Cap Rouge, 9 m. from the city, was completed in 1917, aften ten years of work and two serious accidents to the structure. The completion of the bridge made possible the running of six railways simultaneously into Quebec from the south shore. The Canadian National Railway now has a line running into Quebec from Prince Rupert, thus affording a much shorter route from west to east; the Canadian Pacific also gives ample connection with other parts of the country. The industries of the city are largely determined by the two great natural resources of the province, forests and water power. The Anglo-Canadian Pulp and Paper Company recently opened what is claimed to be the most modern pulp and paper mills in the world; the power is from the Shawinigan Falls and the capacity will be 3,000 tons a week. Manufactures include machinery, cutlery, gunpowder, musical instruments, ropes, steel, boots and shoes.

In May, 1927, the first annual Canadian Folk Song and Handicraft festival was held at the Château Frontenac under the auspices of the National Museum of Canada, for the purpose of developing and preserving an appreciation of the old folk-music and arts and crafts of Canada.

History. — The first known white man to visit Quebec was Jacques Cartier, the French navigator, in 1535, who found on the site a large Indian village, called Stadacona. In July, 1608, the present city was founded, and named by Champlain. Its growth was slow, and in 1629 it had but two permanently settled families, with a shifting population of monks, officials and fur traders. In that year it was captured by the English under Sir David Kirke (1597–1656; *see* H. Kirke, *The First English Conquest* of Canada, 1871, reprinted 1908), but in 1632 it was restored to the French by the Treaty of St. Germain-en-Laye. In 1663 the colony of New France was created a royal province, and Quebec became the capital. In 1690 Sir William Phips, governor of Massachusetts, attempted to reconquer it with a fleet and army fitted out by New England, but was defeated by the French governor, Frontenac. In 1711 a great British expedition sent against it under Sir Hovenden Walker was shipwrecked in the gulf of St. Lawrence. and the French held possession till 1759 (*see* below), when it was captured by the British troops on the 18th of September, five days after the battle of the Plains of Abraham; it was finally ceded to Great Britain by the treaty of Paris in 1763. In 1775 the American generals Montgomery and Benedict Arnold attacked the city, but Montgomery was killed (Dec. 31, 1775) and Arnold was compelled to retreat in the following spring. From 1763 till 1791 Quebec was the capital of the province of Quebec, as then existing; from 1791 till 1841 the capital of Lower Canada; from 1851–55 and from 1859–65 the capital of the United Province of Canada, and since 1867 the capital of the province of Quebec as part of the Dominion. (A. P. Co.; W. S. Wa.)

Wolfe's Quebec Expedition, 1759.—Both in itself and also as the central incident of the British conquest of Canada, the taking of Quebec is one of the epics of modern military history. The American campaigns of the Seven Years' War, hitherto somewhat spasmodic, were, after Amherst's capture of Louisburg in 1758, co-ordinated and directed to a common end by that general, under whom James Wolfe, a young major-general of thirty-three years of age, was to command an expedition against Quebec from the lower St. Lawrence, while Amherst himself led a force from

New England by Lake Champlain on Montreal. Wolfe's column consisted of about 8,000 troops, and was convoyed by a powerful fleet under Admiral Saunders.

The voyage to Quebec was not the least hazardous phase of the expedition, for the currents and shoals of the St. Lawrence were notorious, and its achievement—due largely to the skill of Captain Cook, later famous as the discoverer—astonished the French. Vaudreuil, the governor, wrote: "The enemy have passed sixty ships of war where we dare not risk a vessel of a hundred tons by night and day." Wolfe disembarked on the Isle of Orleans, four miles below Quebec, on June 27. The defenders were commanded by Montcalm, a soldier whose character and abilities, like Wolfe's, need no comment here. The French were superior in numbers, but a considerable part of their force was irregular, and *morale* and discipline were indifferent. On the other hand their position was of great natural strength. Wolfe began the attack by seizing Point Lévis, and thence bombarding Quebec across the St. Lawrence. This, however, affected the main defences of the upper city but little, and they were protected from closer attack by the St. Lawrence and the St. Charles. The third side of the triangle was the "plains of Abraham," to which it was thought there was no approach from the river.

Trusting in this obstacle and in the guns of the city to control the narrow passage which led to the upper reaches of the river, Montcalm entrenched his army on the north shore just below Quebec, between the St. Charles and the Montmorency. Wolfe tried various baits to entice his opponent out of his fastness, but after wasting some weeks, he decided to cross the St. Lawrence 7 m. below Quebec and to fight his way to the city by the St. Charles side. But Montcalm's fortified posts spread out from Quebec through Beauport as far as the Montmorency, and this formidable obstacle checked the English advance at the outset. A mile to the west of Montmorency, there was a narrow strip of land between the river and the heights where the French had built redoubts. Wolfe now planned to land here with all the available grenadiers and part of a brigade hoping, by the capture of a detached redoubt, to tempt the French army down to regain it, and so bring on a battle in the open. Meanwhile two other brigades were to be ready to ford the lower reaches of the Montmorency and join him.

On July 31, the attempt was made, covered by the guns of several ships and by the batteries across the Montmorency gorge. But when the troops got ashore, the grenadiers rushed impetuously on the enemy's entrenchments without waiting for the main body to form up. As a storm of fire broke in their faces, a storm of rain broke on their heads, and the steep slopes, slippery with blood and rain, became unclimbable, as the muskets became unfireable. Realising that his plans had gone awry, Wolfe broke off the fight and re-embarked the troops. It was a severe set-back, and the French were proportionately elated. The Governor wrote, "I have no more anxiety about Quebec." Wolfe's fragile health gave way under the disappointment, and despondency set in in the English camp. But as soon as the young leader had recovered a little, he summoned his brigadiers and worked out a plan for attacking by the upper waters and the heights of Abraham. Access to the heights could be obtained, it was found, by a tiny cove (the Anse du Foulon, now called Wolfe's cove), from which a steep footpath led to the summit. It was no place for artillery, and even for infantry the climb was long and exhausting, but the attempt was made. If it seemed desperate, the annals of military history show that even the most hazardous indirect approaches have often succeeded where the easy direct approach has failed—because the former does not follow the line of natural expectation. Here, one favourable factor was that for some weeks British frigates and smaller vessels had been slipping past the guns of Quebec, as part of a scheme to cut off the French supplies from upstream. On September 3 Wolfe evacuated the Montmorency camp, and on the 5th, after concentrating his forces on the south shore, marched the bulk, some 3,600, overland up the river bank, and embarked them in the ships.

Each day the ships drifted up and down with the tide, perplexing the French command and wearing out their troops with ceaseless marching and counter-marching. At last, just before sunset on Sept. 12, Admiral Saunders with the main fleet drew out along the shore opposite Montcalm's camp below Quebec, and, lowering their boats to suggest a landing, opened a violent fire. This ruse admirably fulfilled its purpose of fixing the enemy, for Montcalm concentrated his troops and kept them under arms during the night—miles away from the real danger point. And while they were straining their eyes to detect the threatened landing, a lantern rose to the maintop of the *Sutherland,* miles up river, and 1,600 troops of the first division noiselessly embarked in their flat-boats. At 2 A.M. as the tide began to ebb, two lanterns rose and flickered, and the whole flotilla dropped silently down-stream, the troops in boats leading. Discovery was narrowly averted when a French-speaking officer twice replied to a sentry's challenge from the shore, his deception helped by the fact, of which deserters had told Wolfe, that the enemy were expecting a convoy.

The landing was safely made at the Foulon cove: a band of picked volunteers swarmed up the steep face of the cliff, and overpowering the French picket on the summit, covered the landing of the main body. Before dawn the army, reinforced by another 1,200 troops under Colonel Burton direct from the south bank, was moving towards Quebec. Wolfe had found, on the heights of Abraham, the open battlefield for which he had thirsted. Should he be beaten he was certainly in a desperate position, but he had sure ground for confidence in the quality of his own men to offset the French quantity in open battle.

Wolfe disposed his force in a single line—to gain the utmost fire effect, wherein lay his strength,—with his left thrown back to guard the inland flank, and one regiment—Webb's (the 48th)—in reserve. Montcalm, warned too late, hurried his troops westwards across the St. Charles and through the city. Wolfe's bait this time had succeeded, even beyond expectation, and Montcalm attacked before his whole force was ready, probably because part was pinned by fear of the threatened landing below Quebec.

The clash was preceded by an attempt of the Canadian irregulars and Indians to work round Wolfe's left, but if their fire was galling, their effort was too uncontrolled to be effective. About 10 A.M. the French main body advanced, but their ragged fire drew no reply from the British line, obedient to Wolfe's instructions that "a cool well-levelled fire is much more destructive and formidable than the quickest fire in confusion." He himself was shot through the wrist, but, wrapping a handkerchief round it, continued his calls to the men to hold their fire. At last, when the French were barely forty yards distant, the word was given, and the British line delivered a shattering volley, repeated it, and then, on Wolfe's signal, charged a foe already disintegrating. At the head of his picked grenadiers Wolfe was an inevitable target. A bullet penetrated his groin, a second his lungs, and he fell, unobserved by the charging ranks. A few minutes later he was dead. His dying words, when told that the enemy were on the run—"Now God be praised, I die happy,"—are historic. But the words preceding these are a finer tribute to him as a general—even on the point of death: "Go, one of you, with all speed to Colonel Burton and tell him to march Webb's regiment down to the St. Charles River, and cut off the retreat of the fugitives to the bridge."

In the city all was confusion, for Montcalm had been gravely wounded in the rout, and that night the wreckage of the French army streamed away up the river in flight. With the death of Montcalm and Townshend's energetic pressing of the siege, Quebec surrendered four days later. (B. H. L. H.; X.)

Bibliography.—Sir G. Parker and C. G. Bryan, Old *Quebec* (1903); B. Sulte, *Hist. of Quebec* (Montreal, 1908); *The King's Book of Quebec* (2 vols., Ottawa, 1911); J. C. Sutherland, *The Province of Quebec* (Montreal, 1922); M. J. Pelton, *Natural Resources of Quebec* (Ottawa, 1923); Willa Cather, *Shadows on the Rock* (1931).

QUEBEC ACT, the title usually given to a bill which received the royal assent on June 22, 1774. This act extended the boundaries of Quebec to include much of the country between the Ohio and the Mississippi. The French inhabitants of the province were granted the liberty to profess "the religion of the Church of Rome"; the French civil law was established, though in criminal law the English code was introduced. Government was vested in a governor and council, a representative assembly not being granted till the Constitutional Act of 1791.

The granting of part of the western territory to Quebec, and the recognition of the Roman Catholic religion, greatly angered the American colonies. On the other hand, it did much to keep the French Canadians from joining the Americans in the coming struggle. The act is still regarded by the French in Canada as their great charter of liberty.

QUEDLINBURG, a town in the Prussian province of Saxony, Germany, on the Bode, near the northwest base of the Harz mountains, 12 mi. S.E. by rail from Halberstadt. Pop. (1939) 30,235. Quedlinburg was a fortress of Henry the Fowler about 922, its early name being Quitlingen. It joined the Hanseatic League. The abbey of Quedlinburg was founded by Otto the Great and it owned, at one time, a territory about 40 sq.m. in area. The abbesses ranked among the princes of the empire, and had no ecclesiastical superior except the pope. The town at first strove to maintain its independence of them, and to this end invoked the aid of the bishop of Halberstadt. In 1477, however, the abbess Hedwig compelled the bishop to withdraw, and for the next 200 years both town and abbey were under the protection of the elector of Saxony. In 1539 the townsmen accepted the reformed doctrines and the abbey was converted into a Protestant sisterhood. In 1697 the elector of Saxony sold his rights over Quedlinburg to the elector of Brandenburg. The abbesses, however, retained certain rights of jurisdiction, and disputes between them and the Prussian Government were frequent until the secularization of the abbey in 1803.

QUEEN, the title of the consort or wife of a king ("queen consort"), or of a woman who is herself the sovereign ruler of a State ("queen regnant"); the widow of a former reigning sovereign is a "queen dowager," and, when the mother of the reigning sovereign, a "queen mother." For the position of the queen in English constitutional law see CONSORT, and for her household see HOUSEHOLD, ROYAL.

QUEEN ANNE'S BOUNTY, the name applied to a perpetual fund of first-fruits and tenths granted by a charter of Queen Anne, and confirmed by statute in 1703, for the augmentation of the livings of the poorer Anglican clergy. First-fruits (annates) and tenths (decimae) formed originally part of the revenue paid by the clergy to the papal exchequer. The former consist of the first whole year's profit of all spiritual preferments, the latter of one-tenth of their annual profits after the first year, but the First Fruits and Tenths Measure 1926 has made provision for the extinction of *annates* and decimae in most cases and for their redemption in the remaining cases. In accordance with the provisions of two Acts (5 and 6 Anne, c. 24, and 6 Anne, c. 27) about 3,900 poor livings under the annual value of £50 were discharged from first-fruits and tenths. Since that date there has been a large mass of legislation dealing with Queen Anne's Bounty, the effect of which will be found set forth in a Report of a Joint Select Committee on the Queen Anne's Bounty Board (1900). (See TITHES.)

QUEEN ANNE'S LACE: see WILD CARROT.

QUEENBOROUGH, a municipal borough in the Faversham parliamentary division of Kent, England, in the Isle of Sheppey, close to the junction of the Swale and Medway, 2 mi. S. of Sheerness on the S.R. Pop. (1938) 2,919. Area, 2.2 sq.mi. A fortress, called Sheppey castle, existed from an early period guarding the passage of the Swale river. Queenborough castle was built about 1361 by Edward III, who named the town after Queen Philippa and made it a free borough, with a governing body of a mayor and two bailiffs. The town has regained its prosperity by the establishment by the railway company of a branch line from Sittingbourne in connection with a service of mail and passenger steamers to Flushing (Holland).

QUEEN CHARLOTTE ISLANDS, a compact group lying off the northern part of the coast of British Columbia, and forming part of that province of Canada. Pop. (1941 census) 2,335; area 3,780 sq.mi. It was named by Captain Dixon, who visited the islands in the "Queen Charlotte" in 1787. Although the islands promise to became important because of their excellent harbours, the discovery of good seams of bituminous coal (beside the anthracite already known), their abundant timber of certain kinds and their prolific fisheries, comparatively little settlement has taken place. The fisheries (largely halibut and herring) of Hecate strait, which separates these islands from the mainland and its adjacent islands, are wonderfully productive. There are also two whaling stations on the islands. Steamers run fortnightly from Prince Rupert to Queen Charlotte city. The natives, the Haida people, constitute one of the finest and most artistic races of the west coast of North America.

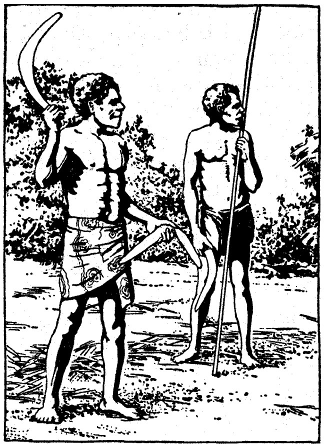
QUEENSBERRY, EARLS, MARQUESSES AND DUKES OF. The Queensberry title, one of the many with which the Scottish house of Douglas (*q.v.*) is associated, originated in the creation of SIR WILLIAM DOUGLAS (d. 1640) as earl of Queensberry in 1633. He was the eldest son of Sir James Douglas of Drumlanrig (d. 1616). His grandson WILLIAM the 3rd earl (1637–1695), was created marquess of Queensberry in 1682 and duke of Queensberry in 1684; he held many high offices in Scotland under James II. His son JAMES DOUGLAS, the 2nd duke (1662–1711), was the royal commissioner to the famous Scottish parliament which met in 1700, and just after the accession of Anne in 1702 he was made one of the secretaries of state for Scotland. In the latter part of 1703 he came under a temporary cloud through his connection with the Jacobite intriguer, Simon Fraser, Lord Lovat. Queensberry was deprived of his offices, but in 1706 he was again commissioner to the Scottish parliament; in this capacity he showed great ability in carrying through the treaty for the union of the two crowns. In 1708 he was created duke of Dover and marquess of Beverley. In 1709 he was appointed third secretary of state.

CHARLES DOUGLAS, the 3rd duke (1698–1778), who had been created earl of Solway in 1706, was lord justice general from 1763 until his death in October 1778. In 1720 he married Catherine, daughter of Henry Hyde, 4th earl of Clarendon; this lady, a famous beauty, although very eccentric, was the friend of many of the wits and writers of her day, notably of Gay, Swift and Walpole. Their two sons predeceased the duke, and when he died his British titles, including the dukedom of Dover, became extinct, but the Scottish titles passed to his cousin, WILLIAM, 3rd earl of March (1724–1810).

This William Douglas, who now became the 4th duke of Queensberry, is best known by his sobriquet of "Old Q." On the turf he was one of the most prominent figures of his time, and his escapades and extravagances were notorious. From 1766 to 1776 he was vice-admiral of Scotland, and in 1760 he was made a lord of the bedchamber by George III.; but later he was an associate of the prince of Wales, being removed from his office in the royal household in 1789. He died unmarried, and the dukedom of Queensberry and some of his other titles, together with his fine seat Drumlanrig Castle, now passed to HENRY SCOTT, 3rd duke of Buccleuch, in whose family they still remain; but the marquessate of Queensberry descended to SIR CHARLES DOUGLAS (1777–1837), the representative of another branch of the Douglas family, who became the 5th marquess. In his family the marquessate remained.

QUEENSLAND, a state of the Commonwealth of Australia, occupying 670,500 sq. miles (22·54%) in the north-east of the continent. A coast-line of 3,000 miles—after that of Western Australia the longest of any individual State—bounds it on the north from the Gulf of Carpentaria and on the north-east and east from the Coral Sea and the Pacific Ocean, Cape York Peninsula being the only outstanding feature of the horizontal profile. In the west the boundary runs successively with that of North Australia and Central Australia along long. 138° E., with that of South Australia along lat. 26° S. and long. 141° E. to the north-west comer of New South Wales. On the south the boundary marches with that of New South Wales along lat. 29° S., by the Upper Darling (Barwon-Macintyre-Dumaresq) rivers and the Macpherson Range to Point Danger. The waters and islands to the north of Cape York nearly to the coast of New Guinea, as well as the Great Barrier Reef, are included within the political boundaries. The maximum length (north–south) is c. 1,300 miles; the maximum breadth (east–west) c. 900 miles.

Physiography.—Physiographically the area falls into two main divisions, the eastern highlands and plateaux and the western plains and lowlands, each of these again containing two main elements. Lowlands occupy the north-west and south-west corner of the State, viz., a broad fringe round the Gulf of Carpentaria (*q.v.*) and irregular semicircles in the south-west and south, portions of the Lake Eyre and Upper Darling basins respectively. Mostly under 500 ft. above sea-level they are relieved here and there by low swellings (Grey, Beal, McGregor "ranges") and rise gradually eastwards as gently undulating country to levels of about 1,000 ft. They consist superficially mainly of younger (Cretaceous–Tertiary) rocks covered in the lower parts by spreads of (flood) alluvium and the Great Artesian Basin (max. bore-depth 7,000 ft.) underlies practically the whole, and also extends beyond them (*v. inf.*). Between the Gulf and the interior plains a broad swell or saddle (500–1,000 ft.) of older (Palaeozoic) rocks — the Selwyn and Kynuna highlands — connects the eastern highlands with the Barkly Tableland (North Australia) and the great tableland of Western Australia and brings valuable mineral deposits near to the surface. Eastwards the lowlands merge gradually into highlands which occupy the eastern two-thirds of the State. They consist of: (a) A broad belt of uplands and plateaux (upwards of 1,000 ft.) due partly to up-warping of the crust or, where they are higher, usually to great basalt flows. Cape York Peninsula is flanked along the east by a low sandstone-capped ridge which mounts southwards. From its south-eastern corner the main belt begins and runs southwards to about Charleville, Roma, and the south-eastern corner of the State. (Cf. the basalt Darling Downs.) OP the few parts which rise above 2,000 ft. (*e.g.,* Clarke Range; Buckland Tableland) the most noteworthy is the Atherton Plateau in the north-east, where an area of c. 15,000 sq. miles all over 2,000 ft. rises eastwards to over 4,000 ft. (Mount Bartle Frere, 5,438 ft.) and falls abruptly upon the coast. This belt now forms the main watershed. (b) Along the coast runs a line of granite masses — and in the south-east a series of volcanic (Tertiary) cones (Peak Range and Glasshouse Mountains) — which are the relics of a former range and earlier watershed now largely broken down and submerged. For the remarkable eastern and north-eastern coast of Queensland, with its islands, rock promontories, north-south inlets, sunken plains, and the beauty, amounting sometimes to grandeur, of its mountain-buttressed sounds, is due to a series of vertical movements, in which subsidence has on the whole predominated, and which have cut transversely across the former relief. Thus the Great Barrier Reef (*q.v.*) has probably been built upon the submerged edges of the former land-mass, while the flat shorelines and low shelving plains of the Gulf of Carpentaria (*q.v.*) are apparently due to elevation. In this surface, not itself naturally rugged except along the east, the coastward-draining streams are excavating considerable basins, eroding out gorges, sharpening residual highland strips into "ranges" and introducing a scenery of wild and broken upper scarplands, roomier and richer lower valleys and, often, silt-choked deltaic plains. The natural drainage of Queensland, which includes many fine streams, is of four main types: the Gulf, the eastern coast, the Darling (Barwon), and the Lake Eyre (Eyre, Cooper's, etc., Creeks, Diamantina, and others). The subject has been referred to under AUSTRALIA: Drainage, and, broadly speaking, only the streams of the two first types-are perennial and of much economic value. On the other hand, practically the whole of the interior south-west of a line from Normanton (Gulf of Carpentaria) to Warwick (except a semicircle westwards from Cloncurry) — in all 376,000 sq. miles or 56% of the State — is underlain by the water-bearing beds of the Great Artesian basin, of which some 50,000 sq. miles of "intake" beds are exposed along the eastern highlands and are thought to receive seepage and soakage from that source. Water is struck at depths varying from 10 ft.–7,000 ft. and the 1,362 flowing wells (1926) yielded nearly 292 mill. gal. a day, besides which some 1,800 other wells yielded "sub-artesian" or pumped supplies. In the nine years 1914–23 the yield of the Queensland wells diminished by 4.6% per ann. or, averaging the yield with the number of bores, 6% per ann.



BY COURTESY OF YORK & SONS, LONDON
QUEENSLAND ABORIGINES. THROWING BOOMERANGS

Climate. — With 359,000 sq. miles (·535) of her territory north of the tropic of Capricorn, Queensland has a warm to hot climate — a mean ann. temp. of over 70° F everywhere in the south-east. Temperatures naturally increase northwards and north-westwards, while the range of temperature increases inland. Thus, in the south, the coastal parts have av. ann. temps. of 85°–45° F, the interior 93°–41° F, northern coastal 88°–58°, northern interior 96°–51° F. Frosts, though not universally common, are liable to occur during 5–7 months or more in the south-east and during decreasing periods further west and north-west. The rainfall, which tends to show a summer max. increasingly towards the north and the interior, varies between wide limits both in average and in annual amounts. Most of it comes from the ocean lying to the east and north-east and the seaward parts of the Atherton Plateau are the wettest in Australia, having an average fall of 144–165 in. with not uncommon falls of 200 in. and over, and at various other parts along the east and north-east (Cape York Peninsula; Mackay, and in the extreme south-east) averages of 60–70 in. are found. The whole of Cape York Peninsula and most of the eastern highland fringes and river-basins average 30 in., but inland the amounts rapidly fall off to less than 10 in. in the south-west (Birdsville: 6.4 in.). The fall is also mostly unreliable, very heavy falls alternating with relative scarcity. Thus over the inland and Gulf portions of the State (534,680 sq. miles), while the mean ann. fall is 19·9 in., the actual yearly average: varied (1888–1913: 26 yr.) from 9 in. to 33.3 in., and even the coastal areas (135,820 sq. miles), with a mean ann. fall of 52·3 in. ranged during the same period from 26.85 to 73.4 in. (Cf. Harvey Creek: 254.8 in.–So. j in.) The effect of these conditions upon river flow, vegetation, and economic conditions in general is such that special precautions and provisions are necessary to secure stability. Along the lowlands of the coast the heat is humid and, to those unaccustomed to it, uncomfortable. The interior, though often hot and trying — Boulia has had as many as 76 consecutive days with shade temperatures over 100° F — is not unhealthy. From Dec.–April (mainly) the coastal parts are liable to hurricanes — an average of one or two a year. They come mainly from the east, but sometimes from inland, and may work considerable destruction. (For further climatic details *see* BRISBANE, ROCKHAMPTON, TOWNSVILLE, CARPENTARIA, GULF OF. For vegetation and fauna *see* AUSTRALIA.)

Population, Settlement **and** Development. — The population of Queensland — 947,789 in 1933 plus some 17,700 aboriginals and half-castes — represents a density of 1·41 per sq. mile, after Western Australia and the Northern Territory the lowest in the Commonwealth, and males show an excess over females of 5·57%. In the 1926 census her birth-rate (22·58 per 1,000) came third after that of Tasmania and New South Wales, her death-rate (9.39 per 1,000) is relatively low, and her rate of increase has been consistently high in recent years (1921–26: 2·81%, the highest in the Commonwealth). Settlement varies in different areas, and about two-fifths of the population is concentrated in the south-east. A large part of the remainder is contained in individual areas spaced out along the east coast up to and including the Atherton Plateau, with centres Maryborough, Rockhampton, Townsville, Cairns, etc.; settlement in the south and centre is spreading westwards along the main railway lines; nearly 23% of the State is unoccupied, and a much greater proportion has a negligible population density. Geographically the following areas may be distinguished: (i.) the great plains and downs of the central west and north-west interior with their almost exclusively pastoral occupation; (ii.) the eastern highlands, with some outliers — notably that of the Cloncurry area in the north-west — with hitherto mainly mining but also pastoral industries; (iii.) the south-east districts with an expanding and intensifying mixed agricultural and dairying régime, as well as mining and some manufactures; (iv.) the eastern coastal lowlands with prevailing sub-tropical to tropical agriculture, some dairying and timber-cutting; (v.) the coasts with their harbours, ports, trade and commerce, besides some manufacturing and fishing interests.

The pastoral industry is by no means confined to the interior plains. Some of the largest cattle-stations are in the coastal belt, and many sheep are kept as an element in the mixed-farming areas of the south-east. Queensland is pre-eminently the pastoral State, itself, in certain respects, a sign of youthful development. Droughts, though often fairly local, cause severe fluctuations: thus in 1926, 31·64% of the total number of sheep was lost, 4,500,000 head (84.4% of the total loss) through drought, the remaining losses being due to disease, dingoes and natural causes. The state of the cattle industry also gives cause for concern. (See AUSTRALIA.) Yet Queensland had (1926) 460,000 sq. miles (296,000,000 acres—68·6%) of her total area occupied for pastoral purposes (cf. 1921: 313,000,000 ac.—73·7%) and the value of her pastoral products (1926: £21,118,000) is greater than that of any other State. Artesian water (*v.* p. 842) has worked a revolution, 4,325 bores (440 Government; 3,885 private) serve an area of 8,300 sq. miles (2,300 miles of "drains") and supply c. 290,000,000 gal. a day.

Sheep, nearly all merinos, have varied in recent years between 20,000,000–16,000,000 (1926: 16,861,000), c. 20% of the Commonwealth's total, second only to New South Wales. Holdings ("runs" or "stations") are still often large: the largest was (1923) c. 5,000 sq. miles, and holdings of under 60,000 ac. are called "grazing farms" or "selections," but the tendency is towards smaller and more-intensively managed units. In 1926 there were 4,860 owners of holdings having an average flock of 3,470 head apiece.

Cattle, which average 5,500,000–7,000,000 head (1926: 5,465,000, including 611,000 dairy cattle), represent 48% of the Commonwealth's total, Queensland leading easily in this respect. Cattle (for slaughter) have a much wider range than sheep, thrive in the hot and humid north and east coastal districts, but are more dependent on ample food and water supplies—the drought of 1925–26 caused the loss of c. 1,000,000 head—and do not pay so well as sheep. There were (1926) 45,000 cattle owners with average herds of 122 each, but much larger holdings and herds exist in the eastern coastlands and in the north-west (10,000–50,000 head). (See CARPENTARIA, GULF OF.)

Of the total pastoral production (1925–26: £21,118,000) wool represented nearly £11,000,000 (c. 159,000,000 lb.; 1927: c. 115,000,000 lb.); live stock slaughtered (cattle, sheep, goats, rabbits), £10,124,500 (339,350,000 lb., of which about 210,000,000 lb.—247·25 lb. per caput—were for home consumption). (For chief towns and settlements: v. p. 844, TRANSPORT.)

(ii.) The ancient rocks of the Eastern Highlands, with the outlying area in the north-west (Cloncurry, etc.) contain the bulk of the State's mineral wealth. The gold, copper, and silver output has declined (1926). On the other hand the output of tin (1926: £174,000) was maintained, while that of coal is steadily rising (1921: £831,000; 1926: £1,100,000 nearly), and these, with lead (c. £116,000) make the bulk of the total production of minerals and quarry products (1926: £1,608,000). Tin is worked in the district behind Cooktown (north), at Stanthorpe (south-east), and at Kangaroo Hills near Townsville (1926: £31,500), but the mineral fields of the Atherton Plateau behind Cairns (*q.v.*), notably those of Herberton (120 miles), are the most productive. Coal is scattered over the eastern highland belt. The seams at present (1926) mainly worked are those of the Ipswich (650,000 tons); Bowen (175,000 tons); Wide Bay (Burrum, Maryborough, *q.v.*) (110,000 tons); Darling Downs (105,000 tons); with smaller amounts from the Blair Athol (Clermont), Rockhampton, Mount Morgan, Bundaberg and other districts. Queensland coals have a great range of variety and utility—anthracite (Dawson-Baralaba field) to bituminous (Ipswich), and the reserves are 412,000,000 tons actual, 2,201,000,000 probable. The State owns and works coal mines on the Bowen, Baralaba, Styx River and Mount Mulligan fields, besides mineral-testing batteries and drilling plants in various mining areas. An opal field of value exists at Anakie (Rockhampton–Longreach railway) east of Emerald (1926: £6,800) and other gems (sapphires, etc.) occur.

(iii.) The South-eastern portion of Queensland—*i.e.*, the area contained approximately south and east respectively of the air-lines Gympie to Roma and Roma to Warwick—being relatively cool, in parts elevated, and easily accessible from the coast, is on the whole the most progressive and rapidly developing portion of the State. Here is the Brisbane basin, a fertile lowland, drained by a network of streams (rivers: Brisbane, navigable for light craft to Ipswich, Logan, etc.), open to the sea but enclosed elsewhere by highlands (2,000–3,000 ft.), with ample rainfall (30–70 in. and upwards), coal reserves (v. sup., Ipswich field) capital city and leading port, and excellent commercial position. Along the coast are further fertile and well-watered lowlands, possessing in addition attractive scenery (Glasshouse Mountains) and seaside resorts (Southport; Coolangatta); while further inland (Dalby to Roma), are good wheat and fruit-growing soils and climate which merge into the more purely pastoral western interior. Here, therefore, is the most highly and rapidly growing population, with the bulk of the State's dairying, arable agriculture (including all the wheat-growing), and manufacturing industries, in addition to a fair proportion of the production of minerals (v. sup.) and temperate and sub-tropical climate fruits. Purely pastoral industries, along with large holdings, are yielding to closer settlement and to mixed (including wheat and sheep) farming. There were, 1926, 28,250 agricultural farms in the State, with an average of 45.6 ac. each. The total area which is cultivated in Queensland is relatively small: (1926) 1,278,000 ac. —of which 550,000 ac. was cultivated grassland—or only 0·55% of the total occupied area and 0·25% of the area of the State. Partly this is due to the fact that development is recent but partly to uncertain rainfall (v. p. 842: Climate) so that the figures of annual production show remarkable variations. In dairying Queensland ranks third after New South Wales and Victoria, with 612,000 head of dairy cattle yielding 132,000,000 gal. of milk per ann. The Brisbane Basin (Beaudesert, Ipswich, etc. areas) the Wide Bay (Gympie) district, and the Darling Downs (Toowoomba, Warwick, and other districts) lead in production and associated are butter and cheese and preserved milk manufacturing (50–60,000,000 lb.; 9–12,000,000 lb.; 6,500,000 lb. per ann. respectively), bacon-curing (16–18,000,000 lb.), besides poultry and bee-keeping. Of cultivated crops, maize is most generally suited to the climate and is widely grown (135,000–150,000 ac., 2–3,000,000 bu. per ann. competing with New South Wales for first place; av. yield 22 bu.). Dairying and maize cultivation are extending all up the east coast, but wheat is confined to the 10–15 in. winter (April–Oct.) rainfall areas of the Darling Downs and westwards as far as Roma. The amount and yield varies widely according to season (55,000–185,000 ac.; 380,000–2,000,000 bu.; 1927: 3,700,000 bu.; yield 5–18 bu. per ac.). Some wheat may in future be grown in the summer-rain areas further north (*e.g.*, Emerald district), but other cultures will probably always limit production. Fodder crops (hay, lucerne) and potatoes are of some importance, while fruits-bananas, pineapples (v. p. 844), but mainly citrus, grapes, etc. (*e.g.*, Roma)—and "northern" varieties in cooler areas (*e.g.*, Stanthorpe) are widely grown. Queensland's total agricultural production is valued at £12–13,000,000 (1926: £12,553,000), or without sugar and tropical fruits, £4,670,000. Dairy production (raw products only) is valued at £6,380,000, giving a total of £11,400,000 for the raw agricultural products and fruit of the south-east area.

The eastern coastal highlands and scarps carry considerable areas of well-grown forests; in the north more of the tropical rain-forest (brush), further south more of the temperate rain-forest. Soft and hard woods—the latter mainly eucalyptus—occur, and in the south are large areas of pure eucalypt forests (*e.g.*, Gympie-Darling Downs; Macpherson Range). Timber-felling and sawmilling are carried on right up the coast but of the 250 sawmills in the State nearly 200 are in the southern districts and they produced (1926–27) 104,000,000 cu.ft. of sawn timber and sleepers (£2,070,000), over half being pine, one-third hardwoods, the remainder including "cedar," "oak," silkwood, silky oak, etc. The total Queensland output of dressed timber (1925–26) was valued at £1,580,000, besides £860,000 firewood, etc. The State Forest Service holds in working trust 5,200,000 ac. timber reserves and dedicated forests, besides 156,200 ac. reserved as National Parks. In addition *c.* 34,000 ac. of plantations or cultivated forest areas had (1927) been created.

(iv.) The Coastal Lowlands, though they consist of a series of individual and more or less independently developed units—the main coast railway-line now complete from Brisbane to Cairns will assist in drawing them together—have many common features in virtue of their physical composition (rough highland interior., river basins, rich alluvial lowlands, coast-lines, estuarine or rock-sheltered deep-water harbours, hot humid climate). Thus their present by no means fully developed economy is capable of summary survey, and for further details reference may be made to the towns mentioned below. In many respects the Brisbane area also can not be distinguished from its northern analogues. Cattle (v. p. 843), and to an increasing extent dairying even as far north as Cooktown, are common to nearly all—the former naturally more and more restricted to wilder and rougher ground, the latter to richer workable ground within reach of factories and markets. Mining has already been dealt with, the most important area at present being that of the Atherton Plateau, based upon Cairns (*q.v.*). Timber, in some cases a by-product of settlement, is sawn in 50 mills—19,200,000 cu.ft. (£515,000), noteworthy being the 12,500,000 cu.ft. of softwoods from the northern districts, in particular the Atherton Plateau. Along the east coast very poor areas alternate with others having extremely rich soils. The agricultural products at present commonly associated with the latter areas are sugar, tropical fruits, and, more recently, cotton, though the cultivation of ground-nuts or peanuts (1926: 775 tons) and tobacco is developing and others again (*e.g.,* coffee) are physically, if not at present economically, possible. Large possibilities, for dairying no less than for agriculture, lie by way of irrigation for which climate, soils, river régimes, and commercial situations are peculiarly favourable. In 1926, *c.* 38,000 ac. were under irrigation in Queensland, the Dawson River being by far the most important area under development (see ROCKHAMPTON) ; further the Burdekin River (Inkermann area 5,000 ac., being extended to 10,000 ac.), besides numerous smaller undertakings.

Sugar is grown in rich bottom-lands with a high rainfall (40–60 in.). In 1926 *c.* 266,500 ac. were under cultivation for sugar (*i.e.,* other than fodder cane), of which 190,000 ac. were cut and yielded 2,926,000 tons of cane, valued at £6,355,000 (1927: 3,575,000 tons cane yielded 487,000 tons raw sugar). In sugar-production Queensland outdistances New South Wales (*q.v.*) the only other Australian producer, but her yields (15–20 tons cane per acre) are lower than those of New South Wales (34·2 tons). Of tropical fruits the chief are bananas (1925–26 15,000 ac.; crop valued at £750,000) and pineapples (4,000 ac.; £301,000), but mangoes and others have also some importance. "Mediterranean" fruits—oranges (1926: £116,000), peaches, apricots, etc., are extensively grown but perhaps mainly in the south-east of the State (v. p. 843). The banana industry is not free from serious insect pests the nature of which is being investigated. The sugar industry is conducted under fiscal and labour conditions which lend it a somewhat artificial appearance. (*See* AUSTRALIA.) Cotton-production, on the other hand, though physically possible over considerable areas, is less amenable to economic "hot-house" methods and the future of the industry, for which great hopes were entertained, is dubious. (1926: 18,740 ac. bearing, 9,060,000 lb. [unginned] cotton valued at £190,000; 1927: rather over 7,000,000 lb. unginned.)

(v.) To distinguish the coast of Queensland as a separate geographical entity is not so artificial when it is remembered that much of the manufacturing industry, as well as of trade and commerce is concentrated in the ports; that the last-named is conducted by means of shipping or over railway systems based upon the ports, and that these play an at present altogether major part in the general development of the State. Fisheries (see AUSTRALIA and BARRIER REEF) are mainly for pearl, turtle, trochus shell, and the total ann. value of all products (1925–26) was £420,000. There are two State fish-supply establishments (turnover 1926–27: £45,000). Manufactures are mainly those concerned immediately with the working up of raw materials—the making of butter, cheese, preserved milk, jams, etc.; bacon-curing, meat-freezing and preserving; tanning; sugar-crushing; saw-milling; smelting, etc. They are naturally located where circumstances demand, *e.g*, smelters at Cairns; sugar-crushing mills: various cane-centres, *e.g.,* Mackay; meat-works mainly near ports. Ipswich and Toowoomba, and other towns possessing coal, have developed important railway engineering or repair works, while most towns, according to their development, have a variety of minor industries. Brisbane (*q.v.*), however, is by far the greatest centre: of the total number of factories in the State (1926: 1,897) with an output (crude value added by process) of £18,135,000, Brisbane has 677 factories with output £17,225,000.

The total value of Queensland's production—primary and manufacturing—is estimated (1925–26) at £63,243,000 or £73·44 per head of population; the (corrected) index number during the decade 1916–26 having varied between 1·046 (1924–25) and 0·939 (1925–26) of the production in 1911. (*Cf.* Commonwealth as whole: 1925–26: 0·950.)

Trade was valued (1926–27) at £28,219,000 (*cf.* 1925–26: £40,158,000—variations being due mainly to bad seasons), of which exports represented £14,721,000 (£16 13s. 9d. per caput) and imports £13,498,000 (£15 6s. od.), these figures representing "overseas" trade only, though interstate trade amounts perhaps to about as much again. The chief items of export were wool (£8,500,000); sugar (£1,638,000); dairy products (£1,625,000); meat, excluding bacon (£1,460,000) ; hides, leather, tallow, rabbit-skins (£1,013,000)—total pastoral: £10,872,000; total agricultural and dairy: £3,348,000; mineral: £34,200. The chief ports, in order of importance are (1927): Brisbane (total overseas trade: £23,496,000); Townsville: £1,547,000; Cairns: £1,227,000; Rockhampton: £761,000; Gladstone: £411,000; Mackay: £330,000 (*qq.v.*).

Of interest are the State (Queensland Government) trading and other enterprises which besides mines, batteries, drilling plants (*see* p. 843, section ii.) included (1927) 5 saw-mills (net capital value: £82,000); 14 cattle stations (total stock: 212,000); 112 retail trading establishments and agencies with a turnover of £1,100,000, in addition to the State services (including railways) usual in Australian States. The State public revenue was (1927) £18 6s. 1d. per caput and expenditure from revenue £18 13s. 10d.

Transport in Queensland ranges from the camel train and bullock-waggon of the pioneer to railway and motor traction and air transport. Motor-cars are, as elsewhere on the great plains of Australia, working a revolution, but a still greater is being worked by the aeroplane. Queensland "squatters" have shown great enterprise in the use of aeroplanes, not only for personal use, but also for the conveyance of fodder to drought-stricken herds. Official air-services covered (1926–27) 164,000 miles with the loss of 4 persons killed and 1 injured. The most important line is that linking the terminals of the 3 main railway systems—Charleville, Longreach, Cloncurry, with Mount Isa, Cammooweal and, by recent arrangement, continued to North Australia (825 miles in all). In the "bush," roads are mainly dirt tracks, liable to floods and "washaways" in wet seasons. There were (1927) 5,150 miles of gazetted roads in the State and 60,877 motor vehicles. Of railways, besides 302 miles (1925–26) of private (light) lines serving cane-fields, mines, etc., there were (1926–27), 6,300 miles (3′ 6″ gauge) Government lines. The main systems are based upon the ports, viz., Brisbane: with a fairly well-developed "branch-work" of lines serving the Brisbane Basin, the Darling Downs, and longer trunk lines serving the pastoral interior, south-west to centres such as Goondiwindi and Dirranbandi (416 miles), west to Roma, Charleville (483 miles), Quilpie (608 miles) and Cunnamulla (*c.* 600 miles); Rockhampton (*q.v.*), in addition to a local "branchwork," has a main trunk system serving the pastoral centres Emerald (branch lines to Blair Athol 240 miles, Spring-sure 206 miles), Barcaldine (361 miles), Blackall and Yaraka (476 miles) and Longreach (428 miles), with extension under construction to Winton and Elderslie; Townsville, a similar trunk-line to Charters Towers (83), Hughenden (236), Winton (368), Cloncurry (481), itself a centre for a branching system serving the mining area (Dajarra, 582 miles); Cairns likewise serves as a base for the Atherton Plateau and Forsayth lines into the interior. The main coast line links Brisbane with all the coast towns as far as Cairns, and Brisbane itself is linked with Sydney via Warwick—Stanthorpe—and Tenterfield (New South Wales). The new "direct" route (standard gauge: 4′ 8½″) is under construction from Warwick to Kyogle (New South Wales). In addition various ports (Bundaberg, Cooktown, Maryborough, Normanton, etc.) have smaller sections of local lines. It is proposed to join the western termini of the great inland lines by a transverse south-east-north-west line which will probably be continued via Camooweal and the Barkly Tableland to Daly Waters (North Australia, *q.v.*) thus linking this territory as well as the northern and north-western portions of Queensland with Brisbane and Sydney (the latter via Bourke, New South Wales). The capital cost of Queensland's railway lines (including lines not yet open) was (1926–27) £60,162,380 and the deficiency upon working for the year £1,964,-365. (See AUSTRALIA: Railways.)

Queensland has a well-developed post and telegraph system and in addition sub-marine cables from Southport to Vancouver Island via Norfolk Island, Suva, Fanning Island, thence overland to Montreal, etc.; also Southport to Sydney; and, in addition to services of regular overseas steamship lines, coastal shipping services plying up the east coast to Thursday Island, the Gulf of Carpentaria and Darwin (North Australia). (O. H. T. R.)

HISTORY

Explorers.—The Portuguese may have known the northern shore nearly a century before Torres, in 1605, sailed through the strait since called after him, or before the Dutch landed in the Gulf of Carpentaria. Captain Cook passed along the eastern coast in 1770, taking possession of the country as New South Wales. Flinders visited Moreton bay in 1802. Oxley was on the Brisbane in 1823, and Allan Cunningham on Darling downs in 1827. Sir T. L. Mitchell in 1846–47 explored the Maranoa, Warrego, and Barcoo districts. Leichhardt in 1845–47 traversed the coast country, going round the gulf to Port Essington, but was lost in his third great journey. Kennedy followed down the Barcoo, but was killed by the blacks while exploring York peninsula. Gregory, between 1855 and 1858, examined the Gilbert river and made his way right to Brisbane. Burke and Wills crossed western Queensland in 1860. Landsborough, Walker, M'Kinlay, Hann, Jack, Hodgkinson and Favenc continued the researches, and squatters and miners opened new regions.

Early History.—Before its separation in 1859 the country was known as the Moreton bay district of New South Wales. A desire to form fresh penal depots led to the discovery of Brisbane tiver in Dec. 1823, and to the proclamation of a penal settlement there in Aug. 1826. The convict population was gradually withdrawn again to Sydney, and in 1842 the place was declared open to free persons only. The first land sale in Brisbane was held on Aug. 9, 1843. An attempt was made in 1846, under the colonial ministry of Gladstone, to establish at Gladstone on Port Curtis the colony of North Australia for ticket-of-leave men from Britain and Van Diemen's Land. Earl Grey, when secretary for the colonies, after strong colonial representations, arrested this policy, and broke up the convict settlement. In 1841 there were 176 males and 24 females; in 1844, 540 in all; in 1846, 1,867. In 1834 the governor and the English rulers thought it necessary to abandon Moreton bay altogether, but the order was withheld. The first stock belonged wholly to the colonial Government, but flocks and herds owned by settlers came on the Darling downs in 1841. In 1844 there were 17 squatting stations round Moreton bay and 26 in Darling downs, having 13,295 cattle and 184,651 sheep. In 1849 there were 2,812 horses, 72,096 cattle, and 1,077,983 sheep.

Some settlers who sought a separation from New South Wales offered to accept British convicts if the ministry granted independence. In answer to their memorial a shipload of ticket-of-leave men was sent in 1850. In spite of the objection of Sydney, the Moreton bay district was separated from New South Wales by an Order in Council of May 13, 1859, and proclaimed the colony of Queensland. The population was then about 20,000, and the revenue £6,475.

The Constitution, which was based upon the New South Wales Act of 1853, provided for 16 electoral districts, with a representation of 26 members. A legislative council was also formed, to which the governor of New South Wales, Sir William Denison, appointed five members, holding office for four years, and Sir George Ferguson Bowen, the first governor of the new colony, eight life members. Robert (afterwards Sir Robert) George Wyndham Herbert was the first premier, and held office until 1866. The white population at the end of 1859 was 25,788, and exports were valued at £500,000. In the next six years the population was quadrupled and trade trebled. The first Parliament opened on May 29, 1860. In the same year a board of general education was established and State aid to religion abolished.

Gold mining is the foundation upon which much of the progress of the colony has been built. The Gympie field was discovered in 1867, Charters Towers and the Palmer diggings in 1872, and the celebrated Mount Morgan mine in 1881. In 1900, dredging the northern rivers for gold became an established industry. In 1924, Queensland produced 98,841oz. of gold, more than one-seventh of the Australian total.

Political History.—A resolution in favour of payment of members was carried in 1871. In the following year, electoral representation was increased to 42 members, and the first agent-general in London, Richard Daintree, was appointed. Railway building began in 1864, and in 1872 the Railways Act Amendment Act authorized the construction of railways by private enterprise, land being offered as compensation for outlay. This act was passed during the administration of A. H. Palmer, the only premier of importance during the period 1866–79.

On Jan. 21, 1879, Mr. (afterwards Sir Thomas) McIlwraith first became premier. The opposition was led by Mr. (afterwards Sir Samuel) Griffith, and the political history of Queensland from that date to 1893 is, in effect, the political biography of these two remarkable men. In 1881 Mr. R. L. Jack, the government geologist, introduced artesian well-boring, which contributed largely to the subsequent prosperity of Queensland. In 1883 in view of Germany's activities in the Papuan gulf the police magistrate at Thursday island was instructed by Queensland to proceed to Port Moresby and take possession of the unappropriated portion of the island in the name of the Crown. The step needed no justification when it is remembered that Papua lies nearer to Queensland than Tasmania to Victoria. This act was afterwards—to the indignation of Australia—repudiated by Lord Derby; and, eventually, under the Berlin Treaty of 1886, England and Germany entered into joint possession of that part of New Guinea lying east of 141°E. In 1887 the number of seats in the assembly was increased to 72 and the department of agriculture was established.

The first sugar crop was grown by the Hon. Louis Hope at Cleveland about 1862. From that date, Kanaka labour on the sugar plantations was a burning question in Queensland politics. After the defeat of Sir Thomas McIlwraith in 1883, on the issues of coloured labour and land-grant railways, Mr. Griffith formed his first administration. The period which followed was marked by labour troubles and financial difficulties. In Dec. 1884, a royal commission reported that many islanders had been deported by "force and fraud." In view of this report, the Griffith Government passed an act prohibiting the importation of Kanakas after 1890. The impending stoppage of Kanaka labour and the low price of sugar almost ruined the planters. In 1890 a financial crisis occurred. A coalition ministry with Griffith as premier and McIlwraith as treasurer was formed, and in 1892 Sir Samuel Griffith announced his conversion to the policy of continuing Kanaka labour on the sugar plantations and also of building land-grant railways. From this year there was no further State legislation on the subject of Kanaka labour; but, in 1904, the Federal Government prohibited the importatian of Kanakas, and by 1906 had deported most of those in Australia. Since then the industry has made progress under a system of bounties and excise tariffs. Sir Samuel Griffith, who had been chief justice in Queensland since 1893, afterwards became chief justice of the Federal high court, and played an important part in bringing Queensland within the Federation.

(See AUSTRALIA.)

The history of Queensland continued to be a story of industrial disputes and financial distresses. Ultimately Queensland became a stronghold of the Labour party, which was in power from 1915–27. The legislative council and capital punishment were both abolished in 1922. Two important acts were passed in the same year, the Primary Producers Organization act, which aimed at a united national organization of agriculture, and the Primary Products Pools act, which created boards to control all markets.

In 1927 the strike of the sugar-cane workers raised an issue of importance when it spread to the railway unions, but was defeated by the firmness of the premier, Mr. McCormack.

Queensland governments have passed various land acts, now in favour of the pastoralist, now in favour of the farmer, but on the whole in favour of the latter. Experiments in such legislation were made easy by the fact that the state held unalienated no less than 643,428 sq.mi. out of the total area of 668,497 square miles.

According to the census of 1927, 69% of Queenslanders were living in the country. Only Tasmania had a larger proportion of her population on the land.

The Queensland policy, unique in Australia, of developing a railway system from several maritime centres instead of from one capital city, may have helped to bring about this satisfactory result.

But it must not be forgotten that Queensland enjoys a uniform rainfall near the coast from Cooktown southward, and that she possesses 234,000 sq.mi. of territory having a rainfall of over 20 inches. (H. D. N.)

QUEENSTOWN, Australia: see TASMANIA.

QUEENSTOWN, Eire: see COBH.

QUEENSTOWN, a town in the province of Cape of Good Hope, Union of South Africa, in the upper valley of the Great Kei river, 154 mi. N.W. of East London by rail, 31° 53' S., 26° 52' E.; altitude 3,544 feet. Population 12,868. The town is the centre of a good wheat and wool-producing area. European pop. (1936), 6,723.

QUELIMANE, QUILIMANE or KILMANE, a town of Portuguese East Africa, in 18° 1' S., 36° 59' E., 14 mi. inland from the mouth of the river Quelimane or QuaQua (Rio dos Bons Signaes).

The river during the rainy season becomes a deltaic branch of the Zambezi, with which it is connected by a channel called Mutu.

There is ample and deep anchorage, but the entrance is obstructed by a bar, over which there is 9 ft. of water at low tide, and about 26 ft. at high water springs. The town (officially São Martinho de Quelimane) is unhealthy. There are 355 Europeans and 3,403 natives and Indians.

The trade of Quelimane, formerly the only port for the produce of the Zambezi valley, declined after the establishment of Chinde (*q.v.*), but of recent years the progress of agricultural and industrial development has been remarkable (see PORTUGUESE EAST AFRICA).

The town has telegraphic communication with the province, and telephonic communication with the interior. There is a wireless station.

It is the starting point of the railway to Mocuba, and a line runs to Maquival, a large *prazo* belonging to the Zambezia company.

The imports for the town are cotton goods, foodstuffs and hardware; exports are copra, groundnuts, sugar, sisal, cotton, sesamum and beans,

The Quilimane river was entered by Vasco da Gama in 1498, who there discovered an Arab settlement. The present town was founded by the Portuguese in the 16th century, and became in the 18th and the early part of the 19th centuries one of the great slave marts.

It was the starting point of Francisco Barreto's expedition to the country of the Monomotapa in 1569, and of David Livingstone's up the Zambezi to Lake Nyasa in 1861. Until 1853 the trade of the port was forbidden to any save Portuguese.

The European population, until the last quarter of the 19th century, consisted mainly of convicts from Portugal.

See Delagoa Bay Directory (annually), and South and East Africa Yearbook Guide (annually).

QUELPART (CHAI-JU), an island to the south of Korea, used as a Korean penal settlement. It measures 40 mi. from east to west and 17 mi. from north to south. It rises gradually from the seaboard, is heavily wooded and is cleared for cultivation to a height of 2,000 ft. There are several crateriform hills, and Hali San (Mount Auckland) has an altitude of 6,558 ft. The island is entirely volcanic, and the soil is finely disintegrated lava.

The estimated population is 115,000, Korean by race, language and costume. There are about ninety villages. The valleys and slopes are carefully cultivated in fields divided by stone walls. Apart from agriculture, the industries consist in the manufacture of fine bamboo hats and mats, and wooden combs for export and local use. For fishing the islanders use double-decked raft boats. similar to those of southern Formosa. Their lucrative pearl fisheries have been practically monopolized by the Japanese, who use proper diving apparatus. A valuable product is a species of clam, the shell of which furnishes a specially iridescent mother-of-pearl, which the natives barter with the Japanese for inlaying lacquer. European goods are not imported, but Japanese articles find ready barter. There are no markets, and few shops.

Chu-sung, the capital and seat of government, a few miles from Port Pelto, has a black lava wall 25 ft. high, with three gates and towers; an imposing audience hall in Chinese style; and a great bell tower, with a fine bronze bell, sounded to drive off "evil dragons." Its population is estimated at 17,000. The governor has a hereditary antiquated army for coercive purposes.

There are no good harbours, and the only anchorage for large vessels is Tai-chung, or Yung-su, at the east end, with g to 13 fathoms of water. Pelto has ancient breakwaters for the protection of small boats, erected probably by the Mongol conqueror, Kublai Khan, who in 1273 built on Quelpart one hundred ships for the invasion of Japan.

QUENTAL, ANTHERO DE (1842–1891), Portuguese poet, was born in the Azores, and studied at the University of Coimbra. After the publication of one volume of verse, he joined the revolt of the young men which dethroned Castilho, the chief living poet of the elder generation, from his place as dictator over modern Portuguese literature. He adopted socialist opinions, worked as a compositor in Paris, though he had independent means, visited the United States, and then returned to Lisbon, where he worked actively for socialism. He found his way through a series of disappointments to the mild pessimism, a kind of Western Buddhism, which animates his later productions. His melancholy was increased by a spinal disease which. after several years of retirement, eventually drove him to suicide in his native island. Quental seldom attempted any other form of composition than the sonnet, but few poets who have chiefly devoted themselves to this form have produced so large a proportion of really exquisite work. The comparatively few pieces in which he either forgets his doubts and inward conflicts, or succeeds in giving them an objective form, are among the most beautiful in any literature.

His friend, Oliveira Martins, edited the sonnets (Oporto, 1886), supplying an introductory essay; and an interesting collection of studies on the poet by the leading Portuguese writers appeared in a volume entitled ***Anthero de Quental. In Memoriam*** (Oporto, 1896). The sonnets have been turned into most European languages; into English by Edgar Prestage (***Anthero de Quental, Sixty-four Sonnets,*** 1894), together with a striking autobiographical letter addressed by Quental to his German translator, Dr. Storck.

QUERCITRON BARK is the inner bark of Quercus *velutina,* a native of the middle and southern states of America. The exterior bark is removed from the tree by shaving, and the inner portion, which contains the colouring matter, is detached and ground. The colouring matter of quercitron bark is quercitrin, $C_{21}H_{22}O_{12},H_2O$, a glucoside which by hydrolysis with acid yields quercetin, $C_{15}H_{10}O_7$, and the sugar rhamnose, $C_6H_{12}O_5$. When quercitron bark is exhausted with hot water under pressure, the extract deposits a crude quercitrin, which is known commercially as "yellow flavine." A second variety known as "red flavine," prepared by digesting an extract of the bark at the boil with dilute acid, is in reality a crude quercetin. These products dye wool mordanted with aluminium and tin bright yellow and orange shades and were, at one time, used in admixture with cochineal for obtaining scarlets of a specially vivid character. For dyeing purposes in Great Britain quercitron bark has been supplanted by the less costly old fustic; in America, however, it replaces the latter. (A. G. P.)

QUERCY, a county in France before the Revolution. The district, which derives its name from the Gallic tribe of the Cadurci, was bordered by Limousin, Rouergue, Armagnac, Périgord and Agenais. In the middle ages it was divided into upper, or black, Quercy, and lower, or white, Quercy, the capital of the former being Cahors and of the latter Montauban. Its two other chief towns were Figeac and Moissac.

Early in the 6th century Quercy passed under the authority of the Franks, and in the 9th century, it was part of the Frankish kingdom of Aquitaine. At the end of the 10th century its rulers were the powerful counts of Toulouse. Later, the possession of the district was in dispute between the kings of England and France. In 1259 lower Quercy was ceded to England; in 1360 the treaty of Brétigny assigned the whole county to Edward III., but in 1440 the English were finally expelled. In the 16th century Quercy was a stronghold of the Protestants, and the scene of a savage religious warfare. The civil wars of the reign of Louis XIII. centred around Montauban.

QUERÉTARO, a city of Mexico, capital of the State of Querétaro, 167 miles by railway N.W. of the national capital. Pop. (1930) 32,585, including a large Indian element. Querétaro is served by the Mexican Central railway. The city stands on a plain at the foot of the Cerro de las Campanas, 6,168 ft. above sea-level. Among the important buildings are the cathedral (said to have been built originally about 1535, and subsequently restored at various times), the Iturbide theatre (in which occurred the trial of Maximilian). the Government offices, the Federal palace and the churches of Santa Rosa, Santa Clara and San Augustín. The Federal palace and the church of Santa Rosa are examples of the work of the celebrated Mexican architect, Francisco Eduardo de Tresguerras (1765–1833), who restored the church of Santa Clara also. The water-supply is brought over a fine aqueduct 5 m. long, dating from the 18th century. Among manufactures are cottons, woollens, pottery and ironwares. The city has one of the oldest and largest cotton factories in Mexico.

Querétaro occupies the site of an Otomie Indian town dating from about 1400. It was captured by the Spaniards in 1531 and was raised to the rank of a city in 1655. It was the scene of a revolutionary outbreak against Spain in 1810. In 1848 a Mexican congress met here to ratify the treaty of peace with the United States, and in 1867 Querétaro was the scene of Maximilian's last stand against the Republicans (under Escobedo) which resulted in his capture and execution on the Cerro de las Campanas north of the city. Querétaro was the seat of the convention which adopted the Constitution of 1917.

QUERÉTARO-ARTEAGA, a central State of Mexico, area, 4,433 square miles. The population for 1910 and 1930 was 244,663 and 234,058, respectively. The State belongs to the elevated plateau region, with its semi-arid conditions. The northern part is traversed from east to west by the wooded Sierra Gorda, whose spurs reach southward to the central districts. The central and southern parts are covered by plains, broken by low hills. The rivers are small and flow chiefly to the San Juan, a part of the Pánuco drainage basin. There are some small lakes and swamps, and a number of mineral springs. Indian corn, beans and considerable quantities of wheat are grown. Silver, gold, copper, mercury, lead, tin, antimony, precious stones and semi-precious stones like opals are found, in some cases in very rich deposits. The Mexican Central and Mexican National railways cross the south end of the State and afford transportation facilities for the agricultural districts, but the mining districts of the north are still dependent upon old methods. The capital of the State is the historic city of Querétaro (*q.v.*) with a population of 32,585 in 1930.

QUESNAP, FRANÇOIS (1694–1774), French economist, was born at Méré, near Paris, on June 4, 1694, the son of an advocate and small landed proprietor. He studied surgery at Paris, where he qualified as a surgeon, and in 1737 he was appointed perpetual secretary of the academy of surgery founded by François la Peyronie. In 1744 he graduated as a doctor of medicine, became physician in ordinary to the king, and afterwards his first consulting physician.

Quesnay is mainly remembered, however, for his work as an economist. About the year 1750 he became acquainted with Jean C. M. V. de Gournay (1712–1759), and round these two men was formed the philosophic sect of the *Économistes* or the *Physiocrates.* The most remarkable men in this group were the elder Mirabeau (author of *L'Ami des hommes,* 1756–60, and *Philosophie rurale,* 1763), Nicolas Baudeau *(Introduction à la philosophie économique,* 1771), G. F. Le Trosne *(De l'ordre social,* 1777), André Morellet (best known by his controversy with Galiani on the freedom of the corn trade), Mercier Larivière and Dupont de Nemours. Adam Smith, during his stay on the continent in 1764–66, made the acquaintance of Quesnay and some of his followers, to whom he refers in his *Wealth of Nations.* Quesnay died on Dec. 16, 1774, having lived long enough to see his great pupil, Turgot, in office as minister of finance.

The *Tableau économique,* Quesnay's principal work, may be considered the principal manifesto of the school. It was highly esteemed by the followers of Quesnay, and is named by the elder Mirabeau, in a passage quoted by Adam Smith, is one of the three great inventions which have contributed most to the stability of political societies, the other two being those of writing and of money. Its object was to exhibit by means of certain formulae the way in which the products of agriculture, the only source of wealth, would, in a state of perfect liberty, be distributed among the several classes of the community (namely, the productive classes of the proprietors and cultivators of land, and the unproductive class of manufacturers and merchants), and to represent by other formulae the modes of distribution which take place under systems of Governmental restraint and regulation, with the evil results arising from such violations of the natural order. It follows from Quesnay's theoretic views that the one thing deserving the solicitude of the practical economist and the statesman is the increase of the net product; and he infers also what Smith afterwards affirmed, on not quite the same ground, that the interest of the landowner is "strictly and indissolubly connected with the general interest of the society." A small *édition de luxe* of this work, with other pieces, was printed in 1758 in the palace of Versailles under the king's immediate supervision.

Quesnay's system is expounded in two articles on "Fermiers," and "Grains" in the *Encyclopédie* of Diderot and D'Alembert (1756, 1757); a discourse in the *Physiocratie* of Dupont de Nemours (1768); *Maximes Generales de gouvernement Cconomique d'un royaume agricole* (1758); *Tableau économique* (1758); and *Dialogue sur le Commerce et des traveaux des artisans.* Collections of his works are published by Guillaumin (Paris), and Oncken (Frankfort, 1888). A facsimile reprint of the *Tableau Cconomique,* from the original ms., was published by the British Economic Association (London, 1895). *See* also F. J. Marmontel, *Mémoires; Mémoires de Mme. du Hausset;* H. Higgs, *The Physiocrats* (London, 1897).

QUESNEL, PASQUIER (1634–1719), French Jansenist theologian, was born in Paris on July 14, 1634, and joined the French Oratory in 1657. His Jansenist sympathies led to his banishment from Paris in.1681. He took refuge with the friendly Cardinal Coislin, bishop of Orléans; four years later, however, foreseeing that a fresh storm of persecution was about to burst, he fled to Brussels, and took up his abode with Antoine Arnauld (*q.v.*). There he remained till 1703, when he was arrested by order of the archbishop of Malines. After three months' imprisonment he made a highly dramatic escape, and settled at Amsterdam. where he spent the remainder of his life. After Arnauld's death in 1694 Quesnel was generally regarded as the leader of the Jansenist party; and his *Réflexions morales sur le Nouveau Testament* played almost as large a part in its literature as Jansens's *Augustinus* itself. The bull *Unigenitus* (1713) condemned 101 sentences from the *Réflexions morales.* Quesnel died at Amsterdam on Dec. 2, 1719.

See also Mme. Albert Le Roy, *Un Janseniste en exil* (Paris, 1900; and Maulvault, *Répertoire de Port Royal* (Paris, 1902).

QUETELET, LAMBERT ADOLPHE JACQUES (1796–1874), Belgian astronomer, meteorologist and statistician, was born at Ghent on Feb. 22, 1796, and educated at the lyceum of that town. He lectured in Brussels from 1819 onwards, and in 1828 he was appointed director of the new royal observatory which it had been decided to found, chiefly at his instigation. From 1834 he was perpetual secretary of the Brussels Academy, and published a vast number of articles in its *Bulletin,* as also in his journal, *Correspondance mathématique* et *physique* (11 vols., 1825–39). He died at Brussels on Feb. 17, 1874.

Quetelet published in 1835 his principal work, *Sur l'homme et le développement de ses facultés, ou essai de physique sociale* (2nd ed., 1869), containing a résumé of his statistical researches on the development of the physical and intellectual qualities of man, and on the "average man" both physically and intellectually considered. His ideas are further developed in his *L'Anthropométrie, ou mesure des différentes faculte's de l'homme* (1871).

A detailed *Essai sur la vie et les travaux* **de** *L. A. J. Quetelet,* by his pupil and assistant E. Mailly, was published at Brussels in 1875.

QUETTA, the capital of British Baluchistan, India, which also gives its name to a district. It rose to prominence in 1876, when Sir Robert Sandeman founded a residency there. The name is a variation of the word *kwat-kot,* signifying a fortress, and the place is still locally known as Shal Kot. Quetta is the southernmost point in the line of frontier posts and system of strategic railways on the north-west frontier of India, 536 m by rail N. of Karachi. It forms the headquarters of a division and of the Western Command. The railway was built in 1879, with a view to its continuance to Kandahar; but its present terminus is New Chaman on the Afghan border. A branch line to Nushki was completed in 1905 and carried on to Duaz-ab during the World War. The cantonment and civil station of Quetta stand in the open plain about 5,500 ft. above sea-level, within a ring of mountains (such as Takatu, Murdar and Chiltan), which overlook it from a height of over 11,000 ft. North of Quetta is the open plain leading to Pishin and the Harnai, also traversed by the Sibi-Pishin railway, which passes through the fortifications. These defensive works, stretching from the base of Takatu to the foot of the Mashelak hills on the west, bar the way to advance from the Khojak pass. During the last quarter of the 19th century Quetta grew from a dilapidated group of mud buildings, with an inferior bazaar and a few scattered remnants of neglected orchard cultivation, into a strong fortress, and one of the most popular stations of the Indian army. The Indian Staff College opened here in 1907. Trade mart for western Afghanistan, eastern Persia, and much of central Asia, its population grew to 60,272 by 1931. However a disastrous earthquake practically destroyed the city in June 1935, claiming a toll of from 20,000 to 40,000 lives—the most fatal quake in twenty years.

The District of Quetta (including Pishin) has an area of 4,806 sq.m. The actual line of valley which contains Quetta and the Bolan pass was originally rented from the khan of Kalat. This perpetual leasehold was afterwards extended so as to include Nushki and give the British government the command of the trade route to Seistan. The Quetta district is administered, together with the assigned districts of Pishin, Tal Chotiali and Sibi by a regular staff of civil officials, the head being known as the Agent to the Governor-General.

See Thornton, *Life of Sir Robert Sandeman* (London, 1896); *Quetta-Pishin District Gazetteer* (Ajmer, 1907). (T. H. H.)

QUEVEDO Y VILLEGAS, FRANCISCO GOMEZ DE (1580–1645), Spanish satirist and poet, was born at Madrid, and was educated at the University of Alcalá. At 21 he was in correspondence with Justus Lipsius on questions of Greek and Latin literature.

He betook himself to the court where the cynical greed of ministers, the meanness of their flatterers, the corruption of the royal officers, the financial scandals, afforded ample scope to Quevedo's talent as a painter of manners. In 1611 he fought a duel in which his adversary was killed, fled to Italy, and later on became secretary to Pedro Téllez Girón, duke of Osuna, and viceroy of Naples. Thus he learned politics (the one science which he had perhaps till then neglected), initiated himself into the questions that divided Europe, and penetrated the ambitions of the neighbours of Spain, as well as the secret history of the intriguers protected by the favour of Philip III. The result was that he wrote several political works, particularly a lengthy treatise, La *Politica de Dios* (1626). The disgrace of Osuna (1620) compromised Quevedo, who was arrested and exiled to his estate at La Torre de Juan Abad in New Castile. On the death of Philip III. (March 31, 1621), Olivares recalled him from his exile and gave him an honorary post in the palace, and from this time Quevedo resided almost constantly at court, exercising a kind of political and literary jurisdiction due to his varied relations and knowledge, but especially to his biting wit, which had no respect for persons. In the midst of incessant controversy he found time to compose a picaresque romance, the *Historia de* la *Vida del Buscón . . .* (1626); to write his *Sueños* (1627), in which all classes are flagellated; to pen a dissertation on *The Constancy and Patience* of *Job* (1631), to translate St. Francis de Sales and Seneca, to compose thousands of verses, and to correspond with Spanish and foreign scholars. But Quevedo was not to maintain unscathed the high position won by his knowledge, talent, and biting wit. An anonymous petition in verse enumerating the grievances of his subjects was found, in Dec. 1639, under the very napkin of Philip IV. Suspicion fell on Quevedo, who had enemies glad to confirm them. He was arrested on Dec. 7, and kept in rigorous confinement in the monastery of St. Mark at Leon till the fall of Olivares (1643). Two years later he died at Villanueva de los Infantes. (J. F.-K.)

Bibliography.—*Obras* (prose), ed. A. Fernandez-Guerra y Orbe, (1852–59, Bib. de Autores esp., xxiii., xlviii.); (verse), ed. F. Janer (1877, Bib. de Autores esp. lxix.); *Obras completas,* ed. A. Fernandez-Guerra y Orbe (annotated by M. Menendez y Pelayo) 1897–1907 (Soc. de Bibliófilos Andaluces). *See* also E. Mérimée, *Essai sur la vie et les oeuvres de Francisco de Quevedo* (1886).

QUEZAL or **QUESAL,** one of the most beautiful of birds, an inhabitant of the mountains of central America. This bird, *Pharomacrus mocinno,* is one of the trogons (*q.v.*), and in body is about the size of a turtle-dove. The plumes of the tail, which may measure $3\frac{1}{2}$ft., are golden-green and, before the Spanish conquest, were only allowed to be worn by chiefs. The rest of the plumage is green above and scarlet below. In the female the tail is short. The eggs are a pale bluish-green.

QUEZALTENANGO, the capital of the department of Quezaltenango, Guatemala, 120 mi. by Pan-American highway W. of Guatemala City and 70 mi. inland from the Pacific port of Champerico. Pop. (1940) 33,538. It is on the river Siguila, and at the foot of the volcano Santa Maria. In size the second city in the republic, it has a large agricultural trade and manufactures of linen, woollen and cotton goods. Its inhabitants are mainly Indians or mestizos of Quiché descent. Quezaltenango was the capital of a Quiché kingdom, and was known as Xelajú. In 1524 it was conquered by the Spaniards under Pedro de Alvarado. In 1902 it was almost completely destroyed by an earthquake and an eruption of Santa Maria.

QUEZON, MANUEL LUIS (1878–), Philippine statesman, mas born at Baler, on the island of Luzon, and studied law at Santo Tomas university in Manila For a time he joined the insurrectionist movement of Emilio Aguinaldo against the U.S.A., but later he swore allegiance to the territorial administrators and became a provincial prosecutor. From 1907 to 1909 he was a member of the Philippine assembly, from 1909 to 1916 resident commissioner to the U.S. Congress, and from 1916 to 1935 president of the Philippine senate. He was elected first president of the Commonwealth of the Philippines Sept. 17, 1935.

QUIBERON, CAMPAIGN AND BATTLE OF. Several plans were made for the invasion of the British Isles by the French during the Seven Years' War, and in 1759 an army was assembled at Vannes in Brittany, with its transports lying in the Morbihan, the landlocked waters inside Quiberon bay. To protect this force while undertaking the invasion, the French planned to unite their fleets at Toulon and Brest; but these ports were blockaded by Admiral Edward Boscawen and Admiral Sir Edward Hawke respectively. During July 1759 Boscawen was compelled to take his squadron to Gibraltar for provisions and refitting, and Admiral de la Clue led the Toulon fleet through the straits of Gibraltar with the idea of reaching Brest. But he was pursued from Gibraltar by Boscawen, and in the running fight which finished in Lagos bay his force was completely disorganized and defeated.

Meanwhile Hawke continued the blockade of Brest with the utmost pertinacity, but on Nov. g, 1759, he was forced to run into Torbay by lack of stores and exceptionally bad weather. On Nov. 14 he was again at sea; but by this time the French had learnt of his withdrawal, thanks to some ships from the West Indies which reached Brest without being held up. Admiral Conflans took the Brest fleet to sea on the same day that Hawke left Torbay (Nov. 14), and headed south. Hawke, on learning from one of his scouting ships the course taken by the French, also headed south. Continual changes of wind and weather made consistent navigation extremely difficult, but on the morning of Nov. 20 both fleets were about 30m. off Belle-Ile. Conflans, seeing a few English ships under Commodore Duff watching Quiberon bay, stood in close to capture them, but on sighting Hawke's fleet to the north-west, he changed his mind and determined to run into the bay itself, keeping his fleet as closed up as possible.

On sighting the French, Hawke signalled "line abreast" in order to concentrate his force, and followed this up by "general chase" and "line of battle ahead." Hawke's leading ships crowding sail with a fresh north-west gale astern of them, soon began to overhaul the French, who were sailing in close order at the speed of the slowest. At 2:30 p.m., just as Conflans was rounding Belle-Ile, his rearmost ships began to be attacked, and soon afterwards both fleets swept into the bay, between the Cardinal islands and the Four sandbank. Inside the bay, owing to its peculiar shape, the sea was terrific; there were innumerable reefs and sandbanks; the short winter's day was rapidly closing in; and both fleets were driving towards a lee shore. There were 21 of the line in each fleet, but the French had a great advantage in carrying pilots who knew the coast, and with scarcely three hours' daylight left there seemed little chance of a decisive action, especially as it was almost impossible to open the lower deck gun-ports. Nevertheless, two French ships were sunk and another was captured before Hawke made the signal to anchor. Next morning, Nov. 21, the French fleet scattered; seven ships after throwing their guns overboard ran up the River Vilaine, and nine ran out to sea for Rochefort, one sinking on the way. A ship which had struck the night before but had not been captured ran on the Four in trying to escape and was burnt, together with two English ships which had also run aground. Conflans' flagship, the "Soleil Royal," which had anchored nearly in the middle of the English fleet, ran herself ashore on Nov. 21 and was burnt by her own crew. An attempt to burn the ships in the Vilaine by a boat attack was abandoned, owing to bad weather and the strong defences of the river mouth. Nevertheless, the French Brest fleet was now quite useless as a tactical combination, and "had we had but two hours more daylight," wrote Hawke, "the whole had been totally destroyed or taken; for we were almost up with their van when night overtook us." With both their fleets defeated, the French were now compelled to abandon their invasion project, and cease all major naval operations for the rest of the war.

See Sir *W. L.* Clowes, *The Royal Navy,* vol. iii. (1898). Sir Julian Corbett, *England in the Seven Years' War* (1918).
(G. A. R. C.; W. C. B. T.)

QUICHE, the most important Indian nation in Guatemala at the time of the Spanish conquest. To-day the Quiché tongue, a Maya dialect, is spoken by about 275,000 pure-blooded natives throughout the Departments of Quiché, Quezaltenango, Totonicapán, Retalhuleu and Sacatepéquez.

Quiché history and tradition are preserved in a book known as the *Popol Vuh,* written by a native shortly after the Conquest. It relates four attempts to create a satisfactory world and people it. On the last attempt the gods made four men: Balam-Quitze, Balam-Agab, Mahucutah and Igi-Balam. Of these the first three became the ancestors of the Quiché. As first constructed these men had too many divine attributes to suit the gods, so their wits were dulled, but in compensation they were given wives. At this time the other Indian tribes were created and they all went to Tulan Zuiva to receive their household gods. The Quiché god, Tohil, then made the first fire by striking it from his sandal, while the other Indians learned the art from the Quiché. To gain this end, with one exception, they were tricked into giving human hearts in sacrifice. All then started to migrate to Guatemala, and when they arrived the first sunrise took place. Then the four leaders withdrew to the woods, and, after the Quiché had successfully fought a war, these holy men died. They were succeeded by their sons who immediately departed on a mystic journey to the East where they received the insignia of temporal power at the hands of the great king, Nacxit, who also taught them the secret of writing.

Upon the return of their leaders the Quiché settled in stone wrought cities, and from this point the *Popol* Vuh assumes a definitely historical character. It describes the reigns of many kings and pictures in detail their wars with neighbouring nations. The apogee of Quiché power was reached under Kicab, who made tributary all his neighbours, but these conquests were never consolidated into a kingdom. Fighting continued with varying fortunes until the arrival of the Spaniards.

In 1524 Pedro de Alvarado, the lieutenant of Cortés, entered Guatemala. The Quiché had received warning of his coming and of the strength of the Spanish arms from the Aztec emperor Montezuma. They had hastily made peace with warring neighbours but were unable to unite them in a common defence. Their preparations to repel Alvarado were impeded by the death of their king, Tanub. His successor, Tecum Umam, met the Spaniards with a huge army upon the plains of Zelahuh near the modern Quezaltenango. There followed a series of desperate actions in which the Indians failed to withstand the Spanish cavalry and artillery, backed by a force of native allies. Finally Tecum Umam personally attacked Alvarado and after unhorsing him was slain. Then the Quiché retreated to their capital, Gumacaah, leaving innumerable dead along the banks of a stream to this day known as Xiquiguel, the river of blood. However, the Quiché were not yet conquered, and the new king, Chignauivcelut, endeavoured to entice Alvarado into his capital, so that he might burn the houses over the Spaniards' heads while his men cut off their retreat over the narrow causeway by which the city was entered. Alvarado discovered this plan, captured the Quiché by stratagem and hanged the king. Thus the opposition was broken.

At the time of the conquest a king ruled the Quiché in regal style. He was surrounded by 24 councillors who gave the ruler their advice and acted as judges and revenue collectors. The principal towns were governed by appointed lieutenants who, however, had no jurisdiction over the nobility. Each governor had his council organized in the same fashion as the king's. All these officials and others down to the rank of door-keeper of the council were drawn from the nobility who took great care to preserve the purity of their blood.

To-day the Quiché live in small villages in the highlands of Guatemala, for the most part on various coffee plantations where the Indians are held in a state of peonage. Some of the towns, however, particularly Chiquinula, Nahualá and Chichicastenango, have maintained a semi-independence and run their affairs with little interference from the Central Government. Chichicastenango is of peculiar interest because its inhabitants claim descent from the Quiché nobility, and recognize one of their number, Manuel Ajanel, as king.

BIBLIOGRAPHY.—Domingo Juarros, *History of the Kingdom of Guatemala* (1823); *J. L.* Stephens, *Incidents of Travel in Central America* (1841); Brasseur de Bourbourg, ed., *Popol Vuh* (1861); Karl Sapper, "Der gegenwartige Stand der ethnographischen Kenntnis von Mittelamerika," *Archiv. für Anthropologie,* iii. *band* (Heft) (1904); S. K. Lothrop, *Note on Indian Ceremonies in Guatemala* (Indian Notes, vol. iv. No. 1) (1927). (S. K. L.)

QUICHERAT, JULES ETIENNE JOSEPH (1814–1882), French historian and archaeologist, was of Burgundian origin. His father, a working cabinet-maker, came from Paray le Monial to Paris where Quicherat was born on Oct. 13, 1814. He was educated at the college of Ste. Barbe and at the École des Chartes. Inspired by the example of Michelet, who had just written an admirable work on Joan of Arc (*q.v.*), he published the text of the two trials of Joan, adding much contemporary evidence on her heroism in his *Procès de condamnation et de rehabilitation de Jeanne d'Arc* (5 vols. 1841–1849), as well as half a volume of *Aperçus nouveaux sur l'histoire de Jeanne d'Arc.* He wrote full biographies of two chroniclers of Louis XI., one very obscure, Jean Castel (in the *Bibliothbque d'École des Chartes,* 1840), the other, Thomas Basin, bishop of Lisieux, a remarkable politician, prelate and chronicler. Quicherat also published the works of the latter (4 vols., 1855–1859). In 1849 he was appointed professor of diplomacy at the École des Chartes. He died at Paris on April 8, 1882.

Bibliography.—After his death his unpublished papers were printed in *Mélanges d'archéologie et d'histoire,* vol. i., Celtic, Roman and Gallo-Roman antiquities, ed. A. Giry and Aug. Castan (1885), and vol. ii., *Archéologie du moyen âge,* ed. R. de Lasteyrie. His *Histoire de la laine,* on which he was occupied for many years, was missing from his papers, and only the introductory chapters (up to the 11th century) of his lectures on archaeology were found. Among his lectures published in contemporary reviews are La *formation française des anciens noms de lieu* (1867); *De l'ogive et de l'architecture dite ogivale* (1850); *L'Âge de la cathe'drale de Laon* (1874); and *Histoire du costume en France* (1875; 2nd ed., 1877), a popular work.

QUICHUA, a South American Indian tribe and stock, the ruling people of Peru when the Spaniards arrived. The Quichuan stock then included the Quichuas proper and the many vassal tribes of the ancient empire of Peru. To-day it numbers some three millions. They are skilful farmers and herdsmen. (*See* Peru; South America: *Ethnology.*)

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QUICHUA INDIAN OF PERU

QUICKENING. A popular term for the first movements of the developing child perceived by the mother. This generally occurs about the fourth month of pregnancy. (*See* Embryo.)

QUICK-MATCH. A quickfiring wick or fuse, made by saturating cotton-wick with a paste of starch and gunpowder and carefully drying it. Used to connect the various parts of a firework, it carries the flame from one part to another. It was formerly also used for firing industrial and military explosives.

QUICKSILVER, a common name for mercury (*q.v.*).

QUIETISM, a complicated religious movement that swept through France, Italy and Spain during the 17th century. Its chief apostles were Miguel de Molinos, a Spaniard resident in Rome; Fénelon, the famous French divine, and his countrywoman, Madame Jeanne Marie Guyon. Quietism was essentially a reaction against the bureaucratic ecclesiasticism always latent within the church of Rome, though it had come more especially to the front during the struggles of the counter-Reformation carried through by the Jesuits. Like their contemporaries, the French Jansenists, and the Quakers and Anabaptists of northern Europe, the Quietists fell back on a doctrine of immediate inspiration of the individual conscience. To the many God spoke only in general terms through the Church; but to the few He made His will directly known. But how did He do so? How distinguish the voice of God from the vagaries of our own imagination? Quietism offered an easy test. The less "sense of proprietorship" a man had in his own good actions—the more they came from a source outside himself—the surer might he be that they were divine. If, on the other hand, they were the fruit of his deliberate thought and will, that was enough to show that they did not come from God; but from his sinful self, Hence the first duty of the Ouietist was to be "passive."

The Spanish monk, Juan Falconi, who is generally reckoned as the father of Quietism, died in the odour of sanctity in 1632; some thirty years later his fellow countryman, Molinos, transported his doctrines to Rome, where they gained unbounded popularity with bishops and cardinals, and even with pope Innocent XI. In 1675 Molinos published the *Guida Spirituale,* the great text-book of his school. But his success soon aroused the suspicion of the Jesuits, the great champions of militant ecclesiasticism. "Passivity" accorded ill with a zealous frequentation of the confessional, their chief centre of influence. Failing to turn public opinion against Molinos in Rome, they brought pressure to bear on Louis XIV. through his confessor, Père La Chaise. At the instance of the French ambassador Molinos was arrested (1685); his papers were seized, and his chief disciples examined by the Inquisition. Two years later he was convicted of heresy, and sentenced to imprisonment for life.

The later stages of the Quietist drama were played out in France. Here Quietist ideas had long been spreading under the leadership of enthusiasts like François Malaval (1627–1719), a blind layman of Marseilles. A more romantic figure was Jeanne Marie Guyon (1648–1717), a widow of good family and remarkable personal charm, who devoted her life to missionary journeys on behalf of "passivity." In 1688 fate brought her to the French court, where she made a great impression on Mme. de Maintenon and other persons of quality. But her most illustrious convert was Fénelon, then tutor to the duke of Burgundy, eldest son of the Dauphin. Mme. Guyon and Fénelon made Quietism famous. In 1697 Bossuet was at work on an *Instruction sur les états d'oraison,* which was intended to distinguish once for all what was true in Quietism from what was false. Fénelon, feeling sure that Bossuet would do the Quietists less than justice, determined to be beforehand with him. While Bossuet's book was still in the press, he suddenly brought out an *Explication des maximes des saints.* The little volume raised a violent storm. For two years Fénelon was at feud with Bossuet; he was banished from Versailles; finally, he was censured by the pope (1699), although in very measured terms. This condemnation, and Fénelon's bitter controversies with Bossuet, proved the death-blow to official Quietism.

Bibliography.—H. Heppe, *Geschichte der quietistischen Mystik* (Berlin, 1875), covers the whole subject. On the place of Quietism in the history of religious thought *see* W. R. Inge, *Christian Mysticism* (London, 1899); on its psychology *see* H. Delacroix, *Etudes sur le mysticisme* (Paris, 1908); J. Denis, *Mémoires de l'Académie de Caen* for 1894; W. James, *The Varieties of Religious Experience* (London, 1902). *See* also the articles on Bossuet; Fénelon; Mme. Guyon; and Molinos.

QUILL, a term applied to the bare, hard, hollow tube of the feather of a bird, also to the large flight feathers or *remiges,* and especially to the strong feathers of the goose, swan, or crow used in the making of quill pens (*see* Feather and Pen). Certain ancient stringed instruments were played with a *plectrum* or plucker made of the quill of a bird's feather, and the word has thus been used of a *plectrum* made of other material.

QUILLER-COUCH (kwil'lur ko͞och), **SIR ARTHUR THOMAS** (1863–), English writer (pseudonym "Q"), born in Cornwall on Nov. 21, 1863. He was educated at Clifton college and Trinity college, Oxford, where he was afterwards appointed lecturer in classics (1886–87). While he was at Oxford he published (1887) his *Dead Man's Rock* (a romance in the vein of Stevenson's *Treasure Island),* following it up with *Troy Town* (1888) and *The Splendid Spur* (1889). Gaining some journalistic experience in London, mainly as a contributor to the *Speaker,* in 1891 he settled at Fowey in Cornwall, and wrote several Cornish tales, including *The Blue Pavilions* (1891), *The Ship of Stars* (1899), *Hetty Wesley* (1903), *The Shining Ferry* (1905). He published several volumes of critical articles, *Adventures in Criticism* (1896); *On the Art of Writing* (1916); *Studies in Literature* (1918; 2nd series, 1927; 3d series, 1929), and *Shakespeure's Workmanship* (Bristol, 1918). In 1898 he completed R. L. Stevenson's *St. Ives.* From his Oxford days he was known as a writer of excellent verse; most of his poetical work is contained in *Poenzs and Ballads* (1896). In 1895 he published a delightful anthology from the 16th and 17th century lyrists, *The Golden Pomp,* followed in 1900 by the invaluable *Oxford Book of English Verse 1250–1900,* probably the best general anthology of English verse, the *Oxford Book of Ballads* (1910), the *Oxford Book of Victorian Verse* (1912) and the *Oxford Book of English Prose* (1925). In 1910 Quiller-Couch was knighted. In 1912 he was appointed King Edward VII professor of English literature at Cambridge, and was elected fellow of Jesus college, Cambridge. A complete edition of the *Tales and Romances of Sir Arthur Quiller-Couch* began in 1928; *Poems* (1929).

QUILLOTA, a town of Chile in the province of Valparaiso, on the left bank of the Aconcagua river, 20 mi. above its mouth and 26 mi. E N.E. of the city of Valparaiso. Pop. (1940) 17,220. The valley is noted for its beauty, fertility and healthfulness, and is the centre of thriving fruit and wine industries. Among its fruits is the "chirimoya" *(Anona Cherimolia).* Quillota is situated on a railway between Valparaiso and Santiago.

QUILON, a seaport of India, on the Malabar coast, in the state of Travancore. Pop. (1931) 33,739. The palace of the maharaja of Travancore stands on the bank of Quilon lake.

QUIMBY, PHINEAS PARKHURST (1802–1866), American mental healer, was born at Lebanon, N H , on Feb. 16, 1802. In 1838, while in business as a clock-maker in Belfast, Me., his interest in hypnotism was aroused by a series of lectures. He studied the subject and delivered lectures. His experiments extended through mental suggestion to mental healing, sometimes accompanied by physical manipulation, which he practised at Portland, Me., having among his patients Mrs. Patterson, later Mary Baker Eddy. He died at Belfast, Me., on Jan. 16, 1866.

See A. G. Dresser, ***The*** *Philosophy* of *P. P. Quimby.*

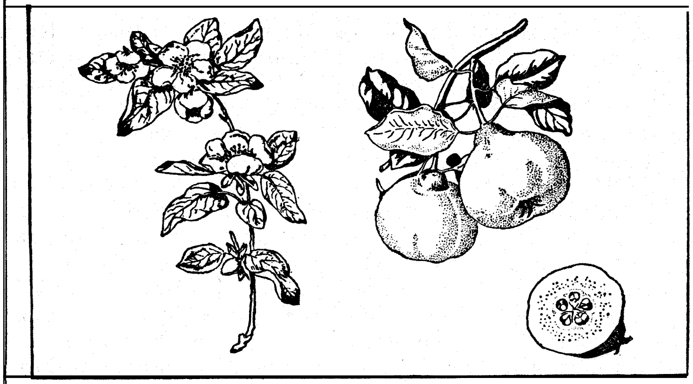
QUIMPER, formerly Quimper-Corentin, a town of France, capital of the department of Finistère, on the Odet 158 mi. N W. of Nantes and 68 mi. S.E. of Brest on the railway between those towns. Pop. (1936) 18,814. Quimper, or at least its suburb Locmaria, was occupied in Roman times, and traces of the ancient foundations exist. Later Quimper became the capital of Cornouailles and the residence of its kings. It is said to have been Grallon Meur who brought the name of Cornouailles from Great Britain and founded the bishopric, first held by St. Corentin about 495. Hoel, count of Cornouailles, united the countship with the duchy of Brittany. Quimper suffered in the local wars of succession. In 1344 it was sacked by Charles of Blois. Monfort failed to take the town in 1345, but it opened its gates to his son John IV in 1364 after the victory at Auray. Remains of the town walls (15th century) are preserved in the terrace of the episcopal palace and near the college. Quimper is the seat of a prefect and of a bishopric in the province of Rennes. The cathedral of St. Corentin (13th to 16th centuries), with a fine façade (c. 1425), is a splendid example of the Gothic style in granite. Famous Breton pottery is made here.

QUIMPERLÉ, a town of western France, in the department of Finistitre, at the confluence of the Isole and the Ellé which unite to form the Laita, 28 mi. E.S.E. of Quimper by rail. Pop. (1936) 6,475. Quimperlé grew up round the abbey of Ste. Croix, founded in the 11th century, the restored romanesque basilica of which still remains. The church of St. Michel (14th and 15th centuries), with a fine tower, crowns the hill above the town. The chapel of Lothéa, in the forest of Carnoet is the scene of the famous annual "Pardon des Oiseaux" (Pilgrimage of the Birds). There are granite deposits; food is preserved; metal boxes, furniture, agricultural implements, etc. are manufactured.

QUIN, JAMES (1693–1766), Irish actor, was born in London Feb. 24, 1693. He first appeared on the stage as Abel in Sir Robert Howard's *The Committee* at the Smock Alley Theatre, Dublin. Quin's first London engagement was in small parts at Drury Lane, and his first triumph was as Bajazet in Nicolas Rowe's *Tamerlane* (Nov. 8, 1715). The next year he appeared as Hotspur at Lincoln's Inn, where he remained for 14 years. On July 10, 1718, he was convicted of manslaughter for killing Bowen, another actor, in a duel. The affair was regarded as an accident. In 1721 a drunken nobleman reeled on to the stage of the theatre and assaulted the manager, Rich, whose life was saved by Quin's prompt armed interierence. This resulted in a riot, and thereafter a guard was stationed in all theatres. In 1732 Quin appeared at Covent Garden, returning to Drury Lane from 1734 to 1741, and in 1742 was again at Covent Garden, where he remained until the close of his career. On Nov. 14, 1746, Quin played Horatio and Garrick Lothario to the Calista of Mrs. Cibber in Rose's *Fair Penitent* to an enthusiastic audience. Quin was a serious rival of Garrick. His Richard III was pronounced inferior to Garrick's; but his Falstaff was preferred. Quin's last regular appearance was May 15, 1757, as Horatio in the *Fair Penitent,* though in 1758 he twice played Falstaff for the benefit of friends. He retired to Bath, where he lived a gay life. Quin died on Jan. 21, 1766. He was buried in the abbey church at Bath. Quin's character is summarized by Smollett in *Humphrey Clinker.* See *The Life of Mr. James Quin, Comedian,* 1766.

QUINAULT, PHILIPPE (1635–1688), French dramatist and librettist, was born in Paris on the 3rd of June 1635. By 1670 he had written some 16 or 17 comedies, tragedies, and tragi-comedies. In 1671 he contributed to the singular miscellany of *Psyché,* in which Corneille and Molière also had a hand, and which was set to the music of Lulli. Here he showed a remarkable faculty for lyrical drama, and from this time till just before his death he confined himself to composing libretti for Lulli's work. His libretti are among the few which are readable without the music, and which are yet carefully adapted to it. Coming at the time when opera became fashionable out of Italy, he had much to do with establishing it as a permanent European *genre.* His first piece after *Psyché* was a kind of classical masque, *Les Fêtes de l'Amour et de Bacchus* (1672). Then came *Cadmus* (1674), *Alceste* (1674), *Thésée* (1675), *Atys* (1676), one of his best and *Isis* (1677). All were classical in subject, as was *Proserpine* (1680), which was superior to any of them. *The Triumph of Love* (1681) is a mere ballet, but in *Persée* (1682) and *Phaeton* (1683) Quinault returned to the classical opera. Then he finally deserted it for romantic subjects, in which he was even more successful. *Amadis de Gaule* (1684), *Roland* (1685), and *Armide* (1686) are his masterpieces, the last being the best. Quinault died Nov. 26, 1688. The best edition of his works is that of 1739 (Paris, 5 vol.).

QUINCE, a fruit tree concerning which botanists differ as to whether or not it is entitled to take rank as a distinct genus, *Cydonia,* or as a section of the genus *Pyrus* (family Rosaceae, *q.v.*). The name *Cydonia oblonga* is to be preferred to *Pyrus cydonia.* Bailey gives five varieties of *C. oblonga,* namely, vars. *lusitanica, maliformis, pyriformis, marmorata* and *pyramidalis.* The quinces are much-branched shrubs or small trees with entire leaves, small stipules, large solitary white or pink flowers like those of the pear or apple, but with leafy calyx lobes and a many-celled ovary, in each cell of which are numerous horizontal ovules. The fruits may be round and flattened or somewhat pear-shaped, with large leafy calyx persisting on the mature fruit.



QUINCE (CYDONIA OBLONGA); SHOWING BLOSSOM IN FULL BLOOM (LEFT), PEAR-SHAPED QUINCE SHOWING SEED BOX (RIGHT)

The common quince is a native of Persia and Anatolia, and perhaps also of Greece and the Crimea. By Franchet and Savatier *C. oblonga* is given as a native of Japan, with the native name "maroumerou." It is certain that the Greeks knew a common variety upon which they grafted scions of a better variety from

Cydon in Crete, whence it was obtained and from which the later names have been derived. The fragrance and astringency of the fruit of the quince are well known, and the seeds formerly were used medicinally for the sake of the mucilage they yield when soaked in water. The quince is but little cultivated in Great Britain; in Scotland it seldom approaches maturity, unless favoured by a wall. The fruit has a strong aroma and in the raw state is astringent; but it makes an excellent preserve, and is often used to give flavour and sharpness to stewed or baked apples.

The Japanese quince, formerly considered in the genus *Cydonia* but now known as *Chaenomeles lagenaria,* has been widely used as an ornamental plant in gardens as a shrub, particularly because of the beauty of its flowers that appear on the stems before the leaves open fully in late winter and early spring months. Some of the small shrubs bear large green fragrant fruits that are quite inedible in the fresh state but have been used in making preserves.

The quince was formerly grown in home fruit gardens and commercial plantings in the northeastern United States but later became the least esteemed of all tree fruits for orchards in that area. The fruit is almost inedible in the uncooked state, and other fruits are preferred in the fresh state for the diet. It thrives under the same systems of cultivation as do apples and pears and does fairly well along fence rows, where it may be given little care. The quince is susceptible to a bacterial disease called fire blight, which is also a serious hazard to Pear growing in the United States. Trees that are not forced into strong vegetative growth by pruning and fertilization are less susceptible to the fire blight disease. The trees are subject to the same scale insects that attack apples and pears and should receive the same dormant spray treatment for the control of these pests. The fruits are golden yellow in colour and the flesh takes on a pink colour when cooked, giving an attractive colour to jellies and conserves made from this fruit. Orange is the most commonly grown variety. Champion is another of the more important varieties. Quince stocks are used on which to graft the pear to dwarf the tree and hasten early bearing. The Angers variety, imported from France, is the most important stock used for dwarfing pears. (F. P. C.)

See W. W. Robbins, *Botany of Crop Plants* (Philadelphia, 1924); L. H. Bailey, *Standard Cyclopedia of Horticulture* (1914–27) and *Manual of Cultivated Plants* (1924).

QUINCKE, GEORGE HERMANN (1834–1924), German physicist, was born at Frankfurt on the Oder on Nov. 19, 1834. He was appointed "privat-docent" at Berlin university in 1859. Between 1860 and 1872 he held various teaching posts. He was professor of physics at Würzburg (1872–75) and at Heidelberg from 1875 until he retired in 1907. He died on Jan. 13, 1924.

Quincke carried out a number of observations on surface tension. He also wrote papers on the reflection of light at metal surfaces, on the penetration of light into the second medium in the case of total reflection, and on elliptic polarization. Quincke also devised methods of measuring the magnetic permeability of liquids and the dielectric constants for non-conductors.

QUINCY, JOSIAH (1744–1775), American patriot, son of Josiah Quincy (1709–84), was born in Boston on Feb. 23, 1744. Between 1767 and 1770, he contributed several papers to the Boston *Gazette* that were flaming tirades against British oppression. After the "Boston massacre," he and John Adams defended Capt. Preston and the accused soldiers and secured their acquittal. From this time on he wrote repeated letters to the Boston Gazette and published several books in which he urged opposition to England. In Sept. 1774 he left for England where he consulted with leading Whigs as to the political situation in America; on March 16, 1775 he started back, but he died on April 26 in sight of land.

See the *Memoir of the Life of Josiah Quincy, Jr., of Massachusetts* (Boston 1825, 2nd ed., 1874), by his son.

JOSIAH QUINCY (1772–1864), son of the above named, American lawyer and author, was born in Boston on Feb. 4, 1772. He graduated from Harvard in 1790, studied law and was admitted to the Ear in 1793, but was never a prominent advocate. He served in the Massachusetts senate in 1804–05; and was a member in 1805–13 of the national House of Representatives. After leaving Congress, he held various political offices until in 1823 he became mayor of Boston. As mayor he brought about municipal reform, and in 1829 resigned to become president of Harvard college. He remained president until 1845 during which time he made many reforms in grading, finances, etc. His last years were spent on his farm in Quincy, where he died on July 1, 1864.

He wrote a *Memoir* of his iather (1825); a *History of Harvard University* (1840), the *Journals of Mayor Samuel Shaw* (1847); *The History of the Boston Athenaeum* (1851); *The Municipal History of the Town and City of Boston* (1852); a *Memoir of the Life of J. Q. Adams* (1858); and many practical contributions to agriculture. See Edmund Quincy, *Life of Josiah Quincy* (Boston, 1867).

JOSIAH QUINCY (1802–1882), son of the last named, was mayor of Boston in 1845–49; his brother Edmund (1808–77) was a prominent abolitionist and author. Josiah Quincy (1802–82) had two sons—Josiah Phillips (1829–1910), a lawyer and author; and Samuel Miller, who became a brigadier-general in the Union army. Josiah Quincy (1859–1919), a son of Josiah Phillips Quincy, was mayor of Boston in 1895–99. (B. B. K.)

QUINCY, a city of western Illinois, U.S.A., on the Mississippi river, 110 m. N.W. of Saint Louis; the county seat of Adams county. It is on Federal highway 24 and is served by the Burlington Route and the Wabash railways, and by river barges and steamers. Pop. (1930) 39,241; 40,469 in 1940 by the federal census The city is built on a picturesque bluff above the river and is surrounded by rich farm lands. It has beautiful parks covering 300 ac., one of which embraces prehistoric Indian mounds, and is the seat of the Illinois State Soldiers' and Sailors' home (1887) with 222 ac. of grounds. The assessed valuation of city property for 1940 was $34,449,095. Bank clearings in 1940 amounted to $32,143,000. In 1822 John Wood, the first white settler, built a log cabin there; and on March 4, 1825, the day of the inauguration of John Quincy Adams, the hamlet of ten inhabitants was made the county seat. In honour of the new president the county was named Adams, the town Quincy, and the public square (now Washington park) was called John's square. The town was incorporated in 1834 and was chartered as a city in [illegible]. In 1850, it[illegible] of 6,902, it ranked next to Chicago among the cities of the state.

QUINCY, a city of Norfolk county, Massachusetts, U.S.A., on Massachusetts bay, just south of Boston, occupying 16·77 sq mi. between the Neponset river on the north and Fore river on the south. It is served by the New York, New Haven and Hartford railroad. Pop. 47,876 in 1920, 29% foreign-born white; 1940 it was 75,810. It is a beautiful residential suburb of great historic interest and has distinctive manufacturing industries, with an output in 1939 valued at $41,475,411. The Quincy granite quarries have been celebrated since the middle of the 18th century. The first freight railway in the United States was established there in 1825.

On Fore river are shipyards (established 1900) which have built many of the modern vessels of the U.S. navy, including 36 destroyers during the war of 1914–18. The city has 2,600 ac. of parks and playgrounds. A settlement known as Merry Mount or Mt. Wollaston was established within the present bounds of Quincy in 1625 by Thomas Morton (*q.v.*), but was abandoned after his arrest; and in 1634 a second settlement was made, by Puritans. In 1792 Quincy was set off from Braintree and incorporated as a town (named in honour of John Quincy, 1689–1767) and in 1888 it was chartered as a city. It was the home of the Hancocks and the Adamses, the birthplace of the first governor of Massachusetts and of two presidents of the United States. The houses in which John Adams and John Quincy Adams were born (built in 1681 and 1716) and the Edmund Quincy homestead (1685) are colonial museums, open to the public. The granite for King's chapel, Boston, in 1752, and for the Bunker Hill monument, in 1826, was quarried in Quincy.

QUINET, EDGAR (1803–1875), French historian and man of letters, was born at Bourg-en-Bresse (Ain), on Feb. 17, 1803. His first publication, the *Tablettes du Juif Errant,* appeared in 1823. He obtained considerable credit irom his translation (1827) of Herder's *Philosophie der Geschichte.* At this time he met Michelet, and also Cousin, who procured him a post on a Government mission to the Morea in 1829. On his return he published *La Grèce Moderne* in 1830. His reputation for speculative Republicanism ruined his hopes of employment after the February revolution, but he joined the staff of the *Revue des deux Mondes*. The most remarkable of the numerous essays which he contributed to it was on *Les Epopées françaises du XIIème siècle.* In 1839 he was appointed professor of foreign literature at Lyons, and in 1841 was transferred to the chair of southern literature at the Collège de France. The *Génie des religions,* embodying his brilliant lectures at Lyons, appeared in 1842. In 1846 the Government put an end to his lectures, because he introduced into them polemic against Ultramontanism.

Quinet took part in the revolution of 1848, and was returned for Ain to the Constituent and then to the Legislative Assembly, where he figured among the extreme radical party. He wrote many pamphlets during the Second Republic, attacked the Roman expedition and was an uncompromising opponent of Prince Louis Napoleon. He was banished from France after the *coup d'état* and settled at Brussels, where he lived for seven years, and published *Les Esclaves* (1853) and *Marnix de Sainte-Aldégonde* (1853). Quinet was restcred to his chair after the fall of the Empire, and during the siege of Paris wrote vehemently against the Germans. As deputy for the department of the Seine (1871) he opposed the terms of peace between France and Germany. He died on March 27, 1875.

BIBLIOGRAPHY.—In addition to the works mentioned above, Quinet wrote *Les Révolutions d'Italie* (1848); *Histoire de mes idées* (1858); *Le Siège de Paris et la defense nationale* (1871); *La République* (1872); *Le Livre de l'exilé* (1875 and later). Three volumes of letters and some other works were published posthumously. A complete edition of his works was published in 28 volumes in 1877–79. His second wife, in 1870, published certain *Mémoires d'exil,* and *Lettres d'exil* followed in 1885. In that year Prof. George Saintsbury published a selection of the *Lettres à sa mère* with an introduction. *See* also E. Paris, *Libres penseurs religieux* (1905); R. Heath, *Early Life and Writings of Edgar Quinet* (1881).

QUININE, the most important alkaloid contained in cinchona bark (*see* CINCHONA, ALKALOIDS OF).

Physiological **Action.**—Our knowledge of this subject is mainly due to Professor Binz of Bonn. Quinine is a bactericide, many bacteria being killed by a ·2% solution, but is more definitely poisonous to minute animal organisms especially malarial parasites.

The first feature of the internal action of quinine is its intensely bitter taste. This induces a reflex secretion from the salivary and gastric glands, followed or accompanied by increased vascularity of the gastric mucous membrane, and some activity of the muscular wall of the stomach. This means that the appetite is strengthened, and digestion rendered more rapid and complete, In this sense alone quinine is a tonic.

The action of quinine on the blood itself—quite apart from its action on malarial blood—is of great complexity and importance. Whilst it is not a haematinic, in that it does not increase the number of the red blood corpuscles, it very markedly influences the stability of the compounds of the haemoglobin with oxygen. Like alcohol and prussic acid, quinine interferes with oxidation, so that oxyhaemoglobin is relatively unable to give up its oxygen to the tissues, the metabol'ism of which is therefore greatly modified. This property is doubtless partly—though not wholly—explanatory of the antipyretic action of quinine.

The action of quinine on the circulatory apparatus is not marked. It is only in very large doses that it weakens the intracardiac nervous ganglia, slows and weakens the pulse, and dangerously lowers the blood pressure, Similarly the depressant action on the respiratory centre in the medulla oblongata occurs only after the administration of enormous doses.

The action of quinine on the temperature is important, for it is the safest of all known antipyretics. Its action on the normal temperature is *nil.* The drug is not an *antithermal.* But when the temperature is raised, quinine will frequently lower it. The action is not due to any influence on the thermic centres, nor to any production of diaphoresis, but to the influence of quinine upon the stability of oxyhaemoglobin. Quinine was the first antipyretic used.

In some of the lower vertebrates quinine reduces the activity of the spinal cord, but in the human species it appears to stimulate the nervous mechanism of the uterus and it is therefore included under the class of *oxytocic* or *ecbolic* drugs.

Therapeutics.—The supreme value of quinine is as a specific antidote to malaria, against which it also possesses a powerful prophylactic action. Ten or fifteen grains of the sulphate are often given three times a day for this latter purpose, and smaller doses of the much more efficacious acid hydrochloride convey even more certain immunity. In treating malaria with this drug certain important facts are to be observed. Quinine administered by the mouth or by any other means will soon enter the blood, and will then kill the *haematozoon malariae,* whether it be contained within corpuscles or free in the blood-plasma. There is one exception, however. Quinine is apparently powerless to kill the organism when it is in its reproductive phase. This phase corresponds to the pyretic attack. It is therefore useless to administer quinine during a malarial paroxysm. Two successful methods may be adopted. The quinine may be given in a single large dose—go grains of the sulphate or 20 of the acid hydrochloride—an hour or two before the attack is due, *i.e.* just before the parent organism in the red blood corpuscles is about to discharge the new generation of young parasites into the blood-plasma. An equally effective method, which may be combined with the above, is to give the quinine in 10-grain doses of the acid hydrochloride every four hours between the attacks. Whichever method be adopted, the paroxysm that was expected will probably not appear.

Quinine is largely used as a bitter tonic in doses of about half a grain. The acid hydrochloride is the best salt to employ. It has some analgesic power, and is a safe and often efficient drug in the treatment of neuralgia, even when the patient has not had malaria.

Cinchonism is the name applied to the congeries of toxic symptoms which follow the prolonged administration of quinine, but may appear after one small dose in certain persons. The symptoms closely resemble those of salicylism, and also, though in less degree, those of carbolism. The patient is deaf, but complains of ringing in the ears, which may assume various forms, especially in musical people. In persons who display a pronounced idiosyncrasy towards cinchonism, the symptoms may often be successfully averted if small doses of hydrobromic acid—10 minims of the dilute solution—are given with the quinine.

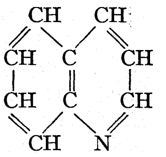
QUINNAT (*Oncorhynchus tschawytscha*), the most important salmon (*q.v.*) of the North American Pacific coast. It has been naturalized in New Zealand.

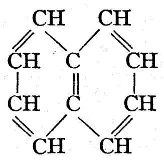
QUINOA (*Chenopodium quinoa*), a small annual herb of the goosefoot family (*Chenopodiaceae*), very similar to the common lamb's quarters (*q.v.*), native to Bolivia, Chile and Peru, where it has long been cultivated as a food plant by the native peoples of the Andean plateau. The plant produces a great profusion of very small seeds, which are ground into meal and made into cakes or gruel or boiled like rice; the green parts are used as a pot herb like spinach. (*See* CHENOPODIUM.)

QUINOLINE is a colourless, highly refractive oil, of specific gravity 1·095, and b.p. 239° C. It has a peculiar characteristic smell and is only slightly soluble in water, but freely soluble in the usual organic solvents. It is alkaline to litmus. As a mono-acid base it forms crystalline salts such as the hydrochloride, which are very soluble in water. Quinoline, C_9H_7N, occurs with its homologues in the fraction of coal tar and bone-oil bases boiling between 230–250° C. It was first obtained from coal tar by Runge in 1834, and later Gerhardt showed that it was produced when cinchonine, quinine and other alkaloids were distilled with potash. Crude quinoline is obtained from coal tar and bone-oil by a process similar to the extraction of pyridine (*q.v.*), but since it is difficult to separate from its homologues, it is usually prepared synthetically by a method devised by Skraup, in which a mixture of aniline, glycerine, nitrobenzene and concentrated sulphuric acid is heated until reaction proceeds without further heating. Since this reaction is often very violent, arsenic acid is sometimes used as an oxidizing agent in place of nitrobenzene, in which case the reaction proceeds more smoothly and gives a cleaner product. During the reaction the glycerine is converted into acrolein which condenses with the aniline to form acrolein-aniline, and oxidation converts this to quinoline.

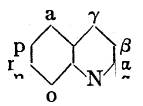
Being a tertiary amine, quinoline gives quinolinium or quaternary ammonium salts with alkyl iodides or methyl sulphate. It forms double salts with inorganic salts, *e.g.*, the platinichloride $(C_9H_7N)_2,H_2PtCl_6,2H_2O$. When potassium dichromate is added to a solution of quinoline hydrochloride, the sparingly soluble quinoline dichromate is formed. Nitric and chromic acids have no action on quinoline, but alkaline permanganate oxidizes it to quinolinic acid ($\alpha\beta$-dicarboxypyridine).

Constitutionally, quinoline bears the same relation to naphthalene that pyridine bears to benzene, for it may be considered as a compound formed by the fusion of a benzene ring with a pyridine ring:—


Quinoline


Naphthalene

And quinoline differs from pyridine just as naphthalene differs from benzene in chemical reactivity. The formation of quinolinic acid on oxidation shows the presence and stability of the pyridine ring in quinoline. The existence of the benzene ring follows from the Skraup synthesis. The pyridine nucleus takes up hydrogen more readily than the benzenoid part of the molecule: reduction with tin and hydrochloric acid yields a tetrahydroquinoline, whilst the decahydride is obtained with greater difficulty. Numerous substitution products of quinoline are known, and the position of any substituent in the molecule is designated in accordance with the scheme shown in the formula, the letters o, *m*, *p*, and a, standing for the terms ortho-, meta-, para-, and ana-.



Derivatives with the substituents in the benzene nucleus are prepared by the methods in use for the introduction of such groups into benzene and naphthalene; or the substituted benzene derivative can be subjected to the quinoline synthesis given above. It is more difficult to introduce halogen, nitro- or similar groups into the pyridine nucleus.

α-Hydroxyquinoline can be obtained in 80% yield by strongly heating quinoline with potash. The hydroxyquinolines are important because of their relationship to the alkaloids. Those with the hydroxyl in the benzene nucleus are conveniently prepared from aminophenols.

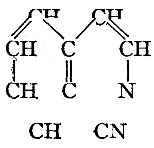
a-Hydroxydihydroquinolines are obtained by the action of alkalis on the alkyl quinolinium iodides. The hydroxide or ammonium base first formed isomerizes into the less ionized α-hydroxydihydroquinoline, which is a pseudo-base. These compounds are distinguished by a remarkable reactivity of the hydroxyl group, forming alcoholates and condensing readily with aniline, phenylhydrazine and hydroxylamine. This great reactivity, together with the capacity that the a- and y-methylquinolines possess for condensing with aldehydes and similar compounds, is utilized in the preparation of the magnificent blue and red dyes of the cyanines, isocyanines and apocyanines. These dyes are used as sensitizers in photography for rendering the plate orthochromatic.

α-Aminoquinoline can be obtained directly from quinoline by treatment with sodamide, as well as by the usual methods for preparation of amino derivatives. The aminoquinolines can be diazotized and coupled to form azo dyes in the same way as aniline, but they are not of great use.

Homologues.—Of the homologues of quinoline, the most important are quinaldine, lepidine and y-phenylquinoline. Quinaldine is α-methylquinoline and is present in coal tar, forming about 25% of the quinoline fraction. It may be readily prepared synthetically by condensing aniline with acetaldehyde by means of hydrochloric acid. It is a colourless liquid, b.p. 247° C. The methyl group is very reactive, condensing readily with aldehydes, and with phthalic anhydride to form the dye known as quinoline yellow. A red isocyanine dye is prepared by treating the mixed ethiodides of quinoline and quinaldine with alcoholic potash. Lepidine or y-methylquinoline also occurs in coal tar. It is produced when the alkaloid cinchonine is distilled with potash. Similarly y-phenylquinoline is related to the quinia alkaloids. Many of the higher homologues of quinoline have been found among the coal tar bases.

Chromic acid oxidizes the methylquinolines to the corresponding quinolinecarboxylic acids. Potassium permanganate produces pyridinetricarboxylic acids.

Uses.—Certain quinoline derivatives find use in medicine for antiseptic, antifebrile and analgesic purposes. The base itself has been used as an insecticide. Isoquinoline, C_9H_7N, the isomeride of quinoline was discovered in coal tar in 1885, but forms only about 1·5% of the quinoline fraction. It has the constitution shown in the formula, which is confirmed by its synthesis and oxidation products. It was separated from the quinoline in coal tar by the fractional crystallization of the mixed sulphates. Isoquinoline can be prepared synthetically by passing benzylidene-ethylamine through a hot tube and by the reduction of homophthalimide. It is a solid, m.p. 23° C, and boils at 240° C. As a tertiary amine and a mono-acid base, it has many reactions in common with quinoline. It is the parent body of many alkaloids. Its most important use is for the preparation of quinoline red, a dye employed as a photo-sensitizer. (J. Ro.)

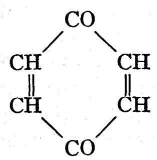

Isoquinoline

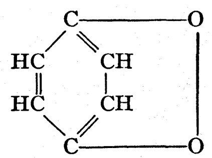
QUINONES in organic chemistry a group of compounds derived from the aromatic hydrocarbons and containing two ketonic groups, CO. (*See* KETONES.) The quinones are of twofold importance, first as being intermediates in the manufacture of synthetic dyes, and secondly as forming the basis of a theory of colour among organic compounds.

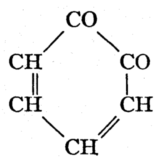
Among the quinones employed in dye production the most important is anthraquinone (*q.v.*), but a few others have found employment, such as acenaphthenequinone (see ACENAPHTHENE) and phenanthrenequinone. (*See* PHENANTHRENE.) Benzoquinone and its halogenated derivatives have also come into use as dye intermediates. There are two main divisions of quinones depending on the relative position of the ketonic groups. The *para*-quinones contain the two ketonic groups at opposite ends of the aromatic ring in the so-called "para-position," whereas in the *ortho*-quinones the two ketonic groups are adjacent to one another. So far there is no decisive indication of the existence of *meta*-quinones.

The para-benzoquinone, or ordinary quinone (formula I.), is prepared by the oxidation of aniline with sodium dichromate and dilute sulphuric acid. It sublimes in golden yellow needles, melting at 115·7° C and dissolves in ether, alcohol or hot water. It has a characteristic pungent smell.

Benzoquinone is also formed during the aerial oxidation of benzene vapour over vanadium pentoxide; maleic anhydride is also produced in this process owing to further oxidation of the benzene nucleus.

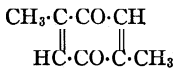

(I.)


(II.)


(III.)

p-Benzoquinone is a tautomeric substance behaving as if it possessed either of the formulae (I.) or (II.). The oxidising power of benzoquinone on hydriodic acid, hydroxylamine or phenylhydrazine suggests the peroxide structure (formula II.). With hydroxylamine hydrochloride, however, it yields either the mono- or di-oxime and with as-benzoylphenylhydrazine or 2:4:6-trinitrophenylhydrazine it condenses to form hydrazones. These reactions indicate the diketonic structure (formula I.) which is now generally used for this quinone. With potassium chlorate and hydrochloric acid it furnishes tetrachlorobenzoquinone (chloranil), a colour intermediate. Other benzenoid *p*-quinones resemble p-benzoquinone in their general physical and chemical properties. An interesting confirmation of formula (I.) is afforded by the synthesis of para-xyloquinone (formula V.) from diacetyl (2 mols., formula IV.) under the influence of warm, aqueous caustic alkali (H. von Pechmann, 1888).

(IV.) $CH_3{\cdot}CO{\cdot}CO{\cdot}CH_2H$
$CHH_2{\cdot}CO{\cdot}CO{\cdot}CH_3$

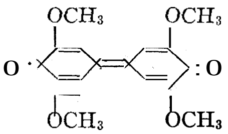
 (V.)

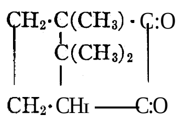
o-Benzoquinone (formula III.) was obtained in chloroform solution by C. L. Jackson in 1901 by the action of iodine on the lead derivative of catechol; it was isolated in 1908 by R. Willstatter and Muller by silver oxide oxidation of catechol dissolved in an inert solvent. It was then obtained either in red or colourless crystals. The red variety, which is inodorous, non-volatile and decomposes below 70° C, is most probably the truly quinonoid compound as its colour corresponds with that of the more stable tetrabromo-o-benzoquinone, which crystallises in dark red prisms first obtained by Stenhouse in 1875.

From the hydrocarbon toluene, ail three possible quinones have been obtained, namely two *ortho*-toluquinones and one *para*-toluquinone; the first two are unstable red substances, odourless and non-volatile like *o*-benzoquinone, the last, resembles p-benzoquinone in its odour, volatility and yellow colour.

The three quinones of naphthalene are discussed under that hydrocarbon (*q.v.*).

Cedriret or *Coerulignone* is a quinone of interesting type (formula VI.) obtained by treating with alkali bichromate the acetic acid solution of pyrogallol dimethyl ether which is present in beechwood or birchwood tars (C. Liebermann, 1873).

(VI.) 

 (VII.)

The crude quinone which slowly separates is dissolved in phenol below 30° C and reprecipitated by alcohol in the form of dark blue needles. Other heteronuclear quinones of the diphenyl series have since been described by R. Willstatter and others.

Quinones on reduction yield colourless dihydro derivatives termed quinols. The combination of quinone and quinol gives rise to a quinhydrone which is more coloured than the quinone itself. Quinol and p-benzoquinone give a green quinhydrone. Quinone chloroimide and dichloroimide, $O{:}C_6H_4{:}NCl$ and $ClN{:}C_6H_4{:}NCl$ are yellow compounds volatile in steam and produced by the action of bleaching powder on *p*-aminophenol and *p*-phenylenediamine respectively.

Quinone-diamine, $HN{:}C_6H_4{:}NH$, produced by oxidising *p*-phenylenediamine in ethereal solution with silver oxide, is colourless, m.p. 124° C (R. Willstatter, 1904).

The foregoing quinones all contain unsaturated aromatic hydrocarbon rings, but camphorquinone (formula VII.), obtained by the hydrolysis of isonitrosocamphor, is a bright yellow substance melting at 198° C.

The quinonoid theory of colour is dealt with in the article COLOUR: Influence of Chemical Constitution.

BIBLIOGRAPHY.—T. E. Thorpe, *Dictionary of* Applied Chemistry, vol. v., 1924, contains a comprehensive article on Quinones and their derivatives. (G. T. M.)

QUINSY, a common term for acute suppurative tonsilitis (*q.v.*).

QUINTAIN, an instrument used in the age of chivalry in practising for the tournament (O. Fr. *quintaine,* from Lat. *quintana,* a street between the fifth and sixth maniples of a camp, where warlike exercises took place). An early form consisted of the wooden figure of a Saracen armed with shield and sword; the object being to strike the figure on the forehead between the eyes.

As late as the 18th century running at the quintain survived in English rural districts.

QUINTESSENCE, in ancient and scholastic philosophy, the name given to the fifth immaterial element, over and above the four material elements, air, water, earth and fire, which Aristotle assumed to be permeating the whole world, and called *οὐσία*; in mediaeval philosophy this was called *quinta essentia,* the fifth essence.

QUINTILIAN [MARCUS FABIUS QUINTILIANUS] (c. A.D. 35–95), Roman rhetorician, was born at Calagurris in Spain. The years from 61 to 68 he spent in Spain, probably in the retinue of the future emperor Galba, with whom he returned to the capital. For at least 20 years after the accession of Galba he was at the head of the foremost school of oratory in Rome. Vespasian created for him a chair of rhetoric. About the year 88 Quintilian retired from teaching and from pleading, to compose his great work on the training of the orator (*Institutio* Oratoria). After two years' retirement he was entrusted by Domitian with the education of two grand-nephews, whom he destined as successors to his throne. Quintilian gained the titular rank of consul, and probably died not long before the accession of Nerva (A.D. 96). A wife and two children died early. His great work, the *Institutio* Oratoria, is in form a manual on the training of a public speaker; in fact it is the outline of a liberal education. As an orator, a teacher and an author, Quintilian set himself to stem the current of popular taste which found its expression in what we are wont to call silver Latin; but apparently he did not attempt to modify the primary cause of it—the excessive concentration on poetry in the early stages of literary training. In his youth the influence of the younger Seneca was dominant. But the chief teacher of Quintilian was a man of another type, one whom he ventures to class with the old orators of Rome. This was Domitius Afer, a rhetorician of Nîmes, who rose to the consulship. His great model was Cicero, of whom he speaks at all times with unbounded eulogy, and whose faults he could scarce bring himself to mention; nor could he well tolerate to hear them mentioned by others. The reaction against the Ciceronian oratory which had begun in Cicero's own lifetime, had acquired overwhelming strength after his death. Quintilian failed to check it, as another teacher of rhetoric, equally an admirer of Cicero, had failed—the historian Livy. The great movement for the poetization of Latin prose which was begun by Sallust ran its course till it culminated in the monstrous style of Fronto. The teachers and audiences in the schools of declamation, and in the courts the judges, juries and audiences alike, demanded the startling, quaint or epigrammatic, and the speakers practised a thousand tricks to satisfy the demand.

Starting with the maxim of Cato the Censor that the orator is "the good man who is skilled in speaking," Quintilian takes his future orator at birth and shows how this goodness of character and skill in speaking may be best produced. The scheme followed is the standard division into three periods, supervised by the litterator, the *grammaticus,* and the *rhetor* respectively. Under the first the child receives elementary instruction, under the second he is grounded in literary criticism and scholarship generally as well as in what we call grammar, especial emphasis being laid on poetry; the third stage studied much the same authors, though more attention was given to prose, but with a direct view to the practice of oratory. The parts of the work which relate to general education are of great interest and importance. Quintilian postulates the widest culture; there is no form of knowledge from which something may not be extracted for his purpose; and he is fully alive to the importance of method in education. Yet he develops all the technicalities of rhetoric with a fulness to which we find no parallel in ancient literature. Even in this portion of the work the illustrations are so apposite and the style so dignified and yet sweet that the modern reader, whose initial interest in rhetoric is of necessity faint, is carried along with much less fatigue than is necessary to master most parts of the rhetorical writings of Aristotle and Cicero. The passages which review Greek and Latin literature are the most famous of all. There is a considerable traditional element in these, greater on the Greek than on the Latin side; but substantially posterity has concurred in his judgment. In the divine government of the universe he seems to have had a more than ornamental faith, though he doubted the immortality of the soul. As to politics Quintilian, like others of his time, felt free to eulogize the great anti-Caesarian leaders of the dying republic, but only because the assumption was universal that the system they had championed was gone for ever.

The Latin of Quintilian is not always free from the faults of style which he condemns in others. It also exhibits many of the usages and constructions which are characteristic of the silver Latin. But no writer of the decadence departs less widely from the best models of the late republican period. The language is on the whole clear and simple, and varied without resort to rhetorical devices and poetical conceits.

Besides the *Znstitutio Oratoria,* there have come down to us under Quintilian's name 19 longer (ed. Lehnert, 1905) and 145 shorter (ed. Ritter, 1884) *Declamationes,* or school exercitations on themes like those in the *Controversiae* of Seneca the elder. The longer pieces are certainly not Quintilian's. The shorter were probably published, if not by himself, at least from notes taken at his lessons. Editio princeps, Carnpames (Rome, 1470). Of the editions of the whole works the chief is that by Burmann (1720); of the *Znstitutio Oratoria* that by Spalding, completed by Zumpt and Bonnell (1798–1834, 5th ed., Meister, 1882).

QUINTUS SMYRNAEUS, Greek epic poet, probably flourished in the latter part of the 4th century A.D. He is sometimes called Quintus Calaber, because the only ms. of his poem was discovered at Otranto in Calabria by Cardinal Bessarion in 1450. According to his own account (xii. 310), he tried his hand at poetry in his early youth, while tending sheep at Smyrna. His epic in 14 books, known as Τὰ μεθ' Ὅμηρον or *Posthomerica,* takes up the tale of Troy at the point where Homer's Iliad breaks off (the death of Hector), and carries it down to the capture of the city by the Greeks, their departure and dispersal in the storm. The poet has no originality; in conception and style his work is ciosely modelled on Homer.

Editio princeps by Aldus Manutius (1504); Köchly (ed. major with elaborate prolegomena, 1850; ed. minor, 1853); Z. Zimmermann, author of other valuable articles on the poet (1891); *see* also Kehmptzov, *De Quinti Smyrnaei Fontibus ac Mythopoiia* (1889); C. A. Sainte-Beuve, *Etude sur . . . Quinte de Smyrne* (1857); F. A. Paley, *Quintus Smyrnaeus and the "Homer" of the tragic Poets* (1879); G. W. Paschal, *A Study of Quintus Smyrnaeus* (Chicago, 1904).

QUIPUS. The Peruvian *quipus* consists of a number of thongs or cords hanging from a top-band or cross-bar, generally forming groups, often with an equal number of cords in each group, with cords from these and again from the last. Knots occur rarely on the main cord. In its simplified form, knots are merely tied upon the individual cords. In its more elaborate forms the cords are of different colours, and are knotted together so as to form open loops of various shapes. In the Antiguedades Peruanas, we are told that the knots of the *quipus* in all probability indicated only numbers originally, but that as time went on the skill of the makers became so great that historical events, laws and edicts could thus be communicated. In every place of any importance there was an official whose business it was to interpret *quipus* received from a distance, and to make *quipus* himself. If, however, the *quipus* came from a distant province, it was not intelligible without an oral explanation. The art of interpretation of *quipus* is lost, so that it is impossible to ascertain how far the knots were merely a mnemonic for the messenger, and how far they were intelligible without explanation to a stranger. Recent examination of a series of complete *quipus* suggests knowledge of an astronomical nature, similar to that of the Mayas, and the use of these devices for magical purposes. Similar mnemonics were used amongst the Chinese, the Tibetans and other peoples of the Old World. See KNOTS.

BIBLIOGRAPHY.—See Leland Locke, *The Ancient Quipus* (1923); E, Nordenskiöld, *The Secret of the Peruvian Quipus* (1925).

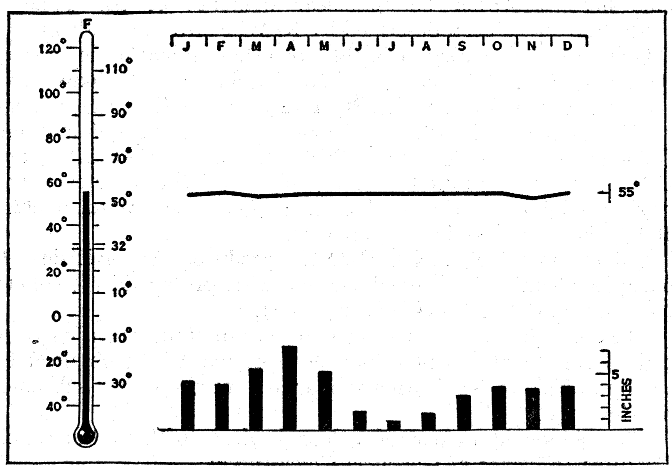
QUIRINUS (*kwĭ-rī'nus,* Lat. *kwĭ-rē'nōōs*) was the third (after Jupiter and Mars) of the purely Roman gods. The name Quirinus is adjectival in form, and it would seem to mean "he of *quirium,*" a word generally taken since Niebuhr to signify a very ancient Sabine settlement which united with the Palatine community to form the original Rome; but (see Kretschmer in Glotta, x. 147 et seq.) it may well mean "assembly" (*covirium*), and therefore the god may be "he of the assembly or assembled host." The identification, in the last century of the republic, of Quirinus with the deified Romulus has greatly obscured his real nature, but we know he resembled Mars (q.v.), had a flamen, the third in rank of the greater flamines, and a college of Salii. His temple lay on the *collis Quirinalis,* and his festival, the Quirinalia, was on Feb. 17. Associated with him in cult were a goddess, Hora, and certain minor deities, the Virites Quirini.

See Wissowa, *Relig. u. Kultus* (2nd ed.), p. 153, and Roscher's *Lexikon.*

QUIRITES (*kwĭ-rī'tēz*), earliest name of the burgesses of Rome (see QUIRINUS). In the phrase "populus Romanus Quirites (or Quiritium)," it denoted the individual citizen as contrasted with the community. Hence ius Quiritium in Roman law denotes full Roman citizenship. Whether the word ever had military associations is a point much debated, but if so it lost them at an early date and came to designate Roman citizens in their civil, as distinct from their military, capacity, and referred solely to Romans concerned in domestic affairs. Thus Caesar is said to have quelled a mutiny among his legionaries by the device of addressing them as "Quirites" (citizens). (See ROMAN LAW.)

QUITMAN, a city of southern Georgia, U.S.A., the county seat of Brooks county; on federal highway 84, and served by the Atlantic Coast Line and the South Georgia railways. Pop. 4,149 in 1930; 4,450 in 1940. It has several mills and factories, and is a shipping point for melons, garden truck, and other agricultural produce. The city was founded in 1858 and incorporated in 1859.

QUITO, the capital of the republic of Ecuador, and of the province of Pichincha, situated in lat. 0° 14′ S., long. 79° 45′ W., about 114m. from the Pacific coast and 165m. in a direct line north-east of Guayaquil, with which it is connected by a railway completed in 1908. In 1941 the population of Quito was estimated at 142,440. It occupies a small basin of the great central plateau formed by the volcano Pichincha on the west, the Puengasi ridge on the east, and ridges north and south formed by spurs from the eastern side of Pichincha. The ground upon which the city is built is uneven and is traversed from west to east by two deep ravines (quebradas), one of which is arched over in great part to preserve the alignment of the streets. The city is in great part laid out in rectangular squares, the streets running nearly



WEATHER GRAPH OF QUITO. THE MERCURY INDICATES THE NORMAL ANNUAL MEAN TEMPERATURE. THE CURVE SHOWS THE NORMAL MONTHLY MEAN TEMPERATURE. AND THE COLUMNS INDICATE THE NORMAL MONTHLY PRECIPITATION

with the cardinal points of the compass. The houses of Quito are chiefly of the old Spanish or Moorish style. The building material in general use is sun-dried bricks, which in the better houses is covered with plaster or stucco. The public buildings are of the heavy Spanish type. Facing the principal square (Plaza Mayor), and occupying the whole south side, is the cathedral; on the west side is the government palace; on the north the archbishop's palace; and on the east the municipal hall. The elevation of this plaza is 9,343ft. above sea-level. The finest building in the city is the Jesuits' church, the façade of which is covered with elaborate carving. Among public institutions are the university, which occupies part of the old Jesuit college, an astronomical observatory, and 11 large monastic institutions, six of which are for nuns. One of the convents, that of San Francisco, covers a whole block, and ranks among the largest institutions of its kind in the world. A part of it is in ruins, and another part has been for some time used as military barracks by the government. The university has faculties of theology, law and medicine, and has 200 to 250 students, but it is antiquated in character and poorly supported. The eminent botanist and chemist, Dr. William Jameson (1796–1872), was a member of its faculty for many years. There are a number of retail and wholesale firms. The city exports include hides and forest products from the wooded mountain slopes near by. Religious paintings of a mediaeval type are produced in large numbers and exported. The native manufactures include tanned leather, saddles, shoes, ponchos, woollen and cotton cloth, fibre sandals and sacking, blankets, coarse matting and woollen carpets. Quito artisans show much skill in wood and ivory carving and in gold and silver work. The women excel in fine needlework.

Quito derives its name from the Quitus, who inhabited the locality a long time before the Spanish conquest In 1533 Sebastian Benalcazar took peaceable possession of the native town and in 1541 it was elevated to the rank of a Spanish city. Its full title was San Francisco del Quito, and it was capital of the province or presidency of Quito down to the end of Spanish colonial rule. It has suffered repeatedly from earthquakes.

QUIT RENT, a yearly payment, a relic of the feudal system, made by the copyholders or freeholders of an English manor to its lord. It is a customary payment based on immemorial usage. It is called quit rent because it acquits the tenant of all dues and obligations to the lord. When paid by a freeholder, quit rent is called chief rent. This form of rent has its origin in the feudal services due to the manor, compounded for an annual payment (see RENT).

In the United States the term quit rent is used to describe a perpetual rent reserved upon the conveyance of a fee simple, more commonly known as a fee-farm rent, a ground rent, or rent charge.

QUIXOTE, DON (in Spanish Don Quijote), the hero of Cervantes' (q v.) romance (part 1, 1605: part 2, 1615), which was originally conceived as a satire of farcical incident directed against the romances of chivalry. *(See* SPANISH LITERATURE.) He has given his name in all European languages to a type of character which misses practical success by supposing that common humanity is governed by ideals as exalted or as imaginative as its own.

QUM, a province and town in Persia. The province lies between Tehran, north, and Kashan, south, producing abundant grain, and cotton of a very long staple. The revenue amounted to 342,088 krans in 1926–27 (about £7,602). Qum, the administrative headquarters, in 34° 39' N. and 50° 55′ E., has an elevation of 3,100 ft. Pop. (1935) 25,000. It is a stronghold of the Shiah faith and has many tombs of saints and pious persons including the shrine of Fatima, sister of the Imam Riza; and the town is visited by large numbers of pilgrims. The later Safavis are buried at Qum. The walls of the town are dilapidated, but though the bazaars are poor, a brisk trade is carried on during the pilgrim season. The industries are the making of glass, pottery and shoes.

BIBLIOGRAPHY.—A. Houtum-Schindler, *Eastern Persian Irak,* Special publication, *R.G* S., 1897; A. V. Williams Jackson, *Persia past and present,* 1906; H. R. d'Allemagne, *Du Khorassan au pays des Backhtiaris. Trois mois de voyage en Perse,* 1911.

QUOIN, in architecture, originally any vertical external corner of a building; more generally applied, at present, to large cut stones used either to form an accurate corner in a wall of rough rubble or brick or else to furnish a decorative termination to a wall surface of any material. Projecting stone quoins, frequently rusticated, or with the edges slightly recessed or bevelled, are common decorative features in the high Renaissance work in Italy, the early 17th century work in France and the Palladian style in England; in these styles they are used not only at the corners of a building, but also often at the edges of windows and doors. In much 18th century work in Scandinavia, England and America, projecting quoin shapes are formed with brick.

QUOITS, a pastime resembling the ancient discus-throwing which formed one of the five games of the Creek pentathlon (*see* DISCUS), the two main differences between the ancient and modern sports being that the quoit is ring-shaped (one surface being rounded, the other—the back--being flat) and is lighter than the discus, and its throwing is a test rather of accuracy than strength. Few traces of a game resembling quoits (O.Fr. *coiter, quoiter,* to incite) can be found on the continent of Europe, and its origin may be sought for on the borderland of Scotland and England. There are references to it in the Midlands dating from the beginning of the 15th century, and it was one of the games prohibited in the reigns of Edward III. and Richard II. in favour of archery. According to the modern rules (1869 code modified), two iron or steel pins 18yd. apart are driven into the ground, leaving 1in. exposed. Each is situated in the centre of an "end," a circle of stiff clay 3ft. in diameter. The quoits, made of iron, may be of any weight, but are usually about g lb. each. They must not exceed $8\frac{1}{2}$in. in diameter, or be less than $3\frac{1}{2}$in. in the bore, or more than $2\frac{1}{4}$in. in the web. When delivering his quoit a player must stand within 4ft. 6in. of the centre of the end and at its side. Matches are played between teams or individuals, the object of the game being to throw the quoit as near to the pin as possible, a "ringer"; *i.e.,* a quoit actually surrounding the pin, counting two, and a quoit nearer to the pin than any of the adversary's, counting one. A match may be for any number of points, the team or player scoring that number first being the winner. In championship matches all quoits farther than 18in. from the end, are foul and removed. All measurements are made from the middle of the pin to the nearest edge of the quoit. If one or more quoits are lapped, the one most accessible is first measured and withdrawn. All quoits on their backs are a foul.

The championship of America is rewarded by the "Bell Medal," presented by the Grand National Curling Club of America.

(T. A. C.)

QUORUM, in its general sense, a term denoting the number of members of any body of persons whose presence is requisite in order that business may be validly transacted by the body or its acts be legal. The term is derived from the wording of the commission appointing justices of the peace which appoints them all. jointly and severally to keep the peace in the county named. It also runs—"We have also assigned you, and every two or more of you (of whom [*quorum*], any one of you the aforesaid A, B, C, D, etc., we will shall be one) our justices to inquire the truth more fully," whence the justices so named were usually called justices of the *quorum.* The term was afterwards applied to all justices, and subsequently, by transference, to the number of members of a body necessary for the transaction of its business.

QUOTATION, a passage repeated from the writings or speech of another. The verb "to quote" comes from Med. Lat. *quotare* (from *quot,* how many), to refer to by numbers, *i.e.,* of page, chapter, etc., also to separate into chapters, verses, etc. The term is also applied to the statement of the current prices of goods, commodities, stocks and shares (*see* STOCK EXCHANGE).

Useful lists of familiar quotations may be found in the following:—H. T. Riley, *Dictionary of Latin and Greek Quotations,* ed. Bohn; J. K. Hoyt and A. L. Ward, *The Cyclopaedia of Practical Quotations, English and Latin* (1892) ; Cassell's *Classified Quotations* (1924) ; J. Bartlett, *Familiar Quotations* (1926) ; C. N. Douglas, *Forty Thousand Quotations* (1921) ; Putnam's *Dictionary of Thoughts* (1930).

QUO WARRANTO, in English law, the name given to an ancient prerogative writ calling upon any person usurping any office, franchise, liberty or privilege belonging to the Crown, to show "by what warrant" he maintained his claim. the onus being on the defendant. It lay also for non-user or misuser of an office, etc. If the Crown succeeded, judgment of forfeiture or ousterlemain was given against the defendant. *(See* OUSTER.) The procedure was regulated by statute as early as 1278 (the statute of *Quo Warranto,* 6 Edw. *I.* ch. 1), which was superseded by the modern form of an information in the nature of a quo warranto, exhibited on behalf of the Crown or a private person called the relator. The information will not be issued except by Ieave of the court on proper cause being shown. It lies where the office is of a public nature and created by statute, even though it is not an encroachment upon the prerogative of the Crown. Where the usurpation is of a municipal office the information is regulated by 9 Anne ch. 25 (1711). Such an information must, in the case of boroughs within the Municipal Corporations Act, 1882, be brought within 12 months after disqualification (s. 225); in the case of other boroughs, within six years after the defendant first took upon himself the office. Though nominally a criminal it has long been really a civil proceeding, and has recently been declared to be so.

In the United States, quo warranto is the proper remedy under the statutes of the various states to ascertain the right of a person to an office of a public nature, or one in a corporation. It also is used to test the validity of a franchise held by a municipality or a public service corporation. Some states have substituted by statute information in the nature of quo warranto and other remedies, and where such substitution has been made, quo warranto is improper.

FOUNDED A·D· 1768

R The letter corresponding to modern R in the ancient Semitic alphabet was 4 (resh). Greek rho is found in a form practically unchanged in the early inscriptions from the island of Thera. The same form also occurs in early inscriptions from Attica and Corinth and in the Chalcidic alphabet. The most usual Greek form was rounded P and this is the form in which the letter occurs in the Lydian alphabet. A form D in which the loop is extended to the bottom of the vertical stroke also occurs in both the eastern and western alphabets. This was the form of the letter in the Umbrian and Oscan alphabets of Italy, although it is not found in Etruscan, the form in which is P or q. In the latter, however, the loop reaches nearly to the ground. In the Chalcidic alphabet a form R with an additional oblique stroke occurred. and this was taken over into Latin and exaggerated, so that we find the forms R, R and R. The last of the three survived.

NAME OF FORM	APPROX-IMATE DATE	FORM OF LETTER
PHOENICIAN	B.C. 1,200	4
CRETAN	1,100-900	4
THERAEAN	700-600	4
ARCHAIC LATIN	700-500	P
ATTIC	600	4
CORINTHIAN	600	4
CHALCIDIAN	600	P
IONIC	403	q
ROMAN COLONIAL	PRE-CLASSICAL AND CLASSICAL TIMES	R R R R
URBAN ROMAN		R
FALISCAN		q Я Я
OSCAN		◁ D D
UMBRIAN		D D
CLASSICAL LATIN AND ONWARDS		R

THE DEVELOPMENT OF THE LETTER "R" FROM THE EARLIEST TIMES TO THE PRESENT DAY

The minuscule form has been subject to many variations. In cursive Latin of the 6th century occurred a form ⋁ in which the loop has disappeared, the three right-hand oblique strokes, or the loop and oblique stroke, being reduced to a single stroke. The Irish form in the 7th century was ɲ in which a similar process had taken place, but the remnants of the loop and oblique stroke had become extended in a horizontal direction. On the basis of this was formed the Carolingian r, in which the vertical stroke was not extended below the line. The Carolingian form is the minuscule r of modern printing, but in handwriting it still contends with the form ʌ, resembling the Latin cursive tradition.

The sound represented by the letter has been the liquid, formed by contact between the tip of the tongue and the palate. The tip of the tongue is sometimes also rolled. In certain continental countries the sound is pronounced farther back in the mouth than in England. In southern England the sound is a very weak one, and when final is completely dropped (*e.g.*, in the words *mother*, steamer, etc.). The ancients recognised a difference in the sound as pronounced by the Greeks and Romans. The Greek R was probably unvoiced or whispered, a fact expressed by placing the rough breathing over the letter when initial and by spelling Greek words containing this letter, when they were borrowed into Latin and the modern languages, by the combination rh.

(B. F. C. A.)

RA, the Egyptian solar god, one of the most important figures in the Pantheon. See EGYPT: Religion.

RABA BEN JOSEPH BEN HAMA (c. 280–352), Babylonian rabbi or amora. He is closely associated in his studies with Abaye. The latter was head of the Academy at Pumbeditha. Raba founded a new school at Mahuza, which eventually became so long as Raba lived the only academy in Babylonia (Persia). The development of Talmudic Law (or Halakkah) was much indebted to this rabbi, whose influence in all branches of Jewish learning was supreme. His friendship with the King Shapur II. enabled Raba to secure a relaxation of the oppressive laws enacted against the Jews of Persia.

See Graetz, *History of* the *Jews* (Eng. trans., vol. ii., ch. xxi.) ; Bacher, *Agada der* Babyl. *Amoraer,* p. 108, etc., and 114–133.

RABAH ZOBEIR (d. 1900), the conqueror of Bornu (an ancient sultanate on the western shores of Lake Chad, included since 1890 in British Nigeria), was a half-Arab, half-negro chieftain. He was originally a slave or follower of Zobeir Pasha (*q.v.*), and is said to have formed one of the party which served as escort to Miss Tinne (*q.v.*) in her journeys in the Bahr-el-Ghazal in 1862–64. In 1879, Zobeir being in Egypt, his son Suleiman and Rabah were in command of Zobeir's forces in the Bahr-el-Ghazal. They persisted in slave-raiding, and denied the khedive's authority, and Gordon sent against them Romolo Gessi Pasha. Gessi captured Suleiman and routed Rabah, who in July 1879 fled westward with some seven hundred Bazingirs (black slave soldiers). He made himself master of Kreich and Dar Banda, countries to the south and south-west of Wadai. He eventually established himself in Bagirmi, a state south-east of Lake Chad. In 1893 Rabah overthrew the sultan of Bornu. In his administration of the country he showed considerable ability and a sense of public needs. To the British, represented by the Royal Niger Company, Rabah gave comparatively little trouble. Early in 1897 he began an advance in the direction of Kano, the most important city in the Fula empire. The news of the crushing defeat by Sir George Goldie of the Fula at Bida, induced Rabah to return to Bornu. He now turned his attention to the French. Bmile Gentil had in this same year (1897) reached Lake Chad, via the Congo and Bagirmi, and had installed a French resident with the sultan of Bagirmi. As soon as Gentil had withdrawn, Rabah again fell upon Bagirmi, and forced sultan and resident to flee. In 1899 the French sent an expedition to re-conquer the country, but it was only after a third encounter (April 22, 1900) that Rabah was slain and his host defeated. The chieftain's head was cut off and taken to the French camp. In this battle Major Lamy, the French commandant, also lost his life.

The French continued the campaigh against Rabah's sons, two of whom were killed. Rabah had left instructions that if his army was finally defeated by the French, his successor should return to Bornu and make friends with the British. Rabah's third son, Fader-Allah, accordingly threw himself entirely upon British protection. But, in the later part; of 1901 Fader-Allah, who had 2,500 riflemen, again made aggressive movements against the French. In retaliation, Captain Dangeville pursued him into British territory. A battle was fought at Gujba, Fader-Allah being defeated. He fled mortally wounded and died the same night.

Connected accounts of Rabah's career are contained in É. Gentil's *La Chute de l'empire de Rabah* (Paris, 1902) and in M. von Oppenheim's *Rabeh und das Tschadseegebiet* (Berlin, 1902).

RABAT (*Ribàt*), a city on the Atlantic coast of Morocco, in 34° 3' N., 6° 46' W., 130 m. S. of Cape Spartel, on the southern side and at the mouth of the Bu-Regreg, which separates it from Salk on the northern bank, administrative capital of the French protectorate, seat of the general residency of France in Morocco. The native town and the mellah form a trapeze, protected from the open winds by a rise of land occupied by vast cemeteries. It is defended on the north by the Kasba of the Oudaïa, built on the cliff which rises at the mouth of the Bu-Regreg; a fine gateway (12th century) gives access to it; there is a museum in the neighbouring medersa (university). Three kilometres to the south of Rabat is the Hassan tower, a magnificent minaret of the Almohade period, and still further to the south the necropolis of Chella, which contains the tombs of the Merinides dynasty. The Dar-el-Makchzen (palace of the sultan) rises to the south-west. Important European quarters, with houses surrounded by gardens, have been arranged outside, and at a certain distance from, the native town; they are traversed by wide avenues. The general residency and the administrative offices are situated in the Touargas quarter. The harbour, impeded by a bar, is difficult of access; works are proceeding with a view to improving the channel, but Rabat, situated between Kenitra and Casablanca, does not seem called to a great commercial future, and will remain above all an elegant residential town. Pop. (1930) 55,348; 27,986 are Muslim, 4,218 Jews, 23,144 Europeans including 16,388 French civilians and 2,342 French soldiers. In 1913 there were only 300 Europeans.

Several towns have followed one another at the mouth of the Bu-Regreg. The most ancient settlement was at Chella, which, under the Romans, was called Sala Colonia. There were on the same spot a Berber town, which was succeeded, in the 12th century, by Salk on the right bank of the river. About the same time the Almohade sultan, Abd-el-Mumen, founded Rabat-el-Fath, the camp of victory, from which the town of Rabat takes its name; it was there that assembled the contingents of the holy war destined against Spain; it was also called Sala-el-Djedid, Salé the New, in opposition to Sala-el-Khedim, Salé the Old. In the 17th century Rabat received numerous Andalusians expelled from Spain, and became an independent republic of famous corsairs, at first rival, then vassal of Salé. The Alauit dynasty endowed it with many monuments, But the real rise of Rabat dates from the French protectorate (1912).

See *Rabat et sa région* (*Villes et Tribus du Maroc*), 4 vols. (Paris, 1918–20); L. Mercier, *Notes sur Rabat et Chella (Archives Marocaines,* tome v. to viii. (1905–08); Henri Basset et Levi-Provençal, *Chella: une nécropole Mérinide* (*Hesperis,* 1922); *H.* de la Casinière, *Les municipalités marocaines* (Casablanca, 1924).

RABAUT, PAUL (1718–1794), French pastor of "the Church of the Desert" (see HUGUENOTS), was born at Bédarieux, near Montpellier, on Jan. 29, 1718. In 1738 he was admitted as a preacher, and after a year's study (1740–41) at the Lausanne Seminary, received charge of the church of Nimes. In 1744 he was vice-president of the general synod. During the persecution of 1745–1752 Rabaut went into hiding, and in 1753 a price was put on his head. During the years that followed he sought, with Antoine Court and others, to place French Protestantism on a solid basis and to improve their legal position. In 1785, when he was visited by General La Fayette, it was arranged that Rabaut's son, Rabaut Saint-Btienne, should go to Paris on behalf of the Reformed Church. In November 1787 Louis XVI.'s edict of toleration was signed, though it was not registered until Jan. 29, 1788. Two years later liberty of conscience was proclaimed by the National Assembly, of which Rabaut Saint-Étienne was chosen vice-president, and it was declared that non-Catholics might be admitted to all positions. After the fall of the Girondists, however, in which Rabaut. Saint-Étienne was involved, Paul Rabaut, who had refused to renounce his title of pastor, was arrested, dragged to the citadel of Nimes, and kept in prison seven weeks (1794). He died Sept. 25, 1794, soon after his release.

See J. Pons de Nimes, *Notice biographique sur Paul Rabaut* (1808); Charles Dardier, *Paul Rabaut, ses lettres à Antoine Court* (1884) and *Paul Rabaut, ses lettres à divers* (1891).

RABAUT SAINT-ETIENNE, JEAN PAUL (1743–1793), French revolutionary, was born at Nîmes, the son of Paul Rabaut (*q.v.*), the name of Saint-Etienne being assumed from a property near Nimes. In the Constituent Assembly he worked on the framing of the constitution, spoke against the establishment of the republic, and voted for the suspensive veto, as likely to strengthen the position of the crown. In the Convention he sat among the Girondins and was proscribed with his party. He went into hiding, but was discovered and guiliotined Dec. 5, 1793.

See J. A. Dartique, *Rabaut St.-Étienne à l'Assemblée Constituante* (1903).

RABBAN BAR SAUMA (*fl.* 1280–1288), Nestorian traveller and diplomatist, was born at Peking about the middle of the 13th century. He started on a pilgrimage to Jerusalem, and travelling by way of Tangut, Khotan, Kashgar, Talas in the Syr Daria valley, Khorasan, Maragha and Mosul, arrived at Ani in Armenia. Warnings of the danger of the routes to southern Syria turned him from his purpose; and his friend Rabban Marcos suggested Bar Sauma's name to Arghun Khan, sovereign of the Ilkhanate or Mongol-Persian realm, for a European embassy, then contemplated, to conclude an anti-Muslin1 alliance with the chief States of Christendom. Bar Sauma set out in 1287, with Arghun's letters to the Byzantine emperor, the pope and the kings of France and England. He went first to Constantinople, then to Rome. The papacy being then vacant, a definite reply to his proposals was postponed, and Bar Sauma passed on to Paris, where he visited Philip IV. In Gascony he met King Edward I. of England, probably at Bordeaux. On returning to Rome, he was cordially received by Pope Nicolas IV., who gave him communion on Palm Sunday, 1288, allowed him to celebrate his own Eucharist in the capital of Latin Christendom, commissioned him to visit the Christians of the East, and entrusted to him the tiara which he presented to Mar Yaballaha. His narrative is of unique interest as giving a picture of mediaeval Europe at the close of the crusading period, painted by a keenly intelligent, broad-minded and statesmanlike observer.

See J. B. Chabot's translation and edition of the *Histoire du Patriarche Mar Jabalaha III. et du moine Rabban Cauma* (from the Syriac) in *Revue de l'Orient latin,* 1893, pp. 566–610; 1894, pp. 73–143, 235–300; O. Raynaldus, *Annales Ecclesiastici* (continuation of Baronius), A.D. 1288, ss. xxxv.–xxxvi.; 1289, s. lxi.; C. R. Beazley, *Dawn of Modern Geography* (1897, etc.) ii. 15, 352; iii. 12, 189–190, 539–541.

RABBI, a Jewish title (Hebr. רַבִּי, My teacher or master; διδάσκαλε, John I., 38) or *Rab* (master) or *Rabbēnu* (our master; Hebrew) or *Rabbān* (our master: Aramaic) are titles applied to Jewish scholars or doctors of the Law, but not used by them in speaking of themselves. They spoke of themselves as *Talmidhē Hakhāmim* (disciples of the wise); in later days a spiritual head of a congregation would style himself הצעיר or הקטן (cf. title page of S. Singer's Authorized *Daily* Prayer *Book).* Rab in biblical Hebrew means "great" and in later Hebrew "master" as opposed to *'ébhedh* or servant. These titles must be differentiated and the *locus classicus* is the famous letter of Sherira (see GĀON) from which it is clear that *Rab* is a Babylonian and Rabbi a Palestinian title. In Rabbi and *Rabbēnu* the pronominal suffixes "my" and "our" soon lost all force. Rabban was reserved for the Patriarchs, the first to bear the title being Gamaliel I. (*haz-Zāqen*), who presided alone over the Sanhedrin. Sherira emphasizes the fact that the earlier authorities (*e.g.,* Hillel) bore no titles. As regards the relative rank of the variants he says, "Rabbi is higher than Rab and Rabban is higher than Rabbi: higher than Rabban is the simple name." This means that the earliest untitled authorities are the most distinguished: these are followed by the Patriarchs and then by the Palestinian Tannaites (see GĀON) and Babylonian scholars successively. It is clear that in the days of Jesus titles were not used and some modern scholars therefore consider Matthew xxiii., 7, 8: Mark x., 51: John xx., 16 as anachronisms. The

Toṣefta to *'Eduyōth* (end) maintains that Rabbi denotes a teacher with at least two generations of disciples: in process of time antiquity makes him regarded as Rabban and by the time the second generation of disciples is forgotten he is styled by his own name alone. On the other hand Judah I., the redactor of the Mishnah is often known as Rabbi *κατ' ἐξοχήν*, while the Amora Abba *Arika* was generally styled Rab. The title of Rabbi was later conferred by ordination (Semikhah or laying on of hands): a still later term is *hattārath hōra'ah* or *facultas* docendi. The Qaraites in the tenth century who rejected Rabbinic tradition designated their opponents as Rabbanites. In mediaeval times Rabbēnu was used of distinguished scholars. In modern days Rabbi or Rab is often a courtesy title.

RABBIT, a well known rodent, formerly called cony. The rabbit, Oryctolagus *cuniculus,* is a member of the family Leporidae (see RODENTIA). From the hare (*q.v.*) the rabbit is distinguished by its smaller size, shorter ears and feet, absence of black on the ears and grey colour; by the facts that the young are born naked and blind and that it lives in burrows in the ground. It breeds from four to eight times a year, a litter comprising three to eight young. It begins to breed at the age of six months and lives seven or eight years.

Originally inhabiting the western half of the Mediterranean basin, the rabbit has spread, partly by the agency of man, throughout temperate Europe, and it is still extending its range. Introduced into New Zealand and Australia, where natural enemies were few, it has increased beyond bounds and is now an unmitigated nuisance. In North America some 57 forms are known, of which the commonest is the cottontail (Sylvilagus *floridanus*). (See HARE for other American Leporidae.)

The rabbit has long been domesticated, and the variations produced are greater than in any other mammal except the dog (*q.v.*). For not only has the weight been quadrupled and the structure of the skeleton modified, but the proportionate size of the brain has been reduced (cf. the domestic duck) and the colour and texture of the fur remarkably altered. The old English lop-eared breed may have ears 23 in. from tip to tip and 6 in. in width. The hardy and prolific Belgian hare resembles the true hare in colour and form, while a similar but larger variety is the (so-called) Patagonian rabbit. The Angora rabbit has very long fur, which is of commercial value; the most valued variety is the albino. The Dutch breed is small and particoloured, being dark posteriorly and white anteriorly. The silver grey is much esteemed for its skin, while the Flemish giant is the biggest of all breeds.

Modern dressing and dyeing methods have developed rabbit fur (known to the fur trade as "coney") into the most satisfactory of low priced furs for wearing qualities. Because it lends itself readily to dyeing it is used in great quantities in imitation of such furs as squirrel, seal, beaver, nutria, Chinchilla, muskrat, ermine, leopard and still others. Various tame varieties of rabbits, which are heavier, and have a fur stronger and less liable to shed, are being raised in increasing numbers, especially in Belgium and France, to supply the demand. Because of the excellent felting properties of rabbit fur it now forms the largest proportion of fur going into the manufacture of felt hats. Forty to fifty rabbit skins furnish material for a dozen hats. Rabbit fur is also in demand for upholstery purposes. The supply of rabbits for the hat industry comes chiefly from Australia (which for some years has averaged 70,000,000 skins annually), New Zealand, Belgium, France and England.

BY COURTESY OF THE AMERICAN MUSEUM OF NATURAL HISTORY
LESSER ARIZONA COTTONTAIL

RABBŪLĀ, a distinguished bishop of the Syrian church early in the 5th century. He was a native of Kenneshrin, a town some few miles south of Aleppo and the seat of a bishopric. He resided for some time in a monastery, and then passed to a life of greater hardship as a solitary hermit. On the death of Diogenes, bishop of Edessa, in the year 411–412, Rabbūlā was chosen his successor. On one occasion he visited Constantinople and there preached before Theodosius II. (who was then favourable to Nestorius) and a great congregation a sermon in denunciation of Nestorian doctrine, of which a portion survives in the Syriac version. He became the friend of Cyril of Alexandria, with whom he corresponded, and whose treatise De recta *fide* he translated into Syriac. The version survives in a British Museum ms.; see Wright's *Catalogue* p. 719. He died in August 435.

RABELAIS, FRANÇOIS (c. 1495–1553), French author, was born at Chinon on the Vienne in the province of Touraine. The date of his birth is uncertain: it has been put by tradition, and by authorities long subsequent to his death, as 1483, 1490 and 1495. Most 17th-century authorities give the earliest date, and this also accords best with the age of the eldest of the Du Bellay brothers, with whom Rabelais was (perhaps) at school. In favour of the middle date, the testimony of Guy Patin (1601–72), a witness of some merit and not too far removed in point of time, is invoked. The only contribution which need be made here to the controversy is to point out that if Rabelais was born in 1483 he must have been an old man when he died, and that scarcely even tradition speaks of him as such. It is said that he had four brothers and no sisters, that his father had a country property called La Devinière, and was either an apothecary or a tavern-keeper. An indistinct allusion of his own has been taken to mean that he was tonsured in childhood at seven or nine years old; and tradition says that he was sent to the convent of Seuilly. From Seuilly at an unknown date tradition takes him to the convent school of La Baumette near Angers, where he is supposed to have been at school with the brothers Du Bellay, with Geoffroy d'Estissac and others. He certainly entered the Franciscan monastery of Fontenay le Comte some time before April 5, 1519, by which date he held a position sufficiently senior to sign deeds for the community. The letters of the well-known Greek scholar Budaeus, together with some notices by André Tiraqueau, a learned jurist, to whom Rabelais rather than his own learning has secured immortality, show what manner of life the future author of *Gargantua* led in his convent. The letters of Budaeus show that an attempt was made by the heads of the convent or the order to check the studious ardour of these Franciscans; but it failed, and there is no positive evidence of anything like actual persecution. Papers were seized as suspicious, then given back as innocent; but Rabelais was in all probability disgusted with the cloister—indeed his great work shows this beyond doubt. In 1524 his friend Geoffroy d'Estissac procured from Clement VII. an indult, licensing a change of order and of abode for Rabelais. From a Franciscan he became a Benedictine, and from Fontenay he moved to Maillezais, of which Geoffroy d'Estissac was bishop. But even this learned and hospitable retreat did not apparently satisfy Rabelais. In or before 1530 he left Maillezais, abandoned his Benedictine garb for that of a secular priest, and, as he himself puts it in his subsequent *Supplicatio* pro *Apostasia* to Pope Paul III., per *seculum* diu *vagatus fuit.* For a time the Du Bellays provided him with an abode near their own château of Langey, but on Sept. 17, 1530, he entered the faculty of medicine at the University of Montpellier, becoming bachelor on Nov. 1, a remarkably short interval, which shows what was thought of his acquirements. Early in 1531 he lectured publicly on Galen and Hippocrates, and his stay at Montpellier, which lasted rather more than a year at first, was renewed at intervals for several years.

In 1532, however, he had moved from Montpellier to Lyons. He was appointed before the beginning of November physician to the Hôtel Dieu, with a salary of 40 livres per annum, and lectured on anatomy with demonstrations from the human subject. He edited for Sebastian Gryphius, in the single year 1532, the medical *Epistles* of Giovanni Manardi, the *Aphorisms* of Hippocrates, with the *Ars* Parva of Galen, and an edition of two supposed Latin documents, which, however, happened unluckily to be forgeries.

At this time Lyons was the centre of an unusually enlightened society, and indirectly it is clear that Rabelais became intimate with this society. A manuscript distich, which was found in the Toulouse library, deals with the death of an infant named Théodule, whose country was Lyons and his father Rabelais, but we know nothing more about the matter. What makes the Lyons sojourn of the greatest real importance is that at this time probably appeared the beginnings of the work which was to make Rabelais immortal. There is no doubt that both Gargantua and Pantagruel were popular names of giants in the Middle Ages, though no mention of the former in French literature much before Rabelais's time has been traced. In 1526, however, Charles de Bordigné, in a satiric work of no great merit, entitled *la Légende de Pierre Faifeu,* has the name Gargantua with an allusion, and in 1532 (if not earlier) there appeared at Lyons *les Grandes et inestimable chroniques du grand et énorme géant Gargantua.* This is a short book on the plan of the later burlesques and romances of the Round Table. Arthur and Merlin appear with Grandgosier, as he is here spelt, Galemelle (Gargamelle), Gargantua himself, and the terrible mare. But there is no trace of the action or other characters of *Gargantua* that was to be, nor is the manner of the piece in the least worthy of Rabelais. No one supposes that he wrote it, though it has been supposed that he edited it and that in reality it is older than 1532, and may be the direct subject of Bordigné's allusion six years earlier. What does, however, seem probable is that the first book of *Pantagruel* (the second of the whole work) was composed with a definite view to this chapbook and not to the existing first book of *Gargantua,* which was written afterwards, when Rabelais discovered the popularity of his work and felt that it ought to have some worthier starting-point than the *Grandes chroniques.* The earliest known and dated edition of *Pantagruel* is of 1533, of *Gargantua* 1535, though this would not be of itself conclusive; but the definite description of Gargantua in the title as "Père de Pantagruel," the omission of the words "second livre" in the title of the first book of *Pantagruel* while the second and third are duly entitled "tiers" and "quart," the remarkable fact that one of the most important personages, Friar John, is absent from book ii., the first of *Pantagruel,* though he appears in book i. *(Gargantua),* and many other proofs show the order of publication clearly enough. Besides this, 1533 saw the publication of an almanac, the first of a long series which exists only in titles and fragments, and of the amusing *Progizosticatioiz Pantagrueline* (still, be it observed, Pantagrueline, not Gargantuine). Both this and *Pantagruel* itself were published under the anagrammatic pseudonym of "Alcofribas Nasier," shortened to the first word only in the case of the *Prognostication.*

On Oct. 23, 1533, *Pantagruel* was condemned by the Sorbonne, and in Jan. 1534 Jean du Bellay, passing through Lyons on an embassy to Rome, engaged Rabelais as physician. The visit did not last very long, but it left literary results in an edition of a description of Rome by Marliani, which Rabelais published in Sept. 1534.

In the spring of 1535 the authorities of the Lyons hospital, considering that Rabelais had twice absented himself without leave, elected Pierre de Castel in his place; but the documents do not imply any blame, and the appointment of his successor was once definitely postponed in case he should return. In the summer of 1535 Rabelais once more accompanied Jean du Bellay, now a cardinal, to Rome, and stayed there till April in the next year. To this period belong letters to Geoffroy d'Estissac, the already-mentioned *Supplicatio pro Apostasia,* and the bull of absolution which was the reply to it. This bull freed Rabelais from ecclesiastical censure, and gave him the right to return to the order of St. Benedict when he chose, and to practise medicine. He took advantage of this bull and became a canon of St. Maur. In 1537 he took his doctor's degree at Montpellier and lectured on the Greek text of Hippocrates, and in July 1538 he was present in the capacity of *maître des requêtes* at the canference between Francis I. and Charles V. at Aigues-Mortes. In 1540 we find him for the third time in Italy in the service of Guillaume du Bellay-Langey, elder brother of Jean, who was governor of Piedmont; and according to the letters of Pellicier, bishop of Montpellier and ambassador to Venice, Rabelais was then employed by him to collect mss. for the king's library. In Dec. 1540 he was compelled to return to France to clear himself of a charge of having revealed diplomatic secrets, but he rejoined Guillaume du Bellay at Turin in the following spring, and remained in his service until he died on Jan. 9, 1543. Rabelais wrote a panegyrical memoir of Guillaume, which is lost, and the year before saw the publication of an edition of *Gargantua* and *Pantagruel,* book i., together (both had been repeatedly reprinted separately), in which some dangerous expressions were cut away. Nothing at all is known of his life, whereabouts, or occupations till the publication of the third book, which appeared in 1546, "avec privilège du roi," which had been given in Sept. 1545.

Up to this time Rabelais, despite the condemnation of the Sorbonne referred to above, had experienced nothing like persecution or difficulty. Even the action of Dolet, who in 1542 reprinted the earlier form of the books which Rabelais had just slightly modified, seems to have done him no harm. But the storm of persecution which towards the end of the reign of Francis I. was fatal to Dolet himself and to Des Périers, while it exiled and virtually killed Marot, threatened him. It is certain that he passed nearly the whole of 1546 and part of 1547 at Metz in Lorraine as physician to the town at the salary of 120 livres, and Sturm speaks of him in a contemporary letter as having been "cast out of France by the times," and says that he himself in another letter gives a doleful account of his pecuniary affairs and asks for assistance. At Francis's death on March 31, 1547, Du Bellay went to Rome, and at some time not certain Rabelais joined him. He was certainly there before June 1548, and he was still there in Feb. 1549, when he dates from Du Bellay's palace a little account of the festivals given at Rome to celebrate the birth of the second son of Henry II. and Catherine de' Medici. This account, the *Sciomachie* as it is called, is extant. In the same year a monk of Fontevrault, Gabriel du Puits-Herbault, made in a book called *Theotimus* the first of the many attacks on Rabelais. It is, however, as vague as it is violent, and it does not seem to have had any effect. Rabelais had indeed again made for himself protectors whom no clerical or Sorbonnist jealousy could touch. The *Sciomachie* was written to the cardinal of Guise, whose family were all-powerful at court, and Rabelais dedicated his next book to Odet de Châtillon, afterwards cardinal. Thus Rabelais was able to return to France, and in 1550 was presented to the livings of Meudon and St. Christophe du Jambet. There is very little ground for believing that the "curé of Meudon" ever officiated or resided there. He certainly held the living for less than three years, resigning it in Jan. 1553 with his other benefice, and at the episcopal visitation of 1551 he was not present.

Some chapters of Rabelais's fourth book had been published in 1548, but the whole did not appear till 1552. The Sorbonne censured it and the parlement suspended the sale, taking advantage of the king's absence from Paris. But it was soon relieved of the suspension. He died, it is said, on April g, 1553, but actual history is quite silent save on the point that he was not alive in May of the next year, and the legends about his deathbed utterances—"La farce est jouée," "Je vais chercher un grand peut-être," etc.—are altogether apocryphal. The same may be said of the numerous silly stories told of his life, such as that of his procuring a free passage to Paris by inscribing packets "Poison for the king," and so forth.

Ten years after the publication of the fourth book and nine after the supposed date of the author's death there appeared at Lyons 16 chapters entitled *l'fle sonnante par maistre François Rabelais,* and two years later the entire fifth book was printed as such. In 1567 it took place with the others, and has ever since appeared with them. But from the beginning of the 17th century there have been disbelievers in its authenticity. The opponents of the book rely (1) on the testimony of a certain Louis Guyon, who in 1604 declared that the fifth book was made long after Rabelais's death by an author whom he knew, and who was not a doctor, and on the assertion of the bibliographer Du Verdier, about the same time, that it was written by an "écolier de Valence"; (2) on the fact that the anti-monastic and even anti-Catholic polemic is much more accentuaf ed in it; (3) on the arguments that parts are apparently replicas or rough drafts of passages already appearing in the four earlier books; and (4) that some allusions are manifestly posterior to even the farthest date which can be assigned for the reputed author's decease. On the other hand, it is urged that, though Guyon and Du Verdier were in a sense contemporaries they wrote long after the events, and that the testimony of the former is vitiated, not merely by its extreme vagueness, but by the fact that it occurs in a plaidoyer, tending to exculpate physicians from the charge of unorthodoxy; that Du Verdier in another place assigns the Prognostication *Pantagrueline* to this same unknown student of Valence, and had therefore probably confused and hearsay notions on the subject; that the rasher and fiercer tone, as well as the apparent repetitions, are sufficiently accounted for on the supposition that Rabelais never finally revised the book, which indeed dates show that he could not have done, as the fourth was not finally settled till just before his death; and that it is perfectly probable, and indeed almost certain, that it was prepared from his papers by another hand, which is responsible for the anachronous allusions above referred to. But the strongest argument, and one which has never been attacked by authorities really competent to judge, is that the "griffe de l'aigle" is on the book, and that no known author of the time except Rabelais was capable of writing the passage about the Chats *fourrés,* the better part of the history of Queen Whims (La Quinte) and her court, and the conclusion giving the Oracle of the Bottle.

Gargantua and *Pantagruel* are, unfortunately, so little read that some sketch of their contents is necessary. The first book, *Gar*gantzia, describes the birth of that hero (a giant and the son of gigantic parents), whose nativity is ushered in by the account of a tremendous feast. In this the burlesque exaggeration of the pleasures of eating and drinking, which is one of the chief exterior notes of the whole work, is pushed to an extreme. Very early, however, the author becomes serious in contrasting the early education of his hero—a satire on the degraded schools of the middle ages—with its subsequent and reformed stage, in the account of which all the best and noblest ideas of the humanist Renaissance in reference to pedagogy are put with exceptional force. Gargantua is recalled from Paris, whither he had been sent to finish his education, owing to a war between his father, Grandgosier, and the neighbouring king, Picrochole. This war is described at great length, the chief hero of it being the monk, Friar John, a very unclerical cleric, in whom Rabelais greatly delights. Picrochole defeated and peace made, Gargantua establishes the abbey of Thelema in another of Rabelais's most elaborate literary passages, where all the points most obnoxious to him in monastic life are indicated by the assignment of their exact opposites to this model convent. The second book introduces the principal hero of the whole, Pantagruel, Gargantua's son, who goes through something like a second edition of the educational experiences of his father. Like him, he goes to Paris, and there meets with Panurge, the principal triumph of Rabelaisian character-drawing, and the most original as well as puzzling figure of the book. Panurge has almost all intellectual accomplishments, but is totally devoid of morality. This book, like the other, has a war in its latter part; Gargantua scarcely appears in it and Friar John not at all. It is not till the opening of the third book that the most important action begins. This arises from Panurge's determination to marry—a determination, however, which is very half-hearted, and which leads him to consult a vast number of authorities, each giving occasion for satire of a more or less complicated kind. At last it is determined that Pantagruel and his followers (Friar John has reappeared in the suite of the prince) shall set sail to consult the Oracle of the Dive *Bouteille*. The book ends with the obscurest passage of the whole, an elaborate eulogy of the "herb pantagruelion," which appears to be, if it is anything, hemp. Only two probable explanations of this have been offered, the one seeing in it an anticipation of Joseph de Maistre's glorification of the executioner, the other a eulogy of work, hemp being on the whole the most serviceable of vegetable products for that purpose. The fourth and fifth books are entirely taken up with a description of the voyage. Many strange places with stranger names are visited, some of them offering obvious satire on human institutions, others, except by the most far-fetched explanations, resolvable into nothing but sheer extravaganza. At last the Land of Lanterns, borrowed from Lucian, is reached, and the Oracle of the Bottle is consulted. This yields the single word "Trinq," which the attendant priestess declares to be the most gracious and intelligible she has ever heard from it. Panurge takes this as a sanction of his marriage, and the book ends abruptly. This singular romance includes the most bewildering abundance of digression, burlesque amplification, covert satire on things political, social and religious, miscellaneous erudition of the literary and scientific kind. Everywhere the author lays stress on the excellence of "Pantagruelism," and the reader who is himself a Pantagruelist (it is perfectly idle for any other to attempt the book) soon discovers what this means. It is, in plain English, humour, which may be said to consist in the extension of a wide sympathy to all human affairs, together with a comprehension of their vanity. Moroseness and dogmatism are as far from the Pantagruelism of Rabelais as maudlin sentimentality or dilettantism. Perhaps the chief things lacking in his attitude are, in the first place, reverence, of which, however, from a few passages, it is clear he was by no means totally devoid, and secondly, an appreciation of passion and poetry.

For a general estimate of Rabelais's literary character and influence the reader may be referred to the article FRENCH LANGUAGE AND LITERATURE.

However, there are three questions without the discussion of which this notice of one of the foremost writers of the world would not be worthy of its present place. These are—What is the general drift and purpose of *Gargantua* and Pantagruel, supposing there to be any? What defence can be offered, if any defence is needed, for the extraordinary licence of language and imagery which the author has permitted himself? What was his attitude towards the great questions of religion, philosophy and politics? These questions succeed each other in the order of reason, and the answer to each assists the resolution of the next.

According to some expositors, Rabelais is a sober reformer, an apostle of sound education, of rational if not dogmatic religion, who wraps up his morals in a farcical envelope partly to make them go down with the vulgar and partly to shield himself from the consequences of his reforming zeal. According to others, Rabelais is all this but with a difference. He is not religious at all; he is more or less anti-religious; and his book is more or less of a general protest against any attempt to explain supernaturally the riddle of the earth. According to a third class, the Rabelaisian legend does not so much err in principle as it invents in fact. Rabelais is the incarnation of the "esprit Gaulois," a jovial, careless soul, not destitute of common sense or even acute intellectual power, but first of all a good fellow, rather preferring a broad jest to a fine-pointed one, and rollicking through life like a good-natured undergraduate. But it is impossible to think that any unbiased judge reading Rabelais can hold the grave-philosopher view or the reckless-goodfellow view without modifications and allowances which practically deprive either of any value. Those who identify Rabelais with Pantagruel, strive in vain to account for the vast ocean of pure or impure laughter and foolery which surrounds the few solid islets of sense and reason and devotion. Those who identify Rabelais with Panurge can never explain the education scheme, the solemn apparition of Gargantua among the farcical and fantastic variations on Panurge's wedding, and many other passages; while, on the other hand, those who insist on a definite propaganda of any kind must justify themselves by their own power of seeing things invisible to plain men.

No one reading Rabelais without *parti pris,* but with a good knowledge of the history and literature of his own times and the times which preceded him, can have much difficulty in appreciating his book. He had evidently during his long and studious sojourn in the cloister acquired a vast stock of learning. He was, it is clear, thoroughly penetrated with the instincts, the hopes, and the ideas of the Renaissance in the form which it took in France, in England and in Germany—a form, that is to say, not merely humanist but full of aspirations for social and political improvement, and above all for a joyous, varied, and non-ascetic life. He had thoroughly convinced himself of the abuses to which monachism lent itself. Lastly, he had the spirit of lively satire and of willingness *desipere* in *loco* which frequently goes with the love of books. It is in the highest degree improbable that in beginning his great work he had any definite purpose or intention. The habit of burlesquing the *romans d'aventures* was no new one, and the form lent itself easily to the two literary exercises to which he was most disposed — apt and quaint citation from and variation on the classics and satirical criticism of the life he saw around him. Here and there persons are glanced at, but for the most part the satire is typical rather than individual, and it is on the whole a rather negative satire. In only two points can Rabelais be said to be definitely polemic. He certainly hated the monkish system in the debased form in which it existed in his time; he as certainly hated the brutish ignorance into which the earlier systems of education had suffered too many of their teachers and scholars to drop. At these two things he was never tired of striking, but elsewhere, even in the grim satire of the *Chats fourrés,* he is the satirist proper rather than the reformer. It is in the very absence of any cramping or limiting purpose that the great merit and value of the book consist. It holds up an almost perfectly level and spotless mirror to the temper of the earlier Renaissance. The author has no universal medicine of his own (except Pantagruelism) to offer, nor has he anybody else's universal medicine to attack. It is not indeed possible to deny that in the Oracle of the Bottle, besides its merely jocular and fantastic sense, there is a certain "echo," as it has been called, "of the conclusion of the preacher," a certain acknowledgment of the vanity of things; but it is little more than a suggestion, and is certainly not strengthened by anything in the body of the work. Rabelais is, in short, if he be read without prejudice, a humorist pure and simple, feeling often in earnest, thinking almost always in jest. He is distinguished from the two men who alone can be compared with him in character of work and force of genius combined — Lucian and Swift — by very marked characteristics. He is much less of a mere mocker than Lucian, and he is entirely destitute, even when he deals with monks or pedants, of the ferocity of Swift. He neither sneers nor rages; the *rire immense* which distinguishes him is altogether good-natured; but he is nearer to Lucian than to Swift, and Lucian is perhaps the author whom it is most necessary to know in order to understand him.

If this general view is correct it will probably condition to some extent the answer to be given to the two minor questions stated above. The first is connected with the great blemish of *Gargantua* and *Pantagruel*—their extreme coarseness of language and imagery. Rabelais's errors in this way are of course, looked at from an absolute standard, unpardonable. But judged relatively there are several, we shall not say excuses, but explanations of them. In the first place, his comparative indecency has been much exaggerated by persons unfamiliar with early French literature. The form of his book was above all things popular, and the popular French literature of the middle ages as distinguished from the courtly and literary literature, which was singularly pure, can hardly be exceeded in point of coarseness. Moreover, Rabelais's coarseness, disgusting as it is, has nothing of the corruption of refined voluptuousness about it, and nothing of the sniggering indecency which disgraces men like Pope, like Voltaire, and like Sterne. The general taste having been considerably refined since, Rabelais has in parts become nearly unreadable — the worst and most appropriate punishment for his faults. As for those who have tried to make his indecency an argument for his laxity in religious principle, that argument hardly needs discussion. It is notoriously false as a matter of experience.

This brings us to the last point — what his religious opinions were. He has been claimed as a free-thinker of all shades, from undogmatic theism to atheism, and as a concealed Protestant. The last of these claims has now been very generally given up, but the accusation of free-thinking, if not of directly anti-Christian thinking, has always been more common. Those who hold this opinion, however, never give chapter and verse for it, and it may be said confidently that chapter and verse cannot be given. The sayings attributed to Rabelais which colour the idea are purely apocryphal. Even a jest at the Sorbonne couched in the Pauline phrase about "the evidence of things not seen," was removed by the author from the later editions. It must be remembered that the later middle age, which in many respects Rabelais represents almost more than he does the Renaissance, was, with all its unquestioning faith, singularly reckless and, to our fancy, irreverent in its use of the sacred words and images. On the other hand, there are in the book expressions which either signify a sincere and unfeigned piety of a simple kind or else are inventions of the most detestable hypocrisy. For these passages are not, like many to be found from the Renaissance to the end of the 18th century, obvious flags of truce to cover attacks — mere bowings in the house of Rimmon to prevent evil consequences. They are always written in the author's highest style, a style perfectly eloquent and unaffected; they can only be interpreted (on the free-thinking hypothesis) as allegorical with the greatest difficulty and obscurity, and it is pretty certain that no one reading the book without a thesis to prove would dream of taking them in a non-natural sense. There is absolutely nothing within the covers of Rabelais's works incompatible with an orthodoxy which would be recognized as sufficient by Christendom at large, leaving out of the question those points of doctrine and practice on which Christians differ. Beyond this no wise man will go, and short of it hardly any unprejudiced man will stop.

BIBLIOGRAPHY.—The first complete edn. of R. was publ. by J. Martin (Lyons, 1567). It is computed that 60 edns. were printed before the close of the 16th century (P. P. Plan, *Biblio. rabelaisienne,* 1532–1711, 1904). The first critical edn. of importance is that of Le Duchat (Amsterdam, 1711). Since the elaborate edn. of E. Johanneau (9 vols., 1823) there have been many edns., M. Marty-Laveaux in the Collection Lemerre (6 tom, 1868–1903), R. Lefranc, and others. There have been many commentaries independent of edns., from J. Bernier's *Jugement et Nouvelles Observations sur les oeuvres . . . de M. F. Rabelais* (1697), onwards.

See monographs by E. Noel (1850); A. Mayrargues (1868); J. Fleury (1876); P. Stapfer (the best) (1889); H. Hatzfield (Leipzig, 1923); J. Plattard, *La Vie de Fr. R.* (1929); also L. Saineanu, *La Langue de R.* (2 tom., 1922–23), and *Le cinqulme livre de R.* in Probltmes Littéraires du seizit-me sit-cle (1927); P. Villey, *Les grands écrivains du XVI siècle, R. et Marot,* in Bibl. Littéraire de la Renaissance, Tom. XI. (1923); J. Boulenger, *R. à travers les ages,* bibl. (1925); W. Nicati, *R. notre maître; son oeuvre, sa doctrine, le Pantagruelisme* (1926); *see* also *Revue des Études Rabelaisiennes* (1903–12), contd. as *Revue du seizième siècle* (1913, in prog).

Rabelais was very early popular in England, and Sir T. Urquhart trans. the earlier books in 1653; Motteux finished it with an extensive commentary in 1694. In 1893 there was a new trans. (2 vols) by W F. Smith. For English criticism *see* A. F. Chappell, *The Enigma of R., an essay in Interpretation* (1924); N. H. Clement, *The Infl. of the Arthurian Romances on the five books of R.* (Univ. of California, 1926). *See* also S. P. Putnam, *Rabelais: Man of the Renaissance* (1929).

RABIES: *see* HYDROPHOBIA.

RABIRIUS, a Latin epic poet of the age of Augustus. Among the papyrus fragments discovered at Herculaneum in the early part of the 19th century were sixty-seven (mutilated) hexameters, referring to the final struggle between Antony and Octavian and the death of Cleopatra, generally supposed to be part of a poem by Rabirius, since Seneca (*De Benef.* vi. 3, 1) informs us that he wrote on those subjects. If genuine, they justify the qualified commendation of Quintilian rather than the exaggerated praise of Velleius Paterculus (ii. 36, 3), who couples Rabirius and Virgil as the two most eminent poets of his time.

Fragments in E. Bährens, *Fragmenta Poetarum Romanorum* (1885); W. Scott, *Fragmenta Herculanensia* (Oxford, 1885); O. Ribbeck, *Geschichte der römischen Dichtung,* ii. (1889); M. Schanz, *Geschichte der rdmischen Litteratur,* ii. 1 (1899); Teuffel, *Hist. of Roman Literature* (Eng. trans., 1900), 252, 9.

RABIRIUS, GAIUS, a Roman senator, who was defended (63 B.C.) by Cicero in a speech still extant. Nearly forty years after the death of Saturninus, Titus Labienus was put up by Caesar to accuse Rabirius of the murder. The obsolete accusation of *perduellio* was revived, and the case was heard before Julius and Lucius Caesar as commissioners specially appointed (*duoviri perduellionis*). Rabirius was condemned, and the people were on the point of ratifying the decision on appeal when Metellus Celer dissolved the assembly.

A nephew known as C. RABIRIUS POSTUMUS, was also defended by Cicero (54 B.C.) in the extant speech *Pro Rabirio Postumo,* when charged with extortion in Egypt and complicity with Aulus Gabinius (*q.v.*).

See Cicero, *Pro Rabirio,* ed. W. E. Heitland (1882); Dio Cassius, xxxvii. 26–28; H. Putsche, *Uber das genus judicii der Rede Ciceros pro C. Rabirio* (Jena, 1881); O. Schulthess, *Der Prozess des C. Rabirius* (Frauenfeld, 1891).

RACAN, HONORÉ DE BUEIL, MARQUIS DE (1589–1670), French poet, became page at the court of Henry IV. and then entered the army, seeing some active service. In 1625 he published his most important work, *Bergeries,* a dramatic pastoral. Racan was a follower of Malherbe, and was one of the original members of the French Academy. He died in February 1670.

His *Oeuvres complètes* which include versions of the Psalms and sacred odes, were edited by Tenant de Latour in 1857, and the edition includes a biographical notice. *See* Sainte-Beuve, *Causeries du lundi.*

RACCONIGI, a town of Piedmont, Italy, in the province of Cuneo, 24 mi. S. of Turin, and 31 mi. N. of Cuneo by rail. 837 ft. above sea-level. Pop. (1936) 6.552 (town), 8,209 (commune). It has a royal château (1570), which in 1900 became the summer residence of the king of Italy.

RACCOON or **RACOON,** the typical representative of a family *(Procyonidae)* of American arboreal CARNIVORA (*q.v.*). The raccoon has a curious habit of washing its food in water before eating it. The typical raccoon *(Procyon lotor)* is a thickly built animal about the size of a badger, with a coat of long coarse greyish-brown hairs, short ears, and a bushy black-and-white-ringed tail. It extends over the whole of the United States and stretches on the west northwards to Alaska and southwards into Central America, where it attains its maximum size. The following notes are from Dr. C. Hart Merriam's *The Mammals of the Adirondacks:*—

THE RACCOON OR "COON" (PROCYON LOTOR), OF NORTH AMERICA

"Raccoons are oinnivorous beasts and feed upon mice, small birds, birds' eggs, turtles and their eggs, frogs, fish, crayfish, molluscs, insects, nuts, fruits, maize, and sometimes poultry. Excepting alone the bats and flying-squirrels, they are the most strictly nocturnal of all our mammals. . . . They haunt the banks of ponds and streams, and find much of their food in these places, such as crayfish, mussels, and fish, although they are unable to dive and pursue the latter under water. . . . They are good swimmers. . . . The raccoon hibernates during the severest part of the winter. . . . It makes its home high up in the hollow of some large tree, preferring a dead limb to the trunk itself. . . . From four to six young are . . . born at a time. . . . The young remain with the mother about a year."

The South-American species, *P. cancrivorus,* the crab-eating raccoon, differs by its shorter fur, larger size, more powerful teeth, and other minor characters. It extends over the whole of South America, as far south as the Rio Negro.

RACCOON-DOG (*Nyctereutes procyonoides*), a small wild dog, found in China, Japan and Amurland. The total length is about 32in. The prevailing hues are black and dusky yellow. In habit these dogs are nocturnal. In winter they feed on fish, and in summer on mice, forming small packs to hunt their prey.

RACEME, in botany, an inflorescence in which the main stem continues onwards, bearing the flowers on lateral branches, as in the wallflower (*q.v.*). A compound raceme is called a panicle. *(See* FLOWER.)

RACES OF MANKIND. The study of the varieties of the human race has occupied the attention of thinkers from early times. Two entirely different forms of classification have been employed, one based on the study of the skull, the second, and more generally used method, on superficial characters, such as skin and hair, which may be observed on the living man. To some extent these two methods have been combined in modern times.

Cranial Form.—Apart from Sergi, who elaborated a method of classification based on *cranial form,* the shape being estimated by viewing the skull from on top, most anthropologists have preferred to take measurements. especial importance being attached to the cephalic index—the percentage ratio of the length to the breadth—but numerous other measurements have been made, mostly of little value for classification. W. L. H. Duckworth suggested the combination of three characters on the skull, the cranial capacity, the cephalic index and the degree of prognathism (measured by taking the angle which the most projecting part of the jaw makes with the forehead). On the basis of the possible combinations of these criteria Duckworth divided mankind into seven groups.

Coefficient Method.—Karl Pearson devised a method, termed the coefficient of racial likeness, which aims by a method of averaging at including a very large number of measurements in a single figure The method is complex, and depends on the difference between a series of measurements taken on a set of skulls belonging to one race, and those taken on a second set. There is less difference in those closely allied than in those more distantly related and the coefficient is correspondingly smaller or bigger. The rather complex mathematical processes involved are the chief disadvantage of the coefficient method.

Colour Groups.—The oldest grouping of mankind, still in popular use, is that of skin colour. It has been suggested that the degrees in pigmentation of the human skin are due to the effects of environment, either to sunlight or humidity or a combination of both, the evolutionary changes which took place at an earlier date having become part of the heritage of the races we know to-day. Although the darkest skins are to be found in the tropics, whereas the fairest occur in the temperate climate of western Europe, attempts to correlate skin colour and environment break down when specific cases are considered. Some exceptions can be explained by recent immigration, others again, especially in the individual, by racial admixture, for where races are mixed we may find members of the same family who are very differently pigmented. On the whole the average value of the skin colour in various groups is correlated with other criteria, which appear to be good bases for classification.

One of the most important of these is the cephalic index. Taking the length as 100, the proportion of the breadth seldom falls below 70 or over 90, and it is usual to describe those peoples with an index below 75 as *dolichocephalic* (long-headed), those above 80 as *brachycephalic* (short-headed), the intermediate group being *mesocephalic.* Taken by itself, either in the individual or the race, the cephalic index is by no means a certain guide. We find brachycephalic, mesocephalic and dolichocephalic groups in all the greater divisions of mankind. In the individual, a series of 6,000 Japanese contained one man with an index of 69, and one of 96, and in a continuous series between these two extremes over 700 (about 12%) having indices between 80 and 81, the average being just under the latter figure.

Of the characters generally in use, however, the cephalic index shows most consistently the lowest *relative* variation within small groups. It is therefore of great value for classifying smaller units within the wider divisions, but deductions can only be drawn from the average of a reasonably large number of individuals, at least 50 of the same sex. The practice of artificial deformation may to a certain extent obscure the true head form, and where it occurs the cephalic index is often of little value.

Usually long heads are associated with long faces and vice versa, the face being then termed harmonic. A certain use of this fact has been made for classificatory purposes. There are other features of facial form which appear to be characteristic of different races, but are difficult to measure exactly.

Stature and Nose Form.—The *average* stature is a useful criterion. The form of the nose is estimated by an index formed by taking the length from the root to the junction with the upper lip as 100 and expressing the breadth across the nostrils as a percentage. Professor Thomson, to whom the idea was due, and Buxton have shown that the nasal index tends to be high in those countries where the air is moist and hot and low where it is cold and dry, the various combinations of these two factors being associated with corresponding nasal indices. The correlation is high with certain very marked exceptions, of which the most important is the Australian aborigines. It seems probable that they migrated from a hot, moist climate, and that they have retained the form of nose most appropriate to such a climate. The evolution of any character needs the time factor, especially when, as in this case, evolution by elimination has played an important part.

Hair Form.—On the basis of the form of the hair, mankind may be divided into straight-haired (*leiotrichous*), woolly-haired (*ulotrichous*) and an intermediate group of wavy or curly-haired (*cymotrichous*). Certain types are difficult to define, but usually the distinction is clear-cut. All types of hair may occur in the same population, where racial admixture has taken place, but normally the variation is slight in the same group.

In section the woolly hair is flat and ribbon-like, straight hair is round, wavy and curly hair showing an elliptical form. Here also there may be a certain correlation with environment. The woolly hair occurs for the most part in the Tropics and may form a protection against the sun, being associated with special sweat-glands. The period at which the evolution of the hair form took place is uncertain, but it remains the most convenient basis for the ultimate classification of the great groups of man, the other criteria being subordinated to it. In this classification physical criteria alone have been used; all cultural or linguistic terms have been avoided. Owing to historical reasons certain peoples have been named after the languages they speak, and subsequently these terms have been applied to physical types. Terms like Malay, Dravidian, Mongo! and Bantu are used as if they could be applied to races and not merely to peoples speaking certain groups of languages.

Other Classifications.—The classification given below is based on the anatomical characters already discussed; attention has, however, been recently directed towards certain physiological characters as a basis of racial differentiation. Several criteria have been put forward, amongst them the different reactions of the blood sera in divergent races and the effect of the ductless glands on the macroscopical anatomical characters. Although great stress has been laid on the latter, especially by Sir Arthur Keith, neither this nor other physiological criteria have to the present time been sufficiently investigated to form a basis for a novel classificatory method.

Straight-haired Groups.—The straight-haired peoples correspond to a large extent to the races called by some writers Mongol or Mongoloid, or "the Yellow-Brown Race." All these peoples possess cheek-bones of a greater or lesser degree of prominence. In most cases the face is flattened, often markedly so. The skin is usually yellow, shading into a coppery yellow or brown on one side, and on the other, especially in women, a pale almost white yellow tinge. In Asia the cephalic index tends to vary between mesocephaly and brachycephaly, with some marked cases of the latter form. In America the Eskimo are dolichocephalic and a wide range of mesocephaly and brachycephaly occurs among the other tribes.

While Haddon divides this race into three groups on the basis of a cephalic index, it is probably more convenient to adopt a primary geographical division and to separate the Leiotrichi into an Asiatic and American group, since the latter have been separated from their kinsmen in Asia for a long time and have to a certain extent specialised.

Asiatic Groups.—There are three groups in Asia, a northern or Arctic group, a central group, the Pareoeans (the Dwellers beside the Dawn) and a southern or Proto-Malay, it being possible that the two latter groups, formerly included under the term Southern Mongoloid, should be classed together.

The northern group is rather indeterminate, and includes a number of tribes living in the circumpolar regions of Asia and extending even as far west as northern Scandinavia, where they are represented by the Lapps. Most of these peoples have mixed with other races, to which fact their diversity is due, but they certainly include a mesocephalic and a round-headed subdivision. In eastern Asia at least there is a more northerly group, living in the most easterly extension of the continent and a more southerly group, but the difference is probably due to racial admixture, consequent on the intrusion of the peoples who brought in the Turko-Mongol culture from the west and thus divided the northern and central groups of the straight-haired peoples.

In Korea there is a narrow belt which forms a connecting link between the northern and the Pareoean peoples. The latter differ most strikingly from their northern neighbours in having less prominent cheek-bones and a broadish nose. In the north of China they are often tall; in the south, where the type is found in greater purity, they are short and more stockily built. The Japanese represent a special variety of this type; they have mixed considerably with the Ainu, and this, at least in some cases, has altered their physical type.

The southern extension of these peoples, the Proto-Malays, are widely spread in south-eastern Asia and in the islands. They have been mixed with the various other peoples of this region and it is often difficult to distinguish them except by their broader heads.

The straight-haired peoples also extend into Central Asia, where they are known as Turks and Mongols. These terms are cultural and linguistic, and cannot be used in a racial sense. Great racial admixture has undoubtedly taken place in this region and much of the population is closely connected with the peoples of the west, but types occur with straight hair and other characters which show affinities with the Arctic group.

Most remote from the straight-haired peoples and showing certain relationships to them are the Polynesians, who live on the islands of the Pacific from Samoa to Easter I. and Hawaii to New Zealand. They probably represent an old mixture between the Proto-Malays and a group of the curly-haired people called Nesiots (islanders, see below), but other admixture has taken place and their position is difficult exactly to determine.

The *Amerinds.*—As regards the American aborigines, for whom the term *Amerind* has become conventionalised, it has been disputed whether they should be considered to belong to one race or not. The Eskimo, who to-day inhabit the Arctic coast of America, with a western extension into Asia, and an eastern into Greenland, once lived as far south as the coast of Massachusetts, and survived near Quebec till comparatively recent times. They differ from the other inhabitants of America in many respects notably in having extremely long skulls (the western Eskimo differ somewhat in this respect), which are compressed laterally and are very high-pitched. They have broad faces, an unusual feature in people with a long skull, and very narrow noses. The jaws are exceptionally well-developed and the individual teeth are very large, possibly owing to the nature of their food.

The Amerinds themselves vary considerably in most of those characters usually considered to be of racial significance. Hrdlicka, ho ever, believes that they all belong to the same race. Verneau has recently affirmed the concurrence of types akin to the Melanesians, a view previously held by others also. Haddon suggests with every degree of probability that side by side with the straight-haired peoples there is a cymotrichous type, which he has called Palaeo-Amerinds.

The subdivisions of the true straight-haired Amerinds are somewhat complicated and need not be discussed in great detail. The best basis for division is the cephalic index, but stature and other features must be taken into consideration. The nasal index, it should be noted, increases towards Central America.

The peoples of the north-west coast are most closely allied to the inhabitants of Asia, and are distinguished from the other Amerinds by their lighter skin colour. East of the Rockies and extending over the great plains and into the woodland area there is a group of tall tribes with mesocephalic heads, of whom the Sioux are a typical example. On the east coast in ancient times there was a different type with longer, narrower heads. On the American plateau and extending into central and southern America there is a round-headed type, of short stature and with straight noses, to whom the Maya of ancient times were akin. The Aztecs were more long-headed and their relationship with the more northerly peoples can be traced through some of the inhabitants of northern Mexico to-day.

The ethnology of South America is as yet not fully established, but several types can be distinguished, one akin to the Maya peoples and a different type, with a round head and tall stature, in Patagonia, oi whom the Fuegians are a branch. Side by side with these straight-haired peoples there exist traces of a curly-haired race, both in ancient deposits and also among some modern tribes. With the exception of the Palaeo-Amerinds the distribution of the straight-haired peoples is continuous, the Bering Strait dividing the Asiatic and American branches.

Woolly-haired Groups.—The woolly-haired people have an extremely discontinuous distribution, namely, an eastern habitat which stretches from the continent of Asia to Fiji, and a western, the greater part of Africa. Attempts have been made to bridge this gap. Hüsing believes that in ancient times short dark curly-haired peoples occurred on the Persian Gulf in localities where negroes are still found. These negroes are, however, the descendants of imported slaves, and there is no information of a definite character to support Hüsing's contention. Some of the jungle tribes of south India are said to have negroid characters, but at present no evidence has been collected to bridge the gap between the two groups, and the characters which link them may be due not to community of ancestry but to the effects of a tropical environment. While the original centre of dispersion of these peoples is at present uncertain, there are almost certainly secondary centres of dispersion in north-east Africa and eastern Asia.

In addition to woolly hair all these peoples have the following characters in common: dark skins sometimes almost black, broad noses, usually a rather small brain in relation to their size, especially among the taller members of the group, with forearms and shins proportionately long. In the skeleton there is a smoothness of contour which even in adults often recalls the bony form of a child, and among some members of the group the forehead has that prominent and smooth form which is so characteristic of the infant of our own race. In both eastern and western groups there is a division which includes some very small or pygmy peoples and another of medium or tall-statured tribes.

Eastern Group.—The eastern group may be divided on this basis into the pygmy Negritos and the taller Papuans and Melanesians. The former are all dark-skinned and have heads which are slightly rounded, the cephalic index varying from just under 80 to about 83. There are slight local differences due to the extreme isolation to which these peoples have been subjected Four separate geographical groups occur, one in the Andaman Islands (the Andamanese), one in the central regions of the Malay Peninsula and eastern Sumatra (the Semang), a third in various parts of the Philippine Is., usually called after a well-known tribe, the Aeta and a fourth group called after a tribe in the western mountains of Dutch New Guinea, the Tapiro, who have left traces in other parts of New Guinea and probably also in parts of Melanesia. All these groups are isolated from one another and occupy as it were almost the circumference of a circle. The Andamanese occupy a very special position, both racially and geographically; they have been isolated for a long period and until recently were not in contact with any other race. Such measurements as have been taken indicate that these people are remarkably true to type and show little variation from the average. They are probably the one human group which can be considered a "pure" race.

The Papuans and Melanesians are distinguished from the Negritos by their greater stature and narrower heads; the former probably represent the original stock. At one time they had a wide distribution throughout all Melanesia, probably to Australia, and the extinct Tasmanian aborigines seem to have been a variety of this stock. To-day Papuans are found in New Guinea and in some of the most easterly of the Indian Archipelago islands. They may be distinguished from their kinsfolk by their retreating forehead, prominent brow-ridges and the form of their noses, which are often prominent and rounded, with a down-turned tip.

The Melanesians are extremely variable and include a variety of racial elements, though the basis of the stock is Papuan. The racial mixing which has taken place will account for the fact that, although they are usually woolly-haired. all varieties of hair are found. Stature is equally variable, although the average height is under 5 ft. 3 inches. The prominent brow-ridges so characteristic of the Papuans is not common and the nose is usually smaller than in these peoples. The Melanesians have a wide distribution from the coastal regions of New Guinea and the neighbouring islands to the Pacific from New Caledonia to the Admiralty Is., and as far eastwards as Fiji; formerly they seem to have extended over most of the Pacific.

The Bushmen.—The Bushmen, who belong to the second group of the woolly-haired peoples, are also short, though not of pygmy stature; they differ from the other Ulotrichi in having yellowish skins. Now restricted to the Kalahari desert, they formerly ranged over the whole of south Africa and possibly over a much wider area. Their hair is short and curls into little tufts like pepper-corns, giving the appearance of bald patches. The head is small and low and there is little or no forward projection of the jaw. The most distinctive character of the Bushmen is a great development of the buttocks (steatopygia); this feature is specially developed in the women. The Hottentots are closely allied to the Bushmen and possess most of the characters already described. They represent a cross between the latter and other negroid stocks.

True Negroes.—The true negroes inhabit the Guinea Coast, but their original range seems to have been over most of tropical Africa. They are tall with black or dark brown skins, long narrow heads and retreating foreheads and prominent jaws. The lips are thickened and everted and the nose is very broad. They have mixed with other elements and have produced hybrid stocks. In the upper Nile valley numerous tribes, called Kilotes, are to be found; they are characterised by a very tall stature, a 'slender build and extremely narrow heads. There is also a more round-headed strain, due probably to an early admixture with some curly-haired people. Most, if not all, of the Nilotes have been considerably altered by contact with other non-negro peoples. In central and southern Africa there are numerous negroid tribes characterised by a variety of physical form, due no doubt to racial admixture. The majority are long-headed with considerable variation in stature.

The Pygmies—In the equatorial forests certain pygmy tribes live. These Kegrillos differ from the tall negroes not only in their stature but also in the lighter colour of their skin, which is often yellowish and covered by a light down, and in the more rounded form of the head; the nose is broader even than that of the negro.

Curly-haired Groups.—The third great division of the human race, the curly-haired or Cymotrichous, occupies in many ways an intermediate position between the other two groups. Its distribution is world-wide, and it includes both undifferentiated and highly differentiated groups of mankind. The white races belong to this class. The centre of dispersion of the group was probably somewhere in Asia, but the precise limits of this cradle land have not yet been determined.

The hair varies from wavy to curly, and, whereas in other races it is, with but few exceptions, black or dark brown, in this group every shade occurs from a dead black to a fair straw colour; the brown, however, predominates. The skin colour is equally variable. Most members of this race have a fairly large brain in relation to their body size, but some of the more primitive members are extremely small-brained. The forehead in the males has usually a well-marked prominence over the eyes, the so-called "bar of Michael Angelo." The face is never flattened nor are the lips everted. The stature is very variable, but no pygmy types are found.

Every degree of cephalic index is found, and this still remains the most convenient method of simple classification. The race, however, contains certain sub-races which appear to be more primitive than others and the division into primitive and more advanced groups brings out certain points which may otherwise be overlooked. The primitive which survive are the Proto-Nordics, the Proto-Indics and the Australian aborigines. The Palaeo-Amerinds also probably belong to this class. The rnore advanced peoples include a dolichocephalic group, a mesocephalic and a brachycephalic group.

Proto-Nordics.—The Proto-Nordics appear at one time to have had a wide distribution over northern Asia. Some of the present inhabitants of the Turkoman steppes present this type in an undifferentiated form. The Ainu, who have within comparatively recent times been driven out of the main islands of Japan, and who still inhabit the northern island (Hokkaido) Saghalien, and to the south the Riukiu islands. This curious people are of medium stature, very stockily built, with large heads and a marked bar across the forehead. They have an abundance of hair on the head and body and long, wavy beards. Their eyes are straight as in Europeans and their general appearance contrasts very strongly with the Japanese who to-day live amongst them.

Proto-Indics.—The Proto-Indics may be classed geographically into three. possibly four, divisions: first, the jungle tribes of southern India (some of the more primitive tribes of northern India also have affinities with this stock); secondly, the Vedda, the most primitive of the inhabitants of Ceylon; and thirdly, some of the more primitive peoples of the southern part of the Malay Peninsula, of whom the best-known are the Sakai and Senoi. In Sumatra and Celebes and possibly elsewhere in the Malay Archipelago there survive tribes who may be considered as a fourth division of the Proto-Indics, but here they have for the most part been mixed with other stocks. In much of southeastern Asia there is a racial background of Proto-Indics who have been overlaid by other invaders, but the stock has survived in a relatively pure state in the places enumerated above. The Proto-Indics have curly hair, very dark and often nearly dead black skins, a short stature and extremely broad noses.

The Australian *Aboriginal.*—The Australian aborigines almost certainly belong to the same stock, but they possess some special characteristics which may be due to the length of time they have been isolated from the parent stem. The skin is usually of a dark chocolate brown, the hair, which is somewhat variable but usually curly, is frequently very abundant on the face and body. The stature is medium, the nose very broad, and their most distinctive feature is the great bony development of the skull, including a great massing of bone over the eyes and a big development of the jaws and teeth. Whereas the Proto-Indics, notably the Veddas, have extremely small skulls, those of the Australians, though often containing an extremely small braincase, are always massively built, and the beetling brows, low forehead and projecting lower part of the face give the males a very characteristic appearance.

Advanced Long-kepded Types.—The long-headed peoples of less primitive type can be divided into several groups, but it seems extremely probable that all belong to the same stock; most of them can be distinguished from the Proto-Indics by their greater stature, and all by the narrower form of the nose. Local groups of these peoples have become separated into sub-races which breed true.

Eastern Groups.—The most easterly representatives of these stocks in Asia are the *Nesiots,* who are found mixed with the straight-haired, round-headed Proto-Malays in the Malay Archipelago, in the Philippines, sporadically in southeastern Asia and in the interior of southern China; the exact extension of these peoples is not yet fully known. In southern India a large proportion of the population belongs to a second group, Chersiots (mainlanders, as opposed to Nesiots, islanders). They are here much mixed with Proto-Indics and round-heads. In the northern part of India the proportion of the round-heads is much greater, and in the northwest the round-headed element predominates. In Rajputana and in the Punjab there is another group of long-heads, to be distinguished from the Chersiots by their taller stature, fairer skins and narrower noses. These Haddon terms Indo-Afghans.

Western Groups.—Further west, in the horn of Africa and the desert between the Nile and the Red Sea, this stock is dominant in the population, though frequently mixed with negroes. These tribes represent the modern descendants of the Proto-Egyptian population. Among the groups of this stock with a white complexion several varieties may be distinguished: one, the *Eur-african,* seems only to occur in isolated spots in north Africa and western Europe, including part of the British Isles, another is met with among the Bedouin Arabs, while the third or Mediterranean race forms the fringing population of the Mediterranean sea and the western Atlantic seaboard of Europe. In the eastern Mediterranean it is inextricably mixed with the Armenoid peoples.

Among the Mesocephals Haddon includes three groups; two, however, the Pyrenean and the Atlanto-Mediterranean are probably hybrids. The third, the Nordic, is more clearly marked and is characterised by fair skin and hair, blue eyes and a tall stature. To-day they form one element in the population of the British Isles and northern France, Belgium and Holland, and northern Germany. They predominate in Scandinavia.

The Round-headed Group.—The great round-headed branch of the Cymotrichi is conveniently called Eurasiatic. It extends all along the great mountain chain from the central plateau of France on the west to the Himalayas on the east. The Alpine branch of the family is distributed along the central massif of Europe into central and even Eastern Asia, the Armenoid or Illyrio-Anatolian has a more limited range in southeastern Europe and western Asia. They may be distinguished by the extreme flatness and height of the head. In the Pamirs, in Persia, and extensively in central Asia and in India, a separate branch of this race, the Pamiri, is found, while locally in western Europe isolated examples of two early groups. the Prospectatores and the "Beaker Folk" still survive. They probably resulted from early crossing of round-heads with Mediterranean and Nordic man respectively. All these peoples are marked by the roundness of their heads, their brown, auburn or black hair and somewhat sallow or olive skins. The eyes vary from brown to hazel, but blue eyes are found.

Most of the migratory movements which resulted in the present distribution of mankind took place too far back in history for us to estimate their exact course, but in all probability human stocks were evolved near the places where we first find them recorded in historic times. Some migrations belong to the domain of ancient history, but it is very doubtful how far these movements have actually affected the physical type. In all probability ethnological history has consisted chiefly of the gradual extension of dominant types. (See A. C. Haddon, Races of Mankind, 1924.)

(L. H. D. B.)

BIBLIOGRAPHY.—W. Z. Ripley, The Races of Europe (1900); Bureau of American Ethnology, Bull. 30 (Various authors). Handbook of *American Indians,* 1907–10. A. H. Keane, Man, Past and Present (1920); Clark Wissler, The American Indian (1922); V. Giuffrida-Ruggeri, Homo Sapiens (1923); R. B. Dixon, Tlze Racial History of Mankind (1923); A. C. Haddon, The Races of Man (1924); L. H. D. Buxton, *The* Peoples of *Asia* (1925); British Museum, Handbook to the *Ethnographic* Collections (1925); J. Deniker, Les Races et les peuples de la terre (1926); R. Martin, *Lehrbuch* der Anthropologie (1928). See also articles on "Blood Tests" in Man (1928).

RACHEL (1821–1858), French actress, whose real name was Elizabeth Felix, the daughter of poor Jew pedlars, was born on Feb. 28, 1821, at Mumpf, in the canton of Aargau, Switzerland. At Reims she and her elder sister, Sophia, afterwards known as Sarah, joined a troupe of Italian children who made their living by singing in the cafés, Sarah singing and Elizabeth, then only four years of age, collecting the coppers. In 1830 they came to Paris, where they sang in the streets, Rachel giving such patriotic songs as the *Parisienne* and the *Marseillaise* with a rude but precocious energy which evoked an abundant shower of coppers. Étienne Choron undertook to give the two sisters gratuitous instruction, and after his death in 1833 they were received into the Conservatoire. Rachel made her first appearance at the Gymnase in Paul Duport's La *Vendéenne* on April 4, 1837, with only mediocre success. On June 12, 1838, she made her *début* at the Théâtre Français, as Camille in Corneille's Horace, when her remarkable genius at once received general recognition. In the same year she won a great triumph as Roxane in Racine's *Bajazet,* but it was in *Phèdre,* which she first played on Jan. 21, 1843, that her peculiar gifts were most strikingly manifested. Her range of characters was limited, but within it she was unsurpassable. She excelled in the impersonation of evil or malignant passion, in her presentation of which there was a majesty and dignity which fascinated while it repelled. By careful training her voice, originally hard and harsh, had become flexible and melodious, and its low and muffled notes under the influence of passion possessed a penetrating quality that was irresistible. Perhaps her most successful appearance in plays by contemporary authors was in 1849 in Scribe and Legouvé's *Adrienne Lecouvreur,* which was written for her. In 1841 and in 1842 she visited London, where her interpretations of Corneille and Racine were the sensation of the season. In 1855 she made a tour in the United States with comparatively small success, but her powers had begun to deteriorate. She died of consumption at Gannet, near Nice, on Jan. 4, 1858, and was buried in the Jewish part of the cemetery of Pkre Lachaise in Paris. Rachel's third sister was Lia Felix.

See Jules G. Janin, *Rachel et la tragédie* (1858); Mrs. Arthur Kennard, *Rachel* (Boston, 1888); A. de Faucigny-Lucinge, *Rachel et son temps* (1910); L. Barthou, *Rachel* (1926); J. Agate, *Rachel* (1928).

RACHILDE (MME. ALFRED **VALLETTE,** née ETMERY) (1862–1938). Rachilde made her name by a series of powerful. sensational novels, dealing in many cases with abnormal personalities. She was an admirable critic, and was for many years one of the principal critics of the *Mercure de France.*

Her works include *Monsieur Vénus* 1889, latest ed. 1926); *La Tour d'Amour* (1899); *La Maison Vierge* (1920); *Les Rageac* (1921); *Le Grand Seigneur* (1922). *See* André David, *Rachilde* (1924).

RACHMANINOFF, SERGEI VASSILIEVITCH (1873–1943), Russian composer and pianist, was born on his father's estate Oneg, near Ilmen Lake, Government of Novgorod, on April 2, 1873. At nine he became a pupil of Demjansky's at the St. Petersburg Conservatoire, going three years later to the Moscow Conservatoire, where he studied piano under his cousin; Siloti, and composition under Taneiev and Arensky. In 1892 he won a gold medal with his opera *Aleko,* which was favourably received when produced at Moscow, 1893. Concert tours in Russia and elsewhere followed. In 1899 he appeared in London as pianist, conductor and composer, and in 1902 he had great success in Vienna. In 1903 he went back to Moscow where he remained for three years as piano professor at the Maryinsky Institute, also conducting at Imperial opera. Subsequently he lived for several years in Dresden where he devoted himself mainly to composition, varied by occasional concert tours. In 1909 he paid his first visit to the United States; while in 1912–13 he conducted the Moscow Philharmonic Symphony orchestra. After the Russian revolution he escaped to Sweden, with his family, and in 1918 took up his permanent residence in the United States.

Among Rachmaninoff's many compositions, particularly notable are the *Second Symphony* in *E Minor,* his piano concertos, opp. 1, 18 and 30, *Rhapsody on a Theme by Paganini,* and *Etudes Tableaux.* His *Recollections,* dictated to his editor, Oskar von Riesmann, was published in 1934. He was internationally known for his creative ability as a composer, and for his technique and interpretation as a pianist. He died in Beverly Hills, Calif., March 28, 1943.

RACINE, JEAN (1639–1699), French tragic dramatist, was born at La Ferté-Milon (Aisne), and was christened on Dec. 22, 1639. His father was a solicitor, and held the office of *controleur au grenier à sel* at La Ferté. Racine's mother died when he was little more than a year old and his father married again but himself died soon afterwards, whereupon the poet went to his grandparents, who had strong Jansenist leanings. He was sent to the grammar school at Beauvais, and in Oct. 1655 was transferred to the school which the "Solitaires" had established at Port Royal. He was a diligent student, and wrote verse both in Latin and French, his Port Royal odes being far from despicable. In 1658 he was entered at the Collkge d'Harcourt, and it is clear from his correspondence, which, as we have it, begins in 1660, that he was not at all of an austere disposition at this time, and that he was already given up irrevocably to literature. The marriage of Louis XIV. was the occasion of an ambitious ode, *La nymphe de la Seine,* which earned 600 livres, and in 1660 Racine finished one piece, *Amasie,* and undertook another, *Les Amours d'Ovide,* for the theatre. The first, however, was rejected by the actors of the Marais, and it is not certain that the other was ever finished. Racine's letters show that he was intimate with more than one actress at this time; he also made acquaintance with La Fontaine, and the foundations of the legendary "society of four" (Boileau, La Fontaine, Molière and Racine) were thus laid. In Nov. 1661 he went to Uzès in Languedoc to live with his uncle the Père Sconin, vicar-general of that diocese, whose attempts to secure a benefice for him were, however, in vain. Racine was back in Paris before the end of 1663, and an ode on the recovery of Louis XIV. from a slight illness secured him another grant of 600 livres in the summer of 1664. The ode in which he thanked the king for his presents, *La Renommke,* is said to have introduced him to Boileau, to whose censorship he was deeply indebted. Unfortunately there is a break in his correspondence after Nov 1663, and from this time forward the gossip of the period, and the *Life* by his son Louis, who was only six years old when his father died, are our main sources.

The first but the least characteristic of the dramas by which Racine is known, *La Thébaide,* mas played by Molière's company at the Palais Royal theatre on June 20, 1664 In Feb. 1665 the greater part of his second acted play, *Alexandre le Grand,* was read before a distinguished audience at the Hôtel de Nevers, and Molière's company played it on Dec. 4. But a fortnight afterwards *Alexandre* was played, "de complot avec M. Racine," says La Grange, by the rival actors at the Hôtel de Bourgogne, and Racine's friendship with Molière ended in consequence. If, however, *Alexandre* was the occasion of showing the defects of Racine's character as a man, it raised him vastly in public estimation as a poet. He was now for the first time proposed as a serious rival to Corneille, and the contrast between the two was accurately apprehended and put by Saint Evremond in his masterly *Dissertation sur l'Alexandre,* still the best criticism of the faults of Racine, though not of the merits, which had not yet been fully seen. It may be added that in the preface of the printed play the poet showed the extreme sensitiveness to criticism which often accompanies a tendency to criticize others. These defects of character showed themselves still more fully in another matter. The Port Royalists detested the theatre, and in Jan. 1666 Nicole, their chief writer, spoke of dramatic poets as "empoisonneurs publics." Racine immediately published a letter to the author, which, though very smartly written, is full of savage personalities. He had written a second pamphlet and was about to publish it when fortunately Boileau, who had been absent from Paris, returned and protested against the publication. It remained accordingly unprinted till after the author's death, and in later years he expressed bitter regret for having published the first.

After this disagreeable episode Racine's life, for ten years and more, becomes simply the history of his plays, if we except his liaisons with the actresses Mademoiselle du Parc and Mademoiselle de Champmeslé, and his election to the Academy on July 17, 1673. The series of his unquestioned dramatic triumphs began with *Andromaque* (Nov. 1667), and this play may perhaps dispute with *Phèdre* and *Athalie* the title of his masterpiece. It is much more uniformly good than *Phèdre,* and the character of Hermione is the most personally interesting on the French tragic stage. Whatever may be thought of the *tragédie pathétique* (a less favourable criticism might call it the "sentimental tragedy"), it could hardly be better exemplified than in this admirable play, which owes its success to the application of the most delicate art to the conception of really tragic passion. *Andromaque* was succeeded, at the distance of not more than a year, by the charming comedietta of *Les Plaideurs* (printed on Dec. S, 1668). At first it was a complete failure, though Molière is reported to have said on leaving the house, "Que ceux qui se moquoient de cette pièce meritoient qu'on se moquoient d'eux"; but the piece was suddenly played at court a month later; the king laughed, and its fortunes were restored. It was followed by a very different work, *Britannicus,* which appeared on Dec. 13, 1669. This was much less successful than *Andromaque,* and seems to have held its own but a very few nights. Afterwards it became very popular, and even from the first the exquisite versification was not denied. But the complete nullity of Britannicus himself and of Junie, and the insufficient attempt to display the complex and dangerous character of Nero are not redeemed by Agrippina, who is really good, and Burrhus, who is solidly painted as a secondary character. Voltaire calls it "la pièce des connaisseurs," a double-edged compliment. The next play of Racine has, except *Phkdre*, the most curious history of all. Henrietta of Orleans proposed the subject of *Bérénice* to Corneille and Racine at the same time, and both plays, but especially Racine's, were successful. *Bajazet,* first played on Jan. 4, 1672, has great technical merit, but it is impossible to imagine anything less oriental than the atmosphere of the piece, which is scarcely saved by its ingenious scenario and admirable style. This charge is equally applicable with the same reservations to *Mithridate,* which appears to have been produced on Jan. 13, 1673, and was extremely popular. Racine's next attempt, *Iphigénie,* was a long step backwards and upwards in the direction of *Andromaque.* Greek tragedy gave examples which prevented him from flying in the face of the propriety of character as he had done in *Bérénice, Bajazet,* and *Mithridate.* The date of its appearance is very uncertain. It was acted at court on Aug. 18, 1674, but it does not seem to have been given to the public till the early spring of 1675.

The last and finest of the series of tragedies proper was the most unlucky. *Phbdre* was represented for the first time on New Year's Day 1677, at the Hôtel de Bourgogne. Within a week the opposition company launched an opposition *Phbdre* by Nicolas Pradon, who had been employed to write it by the duchess of Bouillon and other influential enemies of Racine. So well had their measures been taken that the finest tragedy of the French classical school was all but driven from the stage, while Pradon's was a positive success. The unjust cabal against his piece no doubt made a deep impression on Racine. But it is impossible to decide exactly how much influence this had on the subsequent change in his life. For 13 years he had been constantly employed on a series of brilliant dramas. He now broke off his dramatic work entirely and in the remaining 20 years of his life wrote but two more plays, and those under special circumstances and of quite a different kind. He had been during his early manhood a libertine in morals and religion; he now became irreproachably domestic and almost ostentatiously devout. No authentic account of this change exists; what is certain is that Racine reconciled himself with Port Royal, accepted their doctrine of the incompatibility of the stage and the Christian life, and on June 1 married Catherine de Romanet and definitely settled down to a quiet domestic life, alternated with the duties of a courtier. His wife had money, and he had possessed for some time the post of treasurer of France at Moulins. His annual "gratification" had been increased from 800 to 2,000 livres, and in the year of his marriage he and Boileau were made historiographers-royal with a salary of 2,000 crowns. Racine's labours brought him, in addition to his other gains, frequent special presents from the king, and in 1690 he further received the office of "gentilhomme ordinaire du roi," which afterwards passed to his son. He had two sons and five daughters.

The almost complete silence which Racine imposed on himself after the comparative failure of *Phèdre* was broken once or twice even before the appearance of his two last exquisite tragedies. The most honourable of these was the reception of Thomas Corneille on Jan. 2, 1685, at the Academy in the room of his brother. The discourse which Racine then pronounced turned almost entirely on his great rival, of whom he spoke even more than becomingly. But it was an odd conjunction of the two reigning passions of the latter part of his life—devoutness and obsequiousness to the court—which made him once more a dramatist. Madame de Maintenon had established an institution at Saint Cyr for the education of poor girls of noble family; the tradition of including acting in education was not obsolete, and the favourite asked Racine for a new play suited to the circumstances. The result was the masterpiece of *Esther,* with music by Moreau, the court composer and organist of Saint-Cyr. The beauty of the chorus, the perfection of the characters and the wonderful art of the whole piece need no praise. Almost immediately the poet was at work on another and a still finer piece of the same kind, and he had probably finished *Athalie* before the end of 1690. The fate of the play, however, was very different from that of *Esther* The public cared very little for it, but the just judgment of posterity has ranked *Athalie,* if not as Racine's best work (and there are good grounds for considering it to be this), at any rate as equal to his best. Thenceforward Racine was practically silent, except for a brilliant *Histoire abrégée de Port Royal* and four *cantiques spirituels,* in the style and with much of the merit of the choruses of *Esther* and *Athalze.* The general literary sentiment was against him, and his weakness for spiteful epigrams cost him many friends. At last even the king withdrew his favour. He died April 21, 1699, and was buried at Port Royal.

Racine may be considered from two very different points of view,—(I) as a playwright and poetical artificer, and (2) as a dramatist and a poet. From the first point of view there is hardly any praise too high for him Every advantage of which the Senecan tragedy adapted to modern times was capable he gave it. He perfected its versification; he subordinated its scheme entirely to the one motive which could have free play in it,—the display of a conventionally intense passion, hampered by this or that obstacle; he set himself to produce in verse a kind of Ciceronian correctness. The grammar-criticisms of Vaugelas and the taste-criticisms of Boileau produced in him no feeling of revolt, but only a determination to play the game according to these new rules with triumphant accuracy. The result is that such plays as *Phèdre* and *Andromaque* are supreme in their own way. But his greatest achievements in pure passion—the foiled desires of Hermione and the jealous frenzy of Phbdre—are cold, not merely beside the crossed love of Ophelia and the remorse of Lady Macbeth, but beside the sincerer if less perfectly expressed passion of Corneille's Cléopâtre and Camille. He had cut away from himself, by the adoption of the Senecan model, all the opportunities which would have been offered to his remarkably varied talent on a freer stage, though the admirable success of *Les Plaideurs* makes us regret that he did not experiment further in comedy.

BIBLIOGRAPHY.—The first collected edition of Racine's works appeared in 1675–76; the last which appeared in the poet's lifetime (1697) was perhaps revised by him. Among the innumerable posthumous editions the most important is that of P. Mesnard in the *Grands écrivains* series (8 vols, 1865–73). Louis Racine's **Life** was first published in 1747. Among English imitations are the *Distressed Mother* of Ambrose Philips (1712) and the *Phaedra and Hippolytus* of Edmund Smith (acted in 1707); and there is a complete verse translation by R. B. Boswell (1889–91). *See* Sainte-Beuve, *Portraits Littéraires,* vol i., and for recent criticism the studies by G. Larroumet (1898) and J. Lemaître (1908), and the *Life* by Mary Duclaux (1925). The case for and against Racine has been concisely stated by G Lytton Strachey in *Books and Characters* (1922) and J. C. Bailey in *The Claims of French Poetry* (1907).

RACINE, LOUIS (1692–1763), French poet, second son of Jean Racine, was born in Paris on Nov. 6, 1692. *La Grace* (1720) and *Religion* (1742), his most important work, are inspired by a sincere piety, and are written in verse of uniform clearness and excellence. His other works include epistles, odes, among which the *Ode sur l'harmonie* (1736) should be mentioned, *Mémoires* (1747) of Jean Racine, and a prose translation of *Paradise Lost* (1755). Louis Racine died on Jan. 29, 1763. He was characterized by Voltaire as "le bon versificateur Racine, fils du grand pobte Racine."

His *Oeuvres complètes* were collected (6 vols) in 1808.

RACINE, a city of southeastern Wisconsin, U.S.A., on Lake Michigan, at the mouth of the Root river, 60 mi. N. of Chicago; a port of entry and the county seat of Racine county. It is served by the Chicago and North Western, the Chicago, Milwaukee, St. Paul and Pacific, the Chicago, North Shore and Milwaukee, and the Milwaukee electric railways and by motor coach lines. Pop. 58,593 in 1920 (28% foreign-born white); in 1930, 67,542; and in 1940, 67,195 by the federal census.

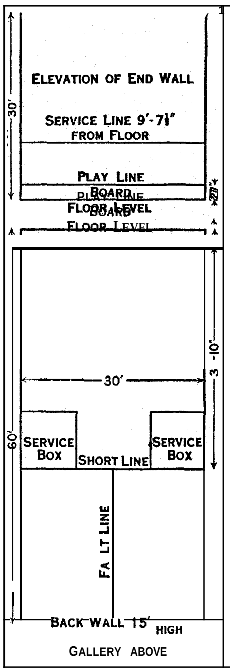
Racine is one of the most important manufacturing centres in the state. It has a good harbour, open throughout the year. There are 163 manufacturing establishments, having products valued at $103,177,883 annually Assessed valuation of property for 1940 was $94,303,946. There are fine bathing beaches and recreation parks along the lake. One of the cemeteries encloses some prehistoric Indian mounds. Early in the 19th century a French trader, Jambeau, established himself on the Root river. and in 1834 Gilbert Knapp, a lake captain, induced a group of men from Chicago to settle at the mouth of the river. The village was called Port Gilbert, but in 1837 the French name of the river was adopted. Racine was incorporated as a village in 1831 and chartered as a city in 1848.

RACKETS or **RACQUETS,** a game played in an enclosed court with a ball and an implement with which the ball is struck called a racket. This is about 2½ft. long and the head is tightly strung with cat-gut. No standard dimensions are laid down.

In the earliest days of the game, the head of the racket was inclined like a tennis racket. Later it was pear-shaped. In modern days it is nearly circular and some 7 or 8in. in diameter. The average weight of a racket is about g oz. and it is made of ash. Experiments have been made with metal frames but with no practical success. The balls are one inch in diameter and weigh one ounce. They are made of strips of cloth tightly wound over each other and then bound with twine, with a sewn covering of smooth white leather. In England the floor of courts is black or red in colour and the walls black.

In India and some other places in the East, where the floor and walls of the court are painted white, black balls are used. There has been no standard size laid down for a racket court but the great majority of courts are about 60ft. long by 30ft. broad. Both the single and the double or four-handed game are played in courts of this size nowadays. Formerly there were several courts as large as 80ft. by 40ft. built specially for the double game, but one or two of these alone now remain. Modern racket courts have four walls and a roof, but in India some courts are left unroofed for the sake of coolness.

The floor, which must be perfectly level and smooth, is made of cement. The floor cannot be too hard, since the faster the ball travels, the better the game; similarly the walls, which should be built of masonry faced with cement and most carefully smoothed, cannot be too hard and fast. The front and side walls are about 30ft. high, the back wall being about half that height, with a gallery for spectators (containing the marker's box) above it. The court is entered by a door in the centre of the back wall, which, when shut, must be perfectly flush with that wall, and without any projecting handle. The court is lighted from the roof. The diagram shows the divisions and the markings of the court. On the front wall is fixed a wooden board, the upper edge of which, 27in. from the floor, constitutes the "play-line," and which usually fills the whole space from that height to the floor; and at a height from the floor of gft. 7½in. is a second line, called the "cut-line" or "service-line," usually painted red or green. At a distance of 35ft. 10in. (in a court 60ft. by 30ft.) from the front wall and parallel to it, a line is painted on the floor, from wall to wall, called the "short-line"; and from the centre of the short-line to the centre of the back wall is the "fault-line," dividing into two equal rectangles the space between the back wall and the shortline. These lines again are usually red or green in colour.



PLAN AND ELEVATION OF RACKETS COURT

The rectangles are the service-courts and are called the right-hand and left-hand court respectively. Against the side walls outside these courts, but so that one side in each case is formed by the short-line, are squares called the service-boxes.

The Game. — Rackets is usually played either by two persons ("singles"), or four persons playing two against two ("doubles"); and the general idea of the game is the same as that in lawn tennis and fives, the object of the player in all these games being to score a point by striking the ball either before it reaches the ground or on its first bound, in accordance with the rules of the game, in such a way that his adversary may fail to make a "good," *i.e.,* a valid, stroke in return. In the four-handed game one of each set of partners takes the right-hand court and his partner the left. The game consists of 15 points called "aces." Aces can only be scored by the "hand-in" (the player, or side, having the service), and the "hand-out" must therefore win a stroke or strokes to obtain service before he or they can score an ace; in "doubles" each of the partners serves in turn, and both must therefore be ousted before "hand-out' obtains the service; but to this rule the first hand of each game affords an exception (see below). The right to serve first is determined by the spin of a racket and the service must be made in the following manner. The server, standing with one foot at least inside one of the service-boxes, must toss the ball from his hand, and while it is in the air he must hit it with his racket so that it strikes the front wall above the service-line and falls to the floor within the service-court on the opposite side; after striking the front wall the hall may, but need not, strike the side wall or back wall, or both, and it may do so either before or after touching the floor. The serve is a "fault" if the ball (1) strikes the front wall above the board but on or below the service-line, in which case it is called a "cut"; or (2) touches the floor on the first bound, outside the proper service-court, when it is called "short" or "fault" according to the position of its pitch (see below). If the "hand-out" player to whom the fault is served "takes" it (*i.e.,* if he plays at it), the fault is condoned and the play proceeds as if the serve had been good. If, however, the fault be not taken, the server must serve again from the same box; and if he serves a second fault he loses his "hand" or innings, and his partner or his opponent, as the case may be, takes his place. Two consecutive faults have thus the same result as the loss of a stroke in the rally by the "hand-in." A serve which makes the ball strike the board, or the floor before reaching the front wall, or which sends it "out-of-court" (*i.e.,* into the gallery or roof of the court), counts the same as two consecutive faults; it costs the server his innings. Skill in service is a most important part of proficiency in rackets; a player can seldom become first-rate unless he possesses a "strong service." A great deal of "cut" may be imparted to the ball by the stroke of the racket, which makes the ball in its rebound from the wall behave like a billiard ball carrying "side" when striking a cushion; and when this "cut" is combined with great pace in the bound of the ball off the side wall, the back wall, and the floor, at varying angles which the server has to a great degree under his control, it becomes exceedingly difficult for hand-out to "get up" the service (*i.e.,* to hit it on the first bound, sending it above the play-line on the back wall), and still more so to make a good stroke which will render it difficult for his adversary in his turn to get up the ball and thus continue the rally. Racket courts vary very much in pace and conditions and in some service is very much easier of return than in others, but it not infrequently happens that a long sequence of aces, sometimes the whole 1 j aces of a game, are scored consecutively by service which hand-out is unable to return. A noteworthy instance of successful service occurred in the semi-final tie of the doubles Amateur Championship matches at the Queen's Club in 1897 when W. L. Foster opened service and scored all the aces in the first two games, and added six in the third, thus putting on a sequence of 36 aces before losing his "hand." To obtain first service is therefore an initial advantage, although in doubles it is limited by the rule that only one partner shall have a "hand" in the opening service.

The server may begin in either of the service boxes; but when he has started, the service must proceed from the two boxes alternately till the close of the innings of the side, whether singles or doubles. When the other side obtains the innings they may in like manner begin in either box, without regard to where the last service of their opponents was delivered. In singles, hand-out changes sides in the court after each serve, answering to the change over of the server: in doubles the serve is taken alternately by the two hand-out players, who permanently occupy the right- and left-hand courts respectively, being allowed to change the order in which they receive the service at the end of any game or rubber. Except in the rare case of left-handed players most of the play in the left half of the court, including the taking of service on that side, is back-handed; and the stronger of the two partners in back-hand play usually, therefore, takes the left-hand court. The best position in the court for the hand-out about to take the serve depends entirely on the nature of the service, and he has to use his judgment the instant the ball leaves the server's racket in order to determine where it will strike the floor and at what precise point in its course it will be best for him to attempt to take it. A strong fast service, heavily cut, that sends the ball darting round the corner of the court, leaving the back wall at an extremely acute angle, or dropping almost dead off it, can only be got up by standing near the back wall a long way across the court and taking the ball by a wrist stroke at the last instant before it falls to the ground a second time. On the other hand, when the server avoids the side mall altogether and strikes the back wall direct and hard, whether he achieves a "nick" serve (*i.e.,* the ball striking precisely in the angle between the back wall and the floor) or hits the wall high up, hand-out will have little time to spare in changing position to get within reach of the ball. Many good players make a practice wherever possible, especially in the case of heavily cut service, of taking the service on the volley (*i.e.,* before the ball reaches the ground), sometimes of taking the ball after it leaves the side wall and before it reaches the back wall; practice alone enables the player to decide with the necessary promptitude how each stroke is to be played. In returning the service, or in playing any stroke during the rally, the ball may strike any of the other walls before the front wall. This "boasted" stroke is quite legitimate, often most valuable and sometimes indispensable. The tendency, however, in modern rackets is towards using it too frequently. Good play consists for the most part in hard low hitting, especially as close as possible along the side walls into the corners of the back wall. One of the most effective and beautiful but difficult strokes in rackets is the drop which occurs when the ball is hit so that it only just reaches the front wall and drops close to it. The "half-volley," in which the ball is struck at the moment of its contact with the floor and before it has had time to rise, is employed with great effect especially in hard play; it makes the return much quicker than when the ball is allowed to rise to the full length of the bound, and requires corresponding quickness on the part of the adversary.

If hand-out succeeds in returning the serve, the rally proceeds until one side or the other fails to make a good return. A good return means (1) that the ball is struck by the racket before its second bound on the floor, and without its having touched any part of the clothes or person of the striker or his partner; (2) that it is hit against the front wall above the board without first touching the floor or going out of court; and (3) that it returns off the front wall into play (*i.e.,* to the floor of the court or to an adversary's racket) without going out of court. If hand-in be the one to fail in making a good return, he loses his "hand," and (in singles) hand-out goes in and proceeds to serve; in doubles one of the hand-in partners loses his "hand," and the second partner goes in and serves till he in turn similarly loses his "hand," except that in the case of the opening service in the game there is (as already mentioned) only one "hand" in any event. If hand-out fails to make a good return to the serve or to any stroke in the rally, hand-in scores an ace, and the side that first scores 15 aces wins the game. When, however, the score reaches "13-all" (*i.e.,* when each side has scored 13 aces), hand-out may, before the next serve is delivered, declare that he elects to "set" the game either to five or three, whichever he prefers; and similarly when the score stands at "14-all," hand-out may "set" the game to three. He makes this declaration by calling "set-5!" or "set-3!" and it means that five aces, or three aces, as the case may be, shall be required to win the game. It is the player's first duty to give the opponent full room for his stroke, but in the confined space of a racket court it is not always easy and sometimes, especially in doubles, absolutely impossible not to obstruct him. The rules, therefore, carefully provide for "lets" (an old English word for impediment or hindrance) when in matches a "let" is claimed by any one of the players and allowed by the referee, or the referee and two umpires, as the case may be, the service or rally counts for nothing and the server shall serve again from the same service box.

In ordinary games, the marker makes the decision as to a let. It is the duty of the marker, who occupies a box in the gallery, to "call the game." As soon as the server serves the ball the marker calls "Play!" if the ball strikes the front wall above the service-line; and "Cut!" if it strikes below the service-line; if the ball falls in front of the short-line the marker calls "Short!"; if the wrong side of the fault-line he calls "Fault!"; but whether to be "cut," "short," or "fault," the serve counts as a fault in its effect. To every good return, as to every good serve, the marker calls "Play!" If a return is made after the second bound of the ball (called a "double") the marker calls "Double!" or "Not up!"; if the ball is hit into the gallery, or against its posts or cushions, or above the girders or cross-beams of the roof, he calls "Out-of-court!" At the end of every rally he calls the state of the game, always naming first the score of hand-in: — "One-love" (love being the term for zero) meaning that hand-in has scored one ace and hand-out nothing, "Two-love," "Five-all," "Five-ten," "Fourteen-eleven," when one player reaches 14 it is customary for the marker to call "game-ball," *e.g.,* "14–11 game-ball." When one side has scored 15, the marker calls "Game!" He then in similar fashion calls the state of the match — "Two games to one," or whatever it may be — before the beginning of the next game. The server in possession at the end of the game continues to serve in the new game, subject as before to the rule limiting the first innings of the game to a single "hand." The usual number of games in matches is five for singles, and seven for doubles. In matches where there are umpires and a referee, there is an appeal to them from the marker's decision except as regards questions relating to the service, on which the marker's decision is final.

Records. — Attempts have been made to trace rackets, like tennis, to an ancient origin; but although it is doubtless true that the striking of a ball with the hand or some primitive form of bat is one of the oldest forms of pastimes, and that rackets has been evolved from such an origin, the game as now known can hardly be said to have existed before the 19th century. The first school which took to rackets was Harrow in the '20s of last century. It was about the middle of the century that closed courts of the modern pattern began to be built, and the founding of Prince's club in 1853 increased the popularity and standing of the game immensely. Here there were a number of courts and the match court was a great favourite—"Old Prince's" came to an end in 1886 and the next year the Queen's club courts were built and were ready for play in 1888—the present Prince's club, Knightsbridge, which has a rackets court, was opened in 1889. Nowadays, largely owing to the expense of the game, there is not so much play except at the English public schools as heretofore, and a number of courts have gone out of use in the last few years. Several have been converted into squash rackets courts including one of the two formerly existing at Queen's club, one of those at Prince's club, and the one at Lord's.

Championships. — The first professional or "open" or world's champion as it may be called was Robert Mackay who claimed the title in 1820. He was succeeded by Thomas and John Pittman, John Lamb and J. C. Mitchell who held it from 1846–60, when he was beaten by Francis Erwood of Woolwich. In 1862 Erwood was beaten by Sir William Hart-Dyke, the only amateur to hold the world's championship until 1937, when D. S. Milford, Great Britain, beat Norbert Setzler, U. S. A.

In 1863 Sir William resigned to H. J. Gray, the first of a large family of great professional players. William Gray, who was champion from 1866 to his death in 1875, was the greatest player of this era of rackets. He had most beautiful style and command of the ball and he was noted for his drop volley. His greatest match was played against an American professional named Foulkes, Gray being the winner. The next champion was H. B. Fairs, of Prince's club, known as "Punch" who, though he was diminutive in stature, was also a splendid player. He died in 1878 and was succeeded by another Gray, Joseph, who held the title from 1878–87. In that year Gray was beaten by Peter Latham, then a boy of 22, who holds the reputation of being the greatest player who has yet appeared. Gray won the first of the two rubbers in this match by four games to three but was beaten in the second at Manchester much more easily. From that date until 1902 Latham reigned supreme. He defended his title against yet another Gray, Walter of Charterhouse in 1888 and against George Standing in 1891 and 1897. The match in 1897 was played at Queen's club and in New York where Standing had gone from Prince's club, Knightsbridge, to become professional, and excited intense interest. Latham here, perhaps, had the hardest fight of his career but again he triumphed. In 1901 he played Gilbert Browne, then of Prince's club, and defeated him easily. In 1902 Latham resigned the title which he had held so long and worthily. In 1895 he had also won the championship of tennis and so held the two titles conjointly from 1895–1902, an unparalleled feat. Latham's first engagement was in Manchester. He was appointed as professional at Queen's club, West Kensington, in 1888, and with one interval, when he was privately employed by Sir Charles Rose at his tennis courts at Hardwick and Newmarket, he has been there ever since. In 1903 W. Jamsetji, a Parsee player, with a particularly fine fore-hand stroke beat Browne and he held the title until 1911, when he was beaten by Charles Williams of Harrow, who has since the World War gone as professional to the Chicago club. Williams in the interval had beaten Walter Hawes (Wellington) for the English professional championship and E. M. Baerlein, the amateur champion for the British championship. Just before the war Williams lost the open championship to Jock Soutar of Philadelphia who has defended it twice since, once against Williams and once against "Blondy" Standing. In 1929 Williams regained the title and has successfully defended it since then.

Very little is known of the form of the early amateur players. In the days of old Prince's club (1853–86) among the leading amateurs in addition to Sir William Hart-Dyke were R. D. Walker, C. J. P. Clay, J. D. Cobbold, R. O. Milne. J. Spens, an army officer in the '70s and '80s, held the reputation of being the best player in England. G. E. A. Ross in India was extremely good. Other soldier players of note of this time and a little later were T. Gallwey, A. Cooper-Key, G. A. Tower, C. D. King. In 1888, when the Queen's club was opened, an amateur championship was established and since then all the greatest amateur players have appeared in it. Spens competed the first year but he was then past his prime and was beaten by C. D. Buxton. The two greatest modern amateurs are generally reckoned to be H. K. Foster, who won the title eight times, and E. M. Baerlein who has won nine. Of the other winners E. M. Butler was a great player and stylist and so was P. Ashworth. F. Dames-Longworth, for many years a master at Charterhouse, where he did a great deal for rackets, was famed for his back-hand service. E. H. Miles was a clever player though not of commanding style. S. H. Sheppard, another clever player and quite tireless, is the only army officer who has won. E. B. Noel was the first left-hander to be successful. B. S. Foster had beautiful style footwork and hitting powers. H. W. Leatham relies to some considerable extent on clever placing but he can serve well and hit hard when he likes. The Hon. C. N. Bruce is a splendid server and fine hitter. C. C. Pell, the winner in 1925, is the leading American player. He is very good all round with a strong service and much judgment.

The winners of the championship have been:

Singles

1888. C. D. Buxton.
1889. E. M. Butler.
1890. P. Ashworth.
1891. H. Philipson.
1892–1893. F. Dames-Longworth.
1894–1900. H. K. Foster.
1901. F. Dames-Longworth.
1902. E. H. Miles.
1903. E. M. Baerlein.
1904. H. K. Foster.
1905. E. M. Baerlein.
1906. Maj. S. H. Sheppard.
1907. E. B. Noel.
1908–11. E. M. Baerlein.
1912–13. B. S. Foster.
1914. H. W. Leatham.
1920–21. E. M. Baerlein.
1922. Hon. C. N. Bruce.

Singles—Continued

1923. E. M. Baerlein.
1924. H. W. Leatham.
1925. C. C. Pell.
1926–28. J. C. F. Simpson.
1929. C. S. Crawley.
1930. Capt. G. N. Scott-Chad.
1931. Capt. V. A. Cazalet.
1932–1934. I. Akers-Douglas.
1935–36. D. S. Milford.,

The doubles championship was started two years after the singles. Some of the most famous pairs have been H. K. Foster and P. Ashworth, E. M. Baerlein and E. H. Miles, F. Dames-Longworth and F. H. Browning, H. W. Leatham and Hon. C. N. Bruce, J. C. F. Simpson and R. C. O. Williams. The winners have been:

Doubles

1890. P. Ashworth and W. C. Hedley.
1891. P. Ashworth and E. L. Metcalfe.
1892. E. M. Butler and M. C. Kemp.
1893. F. H. Browning and H. K. Foster.
1894. H. K. Foster and F. C. Ridgeway.
1895. F. Dames-Longworth and F. H. Browning.
1896. H. K. Foster and P. Ashworth.
1897. H. K. Foster and P. Ashworth.
1898. H. K. Foster and W. L. Foster,
1899. H. K. Foster and P. Ashworth.
1900. H. K. Foster and P. Ashworth.
1901. F. Dames-Longworth and V. H. Pennell.
1902. E. M. Baerlein and E. H. Miles.
1903. H. K. Foster and B. S. Foster.
1904. E. H. Miles and E. M. Baerlein.
1905. E. H. Miles and E. M. Baerlein.
1906. E. H. Miles and F. Dames-Longworth.
1907. W. L. Foster and B. S. Foster.
1908. F. Dames-Longworth and V. H. Pennell.
1909. E. M. Baerlein and P. Ashworth.
1910. B. S. Foster and Hon. C. N. Bruce.
1911. B. S. Foster and Hon. C. N. Bruce.
1912. H. W. Leatham and H. A. Denison.
1913. B. S. Foster and H. W. Brougham.
1914. E. M. Baerlein and G. G. Kershaw.
1920. E. M. Baerlein and G. G. Kershaw.
1921. Hon. C. N. Bruce and H. W. Leatham.
1922 and 1923. J. C. F. Simpson and R. C. O. Williams.
1924–1927. Hon. C. N. Bruce and H. W. Leatham.
1928. Hon. C. N. Bruce and A. C. Raphael.
1929. J. C. F. Simpson and R. C. O. Williams.
1930. Lord Aberdare and H. W. Leatham.
1931. J. C. F. Simpson and C. S. Crawley.
1932. K. A. Wagg and I. Akers-Douglas.
1933. K. A. Wagg and I. Akers-Douglas
1934. Lord Aberdare and P. W. Kemp-Welch.
1935. K. A. Wagg and I. Akers-Douglas.
1936. J. C. F. Simpson and C. S. Crawley.

In America a national singles championship and doubles championship have been established for many years. Among leading American amateur players have been B. S. de Garmendia, G. R. Fearing, Quincy Shaw, Payne Whitney, L. Waterbury, Clarence Mackay, P. D. Haughton, C. C. Fell, S. F. Mortimer, W. Hewitt Morgan, H. D. Sheldon, E. M. Edwards, etc.

See E. B. Noel and the Hon. C. N. Bruce, First Steps to Rackets (1925). (E. B. N.)

RACKHAM, ARTHUR. (1867–1939), English illustrator, born Sept. 19, 1867. He studied at the Lambeth School of Art, London. His first publication was the illustrated Rip van *Winkle* (1905), followed by Peter *Pan* (1906), Alice in Wonderland and the Ingoldsby Legends (1907). In 1906 he gained a gold medal at Milan, and in 1911 at Barcelona. He was elected associate of the Société Nationale des Beaux-Arts in 1912, and in 1919 became master of the Art Workers' guild. Later illustrations include those to Undine, *Grimm's* Fairy Tales, Aesop's Fables, Dickens's *Christmas* Carol, *Comus*, *The* Tempest, *The Compleat* Angler, Poe's Tales of *Mystery and* Imagination, and Peer Gynt.

RADAUŢI, a town in Bukovina, Rumania, 35 m. S. by W. of Czernowitz by rail. Pop. (1930) 16,808, of which about 70% were Germans and 28% Rumanians. It was formerly the seat of a Greek bishopric, removed to Czernowitz in 1786, and possesses a cathedral (1402) with the tombs of Moldavian princes.

RADCLIFFE, ANN (1764–1823), English novelist. only daughter of William and Ann Ward, was born in London on

July 9, 1764. She was the author of four famous novels: *The Sicilian Romance* (1790), *The Romance of the Forest* (1791), *The Mysteries of Udolpho* (1794) and *The Italian* (1797). When she was twenty-three years old she married William Radcliffe, an Oxford graduate and student of law. He gave up his profession for literature, and afterwards became proprietor and editor of the *English Chronicle*. After *The Italian* she gave up writing for publication. She died on Feb. 7, 1823. *Gaston de Blondeville* (1826) was published after her death, as were her *Poems* (1834). In the history of the English novel, Mrs. Radcliffe deserves at least the credit of originating a school of which she was the most distinguished exponent. She had a genuine gift for scenic effect, and her vivid imagination provided every tragic situation in her stories with its appropriate setting. Sir Walter Scott wrote an appreciative essay for the edition of 1824, and Christina Rossetti was one of her admirers. She exercised a great influence on her contemporaries, and "Schedoni" in *The Italian* is one of the prototypes of the Byronic hero.

There are modern editions of *The Italian* (1884); *Udolpho* (1903); and *The Romance of the Forest* (1904). *See* D. Scarborough, *The Supernatural in Modern English Fiction* (1917); C. F. MacIntyre, *Ann Radcliffe in Relation to her Time* (1920); E. Birkhead, *The Tale of Terror* (1921).

RADCLIFFE, JOHN (1650–1714), English physician, born at Wakefield, a well-known physician in the reigns of William III and Anne. He left property to University college for founding two medical travelling fellowships and for building the Radcliffe observatory, hospital and library at Oxford, and enlarging St. Bartholomew's hospital in London. Radcliffe was elected M.P. for Bramber in 1690 and for Buckingham in 1713. He died at Carshalton on Nov. 1, 1714.

See J. B. Nias, *Life of John Radcliffe* (1918).

RADCLIFFE, a municipal borough in the Heywood and Radcliffe parliamentary division, Lancashire, England, on river Irwell, 8 mi. N.W. of Manchester on the L.M.S.R. Pop. (est. 1938), 27,030. Area, 7.7 sq.mi. In the church of St. Bartholomew the tower arch dates from the early 15th century. Radcliffe was incorporated in 1935. There are collieries, cotton and chemical manufactures, and the making of small wares.

RADEBERG, a German town in the *Land* of Saxony, on the Roder, 10 mi. N.E. of Dresden. Pop. (1939) 16 076. It has an old castle.

RADEGUNDA, ST. (d. @;), Frankish queen, was the daughter of Berthaire, king of the Thuringians. Berthaire was killed by his brother Hermannfried, who took Radegunda and educated her, but was himself slain by the Frankish kings Theuderich and Clotaire (529), and Radegunda fell to Clotaire, who later married her. She left him when he unjustly killed her brother, and fled to Medardus, bishop of Poitiers, who consecrated her as a nun. Radegunda stayed in Poitiers, founded a monastery there, and lived for a while in peace. The queen died on Aug. 13, 587.

RADEK, KARL (1885–), Russian politician, was born in Lwów (Lemberg) and he was educated at the universities of Cracow and Berne. In 1904 he became a member of the social democratic party of Poland and Lithuania. During the revolution of 1905 he spent a year in prison, and subsequently became a member of the editorial staff of social democratic newspapers in Poland, Leipzig and Bremen which supported the left wing of the German social democrats. During the World War, after some months of illegal anti-militarist activity in Germany, he established himself in Switzerland where he wrote for the Berne *Tageblatt*. He took part in the Zimmerwald and Kienthal internationalist conferences in Sept. 1915 and April 1916. After the Russian revolution of March 1917 he crossed Germany, together with Lenin, Zinoviev, Martov and others, and remained in Stockholm as the representative of the central committee of the Bolshevik party, issuing a weekly bulletin on the Russian revolution in French and German. After the second revolution, in Nov. 1917, he took part in the Brest-Litovsk peace negotiations. When the German revolution broke out in 1918 he made his way illegally to Germany, where as a representative of the central committee of the Russian Communist party he took a very active part in reorganizing the German Communist party, working in its central committee after the murders of Karl Liebkneckt and Rosa Luxemburg on Jan. 16, 1919. He was imprisoned in Germany from Feb. to Dec. 1919.

On his release from prison Radek returned to Russia, where he became one of the leading members of the praesidium of the Communist International. He returned illegally to Germany, however, and took part in the organization of the joint congress of German Communists and Left Independents. He mas made a scapegoat for the failure of the German Communists to seize power in the autumn of 1923, and, on account of his support of the "Right" groups of the German Communists, he lost his authority in the Communist International, losing his place in its executive committee and in the central committee of the Russian Communist party. He was a most prolific writer in the Russian press on various questions of international politics. Expelled from the Communist party in 1927, he was re-admitted in 1930. In Jan. 1937, he was tried with 16 others for plotting against the Soviet Union and was sentenced to 10 years' imprisonment. He was released after serving only four years of his term, however, in order that he might serve as a propagandist.

RADETZKY, JOSEF, COUNT OF RADETZ (1766–1858), Austrian soldier, was born at Trzebnitz in Bohemia in 1766, of an old noble family, originally Hungarian. He joined the army as a cadet in 1785. Next year he became an officer, and in 1787 a first lieutenant in a cuirassier regiment. He served as a galloper on Lacy's staff in the Turkish War, and in the Low Countries during the Revolutionary War. In 1795 he fought on the Rhine, and next year with Beaulieu against Napoleon in Italy. His personal courage was conspicuous; at Fleurus he had led a party of cavalry through the French lines to discover the fate of Charleroi, and at Valeggio, with a few hussars, rescued Beaulieu from the enemy. Promoted major, he took part in Wurmser's Mantua campaign. As lieutenant-colonel and colonel he displayed bravery and skill at Trebbia and Novi (1799), and at Marengo was hit by five bullets.

In 1801 Radetzky received the knighthood of the Maria Theresa order; in 1805 he was promoted to major-general and given a command in Italy under the archduke Charles, and thus took part in the successful campaign of Caldiero. Peace again afforded him a short leisure, which he used in studying and teaching the art of war. In 1809, now a lieutenant field marshal, he fought at Wagram, and in 1810 received the commandership of the Maria Theresa order and the colonelcy of the 5th Radetzky hussars. From 1809 to 1812, as chief of the general staff, he was active in the reorganization of the army and its tactical system, but, unable to carry out the reforms he desired owing to the opposition of the Treasury, he resigned the post. In 1813 he was Schwarzenberg's chief of staff, and as such had considerable influence on the councils of the Allied sovereigns and generals. He had a considerable share in planning the Leipzig campaign and as a tactician won great praise at Brienne and Arcis sur Aube. He entered Paris with the allied sovereigns in March 1814, and returned with them to the Congress of Vienna.

He then resumed his functions as chief of the staff, but his ardent ideas for reforming the army came to nothing in the face of the general apathy. His zeal added to the number of his enemies, and in 1829, after he had been for twenty years a lieutenant field marshal, it was proposed to place him on the retired list. The emperor, unwilling to go so far as this, promoted him general of cavalry and shelved him by making him governor of a fortress. In 1834, however, his services were again required in Italy, first under Frimont, and then in chief command.

In 1836 Radetzky became a field marshal. Apathy and parsimony caused the authorities again to neglect his many suggestions, and the outbreak of the wars of 1848 found the Austrian army in an unprepared condition through no fault of Radetzky's. Nevertheless, recalled to command, he conducted his famous operations in the Quadrilateral, leading up to the triumph of Novara on March 23, 1849. (*See* ITALIAN WARS.) To the soldiers of his army who idolized him, he was always simply "Vater Radetzky." He died, still in harness, though infirm, on Jan. 5, greatly mourned by all whom he had commanded.

RADFORD, a city of Virginia, U.S.A., in Montgomery county, but administratively independent; 44 mi. W. of Roanoke, on federal highway 11 and the Norfolk and Western railway. Pop. (1940) 6.990. The city lies in a beautiful region, between the Blue Ridge and the Allegheny mountains.

RADHANPUR, a native state of India, in the western India States Agency, Kathiawar, Bombay. It is situated in the north-western corner of Gujarat, close to the Ran of Cutch. The country is an open plain without hills and with few trees. It contains an area of 1,150 sq m. with a population in 1931 of 70,530.

RADIATION, RAYS. Modern physics has developed mainly as a result of an intensive study of radiations and rays. and their relation to matter. It is possible to make a distinction between the two terms, but they are generally used by men of science as more or less synonymous. We have on the one hand the vast field of electromagnetic radiations, all travelling through empty spaces with the same velocity, the velocity of ordinary light. According to the wave-length of these radiations we speak of wireless waves, infra-red radiation, visible light, ultra-violet light, X-rays or y-rays; the order given being that of decreasing wave-length. On the other hand we have radiations which consist of streams of particles all moving in the same direction, either corpuscles of electricity, not associated with ordinary matter, as in cathode rays, or material particles which may be either charged or uncharged, such as positive rays or molecular rays. These particles may travel with any velocity, from zero, up to, in extreme cases, a velocity approaching that of light. We might distinguish between the two classes by agreeing to confine the term radiation to electromagnetic waves, and to restrict the term rays to streams of particles, but while a tendency in this direction is traceable it is by no means correct to represent this convention as one invariably used by experts. For instance, it is quite usual in dealing with β-rays, which are swift electrons, and thus corpuscular in nature, to speak of the scattered radiation and the transmitted radiation, and even to refer to the atoms of radioactive matter thrown back by the discharge of particles as a recoil radiation. (*See, e.g.,* Rutherford's Radioactive *Substances.*) On the other hand it is a commonplace to speak of rays of light. To indicate further the way in which, in actual practice, the terms are used indifferently it may be recalled that in a previous edition of the *Encyclopædia* electromagnetic radiation was dealt with, in different aspects, both under the heading RADIATION and under the heading RAY.

ELECTROMAGNETIC RADIATION

Considerations of electromagnetic radiations are involved in nearly every branch of modern physics, and various aspects of the subject are 'treated in separate articles, notably ELECTRICITY; LIGHT; QUANTUM THEORY; X-RAYS, NATURE OF: Rontgen Rays; SPECTROSCOPY; ELECTRIC WAVES; WIRELESS TELEGRAPHY. The biological effects of radiation are dealt with under the heading RADIOTHERAPY. In this article a general survey is made of the whole range of radiations, with the object of showing how the different types merge into one another, and discussing certain characteristic differences which are associated with different ranges of wave-length.

It may be well to give here the units used for measurement of the shorter wave-lengths. These are:

The micron	= one-millionth of a meter	= 10^{-4} cm.,	denoted by μ
The millimicron	= one-thousandth of a micron	= 10^{-7} cm.,	" " $\mu\mu$
The Ångström unit	=	10^{-8} cm.,	" "AU
The Siegbahn unit	=	10^{-11} cm.,	" " X

The millimicron is often used for giving visible and ultra-violet wave-lengths, and the Siegbahn unit for giving X-ray and y-ray wave-lengths. These two units are not employed in this article, but are inserted for completeness.

Historical.—The fact that there are radiations outside the limits of the visible spectrum was demonstrated by Sir William Herschel in 1800. He found that a thermometer showed a higher temperature when placed in the red end of the spectrum than in the blue, and a still higher temperature beyond the red end, where nothing could be seen. Two years later Ritter and Wollaston independently proved the existence of rays beyond the violet end by establishing that the chemical action of light on silver chloride was even stronger there than in the visible violet. These ultra-violet rays were called at the time "dark chemical rays." The wave nature of the ultra violet was proved by Young, who with the help of paper impregnated with silver chloride produced a record of Newton's rings formed by these invisible rays, the rings being smaller than those formed by the visible violet, which proved the smaller wave-length. The interference properties of the infra-red were established by Fizeau and Foucault in 1847. By the use of a very small alcohol thermometer, read with a microscope, they were able to demonstrate small differences of temperature at different points, corresponding to the alternations of intensity in the interference pattern produced in the infra-red by a suitable arrangement of two mirrors, or by diffraction at a straight edge, as with visible light. (See LIGHT.) Fizeau made measurements of wave-length in the infra-red about this time. In 1842 Becquerel photographed part of the ultra-violet spectrum. By 1850 it had already been definitely established that beyond the red end of the spectrum were invisible radiations of longer wave-length, and beyond the violet invisible radiations of shorter wave-length, and that those rays could be reflected, refracted, polarised and made to interfere in just the same way as the visible rays. In 1884 Langley made accurate measurements in the infra-red as far as $5{\cdot}3\mu$ by means of the diffraction grating, and virtually inaugurated a new branch of spectroscopy. Mascart, in 1864 and 1866, took the first photographs of the ultra-violet which were good enough for wave-length determination.

The electromagnetic waves, first generated by H. Hertz in 1888, were soon proved to have all the properties of light waves, as was to be anticipated from Maxwell's theory. (See ELECTRIC WAVES; ELECTRICITY; LIGHT.) Hertz himself, using parabolic reflectors to obtain definite beams, established the reflection and refraction of the rays, using a large prism of pitch for the latter purpose. (See ELECTRIC WAVES) Polarisation was produced by means of screens of parallel wires, which take the place of the Nicol prisms used in experiments with ordinary light, and also by reflection. Interference, and later dispersion, were also demonstrated with Hertzian waves. The velocity of propagation along wires, measured by Blondlot and by Trowbridge and Duane, was found to be equal to that of light. There is, then, no doubt of the essential similarity in nature between Hertzian waves and light.

The wave-length of Hertzian waves was found by different methods; it varies with the dimensions of the apparatus used for generating the waves. The length of the waves used in wireless telegraphy is measured in hundreds of metres, as against the few hundred-thousandths of a centimetre that give the length of visible light waves. Every source of alternating current is an emitter of very long electromagnetic waves: a dynamo, for instance, running at 3,000 revolutions per minute generates waves of length six thousand kilometres.

At the other end of the scale, in the region of very short waves, lie the X-rays, discovered by Rontgen in 1895, and the y-rays, discovered by Villard in 1900. The nature of these rays was long in doubt, for until 1912 the view that they were neutral particles had its supporters, as well as the view that they were electromagnetic waves. In this year Laue, Friedrich and Knipping established the diffraction of X-rays by crystals, and shortly after W. H. and W. L. Bragg showed how the wave-length of X-rays could be measured by reflection at crystal faces. (See X-RAYS, NATURE OF: *Röntgen Rays;* SPECTROSCOPY.) More recently (1925, 1926) A. H. Compton and R. L. Doan, as well as J. Thibaud, have succeeded in demonstrating the diffraction of Röntgen rays by ruled gratings, of the type used for measuring the wave-length of ordinary light. the rays being made to graze the grating at a very small angle The refraction of Rontgen rays was established at about the same time, by making the rays strike the face of a glass prism, near the apex, at a very fine glancing angle.

The value found for the refractive index by these experiments, as also by the total internal reflection which can be established, is less than unity, as given by the theoretical dispersion formula. Although the velocity of the Rontgen rays has not been measured directly, all the other properties of an electromagnetic wave have been shown to be possessed by the Rontgen rays. In particular, the wave-lengths of all the characteristic X-rays have been carefully recorded, ranging from 22 A.U. to ·1 A.U. As for the y-rays, in 1914 Rutherford and Andrade measured the wave-length by the crystal method, and showed them to be of essentially the same nature as Rontgen rays.

The Electromagnetic Spectrum.—Extending from wave-lengths of some miles to wave-lengths of a few hundredths of an Ångström unit (or a few ten-thousandths of an Ångström unit if we admit radiations which have not yet been measured by any direct diffraction method), there is a range of electromagnetic waves which is often spoken of as comprising over sixty octaves, the term octave, by analogy from sound, being applied to a band of vibrations extending from a given frequency to double that frequency. Of this range only one octave is visible radiation, namely that comprising wave-lengths from 8×10^{-5} to 4×10^{-5} cm., but all the other radiations are propagated with the same velocity as visible light and exhibit the characteristic phenomena which are associated with transverse waves, in particular reflection, refraction, polarisation and interference in its many aspects. Recent researches have served to emphasize the common nature of radiations of widely different frequency: for instance E. V. Appleton has shown that interference phenomena can be obtained with the Hertzian waves used in wireless telegraphy by reflection from the Heaviside layer, and has repeated a variety of experiments on interference and polarisation, usually performed in the laboratory with waves of length of the order 5×10^{-5} cm., over distances of miles with waves whose length is a few hundred metres. (See WIRELESS TELEGRAPHY.)

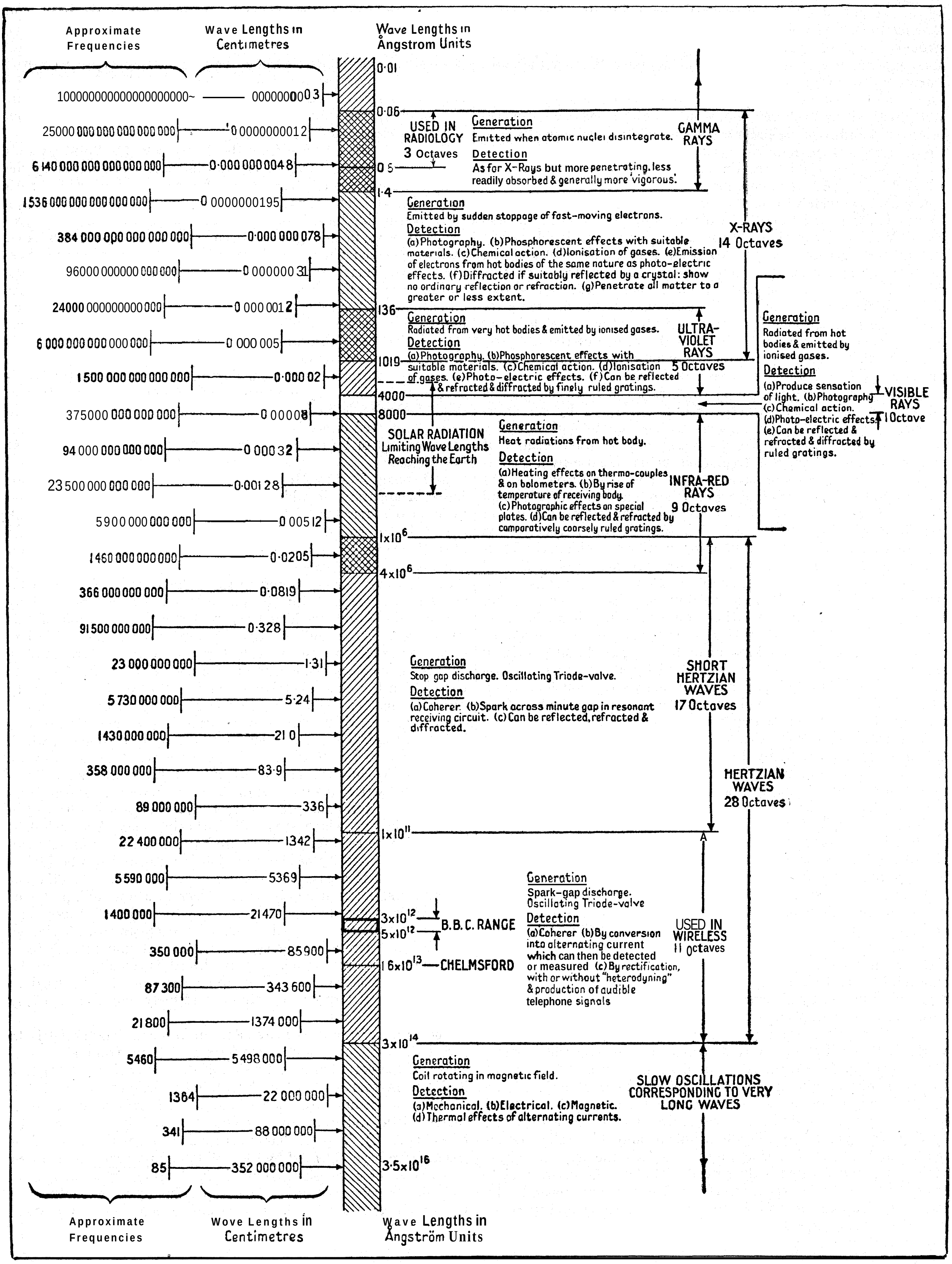
The whole electromagnetic spectrum is diagrammatically represented in the accompanying chart, in which the wave-lengths are set out vertically on a logarithmic scale, to avoid the compression to vanishing point of the shorter wave-length which would be inevitable if a linear scale were adopted. The ends of the spectrum are not definite: waves of frequency as low, that is, of wave-length as great, as may be desired can be generated by rotating a coil in a magnetic field, while at the short wave-length end of the range we have the penetrating cosmic radiations, whose wave-length is shorter than that of the y-rays, but can only be roughly estimated from the absorption. Starting at the top with wave-lengths of ·01 Angstrom units (10^{-10} cm.), which are of the order of the shortest y-ray measured by Ellis ($\cdot5\times10^{-10}$ cm.), we proceed by way of longer γ-ray wave-lengths to X-rays, the rays used for radiotherapy lying in the region 6×10^{-10} cm. to 10×10^{-10} cm. while those used in diagnosis lie generally between 2 and 3×10^{-9} cm. The X-rays merge into the ultra-violet, which in its turn leads into the visible spectrum. On the other side of the visible spectrum we have the infra-red, which leads to a vast range of Hertzian radiations, 28 octaves in extent, succeeded by the ill-defined region of very long waves to which reference has already been made. The frequencies, obtained by dividing the velocity 3×10^{10} cm./sec. by the wave-length in cms., are given on the extreme left: self-explanatory notes as to the method of generation and detection of the waves are added. Detailed information as to the various classes of radiation is given in the articles RADIOACTIVITY; X-RAYS, NATURE OF: Rontgen Rays; SPECTROSCOPY; LIGHT; HEAT; ELECTRIC WAVES; WIRELESS TELEGRAPHY.

While the spectrum was first extended by investigation of the prolongation of the optical spectrum on either side, and thus showed a continuous range of wave-lengths, the Hertzian waves as first investigated had wave-lengths very much greater than those of any measured infra-red radiation, while the X-rays first measured, although forming a continuous range with the y-rays on the short wave-length side, proved, on the long wave-length side, to be very much shorter than the shortest ultra-violet. The gaps between the Hertzian waves and the infra-red, and between the X-rays and the ultra-violet were until recently unexplored regions, in spite of the many efforts that had been made to produce and detect waves there. Since 1922, however, the gaps have been closed, and it is now possible to carry out experiments with waves at any part of the sixty odd octaves of the electromagnetic spectrum.

The gap between the infra-red and the Hertzian waves has been bridged by advances from both sides. The production of shorter and shorter Hertzian waves has been effected by the use of smaller and smaller oscillators. Lebedew (1895) and Lampa (1896) respectively obtained waves which they estimated as of wave-length 6 mm. and 4 mm., but Mobius, who published his results in 1920, considers that these waves must have been of length 1 cm. and 7 mm. respectively. He himself obtained waves 7 mm. long, with which appeared overtones of much shorter wave-length, but such measurements could not be reproduced exactly. The quest for short Hertzian waves was carried much further by Nichols and Tear, who published their final results in 1923. Lebedew and Lampa had constructed oscillators which consisted of minute platinum cylinders, 1·3 mm. long and ·5 mm. thick, arranged axially end to end, with a gap between them. The current from an induction coil had to leap across small spark gaps to reach the oscillator. Nichols and Tear worked on similar lines, but with great experimental skill succeeded in reducing the dimensions of the oscillator still further. The two cylinders which formed the oscillator proper were of tungsten, each being ·2 mm. long and ·2 mm. thick, with an oil-immersed gap of ·01 or ·02 mm. between them. (It appears from a note published by K. K. Darrow in the Bell *System* Technical Journal, Vol. 3, Number 3, 1924, that the dimensions of the cylinders were subsequently reduced to ·1 mm. long and ·1 mm. diameter.) The waves proceeding from the gap were focussed into a parallel beam by a lens of paraffin wax, and then fell on the interferometer used for measuring the wave-length, which was of the simple form due to Boltzmann. This consists of two plane mirrors mounted one above the other, one stationary and the other movable in such a way that the two always remain parallel. Half the beam falls on each mirror. The reflected beam was brought to a focus by a second paraffin wax lens. The intensity distribution of the resulting radiation was measured, as heating effect caused by the rays falling on a conductor, by a modified form of radiometer (*q.v.*). With such apparatus Nichols and Tear obtained waves the length of whose fundamental was as low as 1·8 mm., and in certain cases very prominent harmonics of wave-length ·22 mm. These harmonics were apparently the fundamental wave-length of the part of the minute oscillator cylinders which projected through the glass into the oil, and predominated, so that it may be claimed that Nichols and Tear extended the Hertzian spectrum down to ·22 mm.

More recently still Glagolewa-Arkadiewa has pushed things further by the use of an entirely new type of generator. This consists of a suspension of fine metal filings in machine oil, kept in constant motion by a rotating disc. The spark from an induction coil passes through a mass of closely packed filings separated by oil. This disposition has the advantages that the vibrators, consisting each of a pair of filings, are exceedingly small, which makes the wave-length small: that there is a very large number of them, which gives the requisite intensity: and that they are constantly renewed, which prevents the spark burning them away at the end. The wave-lengths are investigated with a Boltzmann interferometer, while as a detector special thermocouples are used. With this apparatus Glagolewa-Arkadiewa has measured wave-lengths of from 50 mm. down to ·1 mm. This represents the limit reached at the present time (1928) in the way of short wave-lengths produced by what, in spite of all modifications, is essentially the method of Hertz.

The approach from the infra-red side was mainly carried out by Rubens and his collaborators. Important advances were made by the method of *Reststrahlen* ("rest-rays" or "residual rays"). The method depends upon the fact that certain crystals have a strong absorption, accompanied by metallic reflection, for a small range of wave-lengths in the infra-red, at a frequency correspond-


Approximate Frequencies
Wave Lengths in Centimetres
Wave Lengths in Ångstrom Units
100000000000000000000~ 0000000003
0·01
25000 000 000 000 000 000 0 0000000012
0·06
6 140 000 000 000 000 000 0·000 000 0048
0 5
1536 000 000 000 000 000 0 0000000195
1·4
384 000 000 000 000 000 0·000 000 078
96000 000000 000 000 0 0000003l
24000 000000000000 0 000 0012
136
6 000 000 000 000 000 0 000 005
1019
1 500 000 000 000 000 0·000 02
4000
375000 000 000 000 0 00008
8000
94 000 000 000 000 0 00032
23 500 000 000 000 0·00128
5900 000 000 000 0 00512
1x10^6
1460 000 000 000 0·0205
4x10^6
366 000 000 000 0·0819
91500 000 000 0·328
23 000 000 000 1·31
5 730 000 000 5·24
1430 000 000 21 0
358 000 000 83·9
89 000 000 336
1x10^11
22 400 000 1342
5 590 000 5369
1400 000 21470
3x10^12
5x10^12
B.B.C. RANGE
350 000 85900
1 6x10^13 — CHELMSFORD
87 300 343 600
21 800 1374 000
3x10^14
5460 5498 000
1364 22 000 000
341 88 000 000
85 352 000 000
3·5x10^16
USED IN RADIOLOGY 3 Octaves
Generation
Emitted when atomic nuclei disintegrate.
Detection
As for X-Rays but more penetrating, less readily absorbed & generally more 'vigorous'.
GAMMA RAYS
Generation
Emitted by sudden stoppage of fast-moving electrons.
Detection
(a) Photography. (b) Phosphorescent effects with suitable materials. (c) Chemical action. (d) Ionisation of gases. (e) Emission of electrons from hot bodies of the same nature as photo-electric effects. (f) Diffracted if suitably reflected by a crystal: show no ordinary reflection or refraction. (g) Penetrate all matter to a greater or less extent.
X-RAYS 14 Octaves
Generation
Radiated from very hot bodies & emitted by ionised gases.
Detection
(a) Photography. (b) Phosphorescent effects with suitable materials. (c) Chemical action. (d) Ionisation of gases. (e) Photo-electric effects. (f) Can be reflected & refracted & diffracted by finely ruled gratings.
ULTRA-VIOLET RAYS 5 Octaves
Generation
Radiated from hot bodies & emitted by ionised gases.
Detection
(a) Produce sensation of light. (b) Photography (c) Chemical action. (d) Photo-electric effects. (e) Can be reflected & refracted & diffracted by ruled gratings.
VISIBLE RAYS 1 Octave
SOLAR RADIATION Limiting Wave Lengths Reaching the Earth
Generation
Heat radiations from hot body.
Detection
(a) Heating effects on thermo-couples & on bolometers. (b) By rise of temperature of receiving body. (c) Photographic effects on special plates. (d) Can be reflected & refracted by comparatively coarsely ruled gratings.
INFRA-RED RAYS 9 Octaves
Generation
Stop gap discharge. Oscillating Triode-valve.
Detection
(a) Coherer. (b) Spark across minute gap in resonant receiving circuit. (c) Can be reflected, refracted & diffracted.
SHORT HERTZIAN WAVES 17 Octaves
HERTZIAN WAVES 28 Octaves
Generation
Spark-gap discharge.
Oscillating Triode-valve
Detection
(a) Coherer (b) By conversion into alternating current which can then be detected or measured (c) By rectification, with or without "heterodyning" & production of audible telephone signals
USED IN WIRELESS 11 Octaves
Generation
Coil rotating in magnetic field.
Detection
(a) Mechanical. (b) Electrical. (c) Magnetic. (d) Thermal effects of alternating currents.
SLOW OSCILLATIONS CORRESPONDING TO VERY LONG WAVES
Approximate Frequencies
Wave Lengths in Centimetres
Wave Lengths in Ångström Units

ing to the period of vibration of the crystal itself. (See LIGHT, *Refraction in Absorbing* Media; SOLID STATE.) The reflection is strongly selective, that is, very much stronger for the particular narrow range of wave-lengths than for wave-lengths on either side. In consequence repeated reflection from a few (say four) surfaces leaves only the selectively reflected rays present in any intensity. With rock salt and sylvite (potassium chloride) rest-rays of wave-length 52μ and 63μ respectively are obtained, while with thallium iodide rest-rays as long as 152μ result. An advantage of the method of rest-rays is that the experimenter has at his disposal a broad beam, with the consequent relatively high intensity.

A technique which led to the measurement of still longer wave-lengths is the method of focal isolation employed by Rubens and R. W. Wood. The radiation from a suitable source is allowed to pass through a quartz lens, quartz being very transparent and also particularly refracting (refractive index 2.2) for the very long rays. The distance of the source from the lens is so arranged that while the shorter heat and the light waves actually diverge after leaving the lens the long heat rays come to a focus, which is isolated by a hole in a screen. A stop at the centre of the lens prevents the direct passage of practically unrefracted rays through the hole. To purify the radiation still further a second quartz lens with a central stop is used to refract the radiation passing through the hole, The wave-length is measured by an interferometer with quartz plates, maxima and minima of intensity being obtained. With a Welsbach gas mantle wave-lengths of 107μ or so were measured. Replacing the gas mantle by a quartz-enclosed mercury vapour lamp Rubens and von Baeyer (1911) found two bands of very long wave-length, one at about 218μ and the other at 342μ. They used an interferometer of Boltzmann type for the analysis of the radiation. Later (1921) Rubens used a grating made of wires a millimetre thick, with millimetre inter-spaces, to disperse the radiation into a spectrum, and confirined the presence of strong radiations at these wave-lengths, with measurable radiation extending to wave-lengths as long as 400μ. It is probable that the radiation of the mercury lamp is not a temperature radiation (see HEAT), but due to the motion of charged ions; for instance Lindemann has suggested that positively and negatively ionised atoms, separated by about the same distance as the atoms in liquid mercury, may form doublets which rotate like double stars, and has shown that this would lead to wave-lengths of the order required.

As regards radiation from a black body of the hollow-space (*Hohlraum*) type used by Lummer and Kurlbaum (see BLACK BODY), Rubens and Michel made detailed measurements on a radiation as long as 52μ from such a source. It is therefore clear that the gap between Hertzian waves produced by discharge between microscopic particles on the one hand, and infra-red rays produced from hot solids and vapours on the other hand has been closed with an ample overlap, the Hertzian waves extending down to 100μ, and the infra-red rays reaching up to 400μ.

The first great step in the modern extension of the ultra-violet was taken by Schumann, who, by using fluorite lenses and prisms and special plates, in which the emulsion was deliberately made very poor in gelatine, since gelatine has a marked absorption for the far ultra-violet, pushed the recorded limit to 1,220 **A.** He showed (1893) that radiations between 1,800 and 1,200 A. are strongly absorbed by air, and hence that it was necessary to work with the spectrograph in vacuo. (See SPECTROSCOPY.) At about 1,200 A.U. fluorite becomes opaque to the radiation, so that for his work on the still shorter waves Lyman, whose researches extend from 1906 to the present day, used a concave grating without lenses or mirrors, the grating itself forming images of the slit on the photographic plate. The spectrograph was necessarily enclosed in a vessel which could be evacuated. Lyman has reached 500 A. During the years 1923–1928 Millikan and his collaborators made further very important advances into the extreme ultra-violet. The source used is the so-called "hot spark" between electrodes of the metal whose spectrum is being investigated: the spark gap is very short and situated in a highly evacuated space, of pressure ·00001 mm. of mercury or less, and the discharge from a powerful battery of condensers charged by an induction coil is passed intermittently. Specially ruled gratings are used, and the pressure in the whole apparatus maintained at the lowest possible level. The limits reached with the line spectra of certain elements are as follows: carbon 360.5 Å.U., zinc 317·3 Å.U., iron 271·6 A.U., silver 260 A.U., nickel 202 A.U. and aluminium 136·6 Å U. This 136.6 A.U. represents the extreme short wave limit measured by the ordinary methods of optical, as distinct from X-ray, spectroscopy.

Turning to the advance from the X-ray side, the longest waves measured by the methods of crystal diffraction originated by the Braggs are about 13 A.U., *e.g.,* L a for copper is of wave-length 13·3 Å.U., while one of the N series lines of thorium, which seems to represent the limit, is of wave-length 13·8 Å.U. The measurement of rays in the gap between 13.8 Å.U. and 136·6 Å.U. presents peculiar difficulties, because all the wave-lengths in question are particularly easily absorbed, even by gases at low pressure, and because the diffraction methods break down in this region. As an example of the absorption it may be mentioned that Holweck finds that a sheet of celluloid ·00027 mm. thick—and celluloid has a particularly low absorption coefficient in this region—transmits only 3 per cent of the radiation in the neighbourhood of 310 A.U., where the absorption is at a maximum. It is consequently necessary to maintain a very good vacuum in the apparatus, and, if any solid diaphragm is used, to make it exceedingly thin. The rays are usually detected either by their photoelectric effect (see PHOTO-ELECTRICITY) or by the ionisation which they produce in a gas at low pressure.

McLennan, Horton, Hughes and others have employed various forms of apparatus in which the surface of a solid is bombarded by electrons accelerated by a measured difference of potential, the radiation so excited being detected and measured by its photoelectric effect on a metal plate. The highest possible vacuum is maintained in the apparatus, so that the incident electrons have the full energy corresponding to the voltage drop. A curve connecting this voltage with the photoelectric current released by the radiation is obtained, and sharp changes in direction of this curve are taken to indicate the appearance of a new radiation, whose wave-length can be calculated from the corresponding voltage. Such a voltage is a resonance potential (*q.v.*). The plate from which the photoelectric current is measured has to be very carefully shielded from any diffusion of ions by arrangements of charged gauzes which vary in disposition in the apparatus of different workers. The method has also been applied to gases, which are bombarded by electrons of known energy. (See RESONANCE POTENTIAL.) Holweck, on the other hand, has employed a different method, separating the part of the vessel where the short waves are produced from the part where their effect is measured by a solid diaphragm, which stops all disturbing ions. The celluloid films which he uses for this purpose have a thickness of 10^{-5} cm. or less. The intensity of the radiation is measured by the ionisation produced in a gas, the pressure of which varies for different experiments, but is generally of the order of a few millimetres of mercury, as contrasted with pressures of the order of ·00005 mm. of mercury in the generating part of the apparatus. A sudden change in the ionisation corresponds to the attainment of a resonance potential, from which the wave-length is calculated as in the other type of experiment. The apparatus can also be used to measure the absorption of these extremely soft (*i.e.,* easily absorbed) radiations.

The result of these measurements of resonance potential is to reveal the existence of characteristic radiations from given elements, of the nature of an extension of the X-ray line spectra (see X-RAYS, NATURE OF: *Röntgen* Rays), in the region noted, and Holweck's experiments have shown in addition a continuous, or non-characteristic, radiation from 25 volts to 280 volts ($\lambda = 500$ Å.U. to $\lambda = 44$ Å.U.). Typical characteristic lines, for which concordant results have been obtained by several different workers, occur, for the L series of magnesium, aluminium, chlorine, argon, at 46, 68, 200 and 245 volts respectively, corresponding to wave-lengths 269, 182, 62 and 50 Å.U. For the K series of carbon, nitrogen, oxygen, fluorine, neon, Holweck has obtained, by his ionisation method, lines at 280, 397, 528, 684 and 864 volts, corresponding to wave.

lengths 44·1, 31·1, 23·4, 18·1, 14·3 Å.U. respectively. It should be noted that the first three of these lines are in good agreement with the measurements of Mohler and Foote, while Holweck by his method has further obtained an aluminium line at 1,555 volts ($\lambda = 7.95$ Å.U.) which agrees precisely with the K absorption edge determined by Fricke by the method of crystal diffraction. This agreement is important, as it gives additional assurance that the results of the ionisation potential methods have been correctly interpreted.

By these measurements of critical potential wave-lengths have, then, been measure'd from 269 down to 14·3 Å.U. which comfortably bridges the gap between wave-lengths measured by the help of ruled gratings, and those measured by crystal diffraction. The methods of crystal diffraction have been used with X-rays to measure wave-lengths down to ·107 Å.U., the K absorption edge of uranium, while the shortest y-ray measured by Rutherford and Andrade, with the crystal method, was ·072 Å.U. C. D. Ellis and L. Meitner have independently measured much shorter y-ray wave-lengths by the help of the natural and secondary β-ray spectra, a method which is essentially photoelectric. (See PHOTO-ELECTRICITY.) The measurements of Ellis stretch from wave-length ·26 Å.U. to ·005 Å.U., and thus have an ample overlap with the lengths measured by crystal diffraction. This ·005 Å.U. represents the shortest wave-length of which the measurement has much claim to accuracy.

The estimates of the wave-lengths of the very penetrating cosmic radiations investigated by Kohlhorster and later by Millikan depend upon the extrapolation of the absorption law far beyond the limits of our experimental knowledge.

Millikan's latest measurements (*Physical* Review, xxxii., 533, 1928) show that the cosmic radiation is not homogeneous, but consists of two main bands, one having an absorption coefficient $\mu =$ ·35 per metre of water ($\mu\rho =$ ·0035 per cm.), and the other being resolvable into two radiations for which $\mu =$ ·08 and $\mu =$ ·04 per metre of water respectively. This rough resolution into a discontinuous spectrum invalidates the method of generation of the rays formerly suggested, namely that the energy of the radiation might be supplied by the impact of high speed electrons against the nuclei of atoms, for this would be expected to produce a general radiatiop. The fundamental assumptions underlying any explanation so far imagined are: (1) that a frequency ν can be derived from the absorption coefficient of the cosmic radiation by the use of some formula to extrapolate the frequency-absorption relation into regions of low-absorption for which no laboratory measurements are available; (2) that the quantum of energy $h\nu$ must be released by some single atomic process. The problem is to find an atomic process which will liberate so large an amount of energy as the very high frequencies derived by (1) require.

The Einstein relation between mass and energy (*see* RELATIVITY and also NUCLEUS, section Stability of *Nucleus: Atomic Energy*) associates any loss of mass with an emission of energy. There is evidence for a change of mass when protons and electrons are packed together to form a nucleus (see NUCLEUS) and Aston has, from his experiments, obtained a curve' showing the "packing effect" for all elements. (See ISOTOPES.) From this curve it is clear that for the lighter elements, of atomic weight less than 80 or so, energy can only be given out when the nuclei are built up from protons, and not when they break down. The heavier elements would, it is true, give out energy on disintegrating, for they lie beyond the minimum in Aston's curve, and the radioactive elements provide actual examples of atoms disintegrating with emission of energy in the form of a- and β-rays (with y-rays as a secondary phenomenon). However, the energy given out per atom by radioactive disintegration is not sufficient to account for the cosmic radiation. Using a formula of Dirac to obtain a frequency from the absorption coefficient Millikan has argued that the cosmic radiation for which $\mu =$ ·35 per metre of water must originate in the formation of helium from hydrogen in outer space. It is shown in NUCLEUS that there is a loss of energy $4{\cdot}6 \times 10^{-5}$ ergs ($4{\cdot}3 \times 10^{-5}$ ergs with the latest figures, used by Millikan) per atom of helium formed, which from the quantum relation $E = h\nu$ corresponds to a wave-length of ·00046 Å.U. Dirac's formula gives an absorption coefficient ·30 per metre of water for such a frequency, which agrees well enough with the necessarily very rough figure derived from experiment. Reasoning on similar lines, the formation of oxygen from hydrogen in a single act gives rise to a radiation of wave-length ·00010 Å.U., which has an absorption coefficient of ·08 per metre of water: this agrees exactly with that of one of the other cosmic radiations observed by Millikan. The formation of silicon from hydrogen leads to a radiation for which $\mu =$ ·041 per metre of water, agreeing with the second of the more penetrating cosmic radiations of Millikan. Helium, oxygen and silicon are elements which appear in great abundance everywhere in the heavens, which lends plausibility to this theory of the generation of cosmic rays, although the creation of an element like silicon in one act out of 28 atoms of hydrogen is a process which offers grave difficulties to the physical imagination.

As a result of recent experiments it can be said, then, that we have knowledge of an unbroken range of electromagnetic radiations from wave-lengths of hundreds of metres down to wave-lengths of a few hundred-thousand-millionths of a centimetre, and have evidence of cosmic radiations of still shorter wave-length.

Generation of the Radiations.—When we consider electromagnetic radiations in free space, any distinction into groups of different wave-length is purely arbitrary, for the velocity and mechanism of propagation is exactly the same throughout the spectrum. When, however, we turn to the relationship between radiation and matter, and in particular the emission and absorption of radiation, there are certain distinctions which, while giving no sharp boundaries of wave-length between different classes of radiation, do nevertheless divide the radiations into broad natural groups. These distinctions are based upon the nature of the vibrator, or of the quantum mechanism, which gives rise to the undulations.

Starting at the long wave-length end of the spectrum, the Hertzian waves are generated by oscillations of electricity in macroscopic systems of conductors. The atomic or molecular nature, or even crystal structure of the metals constituting these conductors does not enter directly into the calculations from which the frequency of a given system can be derived: the conductors can be treated as uniform and homogeneous, and the problem of the oscillations as strictly analogous to those of mechanical oscillations of systems of springs and masses. The size and geometry of the system determines the wave-length; the engineering stations of the wireless telegraph companies, with their mighty aerials, produce wave-lengths measured in hundreds of metres, while minute oscillators whose size is measured in fractions of millimetres produce wave-lengths of the same order as their own linear dimensions.

The infra-red radiations are produced by a variety of oscillators, if we merely consider an arbitrary group of wave-lengths from ·8μ to 400μ say. The atomic mechanism of quantum jumps executed by an outer electron, which is responsible for line spectra (see ATOM, QUANTUM THEORY, SPECTROSCOPY), leads to certain lines situated well in the infra-red: for instance Brackett (1922) has measured two hydrogen lines, of wave-length 4·05μ and 2·63μ, which can be represented by putting $n' = 4$, $n = 5$, 6 in the general Balmer formula $\nu = R\left(\frac{1}{n'^2} - \frac{1}{n^2}\right)$. Such lines, however, are not representative of infra-red radiations, but should be classed with the optical spectra. More typical are the band spectra consisting of nearly equidistant lines in the far infra-red (in the neighbourhood of 100μ), and the band-spectra consisting of two branches of equidistant lines, with a gap between them, observed in the near infra-red (in the neighbourhood of 5μ). (See BAND SPECTRUM.) These spectra are usually observed as absorption spectra, but emission and absorption are effected by the same mechanism. It has been established beyond doubt that the bands in the far infra-red are due to molecules rotating, the possible rotations being fixed by quantum conditions, and interchanges between stationary states leading to emission or absorption, while the bands in the near infra-red are due to vibrations within the molecule, the distance between the nuclei of the constituent atoms varying periodically. These vibrations are superposed on the rotations, and likewise governed by quantum conditions. The details of their mechanism are described in the article BAND SPECTRUM; what it is desired to emphasise here is that the periodic changes in question, whose frequency is typical of the infra-red, are molecular in nature, the motion being of the molecule as a whole, often supplemented by motions of the atoms, treated as rigid wholes, within the molecule. As soon as changes within the atom itself are added to these motions the corresponding bands are no longer in the infra-red, but in the visible and ultra-violet.

Another case of vibrations of the infra-red class is offered by the rest rays, to which reference was made in the preceding section. The oscillations here in question are those of ionised atoms making up the structure of the crystal in question, and can be calculated, as shown by Born and his collaborators, by considering the possible vibrations of the crystal lattice. Here again we are dealing with vibrations of atoms considered as rigid wholes, governed by interatomic forces. It may be said, then, that frequencies of the orders usually associated with the infra-red are connected with the vibrations of atoms or molecules as a whole, under the influence of their mutual attractions and repulsions, and not with changes within the atom.

The radiations of a heated "black body" (*q.v.*) include theoretically the whole spectrum, but the only portions of measurable intensity with laboratory sources are the visible and infra-red. Planck's law giving the distribution of energy throughout the spectrum of black-body radiation at any temperature (see HEAT, QUANTUM THEORY) has been experimentally confirmed, within the limit of experimental error, from $\cdot 5\mu$ to 50μ, the validity in the long wave region 4μ to 52μ having been the object of a special research by Rubens (1921). The theoretical deduction of the formula, although Planck himself assumed the existence of resonators or vibrators within the solid, need not involve any assumption as to the nature of the vibrators involved in the proof, the reasoning being of a thermodynamical nature, which demands no precise mechanism. It is possible, as Einstein has shown, to deduce the formula on the assumption that the radiation is given out by atoms executing quantum jumps, as demanded by Bohr's theory, but as the distribution of radiation is quite independent of the atomic nature of the black body the precise character of the quantum jumps is immaterial. The radiation from a heated solid cannot be atomic, in the sense that the radiation from a gas is, for the behaviour of the atomic electrons must be influenced by the electric field and radiations of the surrounding atoms. It is, then, probably something which partakes of the nature of both an atomic and a molecular radiation, in that the atoms cannot be considered as rigid wholes, as they can for the infra-red bands, nor yet as independent entities within which quantum changes take place, as they can for the line spectra. Vibrating systems of every possible frequency are demanded by the theory, and they can be provided by some such scheme as that sketched, which is necessarily vague, as there is at present no precise knowledge of the mechanism of radiation from solids.

The generation of line spectra in the visible and ultra-violet region has been explained in terms of Bohr's quantum theory of spectra which is fully discussed under ATOM; QUANTUM THEORY, SPECTROSCOPY. Different stationary states of the atom are determined by the behaviour of the outermost electrons of the groups of electrons which surround the nucleus, and passage from one stationary state to another is accompanied by the emission of a radiation of given frequency. By this mechanism of quantum changes among the outer electrons a vast range of frequencies is emitted, for Brackett's hydrogen lines in the far infra-red, to which reference has already been made, are generated in this way, while Millikan's lines in the extreme ultra-violet are due to such changes in atoms which are already multiply ionised, that is, have lost outer electrons. The band spectra in the visible and ultra-violet are likewise due to quantum changes among the outer electrons in atoms constituting a molecule, the molecule executing changes of its own at the same time. The characteristic mechanism of the visible and ultra-violet is therefore an affair of the outer electrons.

The X-ray line spectra originate in similar quantum changes among electrons, but here it is the inner electrons of the atom that are involved, among which are associated with jumps much greater changes of energy than those among the outer electrons. (See X-RAYS, NATURE OF: *Röntgen Rays.*) The γ-rays are not generated in the electron distribution round the nucleus, but proceed from the nucleus itself. The mechanism of their production is still uncertain. (See NUCLEUS.) The origin of the very penetrating cosmic radiation is still less understood; reference has already been made to Millikan's theory that it is due to atomic nuclei in the process of manufacture.

To sum up, then, corresponding to wide range of wave-lengths of the electromagnetic spectrum there is a range of generators of widely different sizes. The longest waves are generated by large installations of coils of wire, condensers and so on, and generators constructed on these principles can be reduced in size until the oscillator system consists of two minute metal filings. Then there are systems of vibrating molecules such as we have in crystals and in solid bodies in general, which generate radiations in virtue of their heat motion. Another type of generator is the single molecule, effective in the gaseous state, which gives rise to infra-red radiations as long as the atoms can be treated as minute rigid bodies. When changes within the atom itself are taken into account we have another type of generator, and this type can be further subdivided according as the inner or the outer electrons are considered. When the outer electrons only are involved in the generation of radiation we can treat the nucleus and innermost electrons as forming a rigid system: when the inner electrons are in question we can still treat the nucleus as a minute rigid body. Finally, we have to consider the nucleus itself as a generator of vibrations, so that, descending the scale of wave-lengths, we start without the need of considering any atomic or molecular mechanism, and there in succession can treat molecule, atom and nucleus as rigid, finally being forced to take into consideration changes within the nucleus itself.

The ranges of wave-length generated by the types of system just outlined overlap one another widely, as has been already indicated. Changes in the atom can generate lines in the far infra-red: some nuclear y-rays are of longer wave-length than the hardest X-rays, generated by the extra-nuclear electrons. From the purely empirical point of view it may be best to group the radiations according to wave-length, or according to methods of measurement, especially as a sound theoretical basis is still to seek in some regions: from the theoretical point of view it seems preferable to group the radiations according to their method of origin. A rough analogy from acoustics, which must not be pressed too far, may be offered. Air vibrations might be grouped according to wave-length, or according to origin. In the latter case the division might be into inaudibly low notes originating in the vibration of planks: drum notes, piano notes, and whistle notes. Such a classification is quite without the theoretical meaning that attaches to the subdivision of electromagnetic radiations, according to classes of natural vibration, but may serve to distinguish the two points of view.

Absorption of Radiation.—In the article LIGHT, the absorption of light is explained in terms of damped oscillators of given free period, present in the absorbing substance, and the connection between absorption and dispersion is expounded. In the articles ELECTRICITY and ELECTRIC WAVES the properties of the Hertzian waves, as predicted by Maxwell's theory, are described. In the present section the actual course of absorption of the radiations, as the wave-length is varied from one end of the range to the other, is discussed, stress being laid rather upon the facts of observation, the fundamental theories being considered in the articles quoted. The differences of absorption exhibited by the radiations of different regions constitute one of the most striking features of the interaction of radiation and matter.

On Maxwell's theory, metals, in which the electrical conductivity is very high (meaning that an actual convection of electric charge, as distinct from a displacement current, is easily set up in the medium), reflect radiation very well, and also absorb very strongly that part of the radiation which is not reflected. The higher the conductivity, the larger the coefficient of absorption, It is an experimental fact that in the region of Hertzian waves the absorption by metals is very high: for instance Branly found that tinfoil ·008 mm. thick did not let the waves through in measurable intensity. From the same theory it follows that perfectly insulating dielectrics should be perfectly transparent. This has also been to some extent confirmed experimentally, Righi having shown by a direct method that sulphur, ebonite, paraffin and selenite are quite transparent to waves 5 to 20 cms. in length, but glass, marble and wood absorb to some extent, The comparatively good transmission of long electromagnetic waves by substances which are, broadly speaking, non-conducting, is a familiar fact to people living in brick houses who use an inside aerial for the reception of broadcast waves.

According to Maxwell's theory absorption is entirely governed by the conductivity of the medium, and a relation can be worked out which gives the absorption coefficient in terms of the conductivity and the dielectric constant. A great number of measurements have been made by Drude and his followers on the absorption of feebly conducting substances, such as electrolytes and low pressure gases. Qualitatively the relation holds in all cases. Quantitatively it has been confirmed for water solutions of salts, of which the conductivity is measured directly, while the dielectric constant is taken as being that of water. With many organic substances, however, especially those containing hydroayl groups, the measured absorption is greater than that given by the theoretical formula. Drude tried to explain this by the presence of resonators of the type that account for optical absorption, with a large damping coefficient, but there seems no possibility of resonators of sufficiently large free period. A more promising theory is that of Debye, who looks for the explanation in the presence of dipoles in the molecules, which tend to set themselves in the direction of the electric force. When the oscillations are comparatively slow, as in the Hertzian region, the dipoles can follow more or less the alternations of electric force, provided the medium is not too viscous, and dissipate the energy, but when the alternations are very rapid, as in the optical region, they have no time to orient themselves, on account of their great inertia. Some substances show narrow regions of anomalous dispersion in the Hertzian region which do not accord with this explanation. Speaking broadly the Hertzian waves do experience the strong absorption in good conductors and the feeble absorption in dielectrics which can be explained on Maxwell's theory without any consideration of the structure of the medium, or its chemical nature.

The longer infra-red waves are also well removed from the region where the oscillators of the type considered in optical dispersion make themselves felt, and many of the consequences of Maxwell's theory, based on the assumption of a structureless medium, have been confirmed with such waves by Rubens and others, such as the proportionality of the refractive index to the square root of the dielectric constant for non-conductors. For such experiments the long infra-red waves possess the advantage that they do not necessitate the large-scale apparatus required for Hertzian waves many ccntimetres in length. Considering the absorption of infra-red and optical radiations a distinction must be made between the absorption associated with metallic reflection and that conditioned by the atomic oscillators. In the case of strong reflection, exhibited by such crystals as those used for isolating the rest-rays, as well as by metals, the absorption is in general so high that the radiations do not penetrate any appreciable distance into the substance. (The effect takes place with crystals only for a radiation whose frequency agrees with that of the free period of the natural vibration of the crystal.) The surface colour, using the term in a general sense, to apply to invisible as well as to visible radiations, is approximately complementary to the colour transmitted by an exceedingly thin layer, as exemplified by the green light transmitted by a gold leaf, which appears yellow by reflected light. In the case of the ordinary absorption associated with anomalous dispersion, the radiations penetrate further into the body, and the colour by reflected light is the same as the colour by transmitted light. Right down into the optical and ultra-violet region the opacity of metals holds, but it ceases in the X-ray region, where the oscillations are far too rapid to affect the electrons which are responsible for the conduction. It may be noted that there is a certain selectivity in the metallic reflection in the optical region which is not accounted for by the simple Maxwellian theory: for instance gold reflects red selectively as can be seen by reflecting light many times between two plane gold surfaces. The issuing light is deep red.

A large number of measurements of the absorption of radiation by metals has been made by Hagen and Rubens. The absorption coefficient, defined by them as the reciprocal of the thickness which reduces the incident radiation to one-tenth of its initial intensity, varies somewhat with the wave-length, but has a value of the order of 10^5 cm.$^{-1}$ for gold and silver, for instance, in the visible and near infra-red.

While metals show the same opacity to the visual region as to the long waves, the behaviour of non-conducting or badly conducting substances in this region is widely different. All such substances show regions of marked selective absorption either in the visual region or in the neighbouring ultra-violet or infra-red, the theory of dispersion resting upon the presence of absorption bands in this range. A few of the most important examples will be given. Glass, which transmits the visible radiations so well, is opaque for the infra-red and the ultra-violet except in regions immediately adjoining the visible. The ordinary glass fire screen offers a familiar proof of the opacity for infra-red, and this opacity is also the cause of the high temperature prevailing in glass-houses. The visible radiations enter the glass-house and heat the soil, but the very long heat rays emitted by the soil cannot escape. Quartz is transparent in thicknesses of some centimetres to the infra-red beyond 70μ, but has a strong absorption from 4·5μ to somewhere about this value. It is also transparent in the ultra-violet down to 1,800 A.U. Substances which transmit the infra-red well are sylvin, rock-salt, and fluorite down to about 23, 15 and 9μ respectively. The substances transparent to the visible are familiar to everybody, as are coloured glasses with selective absorption. The ultra-violet is often divided into groups by the absorption of various substances: 3,800–3,400 Å.U., glass ultra-violet, transmitted by ordinary glass: 3,400–3,000 Å.U., Jena glass ultra-violet, transmitted by Jena and other glasses specially prepared for the purpose: 3,000–2,200 Å.U., quartz-glass ultra-violet: 2,200–1,800 Å.U., quartz crystal ultra-violet: 1,800–1,200 Å.U., fluorspar ultra-violet, The absorption of glass both for the ultra-violet and the infra-red is a matter that is, to a certain extent, under the control of the glass maker, Crookes prepared glasses very opaque to the far red and near infra-red for the use of furnace-men, while there are many special glasses designed both to stop the ultra-violet as near the visible as possible and to transmit it as far into the short-wave region as possible. The position of the absorption bands of solids in the visible and the adjacent parts of the spectrum is not determined atomic properties, but molecular properties.

Of particular interest is the absorption of the atmosphere for radiation, as it determines the limits of the sun's radiations which reach us. At the long wave-length end of the spectrum the intensity of the radiations has been carefully measured by Abbot up to 5·3μ where the energy is practically zero, probably owing to a strong absorption band of water vapour, which extends to 6.5μ. There are signs of a feeble transmission of infra-red between 10 and 13μ, but it is established that there are no measurable radiations between wave-length 15μ and 300μ. This is in any case not entirely due to atmospheric absorption, for if the sun be treated as a black body of temperature 6,000° absolute it can be calculated that the intensity of radiations of wave-length greater than 15μ would only be about 3/10,000ths of the total energy. In the infra-red of wave-length less than 6·5μ there are marked absorption bands due to carbon dioxide and water vapour.

At the other end of the spectrum the atmosphere transmits the ultra-violet down to about 3,000 Å.U. The limit varies, of course, with the thickness of the atmosphere traversed, and hence is different in summer and in winter. Measurements made in Switzerland by Dorno show that according to the season and the time of day the shortest wave-length of the sun's spectrum present in measurable intensity varies between 2,976 and 3,197 Å.U. It may be noted that it is quite a narrow kange of wave-lengths from about 2,800 to 3,100 Å.U., with a sharp maximum at about 3,000μ that can produce sunburn (light erythema), which accounts for the great variation in the burn produced by strong sunlight at different times of year, for the greatest action lies just in the region about which the limit of wave-length transmitted by the atmosphere oscillates with the seasons.

The great absorption of all matter for the radiation of the extreme ultra-violet, on both sides of 300 Å.U., has already been emphasized. From this region onwards the penetrating power of the radiation increases as the wave-length becomes shorter. With X-rays any distinction between conductors and non-conductors ceases, for the absorption here is entirely an atomic affair, and depends upon the binding of the inner electrons by the nucleus. Sharp absorption edges correspond to the frequencies at which the quantum energy of the radiation first suffices to eject an electron from a given inner group. (See X-RAYS, NATURE OF: *Röntgen* Rays.) For very hard X-rays, shorter than the K absorption edges of the elements considered, the absorption of a given element is proportional to the third power of the wave-length, while for a given wave-length and different elements it is proportional to the fourth power of the atomic number of the element, and thus independent of the periodic physical and chemical properties of the absorbing substance.

Broadly speaking, then, in the Hertzian region the behaviour of the radiation incident on matter can be explained in terms of the macroscopic electric conductivity, without consideration of the mechanism by which the conduction takes place. In the extreme infra-red the free-period of the crystal lattice makes itself felt, and the phenomenon of metallic reflection by crystals is observed in restricted regions, but outside these regions the laws of the Hertzian waves are obeyed. In the visible and adjacent regions the phenomena of absorption and dispersion are governed by damped oscillators of determined free-period, the nature of which is discussed under LIGHT. The chemical constitution and physical state of the body is of prime importance in these regions, and each substance has its regions of high absorption. For the absorption of the very short waves of the X-ray and y-ray region only the inner regions of the atom play a part, and conductivity in particular, and chemical and physical state in general, cease to have any important influence.

The question of the absorption spectra of gases and vapours is considered in full under BAND SPECTRUM and SPECTROSCOPY.

The Nature of Radiation.— The theoretical significance of the study of radiation for modern physics cannot be over-estimated, and most of the articles on physical subjects will be found to have some bearing on the subject. The hypothesis of an ether was created to account for the passage of radiation in interstellar space, and peculiarities of the behaviour of radiation—in this particular case visible light—led to the theory of relativity, as described in the articles RELATIVITY and ETHER. The consideration of the distribution of energy in the spectrum of black body radiation, which comprises, as far as experiment is concerned, the visible and infra-red, led to the Quantum Theory (*q.v.*), which has found significant application in such apparently remote subjects as specific heat. The particular study of radiation termed Spectroscopy (*q.v.*) is at the basis of the modern theory of the atom. The theory of Maxwell and the consequent discovery of long wave radiations by Hertz have left their mark in every branch of theoretical physics. To attempt a full list would be to run over every branch of physical science.

The extension of the electromagnetic spectrum constitutes one of the great unifying principles of modem science, and is a part of the attempt to explain everything in terms of electric and magnetic forces which is characteristic of the age. Until very recently there was, however, a sharp distinction made between radiation and matter. The interaction of the two, both in the way of the emission of radiation by matter and the action of matter on radiation falling on it, has proved to be a subject full of difficulties and paradoxes, in spite of the continued assault of the best brains of science on the problems presented. One group of phenomena is sufficiently explained by a wave theory of radiation; another group seems to demand for radiation a corpuscular character. (See PHOTOELECTRICITY, COMPTON EFFECT.) During the last few years a promising path to a general solution seems to have been found in the theory of wave mechanics initiated by L. de Broglie and Schrodinger. On this theory the distinction between matter and radiation becomes very shadowy. An electron is a certain singularity in a group of waves, and while waves possess certain of the properties of particles, at the same time particles possess many wave-properties. The electromagnetic theory of light was the great achievement of the last quarter of the past century: the explanation of matter in terms of electric charges was the great achievement of the first quarter of the present century. The next period bids fair to be one in which electric charges and radiation will be explained on a common basis, as different manifestations of something more fundamental, but at present less definite, foreshadowed by the wave function in the new wave mechanics.

The subject of wave-mechanics is discussed at more length in the article QUANTUM THEORY.

CORPUSCULAR RADIATIONS

The more detailed properties of the different classes of corpuscular rays are dealt with in other articles, cited as occasion arises. What is here given is a general review of the various types of rays and their relationship to one another.

The corpuscular radiations may be divided into the following groups: (a) Radiations consisting of streams of electrons, often referred to generically as cathode rays, since they were first observed coming from the cathode in an exhausted tube. In this group are included the β-rays from radioactive bodies. (b) Radiations consisting of streams of charged atoms or charged molecules, often called canal rays, since they were first observed passing through holes, or canals, in the cathode. These atoms are generally positively charged, and are sometimes referred to as positive rays, but since negative and neutral atoms are found in conjunction with the positive the name is not altogether suitable, although retained from long usage. The a-rays from radioactive bodies fall within this group. (c) Radiations consisting of streams of uncharged atoms of low velocity, obtained by evaporating an element in a vacuum so high that the free path of the escaping atoms is very large. Such rays are known as atomic rays.

Class (c) can clearly be included in class (b) if desired: the distinction is here made because the mode of generation of the rays and the state of charge are different. The characteristic feature of classes (b) and (c) is that the corpuscles which constitute the radiation have the mass of atoms, which is many thousand times the mass of the electron. Andrade has suggested calling this class of rays mass rays, a term which makes no reference to the state of charge, and this term has been adopted by Aston.

Electronic Radiations.— The cathode rays were discovered by Hittorf in 1869 in the course of his work on the discharge in an exhausted tube. He recognized that the rays streamed in a straight line from the cathode, and discovered that they were deflected by a magnet, behaving in this respect "like a simple current." In 1892 Lenard showed that the rays could pass through very thin metal foils, and so succeeded in obtaining them outside the tube in which they were generated. Later it was proved by J. J. Thomson and others that the rays consisted of streams of electrons, not associated with matter in the ordinary sense, moving with a velocity governed by the potential difference applied to the tube. This work, and the properties of cathode rays in general, is treated in the article ELECTRICITY, CONDUCTION OF: GAS.

The velocity of cathode rays is often expressed in volts, it being understood by this that the velocity in question would be acquired by an electron moving freely through a potential difference of the number of volts specified. Very small velocities' can be obtained by releasing electrons from a metal plate by illuminating it with violet or ultra-violet light (see PHOTOELECTRICITY), or from a metal wire or strip by heating it (*see* THERMI-

ONICS), and applying small accelerating or retarding Gelds. Ramsauer has obtained, with the help of a magnetic field and a system of screens, homogeneous beams of electrons of velocity as low as 1 volt (6×10^7cm./sec.). At the other end of the scale we have the β-rays from radium C which have velocities up to ·998 that of light. This is a velocity of $2{\cdot}994\times10^{10}$ cm./sec., and would need a field of 7.5 million volts to produce it artificially. Cathode rays of every velocity between these two limits are known in the laboratory, the region of velocities occupied by the spontaneous @-radiationsfrom radioactive bodies overlapping with an ample margin the upper limit of velocity producible in tubes by an artificially applied potential difference.

The difference in absorption is one of the most striking distinctions between cathode rays of different speed. For very slow electrons the absorbing cross-section of the atom is of the same order as the size of the atom determined by the accepted methods. Ramsauer and his school have shown very important abnormalities of absorption for electrons whose velocity is in the neighbourhood of a few volts, a comparatively high absorption here diminishing to an abnormally low one as the velocity drops to a volt or so, but these results do not affect the general order of the absorbing cross-section. As the velocity of the electrons increases the absorption becomes less and less: for velocities of 25, 2,560, 24,680, 261,500 and 662,000 volts the relative coefficients of absorption are as 18,000,000, 800,000, 2,900, 19 and 6. This means that the very swift electrons can pass freely through practically the whole cross-section of an atom, meeting less and less obstruction in so doing the higher their velocity. For the rays of highest velocity, which are not, of course, obtained artificially from a tube, but are @-rays, the cross-sectional area of an atom which acts so as to stop the electron is of the order of a millionth of the whole cross-section.

In Lenard's original experiments on the passage of cathode rays through windows of thin aluminium foil, the potential fall was of the order of 30,000 volts. The issuing rays, easily detected by the luminosity which they produce in a screen covered with a suitable phosphorescent substance (*e.g.,* barium platinocyanide), traverse a distance of the order of a centimetre of air at atmospheric pressure before becoming too weak to be observed. Of recent years cathode rays of very much higher velocity, and consequently much longer range, have been produced. There are many experimental difficulties in the way of constructing a tube that will stand up to 100,000 volts and more, but these have been overcome by W. D. Coolidge. In his tube the electrons proceed from a hot-wire cathode, of the type used in the Coolidge X-ray tube (see X-RAYS, NATURE OF: *Röntgen* Rays), in a hemispherical focussing cup, and issue into the air through a window of thin nickel foil, supported by a grid of molybdenum against the pressure of the atmosphere. The window is also the anode, and special precautions have to be taken to preserve the glass near it from puncture. Potentials as high as 200,000 volts have been used by Coolidge. With such a voltage the cathode rays can be detected at a distance of more than 40 cms. from the window in atmospheric air. Such rays are far inferior in speed to the β-rays of radium, but are produced by the tube in quantities far exceeding anything remotely possible with the quantities of radioactive substances available. The effects of this intense high speed cathode radiation are very remarkable. The rays produce a purple glow in the air round the window; they produce in calcite a phosphorescent glow which remains visible for hours after the exposure. The action on organic tissue of all kinds is very striking. Plant leaves after exposure dry up. The effects on animal tissue, as exemplified by a rabbit's ear, vary with the length of exposure. A very short exposure produces a tanning of the skin; an exposure of 1 second leads to the formation of a scab, which afterwards falls off with the hair, and is followed by a profuse growth of new hair which is, however, snow-white; an exposure of 50 seconds leads to scabs in the rayed area which leave a hole right through the ear when they fall. Bacteria are killed by the radiation, which also kills flies and beetles. Milk and butter quickly become rancid. Chemical effects have been produced in many other bodies, such as glue, gelatine and cane sugar, all of which break down under the bombardment of the swift cathode rays.

Mass Rays.—Charged atoms or molecules moving in beams can be produced in a variety of ways. They appear streaming through holes in a pierced cathode in the opposite direction to the cathode rays in a discharge tube and are thus called canal rays. Similar radiations of charged atoms can be produced from cathodes made of two parallel plates metallically connected, from two thin parallel wires used as a cathode, or other dispositions. Rays of material particles have also been observed travelling in the same direction as the cathode stream, and have been called retrograde rays by J. J. Thomson and K_1 rays by Goldstein. In all these cases the rays are derived from the low pressure gases present in the tube. Another method of obtaining such rays, which can be applied when the atoms in question cannot be obtained as a gas or a volatile compound, is to pack the anode of a discharge tube with a paste made of powdered graphite and a metallic salt: the rays then contain charged atoms of the metal in question. Such rays are known as anode rays, from their method of production, but they are of the same nature as the canal rays.

In a beam of canal rays the charged atoms are mainly positive, but neutral and negatively charged atoms exist aiongside. If a beam of positive atoms only be separated out by the application of a magnetic field, negative and neutral particles recreate themselves in the beam, as may be shown by a second magnetic field. This is due to the fact that an atom which starts in the beam as positively charged may become neutral by collision with an electron, or even negative by collision with a second electron. An equilibrium state is set up between positive, neutral and negative atoms, and, if the equilibrium is disturbed by separating out the positive ones, it establishes itself by new collisions a little further on. A moderately satisfactory theory of the reversals of charge has been worked out on the lines of the kinetic theory of gases, by considering the mean free path of charged and uncharged atoms passing through an assemblage of stationary particles. The important application of the canal rays and anode rays to the accurate measurements of the atomic weights of isotopes is described in the articles POSITIVE RAYS and ISOTOPES, where the existence of negatively charged atoms and of atoms with multiple charges also receives reference.

The a-rays from radioactive bodies are of the same nature as the positive rays in discharge tubes (except in that a-rays are always helium atoms, whereas positive rays of any element can be obtained), but have very much greater energy, just as the β-rays are of the same nature as cathode rays, but possess greater energy than can be obtained artificially. The energy of the a-particles of range 8.6 cms. from Thorium C corresponds to a fall through about ten million volts, and the energies with which a-particles are discharged from other radioactive bodies are all measured in millions of volts, as compared to the tens of thousands of volts concerned in the generation of the swiftest positively charged atoms in discharge tubes. There is thus no prospect of the generation of artificial a-rays in the laboratory. Corresponding to these voltages the velocity of the swiftest canal rays is of the order 10^8 cm./sec. (for example the highest velocity obtained for hydrogen canal rays is 3 to 4×10^8 cm./sec.) while the velocity of a-particles is of the order 2×10^9 cm./sec. It is well known that a-particles can pass through thin metal foils *(see* RADIOACTIVITY, NUCLEUS); the smaller velocity of the canal ray atoms does not enable them to penetrate foils as thick as those accessible to the a-rays, but nevertheless it has been demonstrated that they can penetrate matter. For instance swift canal rays of hydrogen and helium penetrate aluminium foil $3{\cdot}8\times10^{-5}$ cm. thick and mica 2 to 6×10^{-4} cm. thick, and hydrogen rays have been observed to go through gold foil of thickness from 7 to 21×10^{-6} cm.

Another point of resemblance between a-rays and canal rays has recently been established, namely that the a-rays can suffer changes of charge during their course. Along with the helium atoms of double positive charge a smaller number of helium atoms with only one positive charge can be observed, and a very few neutral atoms, but no negatively charged atoms. The smaller the velocity of the a-rays the greater the proportion of singly charged atoms; the neutral atoms are found only at very low velocities.

Another class of mass rays is constituted by the very much slower atoms obtained by evaporating a molten metal in a vacuum so high that the mean free path of the atoms leaving the metal surface is much greater than the dimensions of the vessel. By means of a suitable system of diaphragms pierced with slits or holes it can be arranged that the flying atoms take the form of a beam. If the temperature of the glass wall opposite the metal surface is suitable the beam of atoms forms a thin deposit where it strikes, but it must be observed that the necessary temperature is far below the solidification point of the metal. In cases where the deposit is too thin to be seen it can be "developed" by depositing silver on it from a silver nitrate solution, by a special technique. The velocity of such atomic rays, as they are termed, can be measured by rotating the vessel at a known speed and observing the consequent displacement of the line deposit made by a flat beam. The velocity found by this method agrees within experimental error with that to be anticipated on the kinetic theory of gases from the temperature of the molten metal, and this constitutes the first direct measurement of the velocity of atoms due to heat agitation. The velocity of a beam of silver atoms derived from molten silver at about 1,500° absolute is 6×10^4 cm./sec., as compared with about 10^8 cm./sec. for the atoms in canal rays and 2×10^9 cm./sec. for α-particles.

The atomic rays have found an important application in the experiments of Stern and Gerlach on the magnetic moment of atoms, described in the article MAGNETISM.

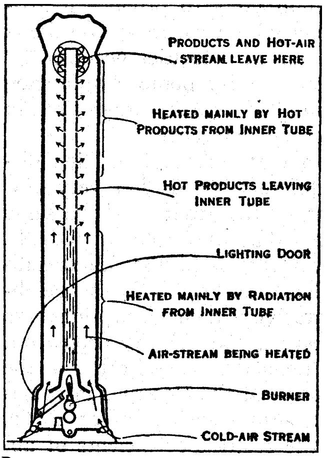
Finally, a word may be said on corpuscular radiations reaching the earth across space. The aurora borealis is attributed to the action of rays from the sun on the rarefied gases of the upper atmosphere at heights of 100 kilometres and more. The magnetic action of the earth on the charged particles constituting these rays concentrates the action in the polar regions. The data available do not suffice to establish with certainty whether these radiations consist of electrons, and so resemble β- and cathode-rays, or whether they consist of positively charged atoms, and so resemble the mass rays obtained in discharge tubes and a-rays. Vegard states that positive rays of hydrogen and helium with velocities of the order of 10^8 cm./sec. may produce an essential part of the aurora, but at the same time asserts that swift electrons combine a sufficiently great magnetic deflectibility and penetrating power to explain the distribution of luminosity and the height at which the aurora is produced. The corpuscular cosmic rays, influenced by the earth's magnetic field, must be carefully distinguished from the penetrating electromagnetic cosmic rays, discussed in the first part of this article.

BIBLIOGRAPHY.—Bibliographies of the various sections of the subject are given under ATOM; BAND SPECTRUM; ELECTRICITY; ELECTRICITY, CONDUCTION OF; ETHER; ISOTOPES; LIGHT; PHOTOELECTRICITY; POSITIVE RAYS; QUANTUM THEORY; RADIOACTIVITY; RELATIVITY; RESONANCE POTENTIAL; X-RAYS, NATURE OF; SOLID STATE; SPECTROSCOPY; ELECTRIC WAVES; WIRELESS TELEGRAPHY. *See* also LIGHT AND RADIATION IN RELATION TO HEALTH.

For the history of the infra-red and the ultra-violet, *see* H. Kayser, *Handbuch der Spektroskopie*, vol. i., 1900.

The following books deal with the completion of the electromagnetic spectrum, and contain full references: F. Holweck, *De la lumière aux rayons X*, 1927; J. Lecomte, Le *spectre infra rouge*, 1928. A general account of recent work in the infra-red, and of experimental method, is given in G. Laski, Ultrarotforschung, *Ergebnisse der exacten Naturwissenschaften*, 1924, p. 86; of the absorption of Hertzian Waves in H. Geiger and K. Scheel, *Handbuch der Physik*, vol. xv., 1927; of the aurora and its excitation in W. Wien and F. Harms, *Handbuch der Experimental-Physik*, vol. xxv., 1928; and of penetrating cosmic radiation in W. Kohlhorster, *Die durchdringende Strahlung in der Atmosphäre*, 1924; full references being given in each case. Recent papers dealing with particular points are: A. Glagolewa-Arkadiewa, "Eine neue Strahlungsquelle der kurzen electromagnetischen Wellen von ultrahertzscher Frequenz," *Zeitschrift für Physik, 24*, 153, 1924; R. A. Millikan and G. H. Cameron, "Origin of the Cosmic Rays," *Physical* Review, *32*, 533, 1928; W. D. Coolidge, "The Production of High Voltage Cathode Rays outside of the Generating Tube," *Journal Franklin Institute, 202*, 693, 1926; and with C. N. Moore, same journal, *202*, 722, 1926; L. Vegard, "Recent Results of Northlight Investigations and the Nature of the Cosmic Electric Rays," *Philosophical Magazine, 42*, 1019, 1921; E. F. Nichols and J. D. Tear, "Joining the Infra-red and Electric Wave Spectra," *Proceedings National Academy of Sciences, 9*, 211, 1923. (E. N. DA C. A.)

RADIATOR, a device usually built of cast iron, steel, copper or brass, used in room or space heating for transferring heat from a heating medium such as steam, hot water, gas or electricity to the surrounding air in the room. Steam radiators act as condensers for steam received through pipes from a boiler outside of the room, the condensate returning through the same or separate set of pipes to the boiler. Water radiators cool the hot water received through pipes from a boiler outside of the room and permit this water to return to the boiler. Gas radiators are equipped with gas burners as a source of heat and are of the following types: gas warm air radiator; gas steam radiator; gas water radiator. A vented gas radiator is provided with a pipe connection from which the products of combustion can be conducted out of the room. In an "unvented gas radiator" the products of combustion are permitted to escape into the space being heated. In gas, steam and gas water radiators, the pressure of steam or temperature of water is used to regulate the amount of gas burned. Electric radiators are equipped with resistances or elements which generate heat when supplied with electric current. If the heat is transmitted directly from the resistance to the air of the room, they are sometimes called space heaters. If electric radiators use steam or water as a means of transferring heat from the electric element to the surface of the radiator they are known as electric steam or electric water radiators. (See HEATING AND VENTILATION; THERMOSTAT; COOLING SYSTEMS.) (C. FL.; X.)



DAVIS GAS-HEATED STEAMLESS RADIATOR. SHOWING INNER STEEL TUBE WHICH HEATS THE CAST-IRON BODY

RADIĆ, STJEPAN (1871–1928), Yugoslav statesman, was born at Trebarjevo, near Fiume, on July 11, 1871. He studied in Zagreb and Prague, being once expelled from the Lycée and twice imprisoned in the former city for Croatian and anti-Hungarian demonstrations. From 1897–99 he studied in Paris and later lived for a time in Semlin as Balkan correspondent to various newspapers, coming into contact with Serb political leaders, and settled in 1902 in Zagreb. In the same year he began to publish the *Hrovatsko Misao,* in which he outlined the programme of the Croatian Peasant Party, which first entered the Croatian Sabor, with 9 seats, after the elections of 1910, but soon became the most powerful political force in Croatia. In 1911–12 Radii was again imprisoned by the Magyar Ban of Croatia. During the World War he became an Austro-Hungarian Legitimist, but on the collapse of Austria-Hungary converted his party, which followed him implicitly, to republicanism. In Feb. 1919 he demanded for Croatia self-determination, and union with Serbia and Montenegro "with equal rights." Disagreement with the Serbs, however, led him back to prison March 1919–Feb. 1920 and March–Nov. 1920.

Radii now condemned his party to a long and singularly sterile period of opposition and Parliamentary abstention, until, tiring of this, he left Yugoslavia in July 1923 for a prolonged visit to London, Moscow and Vienna. He returned to Zagreb in Aug, 1924 with fresh ideas on Panslavism and the cooperation of workmen and peasants, and was imprisoned in Jan. 1925. In March, however, his nephew Pavle Radić (*q.v.*) effected a reconciliation. Radii was released, his party entered the Government. he himself became an enthusiastic supporter of King Alexander, and for a time himself entered the Yugoslav cabinet. His habit of embarrassing his colleagues as often and as highly as possible led to his resignation. He returned to opposition, which he conducted with such verve that a Government Deputy named Račić shot him in the stomach in the Skupština on June 20, 1928. On

Aug. 8, 1928, he died at Zagreb from the effects of his wound.

RADIĆ, PAVLE (1880–1928), Yugoslav statesman, nephew of the above, was born at Trebarjevo, near Fiume on Jan. 1, 1880. He settled in Zagreb as a banker. The coalition of Serb Radicals and Croat Peasants which existed fitfully in 1926–27 was mainly his work; but when it broke down, he rejoined the Opposition. On June 20, 1928, he was murdered in an unsuccessful attempt to save his uncle's life.

RADICAL, in English politics a supporter of the more extreme section of the Whig or the Liberal Party; in American politics, anyone who desires to make radical (Lat. radix, root) changes in the social order—hence usually a Socialist or Communist. The first use of the word in a political sense is generally ascribed to Charles James Fox, who in 1797 declared for a "radical reform." It was thenceforward used as a general term covering all those, from Sir Francis Burdett to Richard Carlile, who supported the movement for Parliamentary Reform. After the passing of the Reform Bill of 1832, the more adventurous of the reformers, of whom the chief organizers were Francis Place (London) and Joseph Parkes (Birmingham) remained in informal but continuous association. They exercised continual but vain pressure upon Lord John Russell and other Whigs, to agree to an extension of the franchise to the working-class. Their most effective work was done after 1835 in the reformed administration of the provincial towns, some of which they controlled from the first democratic election, and in which they had to remove the effects of years of corruption and indolence. Their spokesmen formed for some years a recognized group in the House of Commons, which included George Grote, Slingsby Duncornbe, Thomas Wakley and Joseph Hume. They were out of sympathy and touch with the organized section of the working-class owing to their support of the new Poor Law (1834) and their hostile attitude to the Chartists (see CHARTISM).

From about 1839, consequently, their influence suffered a decline, but it revived after about 1850 when Chartism was practically extinct. The National Reform League, whose president and leader was Edmond Beales, was most active in promoting the reform of the suffrage, achieved in 1867 for the towns and in 1884 for the country: Frederic Harrison, J. S. Mill, and Professor Beesly being the most distinguished of its theorists. The Radicals, through the group of officials known as the Junta, gained also complete control of the political mind of the trade unions and from 1874 to 1892 every trade unionist who gained a seat in Parliament sat as a Radical. Reynold's *Illustrated News*, the most popular Radical organ, somewhat exaggerated the respectable Radicals' view in its vehement Republicanism, its contempt for revealed religion and its advocacy of complete *laissez faire* in economics, but these principles were generally regarded as inherent in Radicalism. The London Radical clubs towards the end of the 19th century probably represented the most powerful single political grouping in the country. They were only induced by the personal intervention and prestige of Charles Bradlaugh to merge their identity in the new machine of the National Liberal Federation, controlled by Mr. Schnadhorst; and from that time we may date the disappearance of organized Radicalism. (R. W. P.)

RADICAL EMPIRICISM, in philosophy, is the theory that experience is the only test of reality and truth. This is the view of W. James (*q.v.*), and was so named by him.

See W. James, *Essays in Radical Empiricism* (1912).

RADIO is the combining form denoting relation to or connection with a ray, a radius, or radiation. In anatomy the term refers to the radius or outer of the two bones of the forearm as radio-carpal. In physics and chemistry it is used in connection with various forms of radiation as in radio-activity (*q.v.*). In electricity its general application is in association with electric waves (*q.v.*). In its specific application to radio communication the word is used to denote the transmission and reception of signals by means of radiated electromagnetic waves. The signals translated may be the ordinary sounds sensed by the ear or they may be the "signals" of images sensed by the eye which have been translated into "sound" signals, as in television. Communication by radio in its various forms, including such phases as wired wireless, wireless telegraphy, wireless telephone, general types of broadcasting, television, is too broad a subject to be treated adequately in a single article.

A basic discussion of atmospheric electricity is given in the article ELECTRICITY, ATMOSPHERIC. A study of the theory of Maxwell and others in the development of theory relative to electric waves is found in the article ELECTRIC WAVES. The theoretical concepts of wireless telegraphy are in the article WIRELESS TELEGRAPHY; the practical applications, including such data as international agreements, standard wave lengths, maps of communication lines throughout the world, are in the same article under a subheading, *Communication* by Wireless.

The principles of the action of heat on matter in generating atomic or subatomic electrically charged particles are found in the article THERMIONICS, while the article THERMIONIC VALVES treats of the several distinct types of vacuum tubes. The more important and most frequently encountered radio terms, numbering several score, are defined and described under their respective headings. The short radio subjects are in turn cross-referred to in the main practical articles listed below.

Television is found under the heading TELEVISION and the transmission of motion pictures by this and other means is discussed under the articles TELEVISION and MOTION PICTURE: *Technology*. Under TELEGRAPH and TELEPHONE is a study of transoceanic wireless telephone and wired wireless. All articles are supplemented by text illustration and photographs and, in many instances, by diagrams showing wiring arrangements and important technical data.

For the convenience of the reader the subject of broadcasting is divided into two main headings: (1) BROADCASTING and (2) BROADCAST MUSIC. The former article is subdivided into (a) a general survey of European practice, *(b)* a general survey of American practice, (c) tecnnical aspects or the engineering problems involved in broadcasting. The latter article is subdivided into two sections: (a) broadcast music in Great Britain and on the Continent and (b) broadcast music in America. In addition, the two major phases of broadcasting—reception and transmission—are dealt with in RADIO RECEIVER and MICROPHONE OR TELEPHONE TRANSMITTER.

So many new developinents are occurring in radio that it is impossible for a survey to predict tendencies even a few years hence; it is believed helpful, however, to include here the most important "peaks" that have been made in wireless progress. The following data are taken from an official bulletin of the U.S. Department of Commerce:

In 1827 Savary found that a steel needle could be magnetized by the discharge from a Leyden jar. In 1837 the first patent for an electric telegraph was taken out by Cooke and Wheatstone (London) and by Morse (United States). In 1840 Henry first produced high-frequency electric oscillations. In 1867 Maxwell read a paper from the Royal Society in which he laid down the theory of electromagnetism, which he developed more fully in 1873 in his electric waves that are now used in wireless telegraphy. In 1870 Von Bezold discovered that oscillations set up by a condenser discharge in a conductor give rise to interference phenomena.

In 1879 Hughes discovered the phenomena on which depends the action of coherer. In 1883 Fitzgerald suggested a method of producing electro-magnetic waves in space by the discharge of a conductor. In 1887 Hertz showed that electro-magnetic waves are in complete accordance with the waves of light and heat, and founded the theory upon which all modern radio signalling devices are based. In 1896 Marconi lodged his application for the first British patent for wireless telegraphy. He conducted experiments in communicating over a distance of $1\frac{3}{4}$ miles successfully. On Dec. 6, 1897, signals were transmitted from shore to a ship at sea, 18 miles distant. On Dec. 17, 1897, the first floating wireless station was completed. On June 3, 1898, the first paid radiogram was transmitted (from the Needles [Isle of Wight] station).

On March 30, 1903, the first transoceanic radiogram was published in *The Times,* London. In 1906 Dr. DeForest was granted a patent (Jan. 18) for a vacuum rectifier, commercially known as the audion. In the same year Gen. H. N. C. Dunwoody discovered the rectifying proportions of carborundum crystals, and Pickard discovered the similar properties of silicon crystals. These discoveries formed the basis of the widely used crystal detectors. In 1912 Frederick August Kolster, of the U.S. Bureau of Standards invented and developed the Kolster decremeter, which is used to make direct measurements of wave length and logarithmic decrement. In 1912 the first practical trials with wireless apparatus on trains were made on a train belonging to the Delaware, Lackawanna and Western Railroad.

In Oct. 1914, E. H. Armstrong was issued a patent covering the regenerative circuit, also known as the feed-back and the self-heterodyne circuit. On July 28, 1915, the American Telephone and Telegraph Co., working in conjunction with the Western Electric Co., succeeded in telephoning by wireless from Arlington, Va., to Hawaii, a distance of nearly 5,000 miles. On Oct. 26, 1915, the wireless telephone experiments were continued, communication being effected across the Atlantic from Arlington to the Eiffel Tower, Paris.

In 1919 the successful trans-Atlantic flights of the American "NC4" and of Alcock and Brown, and of the British dirigible "R34" focused attention upon the great value of radio for aviation purposes. On March 2, 1923, Louis Alton Hazeltine, of Stevens Institute of Technology, presented a paper before the Radio Club of America on tuned radio-frequency amplification with the neutralization of capacity coupling. Professor Hazeltine was granted a patent for the non-radiating neutrodyne receiver. In 1925 radio-compass (direction finder) came into greater use on board vessels. In 1926 directional or beam transmission developed to a point where it is considered practical for commercial usage. In 1927–28 Bell laboratories experiments effected successful transmission by wire and radio of television signals. In 1927–28 extension of radio-telegraphy to the principal countries of the world was accomplished.

RADIOACTIVITY. The subject of radioactivity deals with phenomena exhibited by a special class of bodies of high atomic weight of which uranium, thorium, radium and actinium are the best known examples. These substances possess the properties of spontaneously emitting radiations of a special character which are able to penetrate through matter opaque to ordinary light. The study of the radioactive bodies has proved of great importance in the development of modern Physics and has thrown a flood of light on the structure of the atom and the processes which may occur within it. It showed for the first time that the atoms of certain heavy elements are not permanently stable but break up with explosive violence and great emission of energy, leading to the production of a whole series of new elements which have a limited life. The disintegration of these atoms is accompanied by the expulsion of special types of radiation of great individual intensity which have been of great service in throwing light on the processes which take place in their absorption by matter. The alpha-particles have the greatest individual energy of any particle known to science and have proved invaluable in probing the inner structure of atoms and in effecting the artificial disintegration of certain light elements. A study of the scattering of alpha-particles by matter first disclosed the nuclear structure of atoms and provided us with methods of determining the charge carried by the nuclei of the elements. The examination of the chemical behaviour of the radioactive element first indicated the isotopic constitution of certain elements, *i.e.,* the existence of elements with almost identical physical and chemical properties but yet with different atomic weights and radioactive properties. This has led to the proof of the isotopic constitution of the ordinary elements. In many respects the wonderful series of transformations occurring in uranium and thorium provide data which cannot but prove of great value in attacking that most fundamental of problems—the constitution of atomic nuclei.

The beginning of Radioactivity dates from 1896, and was an indirect consequence of the discovery of the X-rays made a few months before by Rontgen. It was known that the production of X-rays in a vacuum tube was accompanied by a strong phosphorescence of the glass, and it occurred to several investigators that ordinary substances made phosphorescent by visible light might emit a penetrating radiation similar to X-rays. Following out this idea, H. Becquerel, a distinguished French physicist, exposed amongst other substances a phosphorescent compound of uranium, uranium-potassium sulphate, enveloped in paper beneath a photographic plate. A weak photographic effect was obtained. This was shown to be due to a penetrating radiation capable of passing through sheets of matter opaque to ordinary light. Further investigation showed that this photographic action was exhibited by all compounds of uranium and by the metal itself, and had nothing to do with phosphorescence. It was shown if the uranium were kept in darkness it did not vary appreciably with time. Becquerel showed that the rays from uranium like X-rays were capable of discharging a body whether positively or negatively electrified. A uranium compound brought close to the charged plate of a gold leaf electroscope causes a rapid collapse of the gold leaves. This property of uranium, and also of the radioactive bodies in general, has supplied a delicate and quantitative method of accurate comparison of the intensity of the radiations from substances under varying conditions. A modified form of gold leaf electroscope (see INSTRUMENTS, ELECTRICAL) has come into general use for comparison of the radioactivity of substances. Rutherford made a systematic examination of the discharging effect produced by the rays from uranium and showed that it was due to the production of charged carriers or ions in the volume of the gas through which the radiations pass. In an electric field, the positive ions travel to the negative electrode and vice versa, thus causing a discharge of the electrified body. If a sufficiently strong field is used, the ions are all swept to the electrodes before appreciable loss of their number can occur by recombination. The rate of discharge then reaches a steady maximum value which is not altered by a large increase in voltage. This maximum current through the gas is called the saturation current. The ions produced in gases by the rays from uranium and other radioactive substances are in general identical with those produced by X-rays, and the mechanism of conductivity of the gas is very similar in both cases (see ELECTRICITY CONDUCTION, *Through* Gases).

Some time after Becquerel's discovery, Mme. Curie made a systematic examination by the electric method of a large number of chemical elements and their compounds to test whether they possessed the "radioactive" property of uranium. Only one other element, thorium, was found to show this effect to a degree comparable with that of uranium—a result independently observed by Schmidt. Mme. Curie examined the activity of the various compounds of uranium and found that their radioactivity was an atomic property, *i.e.,* the activity was proportional to the amount of the element uranium present, and was independent of its combination with other substances. In testing the activity of the minerals containing uranium, Mme. Curie found that the activity was always four to five times as great as that to be expected from their content of uranium. If the radioactivity were an atomic phenomenon, this could only be explained by the presence in these minerals of another substance more active than uranium itself. Relying on this hypothesis, Mme. Curie made a chemical examination of uranium minerals in order to try to separate this new radioactive substance. In these experiments, the Austrian Government generously provided Mme. Curie with a ton of the residues from the State manufactory of uranium at Joachimstahl, Bohemia. At that place there are extensive deposits of pitchblende or uraninite which are mined for the uranium. After separation of the latter, the residues are three to five times as radioactive weight for weight as the uranium. From this residue Mme. Curie separated a substance far more radioactive than uranium, which she called polonium in honour of the country of her birth. This substance is usually removed with bismuth in the mineral, but by special methods can be partly separated from it. A further examination revealed the presence of a second radioactive substance which is normally separated with the barium, to which the name "radium" was given. This name was happily chosen, for in the pure state radium bromide has a very great activity—about two million times as great as an equal weight of uranium. By means of successive fractionations of the chloride, the radium was gradually concentrated, until finally the radium was obtained so that the barium lines showed very faintly. The atomic weight was found by Mme. Curie to be 226. Radium was found to give a characteristic spark spectrum of bright lines analogous in many respects to the spectra of the alkaline earths. Giesel in the early days took an active part in the preparation of pure radium compounds, and was the first to place preparations of pure radium bromide on the market. He found that the separation of radium from the barium mixed with it proceeded much more rapidly if the crystallizations were carried out using the bromide instead of the chloride. He states that six to eight crystallizations are sufficient for an almost complete separation. From the chemical point of view radium possesses all the characteristic properties of a new element. It has a definite atomic weight, a well-marked and characteristic spectrum, and distinct chemical properties. Its comparative ease of separation and great activity has attracted much attention to this substance, although we shall see that very similar radioactive properties are possessed by a large number of distinct substances.

In addition to polonium and radium, a number of other radioactive substances have been separated from uranium and thorium minerals which have an activity comparable with that of radium, although they have not been isolated in a pure state. Amongst these may be mentioned actinium, discovered by Debierne and Giesel, ionium, discovered by Boltwood and radiothorium and mesothorium discovered by Hahn.

Besides these substances in which the duration of the activity is measured by years a large number of radioactive bodies have been found which have a transient activity lasting for only a few minutes or hours. It will be seen that from the scientific point of view these short lived radioactive substances are just as important as those which have a much longer life.

Emanations or Radioactive Gases.—In addition to their power of emitting penetrating radiations, the substances thorium, actinium and radium possess another very striking and important property. Rutherford in 1900 showed that thorium compounds (especially the oxide) continuously emitted a radioactive emanation or gas. This emanation can be carried away by a current of air and its properties tested apart from the substance which produces it. These emanations all possess the property of ionizing a gas and, if sufficiently intense, of producing marked photographic and phosphorescent action. The activity of the radioactive gases is not permanent but disappears according to a definite law with the time, viz., the activity falls off in a geometric progression with the time. The emanations are distinguished by the different rates at which they lose their activity. The emanation of actinium is very short lived, the time for the activity to fall to half value, *i.e.,* the period of the emanation, being 3.7 seconds. The period of the thorium emanation is 54 seconds and of the radium emanation 3.8 days. This property of emitting an emanation is shown in a very striking manner by actinium. A compound of actinium is wrapped in a sheet of thin paper and laid on a screen of phosphorescent zinc sulphide. In a dark room the phosphorescence, marked by the characteristic scintillations, is seen to extend on all sides from the active body. A puff of air is seen to remove the emanation and with it the greater part of the phosphorescence. Fresh emanation immediately diffuses out and the experiment may be repeated indefinitely. The emanations have all the properties of radioactive gases. They can be transferred from point to point by currents of air. The emanations can be separated from the air or other gas with which they are mixed by the action of extreme cold. Rutherford and Soddy showed that under ordinary conditions the temperature of condensation of the radium emanation mixed with air was $-150°$ C.

The emanations are produced from the parent matter and escape into the air under some conditions. Rutherford and Soddy made a systematic examination of the emanating power of thorium compounds under different conditions. The hydroxide emanates most freely, while in thorium nitrate, practically none of the emanation escapes into the air. Most of the compounds of actinium emanate very freely. Radium compounds, except in very thin films, retain most of the emanation in the compound. The occluded emanation can in all cases be released by solution or by heating. On account of its very slow period of decay, the emanation of radium can be collected like a gas and stored, when it retains its characteristic properties for a month or more. A more detailed account of the properties of the radium emanation, which has proved of great practical importance, will be given later.

Active Deposits.—The radioactive emanations possess another very interesting and important property. The surface of any body exposed in the presence of an emanation acquires a temporary activity. Like the emanations this induced activity, as it was first termed, decays with the time though at quite a different rate from the emanation which causes it. The bodies made active behave as if they were covered by a very thin film of intensely active matter. The active substance can be removed partly by rubbing on the surface and can be dissolved by strong acids. On evaporating the acid, the active matter remains behind unchanged in amount. The active deposit obtained on a platinum wire or plate can be volatilized at a white heat and is again deposited on the cooler bodies in its neighbourhood. The activity can be concentrated to some extent on the negative electrode in a strong electric field, indicating that the radioactive matter carries a positive charge. We shall see later that this activity produced on bodies is due to a deposit of non-gaseous matter derived from the transformation of the emanations. Each emanation gives a distinctive active deposit which decays at different rates. The active deposits of radium, thorium and actinium are very complex, and consist of several types of matter. Several hours after removal from the emanation the active deposit from radium decays to half-value in 26 minutes, from actinium half-value in 34 minutes, from thorium half-value in 10·6 hours.

Radiations from Radioactive Substances.—All the radioactive substances possess in common the property of emitting radiations which darken a photographic plate and cause a discharge of electrified bodies. Very active preparations also possess the property of causing marked phosphorescence in some substances. Bodies which phosphoresce under X-rays usually do so under the rays from radioactive matter. Barium platinocyanide, the mineral willemite (zinc silicate) and zinc sulphide are the best known examples.

There are in general three types of radiation emitted by the radioactive bodies, called the α-, β- and γ-rays. Rutherford in 1899 showed that the radiation from uranium was complex and consisted of (a) an easily absorbed radiation stopped by a sheet of paper or a few centimetres of air which he called the α-rays and (*b*) a far more penetrating radiation capable of passing through several millimetres of aluminium, called the β-rays. Later Villard found that radium emitted a very penetrating kind of radiation, called the γ-rays, capable of passing before absorption through twenty centimetres of iron and several centimetres of lead. A large amount of work, of which a more detailed account will be given later, has been carried out to determine the nature of these radiations.

The Alpha-rays.—The α-rays consist of a stream of material particles which are projected at high speed from the radioactive matter. The α-particles from all types of radioactive matter are identical in mass and consist of charged atoms of helium projected with velocities of about 10,000 miles a second. The α-particles are expelled with a characteristic speed from each radioactive substance and have a definite distance of travel or "range" in matter before they are stopped. The range of the α-particles for different radioactive substances varies between about 3 cm. and 11 cm. in air at atmospheric pressure and temperature. Most of the energy emitted from radioactive bodies is in the form of α-rays.

The Beta-rays consist of a stream of electrons which are projected with high velocities, approaching in some cases that of light. Unlike the emission of α-particles, a radioactive body emits β-particles over a considerable range of velocity.

The Gamma-rays, which are of a very penetrating character, have been shown to be a type of X-rays of very high frequency. Usually the γ-rays accompany the emission of β-rays. Unlike the α- and β-particles, the γ-rays are undeflected by a magnetic or electric field. It will be shown that in general the γ-rays from a radioactive body consist of groups of electromagnetic radiations of widely different frequencies. The three types of radiation from active bodies are thus analogous in many respects to the radiations produced by the passing of an electric discharge through a vacuum tube at low pressure, but the individual intensity is on a much higher scale. In order to produce electrons of speed corresponding to those emitted by radium C, a voltage of three million would have to be applied to the tube, and to excite X-rays of the frequency of the y-rays at least two million volts would be necessary. Similarly the energy of the a-particle from radium C corresponds to nearly eight million electron volts. The a-rays from a deposit of radium C equivalent in activity to ten milligrams of radium, are of very great intensity; they blacken a photographic plate in a fraction of a second and produce intense luminosity in phosphorescent substances like zinc sulphide and willemite. Similarly the β and y-rays from such a source cause an evident luminosity in willemite and barium platinocyanide.

Theory of Radioactive Transformations.— We have seen that the radioactive bodies spontaneously and continuously emit a great number of α- and @-particles. In addition, new types of radioactive matter like the emanations and active deposits appear, and these are quite distinct in chemical and physical properties from the parent matter. The radiating power is an atomic property, for it is unaffected by combination of the active element with inactive bodies, and is uninfluenced by the most powerful chemical and physical agencies at our command. In order to explain these results, Rutherford and Soddy in 1903 put forward a simple but comprehensive theory. Unlike the atoms of the ordinary elements the atoms of radioactive matter are unstable, and each second a definite fraction of the number of atoms present breaks up with explosive violence, in most cases expelling an α- or @-particle with great velocity. Taking as a simple illustration that an α-particle is expelled during the explosion, the resulting atom has decreased in mass and possesses chemical and physical properties entirely distinct from the parent atom. A new type of matter has thus appeared as a result of the transformation. The atoms of this new matter are again unstable and break up in turn, the process of successive disintegration of the atom continuing through a number of distinct stages. On this view, a substance like the radium emanation is derived from the transformation of radium. The atoms of the emanation are far more unstable than the atoms of radium, and break up at a much quicker rate. We shall now consider the law of radioactive transformation according to this theory. It is experimentally observed that in all simple radioactive substances, the intensity of the radiation decreases in a geometrical progression with the time, *i.e.,* $I/I_0=e^{-\lambda t}$ where I is the intensity of the radiation at any time, t, I_0 the initial intensity, and λ a constant. Now according to this theory, the intensity of the radiation is proportional to the number of atoms breaking up per second. From this it follows that the atoms of active matter present decrease in a geometrical progression with the time, *i.e.,* $N/N_0=e^{-\lambda t}$ where N is the number of atoms present at a time t, N_0 the initial number, and λ the same constant as before. Differentiating, we have $dN/dt=-\lambda N$, *i.e.,* λ represents the fraction of the total number of atoms present which break up per second. The radioactive constant λ has a definite and characteristic value for each type of matter. Since λ is usually a very small fraction, it is convenient to distinguish the products by stating the time required for half the matter to be transformed. This will be called the period of the product, and is numerically equal to $\log_e 2/\lambda$. The average life of the atoms of a product before transformation is given by $1/\lambda$. As far as our observation has gone, the law of radioactive change is applicable to all radioactive matter without exception. It appears to be an expression of the law of probability, for the average number breaking up per second is proportional to the number present. Viewed from this point of view, the number of atoms hreaking up per second should have a certain average value, but the number from second to second should vary within certain limits according to the theory of probability. The theory of this effect was first put forward by Schweidler, and has since been verified by a number of experimenters, including Kohlrausch, Meyer, and Regener and H. Geiger. This variation in the number of atoms breaking up from moment to moment becomes marked with weak radioactive matter, where only a few atoms break up per second. The variations observed are in good agreement with those to be expected from the theory of probability. This effect does not in any way invalidate the law of radioactive change. On an average the number of atoms of any simple kind of matter breaking up per second is proportional to the number present. We shall now consider how the amount of radioactive matter which is supplied at a constant rate from a source varies with the time. For clearness, we shall take the case of the production of emanation by radium. The rate of transformation of radium is so slow compared with that of the emanation that we may assume without sensible error that the number of atoms of radium breaking up per second, *i.e.,* the supply of fresh emanation, is on the average constant over the interval required. Suppose that initially radium is completely freed from emanation. In consequence of the steady supply, the amount of emanation present increases, but not at a constant rate, for the emanation is in turn breaking up. Let q be the number of atoms of emanation produced by the radium per second and N the number present after an interval t, then $dN/dt=q-\lambda N$ where λ is the radioactive constant of the emanation. It is obvious that a steady state will ultimately be reached when the number of atoms of emanation supplied per second are on the average equal to the atoms which break up per second. If N_0 be the maximum number, $q=\lambda N_0$. Integrating the above equation, it follows that $N/N_0=1-e^{-\lambda t}$. If a curve be plotted (fig. 1) with N as ordinates and time as abscissae, it is seen that the recovery curve is complementary to the decay curve. The abscissae represent multiples of the time T for half the product to be transformed. The activity, which is proportional to the number of atoms present, falls to $\frac{1}{2}$ in the time T, $\frac{1}{4}$ in time 2T, and so on.

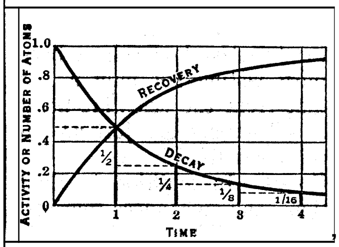


FIG. 1—CURVES ILLUSTRATING THE EXPONENTIAL LAW OF DECAY AND RECOVERY OF RADIOACTIVITY

This process of production and disappearance of active matter holds for all the radioactive bodies. We shall now consider some special cases of the variation of the amount of active matter with time which have proved of great importance in the analysis of radioactive changes.

(a) Suppose that initially the matter A is present, and this changes into B and B into C, it is required to find the number of atoms P, Q and R of A, B and C present at any subsequent time t.

Let λ_1, λ_2, λ_3 be the constants of transformation of A, B and C respectively. Suppose n be the number of atoms of A initially present. From the law of radioactive change it follows:

$$P=ne^{-\lambda_1 t}$$

$$dQ/dt=\lambda_1 P-\lambda_2 Q \qquad (1)$$

$$dR/dt=\lambda_2 Q-\lambda_3 R \qquad (2)$$

Substituting the value of P in terms of n in (1),

$$dQ/dt=\lambda_1 ne^{-\lambda_1 t}-\lambda_2 Q;$$

the solution of which is of the form

$$Q=n(ae^{-\lambda_1 t}+be^{-\lambda_2 t}),$$

where a and b are constants. By substitution it is seen that $a=\lambda_1/(\lambda_2-\lambda_1)$. Since $Q=0$ when $t=0$, $b=-\lambda_1/(\lambda_2-\lambda_1)$

Thus $$Q=\frac{n\lambda_1}{\lambda_1-\lambda_2}(e^{-\lambda_2 t}-e^{-\lambda_1 t}) \qquad (3)$$

Similarly It can be shown that

$$R=n(ae^{-\lambda_1 t}+be^{-\lambda_2 t}+ce^{-\lambda_3 t}) \qquad (4)$$

where

$$a=\frac{\lambda_1\lambda_2}{(\lambda_1-\lambda_2)(\lambda_1-\lambda_3)},\quad b=\frac{\lambda_1\lambda_2}{(\lambda_2-\lambda_1)(\lambda_2-\lambda_3)},\quad c=\frac{\lambda_1\lambda_2}{(\lambda_3-\lambda_1)(\lambda_3-\lambda_2)}.$$

It will be seen from (3) that the value of Q, initially zero, increases to a maximum and then decays; finally, according to an exponential law, with the period of the more slowly transformed product, whether A or B.

(*b*) A primary source supplies the matter A at a constant rate, and the process has continued so long that the amounts of the products A, B, C have reached a steady limiting value. The primary source is then suddenly removed. It is required to find the amounts of A, B and C remaining at any subsequent time t.

In this case of equilibrium, the number n_0 of particles of A supplied per second from the source is equal to the number of particles which change into B per second, and also of B into C. This requires the relation

$$n_0=\lambda_1 P_0=\lambda_2 Q_0=\lambda_3 R_0$$

where P_0, Q_0, R_0 are the initial number of particles of *A*, *B*, *C* present, and λ_1, λ_2, λ_3 are their constants of transformation.

Using the same notation as in case (1), but remembering the new initial conditions, it can easily be shown that the number of particles *P*, *Q* and *R* of the matter *A*, *B* and *C* existing at the time *t* after removal are given by

$$P=\frac{n_0}{\lambda_1}e^{-\lambda_1 t}$$

$$Q=\frac{n_0}{\lambda_1-\lambda_2}\left(\frac{\lambda_1}{\lambda_2}e^{-\lambda_2 t}-e^{-\lambda_1 t}\right),$$

$$R=n_0(ae^{-\lambda_1 t}+be^{-\lambda_2 t}+ce^{-\lambda_3 t}),$$

where

$$a=\frac{\lambda_2}{(\lambda_1-\lambda_2)(\lambda_1-\lambda_3)},\quad b=\frac{-\lambda_1}{(\lambda_1-\lambda_2)(\lambda_2-\lambda_3)},\quad c=\frac{\lambda_1\lambda_2}{\lambda_3(\lambda_1-\lambda_3)(\lambda_2-\lambda_3)}.$$

The curves expressing the rate of variation of P, Q, R with time are in these cases very different from case (1).

(c) The matter A is supplied at a constant rate from a primary source. Required to find the number of particles of A, B and *C* present at any time *t* later, when initially A, B, and *C* were absent.

This is a converse case from case (2) and the solutions can be obtained from general considerations. Initially suppose A, B and *C* are in equilibrium with the primary source which supplied *A* at a constant rate. The source is then removed and the amounts of A, B and *C* vary according to the equation given in case (2). The source after removal continues to supply *A* at the same rate as before. Since initially the product A was in equilibrium with the source, and the radioactive processes are in no way changed by the removal of the source, it is clear that the amount of A present in the two parts in which the matter is distributed is unchanged. If P_1 be the amount of A produced by the source in the time *t*, and P the amount remaining in the part removed, then $P_1+P=P_0$ where P_0 is the equilibrium value. Thus

$$P_1/P_0=1-P/P_0.$$

The ratio P/P_0 can be written down from the solution given in case (2). Similarly the corresponding values of Q_1/Q_0, R_1/R_0 may be at once derived. It is obvious in these cases that the curve plotted with P/P_0 as ordinates and time as abscissae is complementary to the corresponding curve with P_1/P_0 as ordinates. This simple relation holds for all recovery and decay curves of radioactive products in general.

We have so far considered the variation in the number of atoms of successive products with time when the periods of the products are known. In practice, the variation of the number of atoms is deduced from measurements of activity, usually made by the electric method. Using the same notation as before, the activity of any product is proportional to its rate of breaking up, *i.e.*, to $\lambda_1 P$ where P is the number of atoms present. If two products are present, the activity is the sum of two corresponding terms $\lambda_1 P$ and $\lambda_2 Q$. In practice, however, no two products emit a- or β-particles with the same velocity. The difference in ionizing power of a single a-particle from the two products has thus to be taken into account. If, under the experimental conditions, the ionization produced by an a-particle from the second product is *K* times that from the first product, the activity observed is proportional to $\lambda_1 P+K\lambda_2 Q$. In this way, it is possible to compare the theoretical activity curves of a mixture of products with those deduced experimentally.

Analysis of Radioactive Changes.—The analysis of the successive changes occurring in uranium, thorium, radium and actinium has proved a very difficult matter. In order to establish the existence of a new product and to fix its position in the scheme of changes, it is necessary to show (a) that the new product has a distinctive period of decay and shows some distinctive physical or chemical properties; (*b*) that the product under consideration arises directly from the product preceding it in the scheme of changes, and is transformed into the product succeeding it.

In general, it has been found that each product shows some distinctive chemical or physical behaviour which allows of its partial or complete separation from a mixture of other products It must be remembered that in most cases the amount of radioactive matter under examination is too small to detect by weight, but its presence is inferred from its characteristic radiations and rate of change. In some cases, a separation may be effected by ordinary chemical methods; for example thorium X is separated from thorium by precipitation of thorium with ammonia. The Th X remains in the filtrate and is practically free from thorium. In other cases, a separation is effected by a separation of a metal in the solution of active matter. For example, polonium (radium F) always comes down with bismuth and may be separated by placing a bismuth plate in a solution. Radium C is separated from radium B by adding nickel filings to a solution of the two. Radium C is deposited on the nickel. In other cases, a partial separation may be effected by electrolysis or by differences in volatility when heated. For example, when radium A, B and C are deposited on a platinum plate, on heating the plate, radium B is volatilized and is deposited on any cold surface in the neighbourhood. A very striking method of separating certain products has been observed depending upon the recoil of an atom which breaks up with the expulsion of an a-particle. Some of the residual atoms acquire sufficient velocity in consequence of the ejection of an a-particle to escape and be deposited on bodies in the neighbourhood. This is especially marked in a low vacuum. This property was independently investigated by Russ and Makower and by Hahn. The latter has shown that by means of the recoil, actinium C″ may be obtained pure from the active deposit containing actinium A, B and C, for C emits a-rays, and actinium C'' is driven from the plate by the recoil. In a similar way a new product, thorium C'', has been isolated and radium B may be separated from radium A and C. The recoil method has proved of great value in settling whether an a-ray product is simple or complex.

While in the majority of cases the products break up either with the emission of a- or β-particles, some products were at first thought not to emit any characteristic radiation and were called "rayless products." A closer investigation has shown that in most cases a 6-radiation of an easily absorbed type is emitted. Actinium is the only product in which no certain radiation has been detected but from other evidence there can be no doubt that β-rays of slow speed are emitted. The presence and properties of a product emitting a very feeble radiation can be easily inferred if it is transformed into a product emitting a marked radiation, for the variation of activity of the latter affords a method of determining the amount of the parent product. In the table below a list is given of the remarkable series of transformations occurring in uranium, thorium and actinium. The system of nomenclature is not ideal. In general, products of average life greater than one year have been given a distinctive name and are printed in italics. The successive products following the emanations are in all cases denoted by the letters A, B, C, etc. In some cases intermediate products have been discovered after a system of nomenclature has been accepted and have had to be named to indicate as far as possible their positions in the series. As the radioactive emanations are now known to be isotopic elements, the names radon, thoron and actinon have been suggested as distinctive and indicative of the similarity of these products.

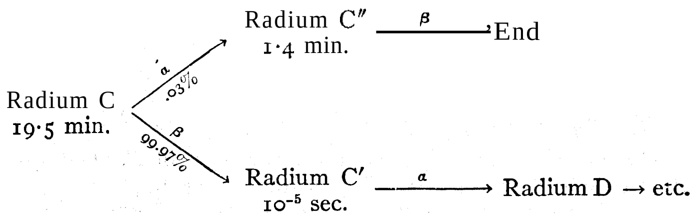
Table of Radioactive Elements

Element	Atomic Wt.	Atomic No.	T	Rays	Range cm. α-Rays in air (15° and 760 mm.)
Uranium-Radium series.					
Uranium I . .	238·18	92	$4{\cdot}5\times10^9$ yr.	α	2·70
Uranium X_1 . .	234	90	23.8 days	β, γ	..
Uranium X_2 . .	234	91	1·15 min.	β, γ	..
Uranium *Z* . .	234	91	6·7 hr.	β	..
Uranium II . .	234	92	about 2×10^6 yr.	α	3·28
Uranium Y . . (3%)	230	90	24.6 hr.	β	..
Ionium . . .	230	90	about 9×10^4 yr.	α	3·19
Radium . . .	226	88	1580 yr.	α	3·39
Radon (Ra Emanation)	222	86	3.82 days	α	4·12
Radium A . .	218	84	3·05 min.	α	4·72
Radium B . .	214	82	26.8 min.	β, γ	..
Radium C . .	214	83	19·7 min.	α, β, γ	6·97
Radium D . .	210	82	16 yr.	β, γ	..
Radium E . .	210	83	5·0 days	β, γ	..
Radium F . . (Polonium)	210	84	136·5 days	α	3·92
Radium G· (end-product uranium-lead) . . .	206	82	..	..	..
Thorium series.					
Thorium . . .	232·1	90	$2{\cdot}2\times10^{10}$ yr.	α	2·90
Mesothorium I. .	228	88	6.7 yr.	β, γ	..
Mesothorium 2 .	228	89	6.2 hr.	β, γ	..
Radiothorium . .	228	90	1·90 yr.	a	4·02
Thorium X . .	224	88	3.64 days	α	4·35
Thoron (Th. Emanation)	220	86	j4 sec.	a	5·06
Thorium A . .	216	84	0·14 sec.	α	5·68
Thorium B . .	212	82	10·6 hr.	β, γ	..
Thorium C . .	212	83	60 min.	α	4·79 8.62
Thorium C″ . .	208	81	3·2 min.	β, γ	..
Thorium D (end-product thorium-lead) . . .	208	82	..	..	..
Actinium series.					
Protoactinium . .	230	91	about 10^4 yr.	α	3·67
Actinium . .	226	89	20 yr.	β	..
Radioactinium .	226	90	19 days	a	4·68
Actinium X . .	222	88	11·2 days	α	4'37
Actinon (Xc. Emanation)	218	86	3.9 sec.	α	5·79
Actinium A . .	214	84	·002 sec.	α	6.58
Actinium B . .	210	82	36 min.	β, γ	..
Actinium C . .	210	83	2·16 min.	a	5·51
Actinium C″ . .	206	81	4.76 min.	β, γ	..
Actinium D (end-product actinium-lead) . . .	206	82	..	..	..

In the table T is the time-period of a product or the time required for the product to be half-transformed. It will be seen that the value of T, which is a measure of the relative stability of atoms, varies between $2{\cdot}2\times10^{10}$ years (Thorium) and ·002 second (Actinium **A**). The atomic weights and atomic numbers of uranium, radium, uranium-lead, thorium, thorium-lead have been directly determined by X-ray methods. The atomic weights and atomic numbers of the others are deduced on the assumption that the expulsion of an a-particle (helium atom) of charge 2 and mass 4 lowers the atomic number of the succeeding element by two units and the atomic weight by four. The expulsion of a β-particle raises the atomic number by one unit, but it is not supposed to influence the atomic weight to a detectable degree.

Branch **Products.**—In the great majority of cases each of the radioactive elements breaks up in a definite way, giving rise to one a- or @-particleand to one atom of the new product. Undoubted evidence, however, has been obtained that in a few cases the atoms break up in two or more distinct ways, giving rise to two or more products characterised by different radioactive properties. **A** branching of the uranium series was early demanded in order to account for the origin of actinium. While the latter is always found in uranium minerals in constant proportion with the uranium, Boltwood showed that the activity of the actinium with its whole series of a-ray products in a uranium mineral was much less than that given by a single a-ray product of the main radium series. The head of the actinium series is generally believed to be uranium Y, the branch product of the uranium series first observed by Antonoff. The branching is supposed to occur in the product uranium II, 3% going into the actinium branch and the other 97% into the main uranium series. The atomic weights of actinium given in the table are calculated on this basis. The more recently discovered product *protoactinium* is on this view the missing link between uranium Y and actinium.

The most striking cases of branching occur in the "C" products of radium, thorium and actinium, each of which breaks up in two or more distinct ways. In the case of radium C, a new substance called radium C" was obtained by recoil from a nickel plate coated with radium C. This product emitted only β-rays and had a period of 1·4 minutes. Fajans estimated that the amount of the product was only $\frac{1}{3{,}000}$ of that of radium C. To account for these results the following scheme of transformation has been proposed:—



where in the main branch a β-particle is first expelled, giving rise to radium C, which emits an a-particle. The reverse process is assumed to take place in the other branch. Radium C, which emits a swift a-particle, has an exceedingly short period of transformation, which has been measured approximately by Jacobsen, and found to be about 10^{-5} seconds. It is uncertain whether the radium C″ branch ends after the expulsion of a @-particle. The resulting product is an isotope of lead like radium D in the main branch.

In the case of thorium C, two sets of a-particles are observed, one-third of the total number having a range of 4.8 cm. and the remainder 8·6 cm. Here, as in radium C, Marsden supposed that the main series goes by a β-ray change to the C′ product. In actinium C, which also shows a dual transformation, Marsden found that 99·84% of the C atoms change with the emission of an a-particle of 5·15 cm. range to the C" product, the remaining 0·16% going to C, which gives a-particles of 6.4 cm. range. Subsequent research has shown that the modes of transformation of the C′ bodies are even more complicated than was at first supposed. Rutherford and Chadwick found two additional sets of a-particles which are emitted in very small numbers compared with the main group of particles. One group has a range in air of 9.3 cm. and the other 11·3 cm. Rutherford and Wood found in the thorium **C** a group of particles of a range 11·3 cm. while Meitner and Freitag found a small number of range 9.5 cm. No evidence has been obtained of the exact origin of these swift a-particles but they are probably due to different modes of disintegration of the C′ bodies. It is quite possible that a close examination of radioactive substances may reveal other examples of such complex methods of transformation, for, after the violent explosion that occurs during the breaking-up of an atom, more than one state of temporary equilibrium may be possible for the residual atom.

Relation Between Range of a-Rays and Period of Transformation.—We have seen that each α-ray product emits α-particles of characteristic velocity which have a definite range in air. It was early observed that there appeared to be a connection between the period of transformation of a product and the velocity of the a-particles emitted. The shorter the period of transformation, the swifter is the velocity of expulsion of the ff-particle. This relation was brought out clearly by the measurements of Geiger and Nuttall, where it was shown that if the logarithm of the range was plotted against the logarithm of λ, the constant of transformation, all the points lay nearly on a straight line.

A similar result has been observed for the thorium and actinium products. This relation, when carefully tested by Geiger, appears to be only a rough approximation. It is still of great interest as indicating a possible relation between the stability of the radioactive nucleus and the velocity of the expelled helium atom. This relation has proved very useful in forming estimates of the period of transformation of ionium and other substances before the results of more direct determinations were available. From this relation also the change which gives rise to the swift α-particle of radium C was believed to be exceedingly rapid. This has been confirmed by the detection of radium C' and measurement of its period. A similar conclusion is drawn for the product emitting the very swift a-particles from thorium C.

Chemistry of the Radio-elements (*see* RADIUM, URANIUM, etc.).—Apart from uranium and thorium, and a few special cases like radium and polonium, the radioactive products of short life exist in too small quantity to examine by the ordinary chemical methods; but by the use of the radioactive method of analysis, it was possible to form some idea of their chemical behaviour. Certain very interesting points soon came to light. Soddy found that the two elements, radium and mesothorium, although quite dissimilar in radioactive properties, were chemically so identical that it was impossible by chemical methods to separate one from the other. Other cases of this kind had long been suspected, viz., thorium and radiothorium, thorium and ionium and radium D and lead. He named such inseparable elements isotopes, since they appeared to occupy the same place in the periodic classification of the elements. (See ISOTOPES.)

Following the chemical study of the radio-elements by Soddy, Fleck and von Hevesy, an important generalisation connecting the chemical properties of the radio-elements was announced independently in 1913 by Russell, Fajans and Soddy. After the expulsion of an a-particle from a radioactive substance, the resulting product shifts two places in the direction of diminishing mass when the elements are arranged in families according to the Mendeleeff classification.

The expulsion of a p-particle causes a shift of one place in the opposite direction. For example, by the loss of an a-particle from ionium of group IV., the resulting product, radium, belongs to group II., while the loss of another particle gives rise to the emanation which occupies the group O, and so on. By this method the chemical properties of all the known radio-elements can be predicted from a knowledge of the radiations emitted from the products. This generalisation can be viewed from another important standpoint. From the work of Moseley, the properties of an element are defined by the atomic number which is believed to represent the resultant positive charge on the nucleus. The loss of an a-particle of mass 4, carrying two positive charges, lowers the atomic number by two units, while the emission of a β-particle raises it by one unit. On looking through the table of the radio elements on preceding page it will be seen that many of them can be grouped under the same atomic number. These represent the radioactive isotopes of which some of the more important are given below, preceded by the atomic numbers:—

81. Thallium (204), thorium C″ (208), actinium C″ (206).
82. Lead (207), uranium-lead (206), thorium-lead (208), radium D (210), thorium B (212), radium B (214), actinium B (210).
83. Bismuth (208), radium E (210), radium C (214), thorium C (212), actinium C (210).
84. Polonium (210), thorium A (216), radium A (218), actinium A (214).
86. Radon (222), thoron (220), actinon (218).
88. Radium (226), thorium X (224), mesothorium I (228), actinium X (222).
90. Thorium (232), radiothorium (228), ionium (230), uranium X_1 (234), uranium Y (230), radioactinium (226).

It will be seen that many of the radioactive elements are isotopic with known chemical elements. These radioactive isotopes differ not only in atomic weight but also in radioactive properties. The isotopes of lead are of special interest as they include the end-products of the uranium, thorium and actinium series—a question that will be discussed more fully later. It is of interest to note that polonium, actinium and protoactinium are new types of chemical elements which have no counterpart among the ordinary inactive elements.

Transformation of Uranium.—In 1900 the late Sir W. Crookes found that the β-ray activity of ordinary uranium could be removed by a single chemical operation and concentrated in an active residue. This is due to the separation of the product uranium X_1, of period 24 days, which emits β-rays and γ-rays. A complete analysis of the transformations of uranium has been a matter of much difficulty. Boltwood showed that the α-ray activity of uranium was about twice as great as that of a corresponding α-ray product in the uranium-radium series, indicating that uranium contained two successive α-ray products. This was confirmed by Geiger, who showed that the α-rays from uranium consisted of two groups with ranges 2·5 and 2.9 cm. respectively. These two α-ray substances, called uranium I. and uranium II. are isotopic, atomic weights 238 and 234 respectively. The latter, whose period is estimated at about 2,000,000 years, exists in relatively very small quantity compared with uranium I. Following the generalisation connecting the radiations and chemical properties of the series of radio-elements. Fajans predicted the presence of a new product with properties analogous to tantalum, and promptly succeeded in isolating it experimentally. The new product uranium X_2, sometimes called brevium, has a period of 1·15 minutes and emits swift β-rays. The series of changes is thus:—

$$\text{Ur I.}\rightarrow\text{Ur } X_1\rightarrow\text{Ur } X_2\rightarrow\text{Ur II}\rightarrow\text{Ionium.}$$

Antonoff discovered another β-ray substance called uranium Y, separated with uranium X_1, which has a period of 24.6 hours. This exists in too small quantity to be in the main line of succession, but is to be regarded as a branch product isotopic with uranium X_1, and is believed to be the first element of the subsidiary actinium series.

Rutherford and Geiger found the number of a-particles emitted per gram of uranium per second to be $2{\cdot}37\times10^4$. From this the period of uranium is calculated to be about 6,000,000,000 years.

Transformation of Radium— Radium is transformed directly into radon which in turn goes through a rapid series of transformations called radium A, B and C. The complete analysis of these changes has involved a large amount of work. Radon changes first into radium A, a substance of period 3 minutes emitting only a-rays. Radium A changes into radium B, a product of period 26 minutes emitting β-rays of penetrating power small compared with those emitted from the next product radium C. The products included under the title radium C have proved of considerable importance, for they not only emit very penetrating α-rays and β-rays, but are the origin of the y-rays arising from radium in equilibrium. We have already seen that radium C breaks up in a complex way. When a wire charged negatively has been exposed for some time in the presence of radon, it becomes coated with an invisible film of radium A, B and C. After removal from radon for 20 minutes, radium A has practically disappeared and the α-rays arise entirely from radium C. Radium C has proved very valuable in radioactive measurements as providing an intense source of homogeneous a-rays. Twenty-four hours after removal, the activity due to radium B and C has become exceedingly small. There still remains, however, a very small residual activity, first noted by Mme. Curie. This residual activity measured by the α-rays rapidly increases with the time and reaches a maximum in about three years. The active deposit of slow change was examined in detail by Rutherford and by Meyer and

Schweidler. It was shown to consist of three successive products called radium D, E and F. Radium D emits slow β-rays and is half transformed in about 16 years. Radium D changes into E, a β-ray product of period about 5 days, and E into F, an a-ray product of period 140 days. The product radium F is of special interest, for it is identical with polonium—the first active body separated by Mme. Curie. In a similar way it has been shown that radium D is the primary source of the activity observed in lead or "radiolead" separated by Hofmann. Radium D is a radioactive isotope of lead of atomic weight 210. It is always separated with the inactive lead present in a uranium mineral. It is interesting to note what valuable results have been obtained from an examination of the minute residual activity observed on bodies exposed in the presence of radon. On account of their special importance as sources of intense radiation a more detailed account will be given of radium and its origin, radon and polonium.

Radium.— The atomic weight of radium was found by Mme. Curie to be 226·45, using for the purpose about 0·4 gr. of pure radium chloride. A careful redetermination by Honigschmid with about one gram of radium gave a value 225.9, and is probably correct to 1 in 1,000. Mme. Curie and Debierne produced metallic radium by electrolysis of a radium salt with a mercury cathode. Radium resembles metallic barium, melts at about 700° C, and is rapidly attacked when exposed to the air.

The number of a-particles expelled per second from one gram of radium is an important constant which requires to be known with accuracy. At the present time, there is considerable difference of opinion as to its exact magnitude. Rutherford and Geiger (1908) found a number $3{\cdot}57\times10^{10}$, Hess and Lawson (1918) $3{\cdot}72\times10^{10}$, Geiger and Werner (1924) $3{\cdot}4\times10^{10}$, Jedrzejouski (1927) $3{\cdot}50\times10^{10}$. If the heating effect of radium and its products is entirely due to the kinetic energy of the expelled a-particles, the value should be about $3{\cdot}7\times10^{10}$. The rate of production of helium by radium leads to a value about $3{\cdot}6\times10^{10}$. The property of radium of producing an emanation has been utilized as a very delicate and certain method, not only of detection but of estimation of small quantities of radium. This "emanation method" depends upon the introduction of the emanation, liberated from a substance by boiling or heating, into a suitable electroscope. The rate of discharge of the electroscope due to the emanation affords a quantitative measure of the amount of radium present. In this way, it is not difficult to determine with certainty the presence of radium in a body which contains only 10^{-11} gram of radium. With care, 10^{-12} gram can just be detected, This emanation method has been employed with great success in measuring the quantity of radium in minerals and in rocks. A very simple method has been devised of determining the quantity of radium present when it is not less than $\frac{1}{100}$ milligram. The tube containing the radium is placed some distance from an electroscope which is surrounded by a lead screen about 3 mms. thick. This cuts off the α- and β-rays and the effect in the electroscope is then due to the penetrating y-rays. By comparison of the rate of discharge with that of a standard preparation of radium at the same distance, the quantity of radium can at once be deduced, provided the radium is in equilibrium. This is usually the case if the radium preparation is one month old. This method is simple and direct, and has the great advantage that the radium tube under test need not be opened, nor its contents weighed.

An international radium standard consisting of about 22 milligrammes of pure radium chloride has been prepared by Mme. Curie and is preserved in the Bureau International des Poids et Mesures at Skvres, near Paris. Secondary radium standards have been issued to all governments who wished to purchase them. These have been calibrated by y-ray methods both in Vienna and Paris, and are supposed to be correct within 1 in 200. The purchase and sale of radium have generally been conducted on certificates given in terms of this international standard.

The wide use of radium for therapeutic purposes, and its high cost—from £12 to £30 per milligram element—have led to close search for uranium deposits. The amount of radium in an old mineral is always proportional to its content of uranium in the ratio of 3.3 parts of radium by weight to 10,000 000 parts of uranium. Consequently, an old mineral containing 1,000 kgm. of uranium should contain 330 milligrams of pure radium. Initially several grams of radium were separated from the uraninite deposits in Joachimsthal, Bohemia, and some of the material, which was the property of the Austrian Government, was generously loaned to representative workers in radioactivity in England. A part of this radium is in the charge of the Radium Institute of Vienna, which is specially devoted to radioactive investigations.

The increasing demand for radium led to the working of low-grade ores, containing on an average only about 2% of uranium oxide, of which there are extensive deposits in Colorado and other parts of the United States. Until 1922 the greater part of the world supply of radium was produced in America, but in that year very rich deposits of uranium ore, containing about 20 times as much radium as the American ore, were found in the Belgian Congo, and the American production practically ceased. Large quantities of radium were employed by the Allies during the World War for night compasses, gun-sights, etc. The radium is mixed with phosphorescent zinc sulphide to form a paint which becomes continuously luminous but, owing to the destruction of the zinc sulphide by the rays, this luminosity gradually decays. Active preparations of mesothorium and radiothorium have also been used for a similar purpose.

Origin of Radium.— According to the transformation theory, radium, like all other radioactive products, must be regarded as a changing element. Preliminary calculations showed that radium must have a period of transformation of several thousand years. Consequently in order that any radium could exist in old minerals, the supply must be kept up by the transformation of some other substance. Since radium is always found associated with uranium minerals, it seemed probable from the beginning that uranium must be the primary element from which radium is derived. If this were the case, in old minerals which have not been altered by the action of percolating waters, the ratio of the amount of radium to uranium in a mineral must be a constant. This must evidently be the case, for in a state of equilibrium the rate of breaking up of radium must equal the rate of supply of radium from uranium. If P, Q be the number of atoms of uranium and radium respectively in equilibrium, and λ_1, λ_2 their constants of change, then

$$\lambda_2 Q=\lambda_1 P \quad \text{or} \quad Q/P=\lambda_1/\lambda_2=T_2/T_1.$$

where T_2 and T_1 are the half-periods of transformation of uranium and radium respectively. The work of Boltwood, Strutt and McCoy has conclusively shown that the ratio of radium to uranium in old minerals is a constant. Boltwood and Strutt determined the quantity of radium present in a mineral by the emanation method, and the amount of uranium by analysis. In order, however, to obtain a direct proof of the genetic relation between uranium and radium, it is necessary to show that radium appears after some time in a uranium compound from which all trace of radium has been initially removed. It can readily be calculated that the growth of radium should be easily observed by the emanation method in the course of one week, using a kilogram of uranium nitrate. Experiments of this kind were first made by Soddy, but initially no definite evidence was obtained that radium grew in the solution at all. The rate of production of radium, if it took place at all, was certainly less than $\frac{1}{10,000}$ part of the amount to be expected if uranium were transformed directly into radium. It thus appeared probable that another product of slow period of transformation existed between uranium and radium. Since uranium must be transformed through this intermediate stage before radium appears, it is evident that the initial rate of production of radium under these conditions might be extremely small. This conclusion has been confirmed by Soddy, who has shown that radium does ultimately appear in the solution which has been placed aside for several years and as theory predicts the amount increases as the square of the time.

Since the direct parent of radium must be present in radioactive minerals, one of the constituents separated from the mineral must grow radium. This was shown to be the case by Boltwood who found that actinium preparations produced radium at a fairly rapid rate. By the work of Rutherford and Boltwood, it was found that the growth of radium was not due to actinium itself, but to a new substance separated in some cases with the actinium. This new substance, which emits a-rays, was separated by Boltwood and called by him "Ionium." It has chemical properties very similar to thorium and as we now know is an isotope of thorium of atomic weight 230. Ionium is always separated mixed with the thorium which is present in the mineral. The period of ionium is probably about 76,000 years, indicating that the amount of ionium in uranium minerals is about fifty times the quantity of radium. It has not yet been directly shown that uranium produces ionium but there can be no doubt that it does do so. Since ionium produces radium, Boltwood and later Miss Gleditsch have determined by direct experiment the period of transformation of radium and have found a number in good agreement with other data on that subject. The constant relation between uranium and radium will only hold for old minerals where there has been no opportunity for chemical alteration or removal of its constituents by the action of percolating water or other agencies. It is quite possible that altered minerals of no great age will not show this constant relation. It secnis probable that this is the explanation of some results of Miss Gleditsch, where the relation between uranium and radium has been found not to be constant for some mineral specimens.

Polonium **and** Radium **D.**—Polonium (radium F) has proved of much importance in experimental work as a source of a-rays entirely free from β- and y-rays. The weight of polonium in equilibrium with one gram of radium is only about one-fifth of a milligram, so that it is difficult to obtain a sufficient quantity of this material for an atomic weight determination.

Mme. Curie separated the polonium from several tons of pitchblende and obtained an exceedingly active preparation of a few milligranirnes, but was unable to obtain it in a pure state, although several of its spectrum lines were detected. It was hoped by this experiment to decide whether polonium was transformed directly into lead, but this was found difficult to establish owing to the presence of impurities with the very small quantity of polonium. The most convenient source for obtaining strong sources of polonium is the radium D+E+F which accumulates in old radium preparations. These substances can be separated from the radium solution by chemical or electrolytic methods. A solution of the radium D thus obtained grows polonium and is thus a very convenient source for obtaining active plates coated with polonium. In this way, also, strong sources of radium D and radium E are obtainable.

Radon ***(Radium** Emanation).*—Radon is to be regarded as a typical radioactive product or transition element which exists in a gaseous form. It is produced from radium at a constant rate, and is transformed into radium A and helium. Its half-period of transformation is 3.83 days. Radon has been purified by condensing it in liquid air, and pumping out the residual gases. The volume of radon at normal pressure and temperature to be derived from one gram of radium in equilibrium is about 0·6 cubic millimetres. This small quantity of gas contains initially more than three-quarters of the total activity of the radium before its separation. In a pure state, radon is 100,000 times as active weight for weight as pure radium. Pure radon in a spectrum tube gives a characteristic spectrum of bright lines. The discharge in the gas is bluish in colour. Notwithstanding the minute volume of radon available, its boiling-point has been determined at various pressures. At atmospheric pressure Rutherford found the boiling-point to be $-67°$ C, and Gray and Ramsay $-71°$ C. Liquid radon appears colourless when first condensed; when the temperature is lowered, the liquid freezes, and at the temperature of liquid air glows with a bright rose colour. The density of liquid radon has been estimated at 5 or *6.*

Since the radium atom in breaking up gives rise to one atom of radon and one atom of helium, its atomic weight should be $226-4=222$. Radon appears to have no definite chemical properties, and in this respect belongs to the group of inert monatomic gases of which helium and argon are the best known examples. It is partially soluble in water, and readily absorbed by charcoal.

Radon has proved of great service not only in radioactive researches but also in therapeutic work, The radium salt is dissolved in an aeid solution and the emanation is pumped off with the large quantity of hydrogen and oxygen liberated by the action of the radiations on water. After sparking the mixture, the radon can be purified by condensation with liquid air. **A** very intense source of β- and y-radiation can be obtained by introducing the purified radon into fine capillary tubes. Such radon needles have been widely used for therapeutic purposes, while the use of very thin-walled tubes provides a powerful line source of α-rays. The β- and γ-activity of such tubes rises to a maximum about four hours after introduction of the radon, and then decays with the period of radon, viz., 3.83 days. The quantity of radon liberated from one gram of radium is called a ***curie*** and from one milligram a *millicurie.* The quantity of radon in a tube can be accurately determined by comparison of its y-ray activity with that of a radium standard, since the penetrating y-rays, both from the radium and the radon in equilibrium, arise mainly from the same product radium C.

Transformations of Thorium — The first product observed in thorium was the emanation of period 54 sec., and this gives rise to the active deposit, which has been shown to consist of at least four successive products called thorium **A,** B, C, C''. The emanation, after the emission of an a-particle, changes into a product of very short life emitting a-rays. Its period was found by Geiger and Moseley to be about $\frac{1}{10}$ second. The succeeding product, thorium B, emits only weak β- and y-rays with a period of 10·6 hours, changing into thorium C of period one hour. We have seen that thorium C breaks up in a complex way, emitting three distinct groups of particles. Thorium C'' is readily separated from C by the method of recoil. It emits penetrating β- and y-rays with a half period of three minutes. The active deposit as a whole decays ultimately with the period of thorium B, viz., 10·6 hours.

A special interest attaches to the product thorium X, first separated by Rutberford and Soddy, since experiments with it laid the foundation of the general theory of radioactive transformations.

A close analysis of thorium has led to the discovery by Hahn of a number of other important products. When the thorium X is separated from a thorium mineral or old thorium preparation, there appears with it another product called mesothorium I, of period 6.7 years, which is transformed with the emission of weak @-raysinto mesothorium 2, of period six hours, which emits swift β-particles and penetrating y-rays. This changes into an α-ray product, radiothorium, of period two years, which is transformed into thorium X.

Radiothorium is an isotope of thorium, while mesothorium I is an isotope of radium. The radiathorium can readily be separated from a solution of mesothorium and obtained in a concentrated form. Mesothorium when first separated would show a very weak activity, but in consequence of the growth of its subsequent product radiothorium, its activity would increase for several years. After reaching a maximum it would ultimately decay with the period of mesotborium, viz., 6.7 years.

Large quantities of mesothorium have been obtained as a by-product in the separation of thorium from monazite sands. This substance emits only β-rays but soon grows radiothorium and subsequent products which emit a-rays and penetrating β- and y-rays. As a source of powerful@-and y-radiation, this substance is very analogous to radium and can be obtained in about the same concentration. Since radium and mesothorium are isotopic elements, they are always separated together. Most commercial sources of thorium contain also uranium and radium, and consequently radium is always separated with the mesothorium and in relative amount depending upon the proportion of uranium to thorium in the mineral. Since mesothorium has a radioactive life short compared with radium, it commands a smaller price. The amount of mesothorium is standardised by comparison of its y-ray effect with a radium standard. Radiothorium, separated from preparations of mesothorium, is widely used instead of radium as sources of β- and y-rays for therapeutic purposes.

Transformations of Actinium. — Actinium of period about 20 years is believed to emit weak @-rays changing into radio-actinium, an a-ray product of period 19 days, first separated by Hahn. This changes into actinium X, an a-ray product of period 11 days, discovered by Godlewski. Then follows the actinium emanation of period 3.9 sec., which gives rise to four further products named actinium A, B, C, C″. Actinium A has the shortest life of any product whose rate of transformation has been directly determined. Its period, as determined by Geiger and Moseley and Fajans, is ·002 second. After emitting an a-particle, **A** changes into B, a product of period 36 minutes emitting weak β- and y-rays, analogous to thorium B. Actinium C of period 2·16 minutes undergoes a complex transformation, giving rise to two distinct groups of a-particles. The main branch gives rise to actinium C″ of period 4·8 minutes, which is readily isolated by the recoil method. Actinium C'', which emits β- and y-rays, is analogous in all respects to thorium C''.

In the above discussion on branch products it has been shown that the parent of actinium, called protoactinium, has been recently isolated by Hahn and Soddy. This substance emits a-rays and has an estimated period of 20,000 years. We have seen that the actinium series is believed to have its origin in a dual transformation of uranium X_1. The first branch product, representing about 3% of the total, is believed to be uranium Y, a /?-ray product of period one day. This is directly transformed into protoactinium.

Assuming a branching ratio of 3%, 1,000 kilograms of uranium contains 130 milligrams of protoactinium. Hahn and Walling have developed methods of purification with a view of determining its atomic weight. This constant should prove of great importance in fixing the atomic weights of the actinium series of products and in throwing light on the origin of the actinium series.

End-products of the Transformations. — After the radioactive transformations have come to an end, each of the elements uranium, thorium and actinium should give rise to an end or final product, which may be a known element or an unknown element of very slow period of transformation. Since the expulsion of an α-particle lowers the mass of the atom by four units, and there are eight a-ray products, the atomic weight of the end atom should be $238-8\times4=206$. The atomic weight of radium by this rule should be $238-3\times4=226$, a result in good accord with experiment. The atomic weight of the end-product of uranium is close to that of lead, viz., 207, and Boltwood early suggested that lead was the end-product of radium. Since in old minerals the transformations have been in progress for intervals measured by millions of years, the end-product should collect and be an invariable companion of the radio-element. Boltwood showed that lead is always present in old radioactive minerals, and in amount to be expected from their uranium content and geologic age.

This problem has been definitely attacked in the light of the chemical generalisation already given. It was clear from this that the end-products of uranium, thorium and actinium should all be isotopes of lead but with atomic weights 206, 208 and 206 respectively. In other words, uranium-lead if uncontaminated with ordinary lead should show a smaller atomic weight than ordinary lead (207), while thorium-lead should give a higher value. By the work of Richards, Soddy and Honigschmid, these conclusions have been definitely confirmed. The lowest value for uranium-lead is 206, and the highest for thorium-lead 207·7.

Since any admixture with ordinary lead tends to give a value nearer 207, these results may be considered as a definite proof of the nature and atomic weight of the end-products. In minerals containing both uranium and thorium the atomic weight of the mixture of the isotopes will depend on the relative amounts of these two elements and their relative rates of transformation. In unaltered minerals the determination of the amount of lead coupled with its average atomic weight allows us to determine the amount of uranium-lead even if some ordinary lead be present. In this way it should be possible to make a reliable estimate of the age of selected minerals and thus indirectly the age of the geologic strata (see GEOLOGY). The amount of helium in the mineral gives a minimum estimate of its age, for, except in the most compact minerals, some of the helium must undoubtedly escape.

Production of Helium. — In 1902 Rutherford and Soddy suggested that the helium which is invariably found in radioactive minerals was derived from the disintegration of radioactive matter. In 1903 Ramsay and Soddy definitely showed that helium was produced by radium and also by its emanation. From the observed mass of the a-particle, it seemed probable from the first that the a-particle was an atom of helium. This conclusion was confirmed by the work of Rutherford and Geiger, who showed that the a-particle was an atom of helium carrying two unit charges of electricity. In order to prove definitely this relation, it was necessary to show that the a-particles, quite independently of the active matter from which they were expelled, gave rise to helium. This was done by Rutherford and Royds, who allowed the a-particles from a large quantity of emanation to be fired through the very thin glass walls of the containing tube. The collected particle gave the spectrum of helium, showing, without doubt, that the a-particle must be a helium atom.

Since the particle is an atom of helium, all radioactive matter which emitsa-particles must produce helium. This has been found to be the case for every a-ray product that has been examined. The rate of production of helium by radium in equilibrium was measured with accuracy by Dewar, Boltwood, and Rutherford. In terms of the international radium standard, the rate of production of helium by one gram of radium in equilibrium with its three a-ray products has been found to be 164 cumm. per year. This value is in excellent accord with that calculated from the rate of emission of a-particles. The rate of production of helium by the radon, ionium and polonium has been found by Boltwood to be in fair agreement with calculation. Soddy has observed the production of helium by purified uranium, while Strutt showed that the rate of production of helium in uranium and thorium minerals was in good accord with calculation.

Strutt has made a systematic examination of the amount of helium present in many minerals and rocks which contain minute quantities of radium, and has utilised the results to estimate the age of the geological deposits. On account of the tendency of the helium to escape from minerals in the course of geologic ages, this method gives only a minimum estimate of the age of the mineral, except in the case of very dense and compact specimens. The measurement of the lead content should ultimately prove a more reliable method of estimating the age.

Heat Emission of Radioactive Matter. — In 1903 it was shown by Curie and Laborde that a radium compound was always hotter than the surrounding medium, and radiated heat at a constant rate of about 100 gram-calories per hour per gram of radium. The rate of evolution of heat by radium has been measured subsequently by a number of observers. There is no doubt that the evolution of heat by radium and other radioactive matter is mainly a secondary phenomenon, resulting largely from the energy of the absorbed radiation. Since the particles have a large kinetic energy and are easily absorbed by matter, all of these particles are stopped by the radium itself or by the envelope surrounding it, and their energy of motion is transformed into heat. The evolution of heat from any type of radioactive matter is thus proportional to the energy of the expelled a-particles, together with the energy of the β- and y-rays absorbed in the envelope. The energy supplied by the recoil of the radioactive atom after the expulsion of an α-particle is about 2% of the energy of the a-particle.

These conclusions have been confirmed by the measurements of Rutherford and Robinson, who found that each of the a-ray products gave a heating effect proportional to the energy of the a-particle and absorbed /?- and y-rays. Radon and its products when removed from radium were responsible for three-quarters of the heating effect of radium in equilibrium. The heating effect of radon, radium A and radium C decayed at the same rate as their activity. From their measurements they found that the total heating effect of radium in equilibrium surrounded by sufficient material to absorb all the radiations was 134·7 gram-calories per hour per gram. Of this, 123·6 gram-calories were due to the α-particles, 4.7 to the β-rays and 6·4 to the y-rays. The energy of the β- and γ-rays comes from radium B and radium C, but on account of their great penetrating power it is difficult to measure the γ-energy with accuracy. The results, however, show that the energy of the γ-rays is even greater than that of the β-rays, and the two together are equal to about 28% of the energy of the α-particles from radium C.

Measurements have been made of the heating effect of radium, uranium and thorium, and of uranium and thorium minerals. In each case the evolution of heat is of about the magnitude to be expected from the energy of the radiations.

Experiments on the evolution of heat from radium and its emanation have brought to light the enormous amount of energy accompanying the transformation of radioactive matter where α-particles are emitted. For example, the radon from one gram of radium in equilibrium with its products emits heat initially at the rate of about 109 gram-calories per hour. The total heat emitted during its transformation is about 14,500 gram-calories. Now the initial volume of radon from one gram of radium is ·6 cubic millimetres. Consequently one cubic centimetre of radon during its life emits $2{\cdot}4\times10^7$ gram-calories. Taking the atomic weight of the emanation as 222, one gram of the emanation emits during its life $2{\cdot}4\times10^9$ gram-calories of heat. This evolution of heat is enormous compared with that emitted in any known chemical reaction. There is every reason to believe that the total emission of energy from any type of radioactive matter during its transformation is of the same order of magnitude as for radon. The atoms of matter must consequently be regarded as containing enormous stores of energy which are only released by the disintegration of the atom.

Nature and Properties of the α-Rays.—Although the α-rays from active substances are of small penetrating power compared with the β- or γ-rays, they are responsible for most of the energy evolved by radioactive substances and contribute most of the ionization. Rutherford showed in 1903 that the α-rays were deflected in a powerful magnetic and electric field and consisted of positively charged atoms of matter projected with high velocity. From the first it seemed probable that the α-particle was an atom of helium carrying two positive charges, and this was subsequently confirmed in a number of ways. The value of e/m—the ratio of the charge on the particle to its mass—and the velocity can be determined from observations on the deflection of the pencil of rays by a magnetic field and electric fields. In this way Rutherford and Robinson in 1914 showed that the α-particle, whether from radon, radium A or C, gave a value of $e/m=4{,}820$ e.m. units, agreeing within the limit of error with the electrochemical value of $e/m=4{,}826$, assuming that the mass of the helium atom is 4·00 and that it carries two unit positive charges. The magnitude of the charge carried by each particle was measured by Regener and Rutherford and Geiger, and found to be twice that carried by the electron. The velocity of the α-particles expelled from radium C (of range 7·06 cm.) was found to be $1{\cdot}92\times10^9$ cm. per sec., or about $\frac{1}{15}$ the velocity of light. From this result the velocity of expulsion of all α-particles can be calculated from the relation found by Geiger, that $V^3=KR$ where V is the velocity of the particle and R its range in air. The evidence indicates that the α-particles from active products are in all cases atoms of helium. The α-particles from a given product are all emitted with constant velocity, which is characteristic for that product. We have already mentioned that the velocity of expulsion appears to be connected with the period of transformation of the element. The laws of absorption of the α-particle were first worked out by Bragg and Kleeman. On account of its great energy of motion, the α-particle travels in nearly a straight line through the gas, producing intense ionization along its track. The effects produced by the α-particle, whether measured by ionization, phosphorescence or photographic action, vanish suddenly after the α-particle has traversed a definite amount of matter. The definiteness of the end of the range of the α-particle of given velocity is remarkable. It is found that the ionization per centimetre of path due to a narrow pencil of α-rays increases with the distance from the active matter, at first slowly, then more rapidly, near the end of the range. After passing through a maximum value the ionization falls off rapidly to zero corresponding to the end of the range. If a uniform screen of matter is placed in the path of the pencil of rays the range is reduced by a definite amount proportional to the thickness of the screen. All the α-particles have their velocity reduced by the same amount in their passage through the screen. The ranges in air of the α-rays from the various products of the radio-elements have been measured and are usually impressed in terms of cm. of air traversed at 15° C and 760 mm. pressure. The ranges for the different products vary between 2.8 cm. and 11·3 cm.

Bragg has shown that the range of an α-particle in different elements is nearly proportional to the square roots of their atomic weights. This approximate empirical relation has proved very useful in estimating the reduction in range of the α-particles in traversing uniform sheets of different kinds of matter.

Rutherford and Geiger in 1908 devised an electrical method of counting the α-particles expelled from radioactive matter. The α-particle enters through a small opening into a metal tube containing a gas at a reduced pressure. The ionization produced by the α-particle in its passage through the gas is magnified several thousand times by the movement of the ions in a strong electric field. In this way, the entrance of an α-particle into the detecting vessel is shown by a sudden and large deflection of an electrometer.

A still more sensitive detector has been devised by Geiger consisting of a fine needle point opposite an opening in a metal tube, charged to a suitable voltage. This counter is equally efficient for β- as well as for α-particles. By the use of a string electrometer, photographic registration of the α-particles can be obtained for several thousand a minute. By magnifying the current by means of suitable amplifiers, the entrance of an α-particle into the detecting vessel can be made to operate a signal.

On account of its great energy of motion the effect due to a single α-particle can be detected in a variety of ways. Sir William Crookes first noted that the α-rays produce scintillations when they fall on a screen of phosphorescent zinc sulphide. It is now known that each of these scintillations is due to the impact of a single α-particle. The number of scintillations can be counted with the aid of a suitable microscope, and this method has proved of great utility in many investigations. Scintillations due to α-rays are observed in certain diamonds, but they are usually not so bright as in zinc sulphide. Kinoshita has shown that a single α-particle produces a detectable effect on a photographic plate. When the α-rays fall on a plate nearly horizontally the track of the α-particle is clearly visible under a high-power microscope. By the expansion method developed by C. T. R. Wilson, the track of the α-particle through the gas is made visible by the condensation of the water on each of the ions produced. In a similar way the track of a β-particle can be easily shown. The photographs of these trails bring out in a striking and concrete way not only the individual existence of α- and β-particles, but the main effects produced in their passage through matter.

When the α-rays fall on a sheet of matter, a cloud of slow speed electrons is emitted. These were first studied by Sir J. J. Thomson and were called by him the delta (δ) rays. Most of the δ-rays have an energy corresponding to only a few volts but a few particles are present which have much higher speeds, some reaching to twice the velocity of the α-particle. These δ-rays are a secondary phenomenon and are liberated from the atoms of matter by the action of the α-particle. The δ-rays can be best studied by photographing the tracks of α-particles in a Wilson chamber containing a gas at low pressure. The swifter δ-particles are able themselves to ionize the gas and their tracks are easily visible. Chadwick and Emeleus and also Auger have shown that the number and velocity of the swifter δ-rays agree excellently with the view that they are produced by the collision of the α-particles with the electrons in the atom. The primary process of ionization by the α-particle is the removal of the electron and the secondary ionization is produced by the swifter δ-particles. In general the primary ionization is about one-half of the total ionization observed.

The α-particle at the moment of its expulsion from a radioactive atom carries two charges and it was at first supposed that it retained this charge until very near the end of its range where the charge was neutralized by capture of two electrons. Later work, however, by Henderson and Rutherford showed that the α-particle changes its charge several thousand times in its passage through matter. When the a-rays pass through a sheet of matter in a good vacuum, the issuing rays consist of doubly charged, singly charged and neutral helium atoms. For high speeds, the doubly charged particles predominate; at low speeds most of the particles are singly charged or neutral. It seems clear that the α-particle in its passage through matter occasionally captures an electron and that this may be removed in a subsequent collision. This process of capture and loss of electrons is repeated many thousand times before the a-particle is brought to rest.

Although most of the a-particles travel in nearly a rectilinear path through absorbing material there is in general a small scattering or deflection of the a-particles in passing through matter, amounting on the average to a few degrees. This scattering increases with the atomic weight of the absorber and with reduction of velocity of the a-particle. In addition to this small angle scattering, a small fraction of the a-particles is deflected by collisions with heavy atoms through angles greater than a right angle. This large angle scattering is in general due to a close collision of an α-particle with a single atom of matter. A close study of the laws of single scattering of a-particles has been made by Geiger and Marsden. The observations on this large angle scattering first disclosed the nuclear structure of the atom and has given us most definite information on the laws of force inside the atom close to the nucleus and on the dimensions of atomic nuclei. (See NUCLEUS.) Blackett has obtained a number of expansion photographs showing close collisions of a-particles with the nuclei of light atoms like hydrogen, helium, nitrogen and oxygen. In general a forked track is obtained, one branch due to the scattered a-particle and the other to the recoiling nucleus.

Properties **of β- and** y-Rays.--We have seen that the @-particles, which are emitted by a number of radioactive products, consist of swift negative electrons spontaneously liberated during the transformation of active matter. The velocity of expulsion and the penetrating power of β-rays vary widely for different products. For example, the rays from radium B are much more easily absorbed by matter than the swift @-rays from radium C. At first sight, the laws of absorption of the β-particle by matter appear very different from those observed with α-particles. This is mainly due to the fact that the average @-particle has much less energy than the α-particle and is consequently much more scattered in passing through matter. This scattering is so marked that in general more than half the @-particles falling on a thin sheet of matter are reflected or rather scattered in the backward direction. The @-particles on the average have a very tortuous path before they are finally stopped. In the early days, it was found that the absorption of β-rays appeared to follow an exponential law and the different groups of 8-rays were characterized by a definite absorption coefficient. We now know that a group of homogeneous β-rays are not absorbed according to an exponential law at all and that the β-particles arising from disintegration of a single product are expelled over a wide range of velocity. In this respect a β-ray transformation is entirely different from an a-ray transformation where the a-particles are all expelled with the same speed. It has however been found that in general one disintegration electron comes from each transformed atom but the speed of the β-particles from different atoms may differ widely. It is difficult to account for the striking difference in the α- and β-modes of transformation. Meitner has suggested that the β-particles are initially liberated from the nucleus with identical speeds but that some lose part of their energy by collisions with electrons in escaping from the atom. If this were the case, we should expect on the average more than one 8-particle to escape from each disintegrating atom. Ellis, however, has shown that the heating effect of the @-rays from radium E is a measure of the actual energy of the escaping β-rays, supposing, as Emeleus observed, that one β-particle is expelled in each transformation. On the Meitner hypothesis, the heating effect should have been greater corresponding to that due to β-particles all liberated with the maximum speed.

Gray has shown that β-rays in passing through matter give rise to y-rays, and that these in some cases correspond to the characteristic X radiations observed by Barkla. The absorption of the y-rays has been determined by the electrical method. Radium B has been found to emit several groups of y-rays which differ in penetrating power. The greater part of the rays from radium C consist of penetrating y-rays which are nearly exponentially absorbed by matter. The ionization in an electroscope falls off according to the equation $I/I_0 = e^{-\mu d}$, where d is the thickness of matter traversed and μ the coefficient of absorption. When lead is used as an absorbing material the value of $\mu = 0{\cdot}5$ for the most penetrating y-rays from radium C. The absorption coefficient for different kinds of matter is proportional to the density, indicating that absorption depends on the mass of matter traversed.

There is undoubtedly a close connection between β- and γ-rays, and swift β-rays are usually accompanied by penetrating y-rays. For example, radium C, which emits very swift β-rays, some of which reach a velocity more than 0·98 of the velocity of light, gives rise to the most penetrating y-rays observed in the uranium-radium series. There is one very notable exception, viz., radium E which emits swift β-particles but very little y-radiations.

Jacobsen has recently found some evidence that in the disintegration of radium C, the y-radiation is not emitted until about 10^{-5} second after the expulsion of the β-particle. It may be that, in general, the y-ray does not accompany the expulsion of the @-particle but is liberated later due to a rearrangement of the constituents of the nucleus. If this be the case, the liberation of a y-ray represents a new type of transformation without change of the charge on the nucleus. On this view, it is to be supposed that in the case of radium E there is no subsequent y-ray transformation.

The detailed study of the β-ray spectra discussed below has led to the conclusion that the y-rays are characteristic radiations emitted from the radioactive nucleus in its rearrangement after the ejection of the β-particle. These radiations from the nucleus in their passage through the atom excite the characteristic radiations of the external electronic system. Thus the total γ-radiation of a radioactive atom consists not only of the y-rays from the nucleus, but also of the characteristic X-rays of the atom.

The first examination of the spectrum of the y-rays was made by Rutherford and Andrade in 1914 by reflection of the rays from a thin crystal of rock-salt, using a fine glass tube filled with radon as a source of y-rays. A complicated spectrum of bright lines was observed corresponding to the y-rays emitted by the 8-ray products, radium B and radium C. Lines were observed corresponding to the ordinary X-ray spectrum of the elements radium B and radium C, and also a number of other lines of much shorter wave-length. These results have been extended by the recent work of Frilley, who by the use of intense sources of radiation has been able to observe still shorter waves, corresponding in energy to about 700,000 volts. The angle of reflection of such short waves from rock-salt is only about 10 minutes of arc, and it does not seem feasible by this method to measure the wave-length of the still shorter waves which are undoubtedly present. This difficulty has been surmounted by the use of an entirely different method which is specially applicable to rays of high frequency and energy. A brief discussion of this method and its application follows:

When the β-rays from a product like radium B or radium C are bent by a magnetic field and fall on a photographic plate, a kind of magnetic spectrum is obtained. Superimposed on the continuous spectrum due to particles of all velocities (between certain limits) certain sharp lines are observed, each of which represents a definite group of β-rays which are emitted at the same speed. The velocity corresponding to each line in the spectrum has been determined for a number of β-ray products by Hahn and Lise Meitner. The magnetic spectrum of radium B and radium C was examined in detail by Rutherford and Robinson, and more than 50 lines were observed, representing β-particles projected over a wide range of velocity. The appearance of these lines in the spectrum appears to be connected with the emission of y-rays and is believed to be due to the conversion of the energy of the y-ray of definite frequency into the energy of an electron according to the quantum relation. When a thin layer of absorbing material is placed over the source, the primary β-rays diminish in velocity and the lines become broad and diffuse. At the same time, however, new groups of @-raysare formed by the conversion of y-rays into @-raysin passing through the absorbing material, and these give well-marked bands on the photographic plate, occupying very nearly the same position as those due to the primary @-rays before absorption. A study of the slight shift in the position of the band when the y-rays traverse elements of different atomic weights was made by Ellis. The results can be interpreted in the following way: A y-ray in traversing the absorbing screen interacts with one of the electrons in an atom and occasionally the energy E of the y-ray is transferred to the electron. The energy of the electron after escape from the atom is given by E–w where w is the work required to move the electron out of the atom. Since on the quantum relation the energy E of a y-ray is given by hv, where v is the frequency of the y-radiation and h the well known constant of Planck; it follows that $h\nu = E - w$. Since the energy, E–w, of the escaping electron can be deduced by its deflection in a magnetic field, and w is known from X-ray data, the frequency ν of the radiation is directly determined. On this view the origin of many of the lines in the primary, magnetic spectrum of the β-rays is at once revealed. A y-ray in escaping from the radioactive atom occasionally interacts with one of the outer electrons in the atom from which it originates, and communicates its energy to it. This electron may belong to any of the well known K, L, M, etc., levels in the atom, but the value of the energy w abstracted from the escaping electron depends on the level. It is greatest for the K level and rapidly diminishes for the L, M, etc., levels. In considering a large number of disintegrating atoms, there is a certain probability that a particular y-ray will be converted in one of these levels and consequently a number of lines will appear in the magnetic spectrum corresponding to the conversion of a single y-ray in the various electronic levels in the atom. Usually, the line due to conversion in the K level is much the strongest, but, for an intense y-ray, the lines due to conversion K, L, M and N levels can be observed. By observations of this kind, it is thus possible to determine the frequency of the y-rays by analysis of the magnetic spectrum of the @-rays.

Determinations of the frequencies of the main y-rays given by a number of radioactive elements have been made by this method by Ellis, Meitner, Thibaud, Black and others. In the case of radium B and radium C, the frequencies so determined agree well with the direct measurements made by the crystal method, so that it is clear that this powerful method can be safely applied for waves of the highest frequency. So far, the highest frequency observed corresponds to over two million volts.

The penetrating y-rays in general accompany a β-ray disintegration, and it has proved of great importance to settle whether the y-rays are emitted before or after the expulsion of the disintegration electron from the nucleus. This question has been attacked by a number of observers by different methods, ultimately leading to a definite proof that the y-ray always follows the emission of the disintegration @-particle, presumably after a short but unknown interval. For example, the y-rays which are ascribed to the disintegration of radium B of nuclear charge 82 actually arise from the nucleus of charge 83 resulting from the expulsion of a @-particlefrom radium B and are converted in the electronic levels of an atom of charge 83.

Ellis has obtained some evidence that the main y-rays from radium B and radium C can be interpreted by assuming a system of energy levels in the nucleus, analogous to the well known system of energy levels in the electronic system of an atom which have been postulated for the explanation of optical and X-ray spectra, but the wave-lengths of the y-rays are not yet known with sufficient precision to fix the levels with much certainty. The general evidence suggests that the y-rays are not due to the passage of an electron from one level to another in the nucleus, but to the movement of a more massive particle, possibly a proton, or helium nucleus.

In this connection, it may prove significant that y-rays are emitted from some products which break up with the emission of α-particles but no @-particles. Whatever may be the exact mode of origin of the y-rays, it seems clear that the high frequency v-rays originate in the nucleus of the transformed atom and represent the characteristic modes of vibration of parts of the nuclear structure.

Radioactivity of Ordinary Matter. — Apart from the well-known radioactive elements of high atomic weight, only two other elements have been shown to exhibit radioactivity to a detectable degree, viz., potassium and rubidium. Campbell showed that these elements emit only β-rays and in amount small compared with uranium. This property appears to be atomic, but no evidence has been obtained of any subsequent changes. If the β-particle comes from the nucleus of the atom, potassium should be transformed into an isotope of calcium, and rubidium into an isotope of strontium. Hervéy has partially separated the isotopes of potassium of atomic masses 39 and 41 by diffusion methods and concludes that the radioactive property is mainly concentrated in the heavier isotope.

Radium and thorium have been found to be distributed, but in very minute amount, in the surface rocks and soil of the earth. The emanation from the soil diffuses into the atmosphere and causes a small ionization which can be readily measured A penetrating y-radiation, no doubt due to the presence of radium and thorium in the earth's crust, has been observed near the earth's surface, but becomes very small over a lake or the sea.

Structure of Radioactive Nuclei.--On modern views, the atom consists of a central positively charged nucleus of very minute dimensions surrounded at a distance by a compensating distribution of electrons. (*See* ATOMS.) The ultimate constituents of the nucleus are supposed to be protons and electrons, the former in excess, but probably combinations of protons with electrons exist as secondary units within the nucleus. It seems clear that radioactivity is a property of the nucleus and that the primary a- and @-particles and the y-rays have their origin in the nucleus. Some of the secondary β-rays are due to the conversion of the energy of y-rays in passing through the outer electronic system of the atom while characteristic X-rays are also excited in the rearrangement of the outer atom. From consideration of the scatterings of α-rays by heavy elements and the energy of emission of a-particles from radioactive atoms, it has been suggested that the nucleus is a complex structure, consisting of a central, highly compact, inner nucleus surrounded at a distance by a number of satellites. Rutherford supposed these satellites to be electrically neutral and to be held in equilibrium by the enormous distorting forces arising from the intense electric field of the central nucleus. For some reason, one of the satellites circulating in a quantum orbit becomes unstable and escapes from the system, shedding two electrons as soon as the electric field falls to a certain critical value, and gaining further energy in its escape through the repulsive field. The final speed of ejection of the a-particle on this view depends on the quantum orbit from which it is liberated. It is suggested that some of the electrons circulate at high speeds close to the central nucleus and that the y-rays arise not from the @-electrons but from the fall of the neutral satellite from one quantum orbit to another. Enskog has suggested that the a-particles are held in equilibrium by magnetic attraction between the a-particles and central nucleus.

BIBLIOGRAPHY.—Mme. M. Curie, *Traitk de Radioactivité*, 2 vol. (1910); Sir E. Rutherford, *Radioactive Substances and their Radiations* (1913); S. Meyer and E. V. Schweidler, *Radioaktivitat* (1927); F. Soddy, *Chemistry of the Radioelements*, parts *I.* and II. (1914–15). See also Hevesy and Paneth, *A Manual of Radioactivity* (1926); Fajans, *Radioactivity* (1922); *A.* S Russell, *Chemistry of the Radioactive Substances* (1922). *See* also under "Radioactivity" in the Annual Reports of the Chemical Society. (E. Ru.)

RADIO COMPASS, a radio receiving set which permits determination of the line of travel of waves as received from transmitting stations. *See* WIRELESS TELEGRAPHY; AERIAL NAVIGATION; NAVIGATION.

RADIO CORPORATION OF AMERICA, an American corporation incorporated in Delaware on Oct. 17, 1919.

The Radio Corporation of America, and its subsidiaries are engaged in the manufacture and sale of apparatus for radio purposes and for recording and reproducing sound, the operation of international, marine and domestic radio communication services, the operation of radio broadcasting stations and the supplying of programs for radio broadcasting. Prior to 1930 RCA, having no manufacturing facilities of its own, purchased from General Electric Company and Westinghouse Electric and Manufacturing Company all of the apparatus sold by them. In 1929 it acquired the Victor Talking Machine Company and as of Jan. 1, 1930, it acquired manufacturing rights and facilities from the General Electric and Westinghouse Companies. These were operated by RCA Victor Company, Inc. and RCA Radiotron Company, Inc., until Jan. 1, 1935, on which date all manufacturing activities were consolidated in RCA Manufacturing Company, Inc., a new company. The international radio communication services were operated by RCA until 1929 at which time they were transferred to R.C.A. Communications, Inc., a subsidiary. In 1935 these services consisted of direct radio circuits, linking the United States with 47 countries, and domestic radiotelegraph circuits connecting 11 United States cities. R.C.A. Communications, Inc. also operates services for the transmission by radio facsimile of pictures, maps etc., between New York–London, New York–Berlin and New York–Buenos Aires. In 1923 RCA commenced the operation of two radio broadcasting stations, WRC in Washington and WJZ in New York. The National Broadcasting Company, Inc., a wholly owned subsidiary, was organized in 1926, and acquired WEAF in New York. NBC programs 189 radio broadcasting stations and engages in network broadcasting on two coast-to-coast networks, the Red and the Blue. The authorized capital stock consists of 920,300 shares of $3.50 Cumulative Convertible First Preferred stock, of which 900,844·8 shares have been issued; 13,693 shares of "B" Preferred stock, authorized and issued; and 18,500,000 shares of common stock of which 13,881,016 shares have been issued. (J. G. H)

RADIOLARIA, a class of marine protozoans, usually planktonic, distinguished by a mineral skeleton. See PROTOZOA.

RADIOLOGY, that branch of science which deals with radiant energy and its physical laws. The term radiology is however often used to denote the application of radiant energy in medicine and that will be its reference here.

Classes of Radiations.— The association of various kinds of radiation with the science and practice of medicine has been a very gradual one, quickened in the last 30 odd years by the discovery of kinds of radiation of which mankind was ignorant, although they are all emitted by the sun. Five groups of aether disturbance are of interest in medicine: a region of radiant heat used in thermo-therapy, the region of light for helio-therapy, that of ultra-violet rays in actino-therapy, the group of radiations known as X-rays used in radio-therapy, but often called Rontgen-therapy in honour of the discoverer of the rays, and finally a group known as gamma rays which are the principal, though not the only, agent in radium-therapy (*q.v.*); this is often spoken of in France as Curie-therapy in honour of the discoverer of radium.

Though differing in many characteristics, these groups of radiation have the common feature of travelling with the speed of light. They are periodic electro-magnetic disturbances in the aether, not mechanical vibrations in any sense of the term.

More use is made in actual practice of measured values of the wave-lengths of these radiations than of their frequencies. Measurements of the wave-lengths of light were first made just over a century ago by Fraunhofer; he estimated the wave-length of the yellow light given out by a sodium flame to be ·0005888 mm. which was afterwards proved to be remarkably accurate. It is usual now to express measurements of wave-lengths in Angstrom units (Å.U.) one of these being equal to one hundred millionth of a centimetre. The bigger the value in Angstrom units, the longer the wave-length. The limits of vision for people of normal colour perception are generally held to extend over wave-lengths ranging from about 7,600–3,800 Å.U.; waves longer than this extend more or less indefinitely but the region adjoining the red rays is called Radiant Heat; on the shorter wave-length side is ultra-violet radiation, the part of medical interest being limited to the wave-lengths between 3,800 and 2,500 Å.U. Waves of shorter wave-length than this are very easily absorbed by practically all forms of matter except when the wave-length becomes very much shorter, then they become more and more able to penetrate matter; the waves from X-rays come in this division. Medical use is made of the rays which extend between the approximate limits 1–0·15 Å.U. Finally the group of gamma rays emitted by radium and other radio-active bodies extends between the limits of 0·04–0·07 Å.U., overlapping the short wave-length X-rays.

Importance in Medicine.—One of the first photographs sent out by Professor Rontgen in 1895 to scientific laboratories announcing his discovery of the X-rays was a picture of a hand showing that, by the help of the rays, one could literally see through the tissues; the soft tissues are less opaque to these rays than bone, so that if the hand is put between the X-rays and a photographic plate, a shadowgraph is formed on the plate.

Advances in Technique.— Some idea of the advances in the technique of radio-diagnosis may be got from the fact that in the early days of X-ray work, for a radiograph of the kidney for a suspected stone, an exposure of about 30 minutes was necessary; for such radiography now, exposures of less than one second are given. This extraordinary shortening of the time has mainly been brought about by three improvements in technique. The most important of these is an increased output of radiation from the X-ray tube; this has been achieved by the construction of more massive X-ray tubes which deal effectively with the large amount of heat generated when X-rays are produced, and by the design of much more effective transformers for the production and maintenance of the high voltages needed. The second and third improvements are on the purely photographic side. The thickness of the coating on the plate or film has been increased, and double-coated celluloid films are now very often used; and intensifying screens are used in close contact with the film of the photographic plate. When X-rays go through the object exposed, they excite these fluorescent intensifying screens, so that they give out light which acts directly on the photographic plate, which of course also receives the transmitted X-ray beam. By means of these technical developments successful cinematographic X-ray records of the movements of the limbs have been produced, but X-ray cinematography does not yet form part of the normal radiographic equipment of a hospital.

In the five years (1895–1900) following the discovery of X-rays, they were much used for therapeutic purposes, mainly for superficial conditions. In 1897 Henri Becquerel discovered that certain substances, of which radium is the prototype, are radio-active, in the sense that they give out rays spontaneously; these rays are of three kinds α, β and γ, the last being akin to X-rays. Similar attempts were soon made to test the therapeutic value of these rays (*see* RADIUM-THERAPY), and at the present time, there is a widely growing use of gamma rays and X-rays in the treatment of disease.

Tissue Reactions.— The tissues of the body respond to the five different groups of rays mentioned at the beginning, in very different ways. In what follows, references will mainly be made to the rays other than those constituting heat and light. Perhaps the most striking physical characteristic shared by ultra-violet, X-rays and gamma rays is that of liberating electrons from matter. No doubt this occurs when the tissues of the body are exposed to these rays.

Suppose that the skin of the abdomen is exposed to a beam of X-rays comprised within certain wave-lengths. With an adequate dose of radiation, a series of reactions occurs which lasts for several weeks; the skin becomes red, any hair there is will come out, a blister may develop and finally if the dose has been a very heavy one, a persistent sort of ulcer may form. Most of the X-rays falling upon the skin will penetrate to the deeper tissues and produce effects upon them which depend essentially upon the kind of organ or tissue irradiated. By suitable choice of the wave-lengths in a beam of X-rays, it is possible to give a sterilizing dose to the cells of the ovary, while causing no more damage to the skin than a transient erythema. Since the rays must be considerably weaker by the time they reach the ovary than they are on the skin, it is usual to say that X-rays have a selective action, meaning that they have apparently more effect upon some cells of the body than others and there is no doubt that this is so; and that it is equally true of gamma rays. Upon this main principle, the foundations of X-ray and Radium therapy have been laid. The difference in the sensitiveness of the normal tissues of the body to these rays covers a wide range; certain cells of the ovary and testicle, glandular structures generally and lymphocytes are profoundly affected by doses of X-rays which do not have very much effect upon muscle, cartilage or nerve cells. How far this is due to the structures of the cell being altered or to the function of the cell being interfered with cannot at present be said.

Treatment of Malignant Turnours.—One of the most important therapeutic uses of X-rays and gamma rays is for the treatment of malignant tumours (*see* TUMOUR). One of the essential principles underlying the treatment of malignant growths was established by Dominici in 1909, who showed that it was possible to irradiate certain malignant tumours causing more damage to them than to the adjoining normal cells. Dominici traced the changes which occur in the tumour under these conditions and found that degenerative changes were set up in the tumour cells which eventually led to their destruction. Such a process takes time for its full development and is influenced by the reaction of the normal tissues; should these normal tissues receive an overdose of radiation, it may prejudice the whole sequence of events. Observations of this kind have established the view that the action of X-rays and radium, when properly used, is unlike that of a cautery but depends essentially on giving pathological tissues a dose, which though harmful enough to ensure their degeneration, will not severely damage any of the normal tissues of the host.

It has been found that the reactions of living cells depend not only upon the actual dose of radiation which they absorb, but also upon the way in which the dose is given. The two chief ways in which a definite physical dose can be varied are either by using a source of strong intensity and applying it for a short time or by using a relatively weak source and applying it for a correspondingly long time, keeping the product of these two quantities the same. Some researches of Lazarus-Barlow, in 1914, showed that the columnar and epithelial tissues of the rat react in quite different ways when the dose was varied in this way; the columnar type of cell being less damaged by keeping the intensity high and the time factor small, while the opposite was the case with cells of the squamous type. Observations of this kind have an obvious bearing upon treatment when deciding the kind of dose required to ensure the degeneration of malignant growths in man.

At the present time, there is a considerable tendency to use rather weak sources of radiation applied for a long time; in some cases, the exposures last as long as 12 or 14 days. Care has however to be taken that the source is not too weak, for there is ample evidence to show that cells can adapt themselves to very weak irradiation. Some idea of the doses commonly used in gamma ray therapy may be obtained from the statement, that a concentration of about 1 milligram of radium element for each cubic centimetre of a malignant growth is often aimed at, and an adequate time of exposure with this concentration is in many cases found to be from 5–10 days. It is perhaps unnecessary to add that this dose is often departed from when conditions make it advisable. In most cases, it is easier to manipulate the gamma rays from radium than X-rays, and for this reason partly there is a growing tendency to use them for the irradiation of deep-seated organs.

It is often very difficult, and in some cases impossible, to get the best physical conditions for arranging the necessary uniform irradiation of a malignant mass; but there is no doubt that those who practise radiotherapy in any form nowadays, and have a sound knowledge of the physical characteristics of the radiation they use, can get much nearer the ideal conditions than was possible in the early days of radiotherapy. The encouraging signs of collaboration between clinical and laboratory investigations are likely in time to establish the subject on a sound quantitative basis. Although much remains to be done to explain the processes set up when the tissues are irradiated by ultra-violet, X-rays, or gamma rays, some of the main changes occurring in cells both normal and malignant, are now well recognized and have been made the subject of detailed study. It has been found too, that cells react differently according to their state of activity at the time of irradiation, and it is generally believed that cells in active division are more vulnerable to radiation than when in a resting stage.

Effects on Cell Life.—It is reasonable to expect that the effects upon cell life will depend on the amount of radiation to which they are exposed. The general principle enunciated by Grothus in 1818 that, "in photo-chemical actions only those rays which are absorbed can produce chemical change," is found to have a much more general application. The reactions of living cells appear to depend largely, though not wholly upon the amount of energy they absorb from the beam of radiation going through them. It has already been stated that, if the intensity of the radiation is too small, the cells can cope with it to a large extent, even though it be prolonged for a very long time. It has been found that the changes shown by cells depend to some extent upon the wave-length of the radiation producing the action, although the amount of energy actually absorbed may be the same, the result may be entirely different; these processes begun in living structures depend not only upon the energy let loose in the structures, but also upon the way in which it is set free.

Generalizations must always be difficult on a subject which is comparatively young; experimental advances too are apt to modify views which can only be held somewhat tentatively, but it is thought that the following may be stated as expressing views which are fairly generally held at present. They are taken from Radium, X-mys and *the Living Cell* by Colwell and Russ.

1. The cells of some tissues are more affected by a given dose of radiation than are the cells of other tissues when exposed to the same dose. This is generally known as selective action.
2. In some cases, at least, the cells of a tissue are more affected by a given amount of energy of one range of wave-lengths than they are by the same amount of energy of another range of wave-lengths. This is known as differential action.
3. Some cells, when in an active state of division are more affected by a measured dose of radiation than are similar cells in the resting stage.
4. Some cells respond to a dose of radiation in different ways, according to whether such radiation is administered so that a large intensity is coupled with a short period of exposure or a small intensity is coupled with a long period of exposure.

Instruction for Practitioners.—The widespread application of radiology in medicine has inevitably affected the courses of instruction laid down for qualifying medical degrees.

Not many years after the first therapeutic trials with X-rays and radium, injurious action on the skin was noticed, and later it was discovered that those who were giving frequent doses of the rays to patients were themselves being damaged; in some cases there was obvious damage to the skin which led eventually to a cancerous condition; in others, a state of anaemia existed, and others were sterilized. Deaths from repeated but unintentional doses of radiation had undoubtedly occurred. With such facts known, protective committees were formed in various countries to lay down measures for the protection of all workers.

In Great Britain, there has been very wide acceptance of the general guiding principles laid down by the X-ray and Radium Protection Committee whose publications are issued from the British institute of radiology. This Institute came into being in 1924 and marks a distinct era in the development of a branch of medicine, whose services in the diagnosis and treatment of diseases have certainly not yet reached the zenith of their attainment. *See* the article RADIOTHERAPY; X-RAYS; X-RAY TREATMENT. (S. RU.)

RADIOMETER, an instrument for measuring the intensity of the radiant energy of rarefied gases. It was noticed by Fresnel that a body delicately suspended in *vacuo* is apparently repelled by radiation. Sir W. Crookes was the first to make systematic experiments; he found that a light vane blackened on one side and bright on the other was repelled if radiation was allowed to fall on the blackened face. He constructed an instrument, which he called a radiometer or light-mill, by pivoting a vertical axle carrying vertical vanes inside an exhausted bulb; one side of each vane was blackened and the other side bright, the black sides all facing the same way round the axle. When rays from the sun or other light source, or dark radiation from a warm body, fall on the vane, the black sides are repelled more than the bright sides, and the vanes are set into rotation. The rate of rotation rises to a value which depends on the intensity of the radiation; the more intense the radiation the more rapidly do the vanes rotate.

That this is so is important, for it indicates that the force opposing the motion is one which increases as the rate of rotation increases. Now the friction of the pivot is independent of the rate of rotation, so that the main opposing force must be that due to the residual gas in the bulb, for the viscous drag on a body in motion through a gas increases as the speed increases.

The name "radiometer" arose from Crookes's idea that the instrument might be used to measure the intensity of radiation; with the instrument he constructed he was able to detect the radiation from a candle 19 meters away.

That it was necessary to blacken one side of each vane suggested that the effect was due to a difference of temperature between sides of the vane caused by the greater absorbing power of the black coating, and the question arose whether the rotation was caused by the direct impact of the radiation (somewhat as the rotation of a cup anemometer is caused by the wind), or whether it was caused by difference of pressure of the gas set up by the inequalities in temperature. This was settled by a very beautiful experiment performed by Sir A. Schuster. He suspended the case of the radiometer by a fine thread so that it was free to rotate about a vertical axis; a small mirror fixed to the case, which reflected a beam of light on to a scale, enabled him to observe any rotation. If the vanes were driven round by the direct action of radiation, then the viscous drag of the gas acting also on the inside of the bulb would drag the latter round in the same sense as the vane. If, on the other hand, the rotation were caused by stress in the gas, the couple which set the vanes in rotation would involve an equal and opposite couple on the case, and the case would thus begin to rotate in the opposite sense. As the rate of rotation of the vanes increased, the viscous opposition of the gas would increase until, when the forces due to viscosity became equal to the driving forces, the resultant on both the vane system and on the case would vanish; the vanes would continue in uniform rotation and the case return to its position of equilibrium. When the rotation ceased to fall on the vanes, there would no longer be any driving couple and the viscosity of the gas would bring the vanes to rest and impel the case in the direction of their rotation.

The experiment completely confirmed this second hypothesis, namely that the rotation of the vanes is due to mutual forces between them and the case. This was further confirmed by suspending the case in an inverted position so that the vane system was no longer free to rotate unless it took the case round with it. There was then no motion of the case. From Schuster's measurements of the angular deflection of the light-mill supported by a bi-filar suspension, O. Reynolds calculated the magnitude of the pressure difference on the two sides of the vane to be of the order of one thousandth of the gas pressure in the bulb.

Instead of allowing free rotation of the vane system on a pivot, it may be suspended by a quartz fibre. Radiation falling on the black face of the vane will then cause the system to turn round until the restoring couple, due to the torsion of the suspension, balances the deflecting couple due to the radiometer action. A small mirror, attached to the vane system and reflecting a beam of light on to a scale, enables very small deflections to be observed. Pringsheim in 1883 constructed such an instrument and used it for spectrographic investigations in the infra-red. In 1893 Nichols constructed a radiometer in which the mica vanes, one at each end of a horizontal arm, and each blackened on its front surface, were suspended by a quartz fibre. Radiation falling on both vanes would tend to turn them in opposite directions, and if they were correctly adjusted the system would not move under the influence of general stray radiation. The radiation to be measured was allowed to fall on one only of the vanes, and the resulting deflection of a spot of light reflected by a small mirror was observed. In 1901 Nichols improved his radiometer, by making it smaller, to such an extent that he was able to measure with it the radiation from individual stars.

The radiometer has been applied to measurements of ultra-violet radiation and to that of short Hertzian waves (wave length 1 to 2 mm.).

THEORY

O. Reynolds in 1874 had shown, on the kinetic theory of gases, that communication of heat from a solid to a gas would involve a reactionary force on the surface of the solid. On the same theory Sir W. Crookes in 1876 gave an explanation of the action of his light-mill; this was as follows: The temperature of a gas is, on the kinetic theory, proportional to the mean kinetic energy of translation of the molecules, and the pressure exerted by a gas on the surface of a solid is due to the bombardment of the surface by the molecules. If the solid and the gas are at the same temperature, the molecules, after striking the surface, will rebound with the component of their velocity normal, the surface merely reversed. If the surface of the solid is warmed, as in the case of the light-mill by radiation, heat will be imparted to the molecules which strike the surface, and they will rebound with greater velocity than they approach.

Vanes, black on one side and bright on the other, on which radiation falls, will be warmer on the black surface, and molecules striking them will rebound with a greater reactionary kick from the warm sides than from the cool sides, and thus produce a greater pressure on the warm sides; it is this extra pressure which sets the mill in rotation.

In this explanation it is assumed that the molecules do not very often collide with each other, that is to say that their mean free path is comparable with the dimensions of the vane. When this is the case the force is proportional to the pressure of the residual gas. If the pressure is higher, and the mean free path is small compared with the size of the vanes, the molecules after rebounding from the warm surface of the vane collide with other molecules imparting their increased energy to them, and the general temperature of the gas in the neighbourhood of the surface is raised; but this involves a reduction of the density of the gas, so that fewer molecules now strike the vane in unit time, and this reduction in the number of rebounding molecules compensates for the greater contribution of each to the pressure on the vane, so that over the central portion of the vane the pressures on both sides become equal. However, near the edge of the vane, molecules from the hot side can collide with molecules from the cold side and the temperature will be the mean of the temperatures on the two sides; the density near the edge will thus tend to be the same on the black as on the bright side. The greater reactionary kick of the molecules hitting the warm side is thus uncompensated by a reduction in the number of collisions. Thus when the mean free path is small, the excess pressure is confined to a narrow region round the edge of the vane, and the resultant force depends on the length of the edge and not on the area of the vane.

The calculation of the pressure on a warm surface formed the subject of another paper by O. Reynolds in 1876; in this he takes into account the Maxwell-Boltzman law for the partition of the energy among the degrees of freedom of the molecule. *(See* KINETIC THEORY.) He assumes that it has the three degrees of freedom corresponding to three mutually orthogonal directions in space, that is to say, he neglects the possibility of spin of a molecule or of any internal vibratory motion. He shows the close connection between thermal transpiration and the radiometer effect, and proves that slip of the gas over the surface of the vane must play an important part in the action of the radiometer. Such slipping had been observed by A. A. Kundt and E. G. Warburg in 1875 In their work on the viscosity of gases. He concluded that the pressure was proportional to the rate of divergence of the lines of heat flow: if these are parallel there is no excess pressure; where they diverge there is an excess pressure.

More recent investigators in Germany have attacked the problem mathematically. Among these may be mentioned Edith Einstein in 1922. She found an expression for the pressure between two plates, one of which was hotter than the other. Using the Maxwell-Boltzman law for the partition of the energy among the three translational degrees of freedom of the molecules, she arrived at the result that the normal component of the pressure is proportional to the gas pressure and to the *square* of the rate of flow through the gas.

In 1926 Sterntal, starting with the same assumptions but introducing the possibility of internal vibratory motion which may absorb energy and applying the Maxwell-Boltzman laws to all these degrees of freedom, showed that the normal pressure is proportional to the first power of the rate of flow of heat instead of its square.

His result is in fair agreement with experiment, while the terms which E. Einstein obtained were second order ones about 10,000 times smaller.

The Knudsen Gauge.—Knudsen in 1909 described an absolute manometer based on the fact that the radiometer effect depends on the gas pressure.

Consider two parallel plates in an inclosure in which the gas pressure p is sufficiently low for the distance between the plates to be small compared with the mean free path of the molecule. Let T_1 and T_2 be the absolute temperatures of the plates and T that of the containing vessel, then the pressure p' between the plates is related to p by the formula

$$p' = p\,\frac{\sqrt{T_1}+\sqrt{T_2}}{2\sqrt{T}}.$$

If one of the plates is at the same temperature as the containing vessel, *i.e.*, if T_2 equals T, we have

$$p' = \frac{p}{2}\left(\frac{\sqrt{T_1}}{\sqrt{T}}+1\right)$$

The excess pressure F which tends to move the plates is

$$F = p' - p = \frac{p}{2}\left(\frac{\sqrt{T_1}}{\sqrt{T}}-1\right).$$

It is assumed that the molecules take on impact the temperature of the plate; this, probably, is not quite true so that the formula is only an approximation.

Knudsen designed a number of gauges, most of which depended on a sudden change of temperature brought about by an admission of steam to one portion of the instrument. During the interval before radiation and conduction have established equality of temperature throughout, repulsion of a small moving part occurs; this motion is taken as a measure of the pressure. Other gauges have been devised by Angerer (1913), by Woodrow (1914) and by Schrader and Scherwood (1918), in which electrically heated strips repel small suspended vanes.

Bibliography.—Fresnel, *Oeuvres,* ii. p. 667; Crookes, *Phil. Trans.* (1876), p. 325; Schuster, *Phil. Trans.* (1876); Reynolds, *Phil. Trans.* (1876); Pringsheim, *Ann. der Phys.* (1883), p. 32; Nichols, *Phys. Rev.,* No. 4 (1897), p. 297; Nichols, *Astrophys. Journ.,* 13 (1901), p. 101; Hull, *Science,* 16 (1902), p. 175; Webb, *Phys. Rev.* 30 (1910), p. 192; O. Reynolds, *Proc. Roy. Soc.* (1874); E. Einstein, *Ann. der Phys.,* 69 (1922), p. 245; Sterntal, *Zeit. für Phys.,* 39 (1926), p. 341; Knudsen, *Ann. der Phys.,* 32 (1909), p. 809. Some of these gauges are described in detail in *Vacuum Practice* by Dunoyer. Also Gerlach and Westphal, *Verh. der D. Phys. Ges.,* 218 (1919); Gerlach, *Zeit. für Phys.,* 207 (1920); A. Einstein, *Zeit. für Phys.,* 27 1f. (1924), p. 1; Hettner, *Zeit. für Phys.,* 16 345 (1923); 27 12 (1924); 37 179 (1926).
(R. S. Cl.)

RADIO RECEIVER. Since the early days of the thermionic valve the design of radio receivers for telegraphy and telephony has undergone profound alteration. In particular, broadcasting has given an impetus to receiver design which has resulted in the creation of a new industry. Many and fanciful are the receivers which have been built to achieve certain purposes in this realm. The necessity for simplicity in the design and operation of broadcast receivers has compelled the designer to think hard and is responsible for numerous innovations by virtue of which receivers for modern radio telegraphy have also benefited. Progress in radio has been very rapid, due largely to the enormous public interest in the subject, to keen competition, and to the ever-widening circle of radio enthusiasts both amateur and professional. Such being the state of affairs, it is necessary here to restrict attention to the main principles governing radio reception. These principles

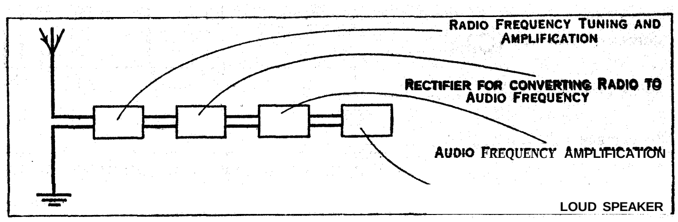


FIG. 1.—DIAGRAMMATIC REPRESENTATION OF A "STRAIGHT" RADIO RECEIVER WITH OPEN AERIAL

are illustrated by examples from modern practice, but it must be remembered that this practice is changing from year to year, almost from month to month. Put broadly, radio reception means the reception of signals from a certain distant transmitter with a reasonable degree of loudness and a *minimum* of interference from other sources of radio transmission. To accomplish this, certain conditions must be recognized and complied with.

The sensitivity of a radio telephone receiver depends upon the aerial system and upon the amplification due to the valves. An open aerial is much more sensitive than a frame or loop aerial, unless the open aerial is unusually small and situated indoors. However, in modern receiver design there is no difficulty in securing adequate signal strength when a frame aerial of but small dimensions is used. The frame is more selective and it also permits—in certain cases—a greater immunity from jamming, owing to its directional properties. There is a limit to the sensitivity of a receiver, and this is fixed by the promiscuous interference due to atmospherics, various radio transmitters, local noises due to tramways, electric motors, and the like. Interference of this nature can be collectively classed as "noise." When, therefore, the "noise" is sufficiently loud to interfere with the reception of a distant station, the limit of sensitivity for that station has been reached and no useful purpose is gained in increasing the amplification.

Selectivity and Quality.—To exclude unwanted signals it is essential that the receiver should be designed to *select,* when desired, a particular transmitting station to the exclusion of all others. To achieve this object a series of tuned circuits is incorporated in the receiver. These are usually associated with valves, so that selecting and amplifying are accomplished simultaneously. In either telegraphy or telephony the receiver must on any particular setting cover a band of frequencies. Suppose, for example, that in broadcasting the frequency of the transmitting station happens to be 800,000 cycles per sec.; the receiver should be capable, when set to this frequency, of receiving a band of frequencies of 10,000 cycles on each side of this with equal facility. The receiver should, therefore, in this case respond to a range from 790,000 to 810,000 cycles.

The *quality* of reproduction from a radio receiver depends upon a number of factors. One of these is the response characteristic of the receiver, apart from the loud-speaker or telephones. The receiver should respond equally to any frequency from 20 to 10,000 cycles—this being the compass required to accommodate all musical instruments—but there are few, if any, receivers which attain to this standard. Assuming that a receiver complies with this condition, when a series of notes of equal loudness are played in a broadcasting studio, they should all have the same loudness at the receiver provided a satisfactory loud-speaker is used. In listening to distant stations it will, in many cases, be found imperative—due to interference—to make the receiver so selective that the band of frequencies covered is much smaller than 20 to 10,000 cycles. When the upper frequencies (above 3,500 cycles) are reduced too much the reproduction becomes muffled and lifeless. Thus when interference is rife, high quality cannot be obtained

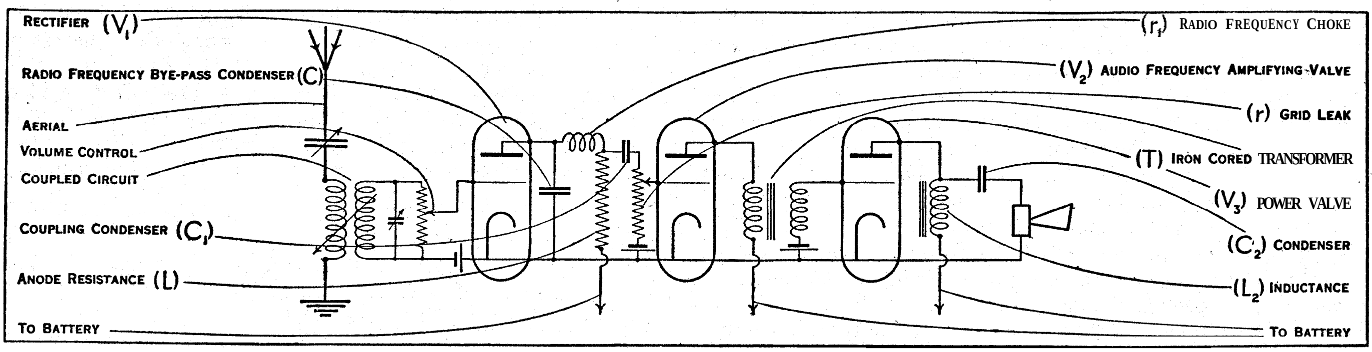


FIG. 2.—DIAGRAM OF CONNECTION OF RECEIVER FOR LOCAL BROADCASTING STATIONS

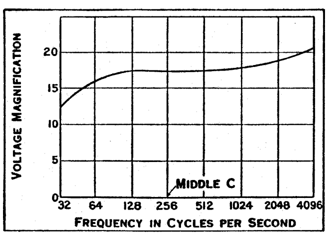
from distant stations. For with a sensitive receiver set to cover the whole musical scale, the signals are swamped by "noise," whereas with a selective receiver the essential musical characteristics are stifled by super-tuning. In general, distant reception and quality are mutually exclusive.

Where telegraphy is concerned, the selectivity can be much greater than in broadcast telephony. To get clear cut signals in the Morse code, it is necessary to receive a band of frequencies whose width increases with the speed of transmission. For example, to receive good signals at a speed of 100 words per minute, the receiver should respond equally to a band of frequencies 200 cycles on each side of the tune point. When the received band is narrowed down, the signals are ill defined, and instead of being square they become rounded. This is detrimental to relaying the signals and subsequently printing them at a central office. Moreover, when it is imperative to narrow the receiver frequency band to avoid interference, the more economical procedure is to reduce the speed of sending, thereby obtaining square signals which can be printed direct on a paper tape, instead of being laboriously transcribed and typed by an operator.

Receiving Instruments.—For broadcast reception, receiving instruments can be divided broadly into two classes: (1) those in which the incoming radio waves are amplified and selected at their original frequency, thereafter being rectified and amplified again at audible frequencies; (2) those in which the incoming waves are first amplified and selected at their original frequency, after which they are rectified and the frequency is reduced to an intermediate value, being still inaudible or supersonic before being rectified a second time and amplified at audio frequency. A receiver of the latter type is known as a supersonic heterodyne. Using ordinary three-electrode valves or triodes, it is possible to get a large overall magnification and a high degree of selectivity more readily by the supersonic method than by a method where all the radio amplification is effected without frequency change. Nevertheless, the quality of reception with a "straight" high frequency amplifier is usually superior to that obtained with a supersonic heterodyne. By suitable design there is reason to believe that the difference in quality could be made negligible. However, the recent introduction of the screened tetrode, this being a valve in which the electrostatic capacity—which is mainly responsible for self-oscillation in high or in low frequency amplifiers—between anode and grid is reduced to a small value, will make the design of the supersonic heterodyne more facile. A diagrammatic representation of a "straight" circuit is shown in fig. 1.

Although in 1928 the majority of receivers on the market which were suitable for broadcast work used ordinary triodes, we shall consider the more modern receivers in which screened grid valves (*see* THERMIONIC VALVE) are incorporated in the high frequency stages. A receiver suitable for use a few miles from a main broadcasting station is illustrated diagrammatically in fig. 2. Here an open aerial is used, this being flatly tuned, since selectivity is unimportant with very strong signals and flat tuning prevents the higher audible frequencies being appreciably attenuated. The aerial can be either directly connected to the grid and filament of the rectifier V_1, or via a coupled circuit. The latter method is shown. After rectification by what is known as the "anode bend" method, which utilizes the curved portion of the valve characteristic, the signals consist of two components (a) high or radio frequency, (b) low or audio frequency. The former are undesired in the output and must be removed or filtered out. With this end in view, an inductance, L, of small self-capacity, is inserted in the anode circuit of V_1, whilst a small condenser, C, is connected from the anode of V_1 to the negative pole of the battery. The radio voltage change occurs on the anode of V_1 and the inductance, L, chokes it back so that it is bye-passed by C and little or no radio enters the audio frequency amplifying circuits. The audio frequency causes a voltage change across a tapped resistance, r, which is passed on to the grid of V_2 by means of the condenser C_1 and resistance r_1—commonly known as the grid leak. The resistance r is tapped to control the output intensity. Valve V_2 is coupled to the power or output valve V_3 by means of an iron-cored transformer T, or by another resistance capacity unit. The loud-speaker is associated with valve V_3 either directly or in conjunction with a filter circuit or a transformer. The filter circuit, as shown by the inductance L_2 and condenser C_2, prevents the anode feed current from the battery to the valve—which is usually fairly large—from passing through the loud-speaker windings, and it also prevents the loud-speaker current from passing through the battery.

To secure a uniform response from the amplifying system over a wide frequency band—apart from the loud-speaker—the various valves and their associated components must be specially selected and properly designed. For example, if C_1 and r_1 are made too small, those frequencies below the middle of the pianoforte will be so weak as to be inaudible. The same result will occur if the inductance of the primary winding of transformer T is too small, or if the internal resistance of valve V_2 is too large. Also, the bye-pass condenser C must not be too large, or some of the higher audible frequencies will be bye-passed in addition to the radio. This bye-pass condenser and the equivalent grid-to-filament capacity of V_2 are responsible for reducing the upper audible frequencies above 3,000 cycles. Moreover, if the transformer T amplifies the upper frequencies more than the lower, there will be a degree of compensation. Over-compensation can be readily averted by augmenting the value of C. Thus transformer T should have a rising characteristic as shown in fig. 3.



FROM N. W. MCLACHAN, "WIRELESS LOUD SPEAKERS" (THE WIRELESS WORLD)

FIG. 3.—DIAGRAM OF TRANSFORMER (PRIMARY 50 HENRIES) WITH D.E.5. VALVE

When an open aerial, either indoors or outside, is impracticable, a loop or frame aerial can be used for receiving the local broadcasting station. Where the receiver is quite near the transmitter, an open aerial can be replaced by a frame aerial. For reception at an increased distance from the transmitter, it will be necessary to augment the valve amplification when a frame aerial is used. This can conveniently be effected by adding a stage of high frequency amplification in the form of a screened grid valve. Thus we must modify fig. 2 by adding a screened valve prior to the rectifier and replacing the open aerial by a tuned frame aerial whose sides can be from 18 inches to 30 inches long. The result is shown in fig. 4. Here it will be seen that the frame is tapped at the centre

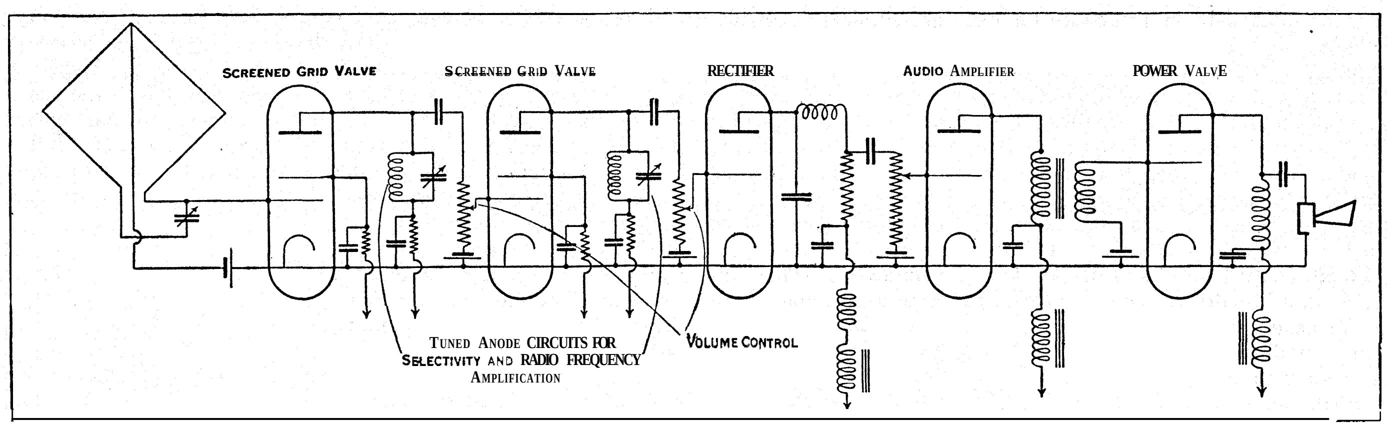


FIG. 4.— DIAGRAM OF RECEIVER FOR DISTANT BROADCAST RECEPTION, INCORPORATING H. T. FILTER SYSTEM. CENTRE TAPPED FRAME AERIAL AND TWO SCREENED H.F. VALVES

and only half of it connected across the grid and filament of the valve. This artifice is not always required for local reception, but is a useful artifice for distant reception. When a powerfui station, which it is desired to exclude, causes trouble, this mid point connection is often helpful in reducing the interference.

Distant Reception.— For the reception of stations 20 m. or more from a main broadcasting station the amplification must be still further increased. This can be accomplished in either the high frequency or in the low frequency portion of the receiver. It is better to achieve the desired result by increasing the high frequency amplification, for the two following reasons: (1) the response of the rectifier falls off rapidly when the strength of the incoming signals sinks below a certain level; (2) increased amplification must be accompanied by augmented selectivity, and the requisite electrical circuits can be incorporated in the high frequency portion of the receiver only.

As the amplification is increased, so also is the tendency of the receiver to generate spurious oscillations, particularly in the high frequency portion. In designing an instrument for distant reception, particular attention must be paid to the elimination of such effects. Moreover, it is imperative to screen each radio frequency circuit to prevent electromagnetic and electrostatic coupling, and to accomplish the same object, the radio frequency must be kept out of the audio frequency circuits. A very fruitful source of self-oscillation at radio and at audio frequency is to be found in the means used to supply filament and anode current to the valves. A battery, whether it be an accumulator or a dry cell, has an internal resistance which is by no means negligible when the voltage amplification runs into thousands. By virtue of this resistance, the relatively large alternating current in the valve preceding the rectifier causes a voltage drop which is applied to other radio frequency amplifying valves at the beginning of the amplifier. This causes enhanced amplification which usually culminates in self-oscillation, thereby putting the receiver out of action. A similar argument applies to the audio frequency portion of the receiver. To avoid this "coupling" due to the battery, it is absolutely essential to use a special system whereby the battery feed is electrically filtered or purged of the alternating current. The golden rule is that no alternating current, either of radio or of audio frequency, must pass through the battery. All alternating current is, therefore. bye-passed from the neighbourhood of the positive terminal of the high tension battery, to the negative terminal. In series with the first battery tapping point is connected an inductive resistance of low self-capacity, while across its outer terminal and the negative pole of the battery a condenser of large capacity is shunted. The resistance offers great impedance to the currents of radio frequency, whilst the condenser bye-passes them with ease. Hence the alternating current through the battery is negligible. A similar procedure is adopted for the audio frequency feed where an audio frequency choke is used in place of a radio frequency choke. Both choke and condenser must have much greater values than those for the radio frequency filter.

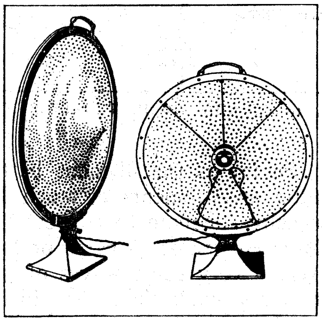
So far as the filament battery is concerned, the question of filter arrangements is much less acute. In this instance, it is usually adequate to connect the positive battery terminal via a large condenser to earth or to the metal screen of the receiver. Where very short waves of 50 metres are used, it is expedient to put a choke in one or in both filament legs. In a complete receiver designed on the above principles the centre tapped frame aerial is followed by two stages of high frequency amplification using screened grid valves with tuned anode coupling, the coils being of toroidal construction and having substantially no external magnetic field. The remainder of the circuit is identical with that in fig. 2. As a limiting case, three high frequency stages can be used, but great care must be exercised to obtain adequate screening of the various components. The side of the frame aerial in this case should not exceed about 12 in. in length, since the amplification is so enormous that signals are drowned by noise.

Degree of Amplification.— A few remarks on the amplification obtained in modern receiving sets may be of interest. There are two methods of expressing amplification:—(I) by the ratio of the input voltage to the power valve to that induced in the aerial by the electro-magnetic waves; (2) by the ratio of the electrical power in the loud-speaker to the power received by the aerial. The power amplification is enormously greater than the voltage amplification and is sometimes cited for purposes of advertisement. It is more usual in scientific circles, however, to consider the voltage amplification. Neglecting interaction of various components in a receiver, the total amplification is the product of the amplification per stage. With any type of valve the gain per stage is limited because of the ever present possibility of self-oscillation. Modern screened valves can be used to secure a stable gain of from 30 to 40 per stage over the wave range 300 to 600 metres. Taking, therefore, the magnification per stage of the last mentioned receiver we obtain the following approximate figures: 1st radio frequency ÷30, 2nd radio frequency ÷30, rectifier ÷20, 1st audio frequency ÷70. The product of these is 126,000. This, however, must be divided by 4 to allow for the audio frequency voltage modulation of the transmitter being only $\frac{1}{4}$ of the radio voltage on the aerial. The an~plification due to the frame has been neglected. It may be estimated at about 60, although higher values can be obtained at the expense of stability. Taking the modulation factor and the frame into account, we get a resulting factor of 20, so that the total magnification is just short of 2 million-fold.

Mains **Supply** Units.—To avoid the difficulties concomitant with high and low tension batteries, particularly the former, a number of schemes have been devised for supplying receivers with the necessary current from either alternating or direct current supply mains. This permits an adequate anode voltage being supplied to the power valve, so that a reasonable intensity of sound can be secured before "blasting" is encountered. A more extensive use of these supply units is advocated.

Radio Telegraphy.— Receivers for this purpose have been described in the appropriate place and it is only necessary to say here that although rhe principles involved are similar, the design technique is quite different. The low frequency portion of the amplifier is preceded as usual by radio frequency circuits and a detector, and a separate radio frequency oscillator is used to generate an audible beat note with the incoming radio frequency. Furthermore, the audio frequency consists of a series of circuits *tuned* to the beat note. Before being passed on to the recording instruments the audio note is rectified and smoothed, so that the result is a series of dots and dashes, in the Morse code, which can be considered as an interrupted direct current.

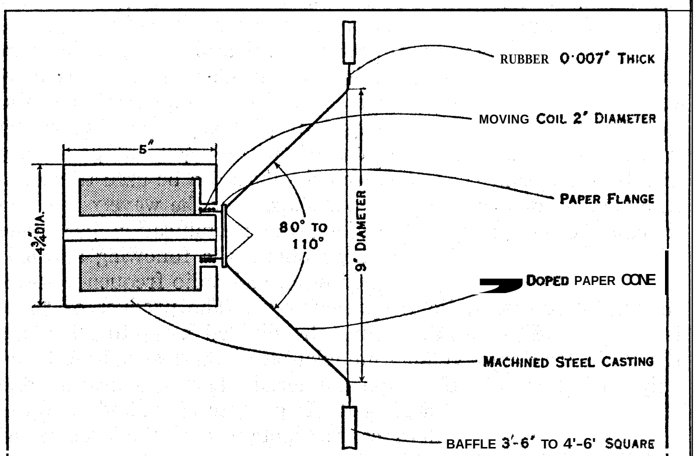
Loud Sounding Telephones (Loud-speakers) The output from a broadcast receiver is taken either to a telephone worn on the head or to some form of loud sounding telephone. The reception on a headphone cannot be realistic, since the original studio conditions and the degree of loudness are completely lost. To obtain more realistic, reproduction it is essential to employ some form of loud sounding telephone—which is not applied to the ear. The reproduction approaches most closely to the original conditions when the room where the loud-speaker is situated is heavily draped to damp the sound, and the intensity of sound from the loud-speaker is equal to that which would be heard by the listener were he or she situated at the same point in the studio as the microphone.



FROM N. W. MCLACHLAN, "WIRELESS LOUD SPEAKERS" (THE WIRELESS WORLD)

FIG. 5.—THE AUTHOR'S CLOTH CONE LOUD-SPEAKER. (LEFT) REAR VIEW; (RIGHT) FRONT VIEW WITH COVER REMOVED

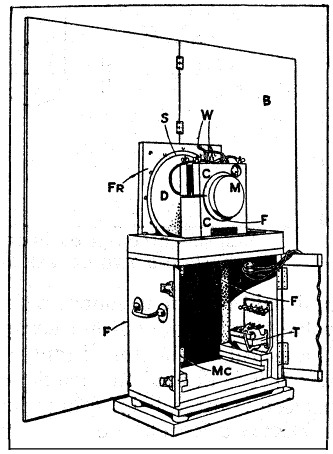
The subject of loud-speakers is wide and varied and can only be touched upon lightly; and though there are numerous forms on the market few reproduce with any degree of accuracy. The essential components of a loud-speaker are some form of diaphragm to agitate the air and a mechanism for driving the diaphragm to and fro under the stimulus of the electric currents from the power valve of the receiver. The motion of the diaphragm reproduces—in a degree—the sounds which are picked up by the'microphone in the broadcasting studio or auditorium.



FROM N. W. MCLACHLAN, 'WIRELESS LOUD SPEAKERS" (THE WIRELESS WORLD)

FIG. 6.—COIL DRIVEN CONE WITH FLAT BAFFLE

When a large diaphragm is used the most general form is the cone. When small conical or flat diaphragms are used, *e.g.,* 2 in. diameter, the loud-speaker is fitted with a horn to increase the intensity of sound and provide the proper coupling between the diaphragm and the surrounding air. No horn is required with a large diaphragm, *e.g.,* 9 in. diameter, but to secure the requisite degree of intensity the two sides must be isolated as explained below. The material of the cone of a large diaphragm is usually some kind of paper, but impregnated fabric is also used, as in the author's cloth cone, fig. 5. When a large diaphragm is in action, at any particular instant the air at one side is compressed and on the other side rarefied (reduced in pressure). Now since one side is at a higher pressure than the other it is necessary to prevent a sound wave travelling from the side at higher to that at the lower pressure, and to avoid this effect the usual practice is to isolate the two sides of the diaphragm by mounting it either at the centre of a large flat board or in one face of a cabinet. Having mounted the diaphragm, it is essential to apply some form of driving force, the mechanism for which is actuated by the electric currents from the receiver. There are two main forms of loud-speaker drive for large diaphragms: (a) reed drive, (b) coil drive. Type (a) is characterized by a reed of steel or other suitable magnetic material poised over two pole pieces on which are wound many turns of wire. The magnetic circuit of the pole pieces is completed through a strong permanent magnet. Since the reed has a natural frequency and its response with frequency becomes gradually less at low and at high frequencies, care is required in designing the diaphragm and its peripheral support to secure a good acoustic register. Where only one reed is used, it is difficult to get full strength in both the lower and the upper register. In general, it is better to get a good upper and middle register. At the same time, it is very desirable to reduce resonances and harmonic tones not present in the original sounds to a minimum. This is accomplished in a new form of reed drive loud-speaker, the Amplion Lion.



FROM N. W. MCLACHLAN, 'WIRELESS LOUD SPEAKERS" (THE WIRELESS WORLD)

FIG. 7.—EXPERIMENTAL COIL DRIVEN CONE

B. Multiplying wooden baffle, C. cradle holding pot, D. doped paper diaphragm, F. felt for damping, (FR) frame on which diaphragm is mounted, M. field magnet pot, (MC) magnet control rheostat and anti-spark resistance, S. diaphragm suspension, T. input transformer for moderate intensity, W. leading in wires to moving coil

The drive indicated as type (b) is capable of giving greater output in the bass register than the reed drive. A coil of wire, situated in the magnetic field produced by either a strong permanent or an electromagnet, is attached to the back of a paper cone, fig. 6. The speech and music currents are passed through the coil and cause the diaphragm to move accordingly. This class of instrument is capable of reproducing orchestras at their original strength. A replica of the coil drive instrument designed by the author and now operating on weekdays and on Sundays in the South Kensington Science Museum, is shown in fig. 7.

See N. W. McLachlan, *Loud Speakers.* (N. W. McL.)

RADIOTHERAPY is the treatment of disease by the application of rays of radioactive substances (*i.e.,* Rontgen rays). The discovery of X-rays by Rontgen in the autumn of 1895 marked an advance in the history of science, which, even yet, is not appreciated by the average individual. Rontgen himself realised immediately the value of his discovery to the science of medicine, and communicated it to the Physico-Medical Society of Wurzburg. Since then, if one excepts the years 1914–1918, hardly a month has passed without some innovation.

In 1910 the X-ray tube had varied but little from the original tube used by Rontgen and Crookes, the improvements in focusing and increasing the intensity of the rays being due to the labours of Campbell Swinton and chiefly to Prof. Jackson in 1896; indeed the modern focus tube (gas tube) has not materially changed since then. In this tube, the current is carried across the tube by a certain amount of gas, which is left behind in the process of evacuation. The current, impinging on a tungsten target, under a pressure of anything over 80,000 volts, results in the production of X-rays, which rays are now known to be electro-magnetic impulses of very short wave-length. The only disadvantage of this tube is that individual control of the current and voltage is not absolute owing to fluctuations in the amount of residual gas. Despite this, however, it is largely used and for many purposes possesses advantages over the Coolidge tube.

The Coolidge Tube.—At a later period Dr. Coolidge of New York discovered that a glowing body emitted electrons, and at once designed a new type of bulb in which the current was carried across the vacuum by a stream of electrons from a hot tungsten wire. The hotter the wire the greater the current which passed across the bulb. This, of course, solved the problem of separate control of the voltage and the current and thereby the problem of being able to reproduce exact working conditions at any interval. Unfortunately the hope, raised at first by the production of this tube, of obtaining an absolutely homogeneous beam of X-rays, was not realised.

The intensity of the X-rays depends upon the voltage employed to produce it and as the manufacture of high-potential generators (induction coils and step-up transformers) has improved out of all recognition since 1910, we can now produce rays of great intensity, far greater than are needed for radiographic purposes.

On the photographic side, improvements in technique have been very noticeable. the most noteworthy improvements being the use of intensifying screens to shorten exposures, double-coated films to increase the contrast of the negative and the Potter-Bucky diaphragm, the latter an ingenious contrivance for the purpose of cutting out secondary radiations and thereby sharpening the resulting picture.

During the years 1914–8 science was more or less subservient to the claims and the necessities of warfare, but even in this limited field X-rays were of enormous help. The localisation of bullets and shrapnel, which by any other means would have been impracticable, if not impossible, was carried out by numbers of experts, and to the energies of these men a host of soldiers practically owe their lives.

Employment in Diagnosis.—The past few years have seen great activity in the X-ray world. Improvements in technique previously mentioned have brought the use of X-rays into much greater prominence in the study and the diagnosis of internal diseases (*see* DIAGNOSIS). Skiagrams of the lungs, which were difficult to make and still more difficult to interpret, are now of the very greatest possible value in the study of diseases of the heart (*q.v.*) and lungs. It is no exaggeration to say that no diagnosis of disease of either of these organs is complete without an X-ray examination.

This advance is seen in the large hospitals for diseases of the chest; where formerly only a few hundred examinations were made, now the number amounts to thousands in the year. Whereas the air-filled lungs showed up clearly against the more dense, blood-filled heart and solid thoracic walls, the abdominal organs, that is to say the hollow viscera, being all of the same density, were all penetrated equally by X-rays and consequently were not readily differentiated on a plate. For a long time this difficulty appeared to be unsurmountable. Many substances were known to be opaque to X-rays but none of them could be taken with safety. Haudek, of Vienna, made careful experiments with bismuth sulphate mixed with jam and watched its progress through the oesophagus, but completely forgot to look for it in the stomach.

Use of Bismuth.—In 1901 Becker gave small doses of the same material and was the first to publish anything definite about the radiology of the alimentary tract. His results were confirmed in the same year by other workers, but the danger of poisoning (chiefly from metallic impurities in the bismuth) was so great that not sufficient could be given for diagnostic purposes, and nothing of any special value resulted. Somewhat later, the publication of a paper on the treatment of gastric catarrh by large doses of bismuth inspired Rieder, of Munich, to give large doses of bismuth in order to examine the stomach and intestines by means of X-rays.

Some few cases of poisoning were later reported, but with the help of the chemist an absolutely non-toxic preparation of bismuth carbonate came into use. The production of this non-toxic preparation of bismuth was difficult and it never attained to universal popularity. In 1910 experiments were made with barium sulphate—which was found to be almost as opaque as bismuth and not only much more readily freed from inorganic impurities but infinitely cheaper to use. With very few exceptions radiologists use some form of this salt in diagnoses.

The Gastro-intestinal Tract.—The production of a safe and suitable method of making the gastro-intestinal tract opaque very greatly stimulated the investigations which were being carried on as to the condition of the alimentary tract in health and in disease. The study of both is still far from complete but, even with the results so far attained, diagnosis of intra-abdominal conditions has been greatly improved and numerous complaints previously described as "indigestion" and "gastritis," for example, are now readily classified.

Cancer and Gastric Ulcers.—Cancer of the stomach gave fairly typical X-ray evidence, but gastric ulcer proved almost as elusive to the radiologist as to the clinician. Certain investigators had observed a "niche" or recess on the wall of the stomach but its significance was not appreciated. In the same year (1910), Haudek and others, but chiefly the former, produced definite evidence that the "niche" was in reality an ulcer on the gastric wall filled with barium. Since then many other signs indicative of gastric ulcer have been noted and now the diagnosis of this condition is not a difficult matter. Thanks to the labours of Carman, Miller, Gregory Cole and Barclay, the duodenum is becoming an open book to the radiologist particularly in respect of ulceration.

Therapeutic Values.—From the earliest days of the discovery of X-rays, they were known to have certain curative properties, and scientists all over the world have been experimenting to place this form of treatment on a sound and scientific basis. Intractable skin diseases (*q.v.*) which resisted every other remedy often responded to X-rays, and it was noticed that some forms of malignant disease disappeared after treatment by irradiation. Means of accurately measuring the dosage of the rays were not known, but cancer had become so terrible a scourge that they were utilised indiscriminately for its relief, and at times with disastrous results. From 1905 onwards methods of measurement improved and in 1914 a dose could be administered with a certain amount of accuracy, the risk of burning became almost negligible, and we are now in possession of instruments capable of giving precise knowledge as to the amount of X-rays falling upon a given area. A spectroscope is used which takes a photograph of the X-ray spectrum. Prom it the wave-length can be ascertained and the shorter the wave-length the more penetrating the X-ray.

Most of this work was carried on in Germany, where the idea prevailed that it was only necessary to get an intense enough ray and to measure it carefully in order to kill cancer. Apparatus for the production of these very intense rays was soon devised and before very long a great number of patients were undergoing treatment, so rapidly did this idea stimulate the popular imagination. In the early stages of this new form of X-ray therapy the results appeared to be most encouraging and the conquest of cancer was thought to be within reach. Subsequent statistics showed relief to be merely temporary. Great credit is, however, due to the early German workers and other pioneer specialists for the ingenuity and skill shown in standardizing and rendering accurate the dosage of X-rays; but as a method of treatment of cancer we are getting no better results than were obtained in 1910. Russ and Colwell (*Radium, X-Rays and the Living Cell*) put the matter thus: "In radiology applied to biological problems there is a double difficulty, for the intensity of the radiation used, whether it be X-rays or Radium is a quantity which under many experimental conditions presents very considerable difficulties in its accuracy of measurement, *and the animal itself provides a complex which refuses to be reduced to simple terms.*"

See X-RAYS; RADIOLOGY; X-RAY TREATMENT.

BIBLIOGRAPHY.—H. A. Colwell and S. Russ, *Radium, X-Rays and the Living Cell* (1924); R. Knox, *Radiography and Radio-therapeutics* (1919). (S. ME.)

RADISH, Raphanus sativus (family Cruciferae), an annual or biennial grown for its large, succulent root. The edible part of the root, together with some hypocotyl, forms a structure varying in shape, among varieties, from spherical, through oblong, to long cylindrical or tapered. Outside colour of the root varies from white, through pink to red, purplish and black. Size of edible part varies among varieties from a few grams in the most popular early American and European varieties to a kilogram or more in the late Japanese field type of radish, or daikon. As generally grown, flower stalks form the first season, bearing white or lilac veined flowers. The seeds are borne in a spongy, non-dehiscent, beaked pod called a silicle. The small, quick-growing spring varieties have a mild crisp, moderately firm flesh, and are quite perishable. The large, slow-growing summer and winter types have pungent, firm flesh. Winter varieties can be stored through the winter. The common radish is probably of oriental origin. R. *raphanistrum* is a wild radish found along the Mediterranean. The rat-tailed radish (R. *caudatus*) has no enlarged root, but bears enormous seed pods 8–12 in. long which are eaten fresh or pickled. R. *sativus* (var. *longipinnatus*) produces deeply pinnate leaves up to 2 ft. long; the roots are large, firm and are grown as a winter radish. This type is much grown in the orient and is generally known as Chinese radish. (V. R. B.)

RADIUM (Symbol Ra, atomic number 88, atomic weight 225.95) is the best known and the most important member of the radio-elements, discovered by Professor and Mme. Pierre Curie and G. Bémont of Paris in 1898. The position of radium in the periodic system of classification is unmistakably that of the heaviest member of the alkaline-earth metals, calcium, strontium and barium, and its chemical properties and all its physical properties, except the most important one, its radioactivity, are those to be expected from the element which occupies this position. It is as a radioactive substance, however, and not merely as a chemical element, that radium claims attention, and as such it is dealt with in the article RADIOACTIVITY.

The Disintegration of Radium. — A radio-element is one which possesses, in addition to the properties of a normal element, the power of emitting a- or @-particles. In so doing the element breaks up to form a new element, or, as it is expressed technically, it disintegrates. The first of these particles is a doubly-charged atom of helium, equal in weight to four units, which is expelled from the centre of the atom with a velocity of about 10,000 miles per second. This almost incredible velocity is surpassed by that of the other particle which is an electron, that is to say, a rapidly-moving single charge of electricity without mass. The velocity of the β-particle varies from about 50,000 miles per second to that of light, 186,000 miles per second. The β-particle is sometimes accompanied by a very penetrating radiation, the γ-ray, which is, in nature, akin to waves of light.

The rate at which disintegration occurs proceeds always according to one fixed plan. In a given interval of time, a second or a day or a year, a definite fraction of all the atoms which make up the radio-element, breaks up, and this fraction, fixed by Kature, cannot be varied by man; it is the same whether millions of millions of atoms are being considered or a few thousands only. No chemical combination of the radio-element with other atoms, no physical agency such as enormous temperatures or pressures seems able to affect the value of this fraction at all. For radium this fraction is $\frac{1}{2,280}$ per year: this means that if we were to weigh out 2.280 units of this element to-day, in a year's time 2,279 would be quite unchanged and 1 would have been broken up. The radium that has broken up, however, is not simply radium in some other form, it is something entirely different; the expulsion of either an α- or a β-particle has so altered the radium atom that it has become a new one. A radio-element, such as radium, consequently contains at least two kinds of atoms, those that have already broken up and those that have not. The unchanged atoms comprise what is called the parent substance; the residual atoms compose the product. This product is perfectly distinct from its parent in physical and chemical properties, and can be easily separated from it by the ordinary methods of analytical chemistry. Radium's product is the gaseous element radon (*q.v.*), which is the heaviest of the inert gases. Radium being a solid and radon a gas at the ordinary temperature, their separation is an obvious one. If now the product happens, like its parent, to be radioactive, a certain fraction of it will disintegrate in a unit of time to form a third substance, and this substance, if radioactive, will produce a fourth, the fourth a fifth, and so on, till a substance is reached which is not radioactive; whereon this series of radio-elements ends abruptly. Such a series is called a *disintegration series;* in it each element is the parent of the one that follows and the product of the one that precedes. Radium and radon are respectively the sixth and seventh of the disintegration series that begins with the rare element uranium and ends with the common element lead. (See RADIOACTIVITY.)

In the accompanying table are set out the elements of the uranium-radium-lead disintegration series, with the symbols by which they are described in the literature on radioactivity, the nature of the particle or ray expelled by the element, the atomic weights of the elements, and finally their atomic numbers. It will be seen from the table that when an a-particle is expelled, the atomic weight of the product is 4 units less and the atomic number two less than that of the parent; and that when a @-particle is expelled the atomic weight of the product is identical with that of the parent, but the atomic number is one greater. The reasons for this generalization are given under RADIOACTIVITY.

Name of element	Symbol	Radiation emitted	Approximate atomic weight	Atomic number
Uranium . . .	UI	α	238	92
	U-X_1	β	234	90
	U-X_2	β	234	91
	UII	α	234	92
Ionium . . .	Io	α	230	90
Radium . . .	Ra	α	226	88
Radon . .	Rn	α	222	86
	Ra-*A*	α	218	84
	Ra-*B*	β	214	82
	Ra-*C*	β, γ	214	83
	Ra-*C′*	α	214	84
	Ra-*D*	β	210	82
	Ra-*E*	β	210	83
Polonium . . .	Po	α	210	84
Lead	Ra-Ω	. .	206	82

The implications of the bare statement that radium is a member of the uranium-radium-lead disintegration series are remarkable. The statement implies, firstly, that the only sources of radium in Nature are minerals containing uranium, for without the ultimate parent of the series there can be no series, and therefore no radium. Secondly, since radium is produced by the disintegration of its parent ionium and disappears on disintegrating into its product radon, the weight of radium in a mineral containing a given amount of uranium is fixed at the weight of radium which has the same number of atoms breaking up to form radon in a given interval of time as is produced in the same time by the disintegration of ionium. There is, thus, a definite ratio between the weight of uranium in a mineral and the weight of radium; experimentally this is found to be 1 to 0·00000033. To extract a gram of radium from a mineral which is half uranium, therefore, no less than 5·9 tons of the mineral must be worked up, or, to extract a pound, no less than 2,680 tons. In actual practice the minerals are rarely as rich as this, and one containing 1 gm. of radium in 10 tons of ore is considered rich; even minerals which contain only 1 gm. in 200 tons are worked. It is not surprising, therefore, that the price of radium is about £15,000 per gram.

Industrial Production. — The principal minerals containing uranium, and therefore radium, are pitchblende, carnotite and autunite. The first of these consists of the oxide of uranium, more or less pure, and is found principally in Czechoslovakia and in Belgian Congo; the second is a vanadate of uranium and potassium mined in Colorado, Utah, and Australia; the third is a phosphate of uranium and calcium mined in Portugal and in the U.S.A. The method of extracting radium varies with the nature and quality of the ore, but in broad outline, all processes consist of five main steps first worked out by Mme. Curie. These consist in getting the uranium mineral into solution, separating from the solution all metallic sulphates which are insoluble in water (these include the whole of the barium and the radium constituents of the mineral), the conversion of the sulphates into double salts, the purification of the compounds of radium and barium, and finally the separation of the radium from the accompanying barium by a process of fractional crystallization.

At St. Joachimstal in Czechoslovakia the broken-up pitchblende is treated with a mixture of nitric and sulphuric acids of such concentrations that, whereas the whole of the uranium goes into solution, the radium remains behind as insoluble sulphate along with impurities of calcium, barium and lead. These sulphates are then boiled several times with a solution of sodium carbonate and so converted into carbonates, and thence into chlorides. A repetition of this process separates the radium and barium from the impurities calcium and lead. Finally, owing to the fact that the chloride of radium is much more insoluble than that of barium in a solution of hydrochloric acid, it is possible to enrich a mixture of radium and barium chlorides in the former until finally radium is quite free from barium.

At Denver, Colorado, the carnotite is heated with a solution of concentrated nitric acid containing hydrochloric acid which dissolves the radium as well as the uranium and the vanadium. To this a solution of barium chloride is added. When the acidity of the solution is reduced by the addition of alkali the barium, and with it the radium and lead, are precipitated as sulphates and removed from the solution by filtration. These sulphates are then heated in a crucible of graphite with wood charcoal and so converted into the sulphides, which unlike the sulphates are easily soluble in hydrochloric acid. From this solution the lead is precipitated by one chemical reagent and the radium and barium by another. The enrichment of the radium in the radium-barium mixture is based on the comparative insolubility of the bromide of radium, and not, as at St. Joachimstal, on the comparative insolubility of the chloride.

Chemical Properties.—The principal compounds of radium are the sulphate $RaSO_4$, the chloride $RaCl_2$, the hydrated chloride $RaCl_2.2H_2O$, the bromide $RaBr_2$, the hydrated bromide $RaBr_2.2H_2O$, the sulphide RaS, the nitrate $Ra(NO_3)_2$, the carbonate $RaCO_3$, and the hydroxide $Ra(OH)_2$. Like the corresponding compounds of barium, strontium and calcium, these are all colourless compounds and their chemical properties may be summarized in the remark that they are exactly what would be expected from a study of the compounds of these three elements. It is not surprising therefore that a purely chemical study of radium compounds has not occasioned much interest. At 25° C the solubility of strontium sulphate is $\frac{1}{14}$ that of calcium sulphate, while that of barium sulphate is $\frac{1}{65}$ that of strontium; it is consistent that the solubility of radium sulphate is $\frac{1}{100}$ that of barium sulphate. As with sulphates, so with chlorides and bromides. On the other hand the lightest of the alkaline-earth metals, calcium, has the most insoluble hydroxide in water; it is to be expected therefore (and confirmed experimentally) that the heaviest, radium, has the most soluble hydroxide.

As with such a property as the solubility of typical chemical compounds, so with most other properties. The optical spectrum of radium, for example, is composed of a comparatively small number of lines of great intensity. The strongest line in the visible part of the spectrum is in the violet, and this line is a very sensitive test for the presence of radium. In this, radium resembles barium, strontium and calcium. They too have a comparatively small number of spectral lines of great intensity, the most prominent of which are used in chemical analysis as tests for their presence. Again, the method in use for the preparation of metallic radium is identical with that used for preparing barium, namely, first the metal is deposited by an electric current on to mercury, and then the volatile mercury is removed by distillation in a current of hydrogen. The metal which remains behind is white, melts at about 700° C, and greatly resembles barium in its chemical reactions. It must be preserved out of contact with the air; it dissolves in water and in all acids with the evolution of hydrogen, forming the hydroxide in the first case and the corresponding salt in the other cases. Radium is generally sold in the form of the chloride or the bromide. mixed, when impure, with the corresponding compound of barium. For the physiological effects of radium see RADIUMTHERAPY.

For scientific purposes standards of radium have been made with which any sample of unknown strength may be easily compared. The comparison is made not by their respective weights but by the intensities of their radiations. The international radium standard was prepared by Mme. Curie and is kept in France at Sèvres; secondary standards, carefully checked with the primary one, are kept in other places, particularly at the Radium Institute, Paris, the National Physical Laboratory, Teddington, England, the Physikalisch-technische Reichsanstalt, Berlin, the Radium Institut, Vienna and at the U.S. Bureau of Standards, Washington. The sample to be measured, which should exceed in intensity that of one-tenth of a milligram of pure radium, is sealed up in glass for at least one month, so that what is called the equilibrium quantity of radon and the successive products radium A, B, C and C′ have formed. The intensity of the γ-radiation from radium C is then determined by an electrical method under specified conditions which need not be detailed. Since there is a constant ratio between the intensity of the γ-radiation from radium C and the actual amount of this product, and also between the amount of this product and that of radium, the measure of the γ-radiation is a measure of the quantity of radium in the preparation under examination.

Radioactive Properties.—The chief particle emitted by radium on disintegration is an α-particle with a range in air of 3.39 cm. at 15° C and the ordinary pressure. (The range is a distance characteristic of a radio-element traversed by its α-particle, beyond which the latter cannot be identified by any known instrument.) The velocities with which the particles issue from the source of radium are identical and equal to 1,510 millions of centimetres (9,380 miles) per second. The number of α-particles emitted per sec. by 1 gm. of pure radium is about 37,000 millions, a number obtained experimentally by counting the flashes per second made by the impact of the particles on a luminescent screen of zinc sulphide, placed at a known distance from a minute fraction of radium of known mass. An idea of the colossal number of atoms which compose 1 gm. of radium (and similarly, of course, for any other substance) may be gained from the statement that despite the destruction of 37,000 millions of atoms of radium per sec. through disintegration, the actual loss of radium is only about 0·04% in a year.

No less remarkable is the amount of energy liberated by radium. This amounts to 25·5 calories per hour or 223,000 cal. per year for every gram of pure radium. This energy shows itself partly as heat (all radium preparations warm the objects in their near vicinity), and partly as light (glowing in the dark). Such an evolution of energy without apparent diminution (the diminution is only 1 in 2.280 parts in a year) is on much larger scale than that obtained from chemical reactions. It is much higher indeed than has been indicated because the figures given refer to radium free from its products. With its products radon, radium A, radium C′, and polonium, which themselves expel particles (see table), the energy evolution per year is as high as 1,236,000 calories. This, owing to the slow rate of decay of radium, will not be reduced to half, it may be calculated, until after 1,580 years, or to a quarter until after 3,160 years, or to an eighth until 4,740 years have gone by. The evolution will, in fact, go on for ever, although at a steadily diminishing rate. Such a rate of energy emission is about a million times greater than that from an equal weight of chemical reactants.

Radium, in addition to its α-particle, expels also a comparatively unimportant β-particle and a feebly penetrating γ-ray. These must not be confused, however, with the β-particles and the γ-radiation which are emitted by preparations of radium. If a preparation containing radium be sealed up so that its gaseous product radon may not escape, then quickly there form in it radon, radium A, B, C and C′ (which in a month have formed in maximum amount), and more slowly there form radium D, radium E and polonium (which in about 150 years reach their maximum amount). Since these products expel α- and β-particles, and in one case a penetrating γ-radiation, the radiations from radium appear much more complex than those from radium without these products. Radon, radium A, radium C' and polonium expel a-particles with ranges in air of 4·12, 4·72, 6.97 and 3·925 cm., respectively (cf. radium, 3.39 cm.); radium B and radium C expel very penetrating, and radium D and radium E feebly penetrating, β-particles; accompanying the β-particle from radium-C is a very penetrating γ-radiation.

Physiological Effects.—A strong source of radium, if left on the skin for some time, causes sores which have the appearance of burns; prolonged exposure to the radiations leads to atrophy of the part affected and perhaps to cancer. Under suitable conditions, however, the rays from radium have been successfully used in the treatment of cancer and are undoubtedly beneficial in this and similar conditions, though it cannot yet be said that radium is a "cure" for all forms of this scourge. Even when it cannot be averred that the rays heal, it is established that they relieve pain in cancerous conditions. Healthy tissue is from four to seven times more resistant to the action of the rays than diseased tissues, and in conditions in which the diseased tissue may be destroyed without any of the healthy tissue radium is very beneficial. Young plants benefit in growth when exposed to a certain small amount of radiation (it is administered principally as radon) but are harmed by a larger amount. In this respect the rays resemble other specifics which are beneficial in small, but harmful and even poisonous in large, amounts when applied to living things. A strong source of radium can destroy the vitality of seeds and kill the bacteria which cause typhus, cholera, anthrax and similar diseases; even caterpillars have been killed by the rays. In 1906 it was claimed that the rays from radium could cause spontaneous generation, a claim that was never confirmed and is now regarded as fantastic.

BIBLIOGRAPHY.—E. Rutherford, *Radioactive Substances and their Radiations* (1913), still an excellent book despite its age; F. Soddy, *The Chemistry of the Radio-Elements* (1915), and *The Interpretation of Radium* (1920); A. S. Russell, *Chemistry of Radioactive Substances* (1922); G. Hevesy and F. Paneth (trans. R. W. Lawson), *Radioactivity* (1926, bibl.); S. Meyer and E. Schweidler, *Radioaktivität* (1927, bibl.). (A. S. R.)

RADIUMTHERAPY. Since 1913 the name Curietherapy has been applied, particularly in France, as a generic term to therapeutic methods in which radioactive bodies are employed. The term *radiumtherapy* is used primarily for curietherapy carried out by means of radium, and (by extension) by radioactive bodies derived from radium.

Radiumtherapy dates from the times immediately following the discovery of radium by the Curies (1898); it succeeded observation of the effects produced on the skin by radium tubes kept in its vicinity (Becquerel, P. Curie). The first case-notes on radiumtherapy were published by Danlos (1904).

There are two methods of employing radioactive bodies therapeutically. One consists in introducing them into the blood, so that they may be diffused throughout the organism: this is called general curietherapy. The other consists in producing a local action in the form of limited fields of radiation, and this is called local or focal *curietherapy*.

I. General **Curietherapy.**—In this imponderable quantities of radioactive bodies are used. These bodies act on the living tissue with the whole of their alpha-, beta-, and gamma-ray systems. Inasmuch as the alpha-ray system represents more than 90% of the energy released by the disintegration of radium and its disintegration-products, it is correct to say that general curietherapy is primarily an alpha-ray treatment.

Radium is no longer employed in general curietherapy, because, owing to its insolubility and slowness in disintegration, it remains for a long time, and not without danger, in the organism. It is, however, possible to inject radon (radium emanation), a solution or suspension of the active deposit of radon (radium A, B, C), or radium F or polonium (see RADIUM). In practice the gaseous radon is used.

Radon can be employed without danger because it does not accumulate (being eliminated by pulmonary ventilation) and lasts a very short time (period of semi-disintegration = 3·85 days). It is administered either by inhalation, or as a drink, or by subcutaneous or intravenous injection. By inhalation in closed cabinets an equilibrium lasting several hours can be established between the radon content of the confined atmosphere and that of the interior of the organism. The inhalation of the gases given off by the waters of radioactive mineral springs is a variety of general curietherapy. It is believed that radioactivity is a highly important factor in the efficacy of certain mineral springs.

It is in the treatment of some general diseases, of which chronic rheumatism is the most favourable type, that general curietherapy has been employed with the highest degree of success. The injection of considerable quantities of radon has also been advocated in the treatment of cancer, but the efficacy of this treatment requires confirmation.

The physiological and therapeutic actions of radioactive bodies introduced into the interior of the organism are sure and powerful, but insufficiently known; their use is not devoid of risk (particularly on account of their destructive effect on the haematopoietic cells). For this purpose, substances of the radium family have alternatives in the homologous substances of the thorium family. Thorium X in particular has a period of semi-disintegration of the same order as that of radon; it is not volatile, and is less rapidly eliminated than radon.

II. Focal **Curietherapy.**—This has gained a very important place in medical practice. In this method, radium and radon are superior to other radioactive bodies. The superiority of radium is due to the relatively large quantities available (now measurable in grammes) and to the constancy of its radiation, which is itself a result of the slowness with which spontaneous destruction proceeds. The chief advantage of radon is that the radium solutions from which it is periodically extracted can be preserved from loss. Notwithstanding the somewhat rapid decrease of radiation in the case of radon, the biological effects of a radium focus and a radon focus are approximately the same, if the rays are purified by filtration through similar screens.

Alpha-rays are not employed in focal curietherapy, as their penetrative power is very small.

General Technical **Principles.**—Dominici (1907) showed that equal efficacy is obtained through a greater thickness of tissue if the beta-rays and the less penetrative part of the gamma-rays are stopped by suitable filtration. This most important discovery led to the use of radium or radon foci enclosed in heavy metal cases, which filter all but the gamma-rays.

Radium is employed in the form of powdered sulphate (insoluble); with this salt the manufacturer completely fills cylindrical tubes. The length and diameter of these tubes are proportionate to the content desired. The powdered sulphate of radium is diluted with a suitable quantity of sulphate of barium, when a tube has to be completely filled with a small dose. Usually the tubes are made of platinum. The cavity is generally 0·5 or 1 mm. in diameter and from 10 to 30 mm. in length, and the wall of the tube 0·5 or 1 mm. thick. The strength of the filter can be increased as desired by the addition of a detachable case made of gold, lead, etc. The content of the tube is calculated in terms of radium element; for ordinary purposes it varies from 2 to 15 milligrammes. The tube is closed with a platinum stopper hermetically sealed with gold. One end of the tube is rounded; the other has a needle-eye through which a thread can be passed if necessary. The radioactivity of the tubes is not constant unless they are air-tight and it should therefore be measured from time to time.

Series of tubes are made containing the same weight of radium —*i.e.*, having the same power—and interchangeable. These series of sources of radiation can be used to make up radiant surfaces of any size, shape and power desired.

For radium puncture (see p. gog), hollow needles with iridio-platinum points are used. It is not advisable to charge these needles with more than 1 or 2 milligrammes of radium element. Their wall-thickness varies from 0·3 to 0·5 mm.

Radon is generally contained in glass capillary tubes, and these tubes serve the same purposes as radium in tubes and needles.

When the radiation has to act through normal tissues (such as the skin or a mucous membrane) which it is important to protect, each platinum tube is enclosed in a secondary filter, in the form of a casing of some substance of low density containing no heavy atoms (aluminium, rubber, cork, wax, etc.), so that the secondary burning rays emitted by the denser metal of which the tubes are made may be absorbed without any harmful additional radiation.

The aim of all processes of radiumtherapy should be to administer a uniform proportion of radiation throughout the volume of tissue to be treated (homogeneous radiation). Equality of radiation is hindered, however, by two phenomena—the dispersion of the rays, and their absorption.

Dispersion weakens the radiation from a punctiform focus in inverse proportion to the square of the distance. Its effects may be diminished by increasing: (a) the distance from the focus; (b) the radiant surface; (c) the number of positions of the focus (round or within the space to be radiated: "cross fire").

Absorption weakens radiation proportionately to the lowness of its penetrative power and to the thickness of the tissues. The injurious effects of unduly unequal absorption may be palliated by filtration.

The strength of the radiation is a matter of great importance. Excessive strength sets up radium necrosis, an accident of radiumtherapy which is often serious.

The strength of the radiation emitted can be measured with great accuracy by its constancy (radium) or its diminution according to a mathematical formula (radon), and is expressed either by the weight of radium or quantity of radon used and the length of the period of application (*i.e.,* milligramme-hours, millicurie-hours), or by the quantity of radon destroyed during application (i e., millicuries destroyed). The notation of the other circumstances of the application (filtration, distance, etc.) should be associated with that of the strength of radiation emitted.

General Biological Principles.—In its main applications radiumtherapy is based on the unequal radiosensibility of anatomic elements. As a general rule the idea is to effect a cure by electively destroying the diseased or neoplastic cells (as in malignant tumours), advantage being taken of the fact that these are more radiosensitive than normal cells.

Great importance attaches to the questions of relative radiosensibility, quantities absorbed, period of radiation, repeated or single treatment, auto-immunisation of the tissues to radiation, and perhaps to that of the different effects of rays of different wave-lengths. These questions, however, cannot be considered here. They are, moreover, common to radiumtherapy and rontgentherapy. The biological superiority of gamma rays over X-rays is mainly due to the greater penetrative power of the gamma rays.

Methods of **Radiumtherapy.**—The methods employed are: (1) intracavitary radiumtherapy; (2) interstitial radiumtherapy; (3) juxtacutaneous radiumtherapy; and (4) distant radiumtherapy. In many cases radiumtherapy is associated with röntgentherapy or surgery in various ways.

(1) Intracavitary *Radiumtherapy.*—This consists in introducing radioactive tubes, without rupturing the mucous membrane, into the natural cavities which form the site of a tumour or are close to a tumour. In such cases uncovered radium tubes are never used; the tubes are surrounded by light envelopes which not merely arrest the secondary radiation, but also, as far as possible, increase the focal distance. Many such applications of radiumtherapy have been abandoned. Those that survive affect cancers of the rectum, the prostate and bladder, and the uterus and vagina; fibromyomata of the uterus and haemorrhagic metropathies; and cancers of the buccal mucous membrance and the oesophagus.

Good palliative results can be obtained—sometimes readily, sometimes with difficulty—in most of the above-mentioned localisations of cancer. The only type of cancer, however, that is regularly cured—as often as by surgical treatment, and indeed probably more often—is the "pavement," cancer of the cervix uteri.

(2) Interstitial *Radiumtherapy.*—This consists in introducing the foci into the interior of the tissues through openings made for the purpose. In some cases a surgical operation is used as a mode of access (radium surgery). When possible, small foci are introduced by injection through the skin or mucous membrane covering the area to be treated. This method embraces several processes, of which the two following are the chief. One (the American method) is to inject into the tissues, with a trocar and a fine style, minute glass or gold tubes ("seeds") containing radon, and to leave them there. The other (radium puncture) consists in temporarily planting needles in the tissues, fixing them by suturing, and withdrawing them when the treatment comes to an end. The advantage of radium puncture with platinum needles is that effective filtration is possible.

Interstitial curietherapy has been applied to most of the localisations of cancer. The most striking results have been obtained from it in cancers of the mouth, especially of the tongue, in which the prognosis has been considerably improved.

(3) *Juxtacutaneous Radiumtherapy.*—In the early days of radiumtherapy, one or more tubes of radium were applied direct to the skin and kept in place with an adhesive. Later. radium was incorporated in a varnish or enamel, which was spread on metal supports in geometrical shapes. These radiant surfaces were then applied to the skin, being kept from touching it by a very thin sheet of filtrative metal and a certain thickness of gauze. Such methods were not fit to survive, and have been displaced by that of making, as required, supports of plastic materials (*e.g.,* a mixture of wax, paraffin and sawdust, known as Columbia paste). A layer of such a material, of an even thickness suitable to the distance desired (5 mm., 1, 2, etc., cm.), is moulded under heat (40–45° C) over the area to be treated and is then allowed to cool. Radium tubes containing equal quantities, whatever may be appropriate, are affixed to its outer surface at certain intervals. By this method radiant surfaces are obtained which are exactly right for each individual case.

The juxtacutaneous plastic radiant surface method can be applied to the treatment of lesions (notably cancers) of the skin, certain mucous membranes, the pharynx, the larynx, the nipple, etc., and of cancerous adenopathies. It has greatly improved the results of radiumtherapy in squamocellular cancers of the skin and the orifices of the skin.

(4) Distant *Radiumtherapy.*—The increase in the available quantities of radium has made it possible to establish foci containing several grammes of radium, and to increase the distances at which they operate, so that deep-seated cancers can be treated in the same manner as by X-rays. These appliances are so powerful that the focus has to be enclosed in a leaden case with a thick wall. This makes them very heavy, so that mechanical apparatus has to be used, which renders the appliance independent of the patient. Great results may be anticipated from this method, which is quite a new one.

Indications and Results.—The same diseases as are successfully treated with X-rays may be treated with radium. In the days when only small quantities of radium were available, and when no means of producing X-rays of great penetrative power was known, radium was reserved for the treatment of cancers by introducing foci into the natural cavities, and for strictly limited applications, chiefly in cases of small superficial lesions. Both agents can now be used, and it makes little difference whether the lesion is superficial or deep-seated.

In the treatment of dermatoses, inflammatory processes, tumours and benign hyperplasias, the same results can be secured more easily and inexpensively by the use of X-rays. This is also true of the treatment of the more radiosensitive neoplasms (seminomata, lymphosarcomata, myelosarcomata) and the less malignant epithelial cancers ("basal-celled" epitheliomata).

On the other hand, the treatment of the less radiosensitive cancers by radium has the advantage, that the normal tissues are much less affected by the gamma rays than by the X-rays, at the high concentrations that are essential if a cure is to be brought about.

It is far from true, however, that all kinds and all cases of cancer yield the same favourable results to radiurntherapy, The pathological condition in the treatment of which radiumtherapy has produced the most striking advance is the stratified "pavement" epithelioma developing epidermoidally (spinocellular, squamous-cell carcinoma). Whatever may be the site of this cancer, in the skin, in the lip, in the mouth, in the cervix of the uterus, etc., it can now be treated with prospects of cure as good as, if not better than, those afforded by surgical treatment in operable cases. On the other hand, cancers of the glandular organs (breast, prostate, liver, etc.), the prismatic-celled epithelia (stomach, rectum, etc.), the moulded connective tissues (fibrosarcomata), the nervous tissues, etc., are much less radiosensitive, and in such cases palliative results are obtained, but cures are infrequent.

Further, it is clear that, since radiumtherapy is a form of local treatment, its chances of success are greater where the lesion is a small one. Hence the practical importance of early diagnosis.

With its present methods radiumtherapy, as a means of attacking cancer, is difficult. It calls for very extensive and special knowledge, and requires the assistance of experts in various branches. For this reason there is a very proper tendency for it to be monopolized by special establishments which possess the equipment and staff required. (CL. R.)

BIBLIOGRAPHY.—There exists at the time of writing no complete treatise on radiumtherapy, but some of the latest and most important contributions to the literature of the subject may be found in the following publications: *Acta radiologica,* Stockholm; *The American Journal of Rontgenology and Radium Therapy,* New York; *Archives d'électricité médicale,* Bordeaux; *The British Journal of Radiology,* London; *Journal de Radiologie et d'Electrologie,* Paris; *Radiologica medica,* Milan; *Radiology,* Chicago; *Radiophysiologie et Radiothérapie,* Paris; *Strahlentherapie,* Berlin.

RADNORSHIRE, an inland county of Wales, bounded north by Montgomery, north-east by Shropshire, east by Hereford, south and south-west by Breconshire and north-west by Cardigan. Its area is 470.6 sq. mi., and it is consequently the smallest of the six south Wales counties. Pop. (1938) 19,540. The county is a highland region grading eastwards to the plain of the Severn. The western section is formed of Ordovician rocks which are succeeded eastwards by the Llandovery, Wenlock and Ludlow beds of the Silurian. This region forms part of the central Wales plateau with a general level of about 1,000 feet. To the east of the L.M.S. mid-Wales line that cuts the county diagonally from south-west to north-east the grits and shales of the lower Palaeozoic rocks are over-lain by the Old Red Sandstone which culminates in the rugged mass of Radnor forest (2,166 feet). The railway follows the lower Ithon valley (a tributary of the Wye) from near Builth Road to Llanbadarn Fawr. The Wye forms the south-west boundary of the county between Newbridge and Three Cocks, and divides Radnor forest from the Epynt mountains of Breconshire. Between Llandrindod and Builth is a disturbed area of Ordovician strata with masses of andesitic and diabasic igneous rocks. The region has also saline, sulphurous and chalybeate springs. East of New Radnor in the eastern section of the county an inlier of Wenlock rocks is surrounded by Ludlow beds; while at Old Radnor a ridge of very ancient rocks appears. The eastern half of the county is characterized by the number of river valleys that open out to the English plain and consequently offer important ways into the county from the East. In the north the Teme opens out to Knighton and Ludlow and forms the northern boundary of the county for a part of its course. The Lugg flows eastward past Presteign, and the Arrow past Kington, while the vale of Wye leads down to Hereford.

History and Early Settlement. — The heavily forested nature of the county in early times made it unsuited for settlement. Indeed, the region does not seem to have been densely peopled at any time. There are remains on the open higher ground especially in the north of the county of tumuli of uncertain date. Evidences of Bronze age and Megalithic cultures are almost entirely absent. There are, however, a few good examples of hill-top camps, especially at Burfa, and Castle Ring in the parish of Evenjobb. The Roman interests in the region seem to have centred on Castell Collen a focus of ways among the hills and on the road running due north from Brecon to Caersws. The post-Roman centuries were naturally times of difficulty in this region and the outstanding memorial of the time is the remains of Offa's Dyke that traversed the county. The best preserved sections are in the hilly districts west of Knighton and Presteign. Church dedications show the influence of the Celtic Saint movements of these centuries. Towards the close of the 9th century Maesyfed was absorbed into the middle kingdom of Powys, and in the 10th century it was included in the realm of Elystan Glodrudd, prince of Fferlys, or Feryllwg, who ruled over all land lying between the Wye and Severn. In the reign of William I., the Normans began to penetrate into Maesyfed, where, according to Domesday, the king already laid claim to Radenoure, or Radnor, in the lordship of Melenith (Moelynaidd), which was subsequently bestowed on the Mortimer family. The Domesday records are of interest in that they show evidences of cultural penetrations along the valley ways from the east. (English place-names west of Offa's Dyke, etc.) Influences from the plain have long been a feature of the social, religious and political life of the county. Later, the Norman invaders forced their way up the Wye valley, the de Braose family, lords of Elvel (Elfael), building fortresses at Painscastle and at Colwyn or Maud's Castle. The Wye valley long formed one of the debatable districts between Welsh and Normans. After the annexation of Wales by Edward I., the district of Maesyfed remained under the jurisdiction of the Lords-Marchers, represented by the families of Mortimer and Todeney.

The weakness of the Norman hold on many parts of the county is illustrated by the absence of large numbers of stone castles and the great number of those of the motte and bailey type. The valley ways show evidences of compact settlements in marked contrast to the single farms of the upland west. The difficult nature of much of the county throughout mediaeval times, together with the weak Norman hold, meant that the manorial system was very late in establishing itself. The ravages of the Black Death which were particularly severe in this region brought manorial conditions to an early end and the county became almost entirely dependent on sheep rearing. The increase in the number of sheep and the development of the wool trade and the great wool-markets of the Welsh Border — Shrewsbury, Ludlow, Hereford and Gloucester — were features of 14th and 15th century England. There was only one monastic house of consequence in this pastoral county, the Cistercian abbey of St. Mary, founded by Cadwallon ap Madoc in 1143 in "the long valley" of the Clywedog, 6 m. E. of Rhayader, and from its site commonly called Abbey Cwm Hir. Its existing ruins are insignificant, but the proportions of the church, which was 238 ft. long, are still traceable. The churches of Radnorshire are mostly poor and small

The political instability of the county continued throughout the 15th century and in 1402 Owen Glendower entered the Marches and raided the lands of the young Edward Mortimer, earl of March.

Radnorshire (Maesyfed) was created a county on the English model by the Act of Union (1536). It was parcelled out of the suppressed marches lordships. The new county was represented in parliament by two members, one for the county and one for the group of united boroughs. Together with the rest of moorland Wales the county was conservative and royalist during the 17th century, the local clergy during the commonwealth coming in for severe criticism under the administration of the Puritan Vavasor Powell (1617–70). The developments in the wool trade and local weaving attracted in the 16th and 17th centuries numbers of continental weavers, mostly religious refugees and the county is well known for the strong points of view it took later in religious matters. It was an old stronghold of the Quakers and later of the Baptists.

During the 20th century the rise of Llandrindod as a watering-place and the construction of the Birmingham reservoirs in the Elan valley have tended to increase interest in the county.

Occupations. — Good hay and cereals are raised in the valleys, oats being by far the chief crop. The extensive upland tracts, which cover over one-third of the total area of the county, afford pasturage for large flocks of sheep. The quality of the wool of Radnorshire has long been celebrated, and also the delicacy of the

Welsh mutton of the small sheep that are bred in this county. Important sheep fairs are held at Rhayader. There are practically no mining industries, nor are the quarries of great value.

The Central Wales branch of the L.M.S. enters the county at Knighton, traverses it by way of Llandrindod and passes into Brecknock at Builth Road Junction on the Wye. The G.W. Railway follows the course of the Wye, by way of Builth and Hay. Two small branch lines connect New Radnor and Presteign with the G.W.R.

There is no existing municipal borough, although New Radnor, now a mere village, was incorporated in 1561, and its municipal privileges were not formally abolished till 1883. The chief centres are Presteign, Llandrindod Wells, Knighton and Rhayader, all, except Rhayader, being urban districts. Radnorshire is included in the South Wales circuit, and Presteign ranks as the county town. The whole county together with that of Brecknock returns one member to parliament. Ecclesiastically, Radnorshire is divided into 46 parishes, the majority of which, lay after 1923 in the diocese of Swansea and Brecon, but, before that, had been for centuries included in the diocese of St. David's. Wartime population movements caused an increase of 10% in the Radnorshire population between Sept. 1939 and Feb. 1941.

RADOM, a town of Poland in the province of Kielce, 100 mi. by rail S. from Warsaw. Pop. (1931) 77,400, half of whom were Jews. The church of St. Waclaw, contemporary with the foundation of the town, was transformed by the Austrians into a storehouse, and subsequently by the Russian government into a military prison. The old castle is in ruins. Radom has several iron and agricultural machinery works and tanneries. In 1216 it occupied the site of what is now Old Radom. New Radom was founded in 1340 by Casimir the Great, king of Poland. Here Jadwiga was elected queen of Poland in 1382, and here too in 1401 the first act relating to the union of Poland with Lithuania was signed; the *sejm* or diet of 1505, where the organic law of Poland was sworn by the king, was also held at Radom. Several great fires, and the Swedish war of 1701–7, ruined the old city. After the third partition of Poland in 1795 it fell under Austrian rule; it was in 1815 annexed to Russia, and it was returned to Poland in 1918. Germany conquered Radom after bitter fighting in Sept. 1939.

RADON, known formerly as radium emanation or as niton, is the gaseous element (Symbol Rn) of atomic number 86 and atomic weight 222 produced by the disintegration of radium. It was discovered by Dorn in 1900. Its relation to the elements uranium and radium and to its successive products radium -*A*, -B, -C, -*C'*, -*D*, and -*E* and polonium are discussed under RADIUM. Radon is the heaviest member of the group of inert gases helium, neon, argon, krypton and xenon, and, like these elements, it is totally unable to form chemical compounds with other elements, and therefore may be said to have no chemical properties whatever. Its physical properties are described under RADIOACTIVITY.

In a mineral or solid preparation of radium, radon remains with the solid material, little of it escaping into the air. The higher the temperature to which the solid is heated the more easily does it escape, and at a temperature of 800° C practically the whole of the radon is expelled. When a solution of radium in water or acid is kept in a closed flask, radon is evolved together with oxygen and hydrogen produced by the decomposition of the water. After purification (*see* RADIOACTIVITY) radon is sealed up in a tube and used for scientific, medical, or other work.

Radon expels an α-o particle of range 4·12 cm. and disintegrates at such a rate that it diminishes by one-half every 3.83 days. A quantity of radon, therefore, freed from its parent, falls to half its original amount in 3.83 days, to a quarter in 7.66 days, to an eighth in 11·49 days, and so on. But it is a consequence of the disintegration theory of radioactivity that, in the solution of radium which has been freed from its radon, the latter grows as fast as it decays after separation from radium; that is to say, in 3.83 days one-half, in 7.66 days three-quarters, and in 11·49 days seven-eighths of the equilibrium amount of radon has reformed in the radium solution. If therefore the radon be pumped off from the radium solution once a week, nearly three-quarters of the maximum amount may be removed, purified, sealed up and used for experimental work. The valuable radium solution need not then be directly handled in experimental work. It generates under conditions of safety the radon which, with its successive disintegration products, is as valuable for most experimental work as radium itself. Should an accident befall the tube of radon, time (in waiting for more to accumulate in the solution of radium) but not the value of the radium, is lost; the interest on one's money, so to speak, has been spent, but the capital itself is still safe in the bank. Radon in tubes, of course, is not permanent in the sense that radium is permanent, for it diminishes in the manner already explained; but for most practical purposes that does not matter.

For Bibliography, *see* RADIUM. (A. S. R.)

RADOWITZ, JOSEPH MARIA VON (1797–1853), Prussian general and statesman, was born at Blankenburg in the Harz Mountains, his family being of Hungarian origin. As a lieutenant in the Westphalian artillery he was wounded and taken prisoner at Leipzig (1813), subsequently entered the Hanoverian service, and in 1823 that of Prussia, becoming chief of the general staff of the artillery in 1830. In 1836 he went as Prussian military plenipotentiary to the federal diet at Frankfort, and in 1842 was appointed envoy to the courts of Carlsruhe, Darmstadt and Nassau. He was an intimate friend of the crown prince (afterwards King Frederick William IV.), and the Prussian constitution of Feb. 1847 owed much to his *Gespräche aus der Gegenwart über Staat und Kirche,* published under the pseudonym "Waldheim" in 1846. In the Frankfort parliament he was leader of the extreme Right; and after its break-up he worked for the Unionist policy of Prussia in the Prussian diet and the Erfurt parliament. On Sept. 27, 1850, he was appointed minister of foreign affairs, but resigned on Nov, 2. In Aug. 1852 he was appointed director of military education. He died on Dec. 25, 1853.

Radowitz published, in addition to several political treatises, *Zkonographie der Heiligen, ein Beitrag zur Kunstgeschichte (1834)* and *Devisen und Mottos des spätern Mittelalters* (*ib.,* 1850). His *Gesammelte Schriften* were published in 5 vols. at Berlin, 1852–53.

See Hassel, *Joseph Maria von Radowitz* (1905, etc.).

RAE, JOHN (1813–1893), Scottish Arctic explorer, was born on Sept. 30, 1813, in the Orkney Islands. He studied medicine at Edinburgh university. He made a voyage as surgeon in one of the ships of the Hudson's Bay company, and was resident surgeon for ten years at the company's station at Moose Factory, at the head of James bay. In 1846 he made a boat-voyage to Repulse bay, and next spring surveyed 700 m. of new coast-line connecting the earlier surveys of Ross and Parry. He then joined the expedition under Sir John Richardson in search of Franklin; and in 1851, at the request of the Government he travelled some 5,300 m., much of it on foot, and explored and mapped 700 m. of new coast on the south side of Wollaston and Victoria Lands. For this achievement he received the Founder's gold medal of the Royal Geographical Society. In 1853 he commanded another boat-expedition fitted out by the Hudson's Bay company, which connected the surveys of Ross with that of Deane and Simpson, and proved King William's Land to be an island. He subsequently travelled across Iceland, and in Greenland and the northern parts of America, surveying routes for telegraph lines. He died at his house in London in 1893 and was buried in the Orkney Islands. He wrote *A Narrative of an Expedition to the Shores of the Arctic Sea in 1846 and 1847* (1850).

RAE BARELI, a town and district of British India, in the Lucknow division of the United Provinces. The town is on the river Sai, 48 m. S.E. of Lucknow. Pop. (1931) 18,180. It possesses many architectural features, chief of which is a strong and spacious fort of solid brick. Among other ancient buildings are the magnificent palace and tomb of nawab Jahan Khan, governor in the time of Shah Jahan, and four fine mosques. It is an important centre of trade, and muslins and cotton cloth are woven.

The DISTRICT OF RAE BARELI has an area of 1,749 sq.m. The general aspect of the district is slightly undulating, and the country is beautifully wooded. The soil is remarkably fertile, and the cultivation of a high class. The principal rivers of the district are the Ganges and the Sai. In 1931 the population was 974,127. The principal crops are rice, pulse, wheat, barley, millet and poppy.

RAEBURN, SIR HENRY (1756–1823), Scottish portrait-painter, was born at Stockbridge, Edinburgh, on March 4, 1756, the son of a manufacturer of the city. He was educated at Heriot's hospital, and at 15 was apprenticed to a goldsmith in Edinburgh. He began to paint miniatures; and, meeting with success and patronage, he extended his practice to oil-painting, being all the while quite self-taught. The goldsmith his master watched his pupil with interest, and introduced him to David Martin, the leading portrait-painter in Edinburgh. From him Raeburn received considerable assistance, and was given portraits to copy. When he was in his 22nd year he was asked to paint the daughter of Peter Edgar of Bridgelands and widow of Count Leslie. A month later she became his wife, bringing him an ample fortune; but the acquisition of wealth affected neither his enthusiasm nor his industry, He decided to visit Italy with his wife, and, in London, called upon and was kindly received by Sir Joshua Reynolds, who gave him excellent advice as to his study in Rome, commending to him in particular the works of Michelangelo. He also offered him more substantial pecuniary aid, which was declined as unneeded; but Raeburn carried with him to Italy many valuable introductions from the president of the Academy. In Rome he made the acquaintance of Gavin Hamilton, of Batoni, and of Byers, who advised him "never to copy an object from memory, but, from the principal figure to the minutest accessory, have it placed before him." After two years of study in Italy he returned to Edinburgh in 1787, where he began a most successful career as a portrait-painter. In that year he executed an admirable seated portrait of the second Lord President Dundas.

Interesting examples of his earlier portraits are those of Mrs. Johnstone of Baldovie and the three-quarter-length of Dr. James Hutton. The portraits of John Clerk, Lord Eldin, and of Principal Hill of St. Andrews belong to a somewhat later period. Raeburn was fortunate in the time in which he practised portraiture. Sir Walter Scott, Blair, Mackenzie, Woodhouselee, Robertson, Home, Ferguson and Dugald Stewart were resident in Edinburgh, and they all, along with a host of others less celebrated, honoured the painter's canvases. Of his fully matured manner the finest examples are his own portrait and that of the Rev. Sir Henry Moncrieff Wellwood, the bust of Dr. Wardrop of Torbane Hill, the two full-lengths of Adam Rolland of Gask, the remarkable paintings of Lord Newton and Dr. Alexander Adam in the National gallery of Scotland, and that of William Macdonald of St. Martin's Raeburn was considered less successful in his female than in his male portraits, but the exquisite full-length of his wife, the smaller likeness of Mrs. R Scott Moncrieff in the Scottish National Gallery, and that of Mrs. Robert Bell, prove that he could portray all the grace and beauty of the gentler sex.

Raeburn spent his life in Edinburgh, rarely visiting the metropolis, and then only for brief periods, thus preserving his own sturdy individuality. But though he, personally, may have lost some of the advantages which might have resulted from closer association with the leaders of English art, and from contact with a wider public, Scottish art certainly gained much from his disinclination to leave his native land. He became the acknowledged chief of the school which was growing up in Scotland during the earlier years of the 19th century, and to his example and influence at a critical period is undoubtedly due much of the virility of his followers and immediate successors Professional honours fell thick upon him. In 1812 he was elected president of the Society of Artists in Edinburgh, in 1814 associate, and in the following year full member of the Royal Academy. In 1822 he was knighted by George IV and appointed His Majesty's limner for Scotland He died at Edinburgh on the 8th of July 1823.

In his own day the portraits of Raeburn were excellently engraved by the last members of the great school of English mezzotint In 1876 a collection of over 300 of his works was brought together in the Royal Scottish Academy galleries; in the following year a series of twelve of his finest portraits was included in the winter exhibition of the Royal Academy, London; and a volume of photographs from his paintings was edited by Dr. John Brown.

See *Life of Sir Henry Raeburn, R A*, by his great-grandson William Raeburn Andrew (2nd ed., 1894), with complete catalogue of the exhibition of 1876; *Works* of *Sir Henry Raeburn, R A.*, with tributes by Dr John Brown and others (Andrew Elliot, Edinburgh); *Tribute to the Memory* of *Raeburn* by Dr. Andrew Duncan; the *Catalogues* of the loan exhibitions in Edinburgh of 1884 and 1901; and the Essay by W. E. Henley—*Sir Henry Raeburn* (1890) with a finely produced series of plates, printed by T. & A. (Constable); *Sir Henry Raeburn* by Sir Walter Armstrong, with an introduction by R. A. M. Stevenson and a biographical and descriptive catalogue by J L. Caw (1901).

RAEDWALD (d *c* 620), king of the East Angles, was the son of King Tytili. He became a Christian during a stay in Kent, but on his return to East Anglia he sanctioned the worship both of the Christian and the heathen religions. Very little is known about his reign, which probably began soon after 600. For a time he recognized the overlordship of Aethelberht, king of Kent, but he seems to have shaken off the Kentish yoke. He gained some superiority over the land south of the Humber with the exception of Kent and is counted among the Bretwaldas. Raedwald protected the fugitive Edwin, afterwards king of Northumbria, and in his interests he fought a sanguinary battle with the reigning Northumbrian king, Aethelfrith, near Retford in Nottinghamshire, where Aethelfrith was defeated and killed in April 617. He was followed as king of the East Angles by his son Eorpwald.

See Bede, *Historiae ecclesiasticae*, edited by C. Plummer (Oxford, 1896); and J. R. Green, *The Making* of *England* (1897–99).

RAEMAEKERS, LOUIS (1869–), Dutch cartoonist, was born at Roermond, Holland, on April 6, 1869. He was educated in Amsterdam and Brussels, and began his career by painting landscapes, portraits and posters. In 1908 he produced his first political cartoons, and subsequently gained international fame by his violent anti-German cartoons in the Amsterdam Telegraaf and other papers during and after the World War.

His cartoons have been published in *The Great War in 1916; The Great War in 1917; Devant l'Histoire* (1918); and *Cartoon History of the War* (1919).

RAETIA (so always in inscriptions, in classical mss. usually RHAETIA), in ancient geography, a province of the Roman empire, bounded on the west by the country of the Helvetii, on the east by Noricum, on the north by Vindelicia and on the south by Cisalpine Gaul. It thus comprised the districts occupied in modern times by the Grisons, the greater part of Tirol, and part of Lombardy. The land was very mountainous, and the inhabitants chiefly supported themselves by cattle-breeding and cutting timber, little attention being paid to agriculture. Some of the valleys, however, were rich and fertile, and produced corn and wine. Trade was also carried on in pitch, honey, wax and cheese Little is known of the origin or history of the Raetians, who are described as one of the most powerful and warlike of the Alpine tribes. It is stated by Livy (v. 33) that they were of Etruscan origin At the time when the land became known to the Romans, Celtic tribes were already in possession of it and had amalgamated so completely with the original inhabitants that, generally speaking, the Raetians may be regarded as a Celtic people, although non-Celtic tribes (Lepontii, Euganei) were settled among them They retained their independence until their subjugation in 15 B.C. by Tiberius and Drusus. At first Raetia formed a distinct province, but towards the end of the 1st century A.D. Vindelicia was added to it; hence Tacitus (Germania, 41) could speak of Augusta Vindelicorum (Augsburg) as "a colony of the province of Raetia." The whole province (including Vindelicia) was at first under a military prefect, then under a procurator; it had no standing army quartered in it, but relied on its own native troops and militia for protection In the reign of Marcus Aurelius it was governed by the commander of the Legio *iii. Italica*. Under Diocletian (*q.v.*) it formed part of the diocese of the *vicarius Italiae*. During the last years of the Western empire, the land was in a desolate condition, but its occupation by the Ostrogoths in the time of Theodoric, to some extent revived its prosperity. The chief towns of Raetia were Tridentum (Trent) and Curia (Coire or Chur). It was traversed by two great lines of Roman roads—one leading from Verona and Tridentum across the Brenner to Oenipons (Innsbruck) and thence to Augusta Vindelicorum; the other from Brigantium (Bregenz) on Lake Constance, by Coire and Chiavenna to Como and Milan.

BIBLIOGRAPHY.—J. Marquardt, *Römische Staatsverwaltung*, i. (2nd ed., 1881) p. 288; Smith's *Dict. of Greek and Roman Geography* (1873); T. Mommsen, *The Roman Provinces* (Eng. trans., 1886), i. pp. 16, 161, 196; Mary B. Peaks, *The General Civil and Military Administration of Noricum and Raetia* (Chicago, 1907).

RAFF, JOSEPH JOACHIM (1822–1882), German composer and orchestral conductor, was born near Zurich, Switzerland, on May 27, 1822, and educated chiefly at Schwyz. He was encouraged and assisted by Liszt and von Bulow, his opera, *König Alfred,* being produced at Weimar under Liszt's direction.

Raff lived at Weimar until 1856. In 1859 he married Doris Genast, an actress of high repute, and thenceforward devoted himself with renewed energy to the work of composition, displaying an inexhaustible fertility of invention and great technical skill. He resided chiefly at Wiesbaden till 1877, when he was appointed director of the Hoch-Conservatorium at Frankfort, an office which he retained until his death on June 25, 1882.

Raff's compositions included symphonies, quartets, concertos, sonatas and songs.

RAFFIA. A fibrous product consisting of the epidermal strips of the leaves of *Raphia ruffia* (from Madagascar) and R. taedigera (from Japan) largely employed as a binder twine in horticulture and in various kinds of handwork.

RAFFLE, a special kind of lottery, in which a particular article is put up as the prize, the winner being drawn for by lot out of the number of those who have paid a fixed sum for admission to the drawing; the total amount realized by the sale of tickets is supposed to approximate to the value of the object raffled for. The word appears in English as early as Chaucer (The *Parson's* Tale), where it is used in its original sense of a game of dice, the winner being that one who threw three dice all alike, or, next, the highest pair. The Fr. *rafle,* Med. Lat. *raffla,* was also used in the sense of a "sweeping-off" of the stakes in a game; it has been connected with Ger. raffen, to carry off.

RAFFLES, SIR THOMAS STAMFORD (1781–1826), English administrator, founder of Singapore, was born on July 5, 1781, on board a merchantman commanded by his father, Benjamin Raffles, when off Port Morant, Jamaica. He became a clerk in the office of the East India Company, and in 1805 was sent out to Penang as assistant secretary to the first governor. In addition to his duties as secretary he acted as Malay interpreter, and in 1807 he became secretary.

In 1808 his health gave way, and he was ordered for a change to Malacca. The East India Company had decided to abandon Malacca, and orders had been issued to dismantle it. Raffles drew up a report explaining the great importance of Malacca, and urging in the strongest manner its retention. Lord Minto was so impressed by the report that he at once gave orders ior suspending the evacuation of Malacca, and in 1809 the company decided to reverse'its own decision. In June 1810 Raffles, of his own accord, proceeded to Calcutta, where Lord Minto gave him the kindest reception. Raffles remained four months in Calcutta, and gained the complete confidence of the governor-general. He brought Lord Minto round to his opinion that the conquest of the island of Java, then in the hands of the French, was an imperative necessity. To prepare the way for the expedition, Raffles was sent to Malacca as "agent to the Governor-General with the Malay States." He did his work well and thoroughly—even to the extent of discovering that the short and direct route to Batavia by the Caramata passage would be a safe one for the fleet to take.

In August 1811 the expedition, accompanied by Lord Minto, and with Sir Samuel Auchmuty in command of the troops (11,000 in number, half English and half Indian), occupied Batavia without fighting. On the 25th a battle was fought at Cornelis, a few miles south of Batavia, and resulted in a complete English victory. On Sept. 18 the French commander, General Janssens, formally capitulated at Samarang, and the conquest of the island was completed. Lord Minto's first act was to appoint Raffles lieutenant-governor of Java. From September 1811 until his departure for England in March 1816, Raffles ruled this large island with conspicuous success. He increased the revenue eightfold at the same time that he abolished transit dues, reduced port dues to one-third and removed the fetters imposed on trade and intercourse with the Javanese by Dutch officialdom. In his own words, his administration aimed at being "not only without fear, but without reproach." He had a still greater ambition, which was, in his own words, "to make Java the centre of an Eastern insular Empire," and to establish the closest relations of friendship and alliance with the Javanese, whom he described as "a highly polished people, considerably advanced in science, highly inquisitive and full of penetration." It is interesting to note that when another great Englishman, Rajah Brooke, began his career in Sarawak in 1838, he announced: "I go to carry Sir Stamford Raffles's views in Java over the whole Archipelago."

In November 1817 Raffles quitted England on his return to the East, where the lieutenant-governorship of Fort Marlborough (Sumatra) had been kept in reserve for him. His administration of Sumatra (1818–23) was characterized by the same breadth of view, consistency of purpose and energy in action that had made his government of Java remarkable, He had not, however, done with the Dutch, who, on their recovery of Java, endeavoured to establish a complete control over the Eastern archipelago, and to oust British trade. This design Sir Stamford set himself to baffle, and by a stroke of genius and unrivalled statecraft he stopped for all time the Dutch project of a mare *clausum* by the acquisition and founding of Singapore on Jan. 29, 1819.

In 1824 Raffles returned to England to vindicate his acts to the East India Company. The court exonerated him from the charges made against him, but censured him for "his precipitate and unauthorized emancipation of the Companyls slaves," and after his death charged his widow to pay £10,000 for various items, which included the expense of his mission to found Singapore. Harassed by these personal affairs, he still found time to help in the foundation of the zoological society in London. His fine Sumatra collection formed its endowment. He died July 5, 1826.

See Lady Raffles, *Memoir of Sir Thomas Stamford Raffles* (1830); D. C. Boulger, *Life of Sir Stamford Raffles* (1897); Hugh Egerton, *Sir Stamford Raffles* (1899); J. Buckley, *Records of Singapore* (1903).

RAFFLESIA, a genus of plants of the family Rafflesiaceae with six species confined to Malaya. They are all parasitic on the roots of vines (Vitis). R. *Arnoldi* has the largest flower known, measuring 18in. across and weighing 15lb. with a smell like decaying flesh. It is pollinated by carrion-flies, and is the only part of the plant visible above ground, the remainder being reduced to a fungus-like mycelium.

RAFTER. A beam in a sloping roof to which is attached the framework for the slating, tiling or other external covering (*see* ROOFS).

O.E. raefter, a beam, in the special sense of a floating collection of timbers, gives the English "raft."

The ultimate base of this word is the root raf-, to cover, seen in Gr. ὄροφος, roof.

RAGAZ or RAGATZ, a famous watering-place in the Swiss canton of St. Gall, situated on the left bank of the Rhine. and by rail 61½ m. S.E. of Ziirich. It stands at a height of 1,696 ft., at the entrance to the magnificent gorge of the Tamina, about 3 m. up which by road are the extraordinarily placed Baths of Pfäfers. Since 1840 the hot mineral waters of Pfafers have been conducted to Ragaz, which has much increased in importance as a result. In 1930 its native population was 2,162, mainly German-speaking, while there were 1,500 Roman Catholics and 500 Protestants. About 2 m. by road above Ragaz are the 17th-century buildings (now the cantonal lunatic asylum) of the great Benedictine abbey of Pfäfers (720–1838), to which all this region belonged till 1798; while between them and Ragaz are the ruins of the 14th-century castle of Wartenstein.

RAGGED ROBIN (*Lychnis Flos-cuculi*), a perennial plant with pink, divided petals, belonging to the pink family, Caryophyllaceae (*q.v.*), native to Europe and Asia, common in Great Britain and naturalized in the eastern United States. It is a slender herb, about 1½ ft. high, and is much parasitized by a fungus, *Ustilago antherarum,* which forms its spores in the stamens, whence they are transported from plant to plant by insects.

RAGLAN, FITZROY JAMES HENRY SOMERSET, 1ST BARON (1788–1855), British field marshal, was the eighth and youngest son of Henry, 5th duke of Beaufort, by Elizabeth Boscawen, and was born on Sept. 30, 1788. Lord Fitzroy Somerset was educated at Westminster school, and entered the army in 1804. He served on the staff of Sir Arthur Wellesley in the expedition to Copenhagen (1807), and went with him to Portugal in 1808. During the whole of the Peninsular War he was at his right hand, first as aide-de-camp and then as military secretary. He was the first to mount the breach at Badajoz, and afterwards showed great resolution and promptitude in securing one of the gates before the French could organize a fresh defense. During the short period of the Bourbon rule in 1814 and 1815 he was secretary to the English embassy at Paris. On the renewal of the war he again became aide-de-camp and military secretary to the duke of Wellington. About this time he married Emily Harriet, daughter of the 3rd earl of Mornington, and Wellington's niece. At Waterloo he was wounded in the right arm and had to undergo amputation, but on the conclusion of the war resumed his duties as secretary to the embassy at Paris. From 1818 to 1820, and again in 1826–29, he sat in the house of commons as member for Truro. In 1819 he was appointed secretary to the duke of Wellington as master-general of the ordnance, and from 1827 till the death of the duke in 1852 was military secretary to him as commander-in-chief. He was then appointed master-general of the ordnance, and was created Baron Raglan.

In 1854 he was promoted general and appointed to the command of the British troops sent to the Crimea (see CRIMEAN WAR) in co-operation with a strong French army under Marshal St. Arnaud and afterwards, up to May 1855, under Marshal Canrobert. Here the advantage of his training under the duke of Wellington was seen in the soundness of his generalship, and his diplomatic experience stood him in good stead in dealing with the generals and admirals, British, French and Turkish, who were associated with him.

For the hardships and sufferings of the British soldiers in the terrible Crimean winter before Sevastopol, owing to failure in the commissariat, both as regards food and clothing, Lord Raglan and his staff were at the time severely censured by the press and the government; but it afterwards appeared that the chief neglect rested with the home authorities. He was made a field marshal after Inkermann. During the trying winter of 1854–55 his health was undermined. Disappointment at the failure of the assault of June 18, 1855, finally broke his spirit, and on June 28, 1855, he died.

See Kinglake, *Invasion of the Crimea* (1863–87); Hamley, *War in the Crimea* (1891).

RAGMAN ROLLS, the name given to the collection of instruments by which the nobility and gentry of Scotland were compelled to subscribe allegiance to Edward I of England between the conference of Norham in May 1291 and the final award in favour of Baliol in Nov. 1292, and again in 1296. Of the former of these records two copies were preserved in the chapterhouse at Westminster (now in the Record office, London), and it has been printed by Rymer (Foedera, ii. 542). Another copy, preserved originally in the Tower of London, is now also in the Record office.

The derivation of the word "ragman" has never been satisfactorily explained, but various guesses have been made. One is that the Scots spoke of such an instrument as "ragman" because of the numerous seals attached to it. The name "ragman roll" survives in the colloquial word "rigmarole," a rambling, incoherent statement.

RAGNAR LODBROK, Scandinavian ruler of the 8th or 9th century, supposed to have invaded England and France. It is nearly certain that such a person existed, but he has become a Scandinavian hero and the myths surrounding him are so extensive that it is difficult to separate the true from the fictional and to determine precisely what took place during his reign. One theory is that there were two men around whom the stories are woven: a prince named Ragnar Lodbrok, who died in 794; and another prince named Raginfrid or Regnier, who actually led the invasions of France and England, which did not take place until the 9th century, but who is known in Scandinavian history and legend as Ragnar Lodbrok also. In any case, the myths about the two men of the same name have become inextricably intertwined.

The story is that Ragnar Lodbrok sailed up the Seine river to Paris, which he captured and which was only redeemed by a ransom of 7,000 lbs. of silver. Later, the story runs, jealous of the reported achievements of his two sons, he planned to outdo them by invading England. He constructed two ships, the largest that had ever been built in Scandinavia, and sailed for Northumberland. He was captured by Aella, the Saxon king of Northumberland, after a valiant fight, and thrown alive into a pit of snakes, which stung him to death. His death song, the Lodbrokar-quida, has become a Scandinavian epic. His sons revenged him by killing Aella, and Northumberland ceased to be a Saxon kingdom and was looted and plundered by the Norsemen.

RAGNAROK, a Scandinavian myth telling of the death of the gods and the destruction of the world. The name is probably derived from the Old Norse words *regin* or rogn, god, and rok, reason, origin or history, although it is sometimes thought that the word comes from the Icelandic *ragna,* gods, and *rokr,* twilight. The story is contained in the Icelandic saga *Völuspá.* It tells of the war between the gods, led by Odin, and their evil opponents, led by Loki. The Ragnarok combines three common stories of the destruction of the world: the sinking of the earth into the sea and the devouring of the sun by a monster; a devastating winter; and the destruction of the earth by fire. In addition to the annihilation of the earth, the chief protagonists on each side are killed and there is a period of darkness and chaos. Afterwards, however, some of the gods who were not destroyed return to the earth, which has risen from the sea, and with them return a human couple, Lif and Lifthraser (Life and Vitality), who are the progenitors of a new race. This is the story used by Richard Wagner, the German composer, in his opera Gotterdammerung, the German word for "twilight of the gods."

RAGS. With the growth of the textile industries throughout the world, the consumption of rags of various sorts became enormous. The aggregate cannot be computed, but some conception of the dimensions of the trade may be gathered from the fact that the United Kingdom, in addition to consuming the greater part of her own production of rags, has a substantial import trade in linen, cotton and woollen rags. The linen and cotton rags are used in paper manufacture, and the woollen rags are employed in the textile industries. (*See* PAPER; SHODDY.)

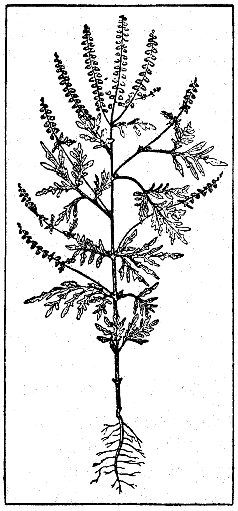
RAG-STONE, a name given sometimes to work done with stones which are quarried in thin pieces, such as the Horsham sandstone, Yorkshire stone, the slate stones, etc.; but this is more properly flag or slab work. Technically, rag-stone is an excellent material from the neighbourhood of Maidstone, near London; a very hard limestone of bluish-grey colour, peculiarly suited for mediaeval work. It is often laid as uncoursed work, or random work, sometimes as random coursed work and sometimes as regular ashlar. (*See* MASONRY.)

RAG-TIME: see JAZZ.

RAGUSA, a town and provincial capital of Sicily in the province of Ragusa, 70 mi. S.W. of Syracuse by rail and 32 mi. direct. It consists of an upper and a lower town united into one commune in 1926. Pop. (1936) 40,480 (town); 49,530 (commune). The city has an entirely new quarter, called Littorio. It has some churches with fine Gothic architecture, and is commercially important, a stone impregnated with bitumen being quarried and prepared for use for paving slabs by being exposed to the action of fire. Oil suited to Diesel motors is extracted. On the hill occupied by the castle of the lower town (Ragusa Ibla) stood the ancient Hybla Heraea, a Sicel town, under the walls of which Hippocrates of Gela fell in 491 B.C. During World War II Ragusa was severely bombed by the U.S. and British air forces prior to its occupation.

RAGUSA, Yugoslavia: see DUBROVNIK.

RAGWEED, the name given in North America to native plants of the genus Ambrosia (family Compositae). They are chiefly coarse annuals, with rough-hairy stems, mostly lobed or divided leaves, and greenish flowers borne in small heads, the male in terminal spikes and the female in the upper axils of the leaves. The common ragweed *(A. artemisiifolia)*, called also Roman wormwood, hogweed and bitterweed, found across the continent, grows from 1 to 7 ft. high, with thin, alternate or opposite, much-divided leaves. The great ragweed *(A. trifida)*, called also bitterweed and horse cane, native from Quebec to Saskatchewan and southward to Florida, Arkansas and Colorado, grows from 3 to 17 ft. tall, with opposite, entire or palmately three- to five-lobed leaves. Both the foregoing are annuals and often become pernicious weeds; their pollen, which is shed in great abundance in late summer, is a prolific source of hay fever. The western ragweed *(A. psilostachya)*, found from Illinois to Alberta and southward to California, Texas and Mexico, is similar to the common ragweed, but is a perennial and has thicker leaves.



FROM NEW YORK STATE COLLEGE OF AGRICULTURE AT CORNELL UNIVERSITY

COMMON RAGWEED (AMBROSIA ARTEMISIIFOLIA), WITH SPIKES OF POLLEN-BEARING FLOWERS, READY TO SHED THE POLLEN WHICH CAUSES HAY FEVER

RAGWORT (Senecio jacobaea), a common plant in European pastures and wasteland, growing to a height of over 2 ft., with heads of bright yellow flowers. It is allied to the groundsel (*q.v.*) and is one of the five noxious weeds whose removal in Great Britain is enforced by law. This weed, known also as staggerwort, is sparingly naturalized in North America from Newfoundland to Ontario and southward to Pennsylvania. In the United States and Canada various other species of Senecio are called ragwort, *e.g.*, the golden ragwort or swamp squaw-weed (S. *aureus*), a conspicuous wild flower of early summer, inhabiting swamps and wet meadows.

RAHAB, a Biblical character, who sheltered the spies sent by Joshua to investigate Jericho before the Jews crossed into Canaan. Rahab, whom Joshua ii speaks of as a harlot, admitted the spies to her house and concealed them from the messengers of the king of Jericho by hiding them under sheaves of flax on the roof. She sent the king's messengers away and then let Joshua's spies out of her window by a cord; and, since her house was built on the town wall, they escaped. In return, she asked that she and her family be spared from injury if the Israelites should take Jericho. This request the spies granted, telling Rahab that when the Israelites came, she should hang a red cord from the window through which the spies had escaped. This she did, and she and her family were saved. Later, when the Israelites had taken Jericho, Rahab was admitted to the community. Jewish tradition is that Rahab married Joshua and that eight prophets were descended from them. Another story is that she married Salmon, one of the spies, and that they were the parents of Boaz and thus she is an ancestor of David and of Jesus Christ. The Roman Catholic Church has made her a saint, whose day is celebrated Sept. 1. The Targum and the majority of older Jewish commentators translate the Biblical word *zōnāh,* used to describe Rahab as "innkeeper," deriving it from the root, *zūn,* "to feed," instead of from the root, *zānāh,* "to be a harlot"; but most versions translate "harlot."

RAHWAY, a city of Union county, New Jersey, U.S.A., on the Rahway river, 20 mi. S.W. of New York city. It is served by the Pennsylvania railroad, interurban trolleys and motorbus lines. Population in 1920 was 11,042 (18% foreign-born white); 16,011 in 1930; and 17,498 in 1940, by federal census. The city has attractive parks and many houses dating from colonial times. At the Old Peace tavern (still standing) Lafayette was entertained in 1824. The manufactures include vacuum cleaners, office equipment, furniture. automobile bodies and accessories, books, oil, bleaches, chemicals, cotton and wool waste and cereals. In the outskirts of the city is the New Jersey reformatory (1903) for men from 16 to 30 years of age. Rahway was settled in 1720; named after the Indian chief Rahwack of the tribe which owned the site; and was chartered as a city in 1858. A skirmish of the Revolution (called the battle of Spanktown, from the name by which the town was popularly known at the time) took place there in Jan. 1777.

RAICHUR, a town and district of India, in the state of Hyderabad, at the junction of the Madras and Southern Mahratta and Great Indian Peninsula railways, 351 mi. N.E. from Madras. Pop. (1931) 27,910. It gives its name to the doab, or tract between the rivers Kistna and Tungabhadra, which was the scene of much fighting betwekn Mohammedans and Hindus as debatable land during the 16th century. The district has an area of 6,791 sq.mi. and a population of 922,322. The town contains a well-preserved fort and palace. It is a thriving centre of trade, with a number of cotton ginning and pressing factories.

RAIFFEISEN, FRIEDRICH WILHELM (1818–1888), founder of the German system of agricultural co-operative banks. was born at Hamm on the Sieg on March 30, 1818. He entered the public service at Coblenz. The distress of 1846–47, which he attributed largely to absence of credit facilities for small peasant proprietors, led him to found the first agricultural co-operative credit societies (*Darlehnskassenvereine*), which ever since have been called after his name. He died Mar. 11, 1888.

Among Raiffeisen's writings are, Die *Darlehnskassenvereine als Mittel* eur *Abhilfe* (Neuwied, 1866; new ed., 1887); and *Kurze Anleitung zur Gründung* von *Darlehnskassenvereinen* (new ed., 1893).

See A. Wattig, Friedrich Wilhelm Raiffeisen (1890); H. W. Wolff, People's Banks. *A Record* of Social and Economic Success (1895); and Fassbender, Friedrich *Wilhelm* Raiffeisen (1902).

RAIGARH, a feudatory state of India in the Chhattisgarh division of the Central provinces. Area 1,486 sq.mi.; population (1931) 277,569. It is traversed by the Bengal-Nagpur railway with a station at Raigarh Town, 363 mi. from Calcutta. Fine tussore silk is produced at Raigarh town (pop. 8,667).

RAIKES, ROBERT (1735–1811), English educationalist, founder of Sunday schools, was the son of Robert Raikes, a printer in Gloucester and proprietor of the Gloucester Journal, and was born on Sept. 14, 1735. On the death of his father in 1757 he succeeded him in the printing business, which he continued to conduct until 1802. In 1780 he started a Sunday school at Gloucester, and although it was not the first of its kind, it was the first to attract general attention and thus was actually the beginning of the movement to provide schools for the instruction of children on Sunday. Raikes lived to witness its wide extension throughout England. He died on April 5,1811.

RAIL, the general English name for birds of the family *Rallidae,* to the two British species of which it originally applied. The first of the latter is the corncrake or land rail, Crex crex, recognizable by its monotonously repeated grating cry which has been aptly likened to the sound made by a rusty gate-hinge. It is a summer visitor to north Europe, retiring south in winter. The plumage is of various shades of brown above and yellowish-white below, rendering it very inconspicuous. It haunts the open country and agricultural land, the nest being on the ground, usually in long grass. Nine to 11 eggs are laid, of a cream-colour blotched with light red and grey. The young are hatched clad in black down.

The water rail, Rallus aquaticus, is less abundant than the preceding, but has a wide distribution, extending all over the old world north of the tropics. The call is harsh, loud and uttered only at intervals. It has a long partly-red bill and the plumage is darker than that of the land rail. It inhabits marshes. Closely related is the sora, or Carolina rail, *Porzana carolina;* also the coot (*q.v.*), moorhen (*q.v.*) and ocydrome. The "fin-foots" (Heliornis and Podica) show the extreme in adaptation to aquatic life in the development of a fringe round the toes (see COOT).

RAILWAY BENEFIT SOCIETIES: see FRIENDLY SOCIETIES.

RAILWAY EXPRESS AGENCY, INC., THE, was formed in 1929 by the Class I railroads of the United States to take over and carry on the express business formerly handled by the predecessor company, American Railway Express. It is a common carrier under jurisdiction of the Interstate Commerce Commission. Express is carried on approximately 10,000 passenger trains daily, and in 1938 the company handled 138,896,324 shipments. The air express service, established Sept. 1, 1927, transported more than 500,000 shipments wholly or in part during 1938.

The total mileage operated by the Railway Express Agency as of Dec. 31, 1938 was 281,384, including steam railroads, 205,015; electric lines, 2,685; transoceanic steamship lines, 5,366; coastwise steamship lines, 11,025; inland steamship lines, 4,178; airlines, 39,289; gas motor lines, 1,538. It has a vehicle fleet of 11,300 units, maintains approximately 23,000 offices (18,000 jointly with railroads) and employs approximately 57,000, including those employed jointly with railroads. See also EXPRESS.

RAILWAYS: In this article, railways are treated under the following heads:

A. History and development.
B. Engineering and general construction.
C. Economics.
D. Legislation.
E. The British railway groups.
F. The United States railroads.

For the development of railway engines, reference should be made to the article LOCOMOTIVE.

A. HISTORY AND DEVELOPMENT

The steam railway was a development of the wagon- or tramway frequently employed during the 16th, 17th and 18th centuries to haul minerals to rivers or ports, notably in the areas of the Clyde, the Tyne and South Wales. One of the most famous of these was the Sirhowy Tram-way incorporated in 1802. The invention of the steam engine induced Richard Trevithick (1771–1833) to design a steam engine mounted on wheels which generated sufficient power to move itself, in fact it became a locomotive. (See LOCOMOTIVE.) In 1802 it was tested on a circular track in London and two years later at Pen-y-darran near Merthyr, Wales, where it did not appear as a commercial success, and horse traction continued to reign supreme on the wagon-ways and tram-ways (see Section B). In 1811 John Blenkinsop (1783–1831) patented a design of rack railway, a toothed wheel on his locomotive working into a toothed rail beside the line as pinions work into a rack; this system proved successful on his Middleton colliery railway at Leeds, and is still employed in very different form on some of the world's mountain railways where very steep gradients are experienced. The following year William Hedley built two steam locomotives for the Wylam colliery near the Tyne, which trusted to their own weight for adhesion, and in 1814 George Stephenson (1781–1848) built his first locomotive.

The success Stephenson achieved enabled him to propose steam locomotives as the means of traction on the Stockton and Darlington Railway, projected in 1818, the first public passenger carrying railway in the world, which was opened Sept. 27, 1825. This railway, of single track with passing places every ¼m., was 38m. long and George Stephenson drove the first train, weighing about 90 tons, from Brusselton to Stockton; for some years the passenger traffic was carried by horse drawn coaches but these were finally withdrawn in 1833. Other early lines were the Kilmarnock and Troon, incorporated in 1808; the Gloucester and Cheltenham of 1809; the Plymouth and Dartmoor of 1819; the Stratford and Moreton of 1821; the Rumney; the Nantile, a plate-way in Carnarvonshire; the Cromford and High Peak; the Bolton and Leigh; and the Canterbury and Whitstable; all of 1825. The following year saw the incorporation of the Ballochney; the Edinburgh and Dalkeith; the Dundee and Newtyle; and the Garnkirk and Glasgow, all in Scotland, and the more famous Liverpool and Manchester in England. The Liverpool and Manchester is noteworthy because from the first it adopted locomotive power wholly as a form of traction, and was definitely built to carry passenger traffic as well as goods and minerals. Opened Sept. 15, 1830, it was 31m. long, with double line throughout, the average time for a passenger train to complete the journey was about 90 minutes and the average fare about 5s. In 1829 a contest had been arranged between various locomotive designers and the engines were tested at Rainhill, near Liverpool, George Stephenson's "Rocket" carrying off the prize of £500; other locomotives in the contest were the "Novelty" of John Braithwaite, and the "Sanspareil" of Timothy Hackworth. Both the "Rocket" and "Sanspareil" are preserved in the Science Museum, South Kensington, London. Great difficulties had to be overcome in the construction of the line through the opposition of the local landowners and of the canal interests, while the original cost was greatly increased owing to the difficulty of crossing Chat Moss, a large peat bog. Although the opening of the Liverpool and Manchester was marred by the fact that Huskisson (1770–1830), at that time one of the members of Parliament for Liverpool, was killed by one of the engines, the railway proved a great commercial success, with the result that railway projects were set on foot, not only throughout Great Britain, but on the continent pf Europe and in North America. The Carbondale and Honesdale line in Pennsylvania had used a British built steam locomotive, the "Stourbridge Lion," in 1829, while Stephenson sent to the Lyon-St. Etienne line in France, then about to be opened, two locomotives in the same year.

The British Main Lines.—Amongst the early British lines which were to form the great trunk railways of the later 19th century were the Grand Junction, which absorbed the Liverpool and Manchester; the London and Birmingham, incorporated in 1833; the Chester and Crewe; the Manchester and Birmingham, of 1837; and the Chester and Holyhead and the Lancaster and Carlisle of 1844.

The London, Midland and Scottish Railway.—These lines formed the nucleus of the London and North Western Railway (L.N.W.R.), which stretched from London (Euston Station) through Rugby, Stafford, and Crewe to Carlisle, with branches to Birmingham, Manchester, Liverpool, Holyhead, and through Central Wales. In Scotland, the L.N.W.R. worked closely with the Caledonian Railway (C.R.), a combination of the earlier Dundee and Perth, Scottish Midland, and Scottish Northeastern Railways. The Leicester and Swannington of 1830, together with the Birmingham and Gloucester, the Birmingham and Derby, the Midland Counties, the North Midland of 1836 and the Bristol and Gloucester of 1839, formed with other lines the Midland Railway (M.R.), as it was known prior to 1923. It stretched from London (St. Pancras) through Bedford, Leicester, and Derby to Leeds and Carlisle, with branches to Manchester, Bristol and York, in the shape of an X with its centre at Derby. The Scottish partner of the Midland was the Glasgow and South Western Railway, whose earlier title had been the Glasgow, Paisley, Kilmarnock and Ayr line. The great textile centres of Lancashire and Yorkshire were served for many years by an important railway of that name which resulted from a combination of the Manchester and Bolton of 1831 and the Manchester and Leeds of 1836. The present London, Midland and Scottish Railway (L.M.S.R.) is a combination of the London and North Western, the Midland, the Lancashire and Yorkshire, the Caledonian and the Glasgow and South Western railways, together with the smaller Furness, Highland, and North Staffordshire railways, in addition to many lines of purely local importance.

The Great Western Railway.—In the west of England I. K. Brunel's (1806–1859) broad gauge 7ft. railway, known from the time of its construction in 1835 as the Great Western Railway (G.W.R.), extended its sphere of activities through Somerset to Exeter by means of the Bristol and Exeter, and then by means of the South Devon, at one time worked atmospherically, to Plymouth and finally to Penzance. In South Wales it reached to Pembroke and later to Fishguard, a port for Ireland, while in the north it stretched to Birkenhead through Banbury, Warwick, Birmingham, Wolverhampton, Shrewsbury and Chester. The policy of amalgamation brought about by the Railways Act of 1921 (see Section D) did not alter the title of this line nor change its character as greatly as it did in the case of the other three railways, for the G.W.R. merely took over certain mineral lines serving the ports of South Wales, and one or two other railways, such as the Cambrian which served Cardigan Bay and the Midland and

South Western Junction line which ran southwards from Cheltenham to Andover.

London and North Eastern Railway.—The successful Stockton and Darlington Railway of 1825 naturally led to considerable railway construction in the north-eastern counties of England, and amongst the more important of these lines were the Newcastle and Carlisle, incorporated in 1829; the Leeds and Selby of the following year; the Whitby and Pickering of 1833; and the Hull and Selby, the York and North Midland, and the Great North of England of 1836. From these arose the erstwhile North Eastern (M.E.R.), which in turn took over the Stockton and Darlington, and gained almost complete railway monopoly of the country lying between the Humber and the Tweed, and stretched as far westwards as Leeds and Harrogate. Forming part of the "east coast route" to Scotland, the N.E.R. worked in close partnership with the North British (N.B.R.) in Scotland, whose ancestry dated back to the early Monkland and Kirkintilloch, the Edinburgh and Dalkeith, and the Ballochney lines. Centred on Edinburgh, the North British of 1844 gradually absorbed many small lines and finally ran from Berwick and Carlisle to Edinburgh, thence westwards to Glasgow, and northwards to Perth, Dundee and Montrose. North of Aberdeen was the Great North of Scotland (G.N. of S.R.), serving Elgin and many Scottish fishing ports.

On its southern boundary the N.E.R. worked in close harmony with the Great Northern (G.N.R.), opened in 1852 with its London terminus at King's Cross. This line with a main stem from London through Peterborough and Newark to just north of Doncaster formed the southernmost partner in the east coast route, but possessed also many branches serving Cambridge, Lincoln, Nottingham, Bradford, Leeds and Grimsby. In 1837 a small railway was incorporated known as the Sheffield, Ashton-under-Lyne and Manchester, which was destined to have a big future, under the title of the Manchester Sheffield and Lincolnshire. It gradually extended, eastwards to the Lincolnshire coast, and westwards to North Wales, while finally, like its neighbour the Midland, it effected an entry into London after much opposition from its rivals already established there, through Nottingham, Leicester and Rugby in 1899, changing its name to the Great Central (G.C.R.) in 1897. The London terminus is at Marylebone, which is reached by running alongside a London suburban railway, the Metropolitan.

The eastern neighbour of the G N.R. was the Great Eastern (G.E.R.), which resulted from a combination of Braithwaite's Eastern Counties, incorporated in 1836, with the Northern and Eastern and the London and Blackwall lines of the same year. By combination with the Eastern Union and the Norwich and Brandon, both of 1844, and many smaller lines, the G.E.R. obtained an almost complete monopoly of railway transport in East Anglia, and by means of a joint line with the G.N.R. spread northwards to Doncaster through Spalding, Lincoln and Gainsborough. Since 1922 the North Eastern, North British, Great North of Scotland, Great Northern, Great Central, and Great Eastern railways together with certain small lines, notably the Hull and Barnsley, have been combined and now form the London and North Eastern railway (L.N.E.R.), the second largest British system.

***The** Southern* Railway.—South of London there were combined to form the Southern Railway (S.R), by the Railways Act of 1921, three important railways, namely, the London and South Western (L S.W.R.); the London, Brighton and South Coast (L.B. & S.C.R.); and the South Eastern and Chatham railways (S.E. & C.R.). The L.S.W.R. began as a line from London to Southampton, incorporated in 1834, though what were destined later to be parts of this line were the Bodmin and Wadebridge in Cornwall which dated back to 1832, and the Taw Vale of 1838; it gradually covered the area between London, Southampton and Exeter, reaching Plymouth through North Devon and terminating at Bude and Padstow in Cornwall. By means of a joint line with the Midland it reached Bath, and came into contact with the Great Western at Weymouth, Reading, Exeter and Plymouth. At Portsmouth on the east it met the L.B. & S.C.R. which had originated in the London and Croydon line incorporated in 1835, and the London and Brighton of 1837. The former is of interest as it was at one time worked on the atmospheric system. By this method of propulsion power was derived from atmospheric pressure contained in a large diameter tube placed between the rails. A vacuum being formed ahead of the train, the carriages were propelled by the pressure behind; owing to leakages the system was not a success. The territory of the L.B. & S.C.R. covered roughly a triangle between London, Hastings and Portsmouth, with Brighton near the centre of the base line. At Tunbridge Wells and Hastings it maintained contact with the S.E. & C.R. In this latter case there was a managing committee (1899) to operate what were in reality two separate railways, the London, Chatham and Dover, and the South Eastern. The violent competition between these two railways led to a position such that practically every important town in Kent was served by both companies, and such a degree of competition was disastrous to the financial position of both. An early portion of the South Eastern was the London and Greenwich opened in 1836, with its London terminus at London Bridge, reaching the latter over 900 brick arches.

British Mileage.—Thus there are to-day, four great British railway systems, the L.M.S.R., the L.N.E.R., the G.W.R., and the S.R., each built up of many small lines, as the above brief outline illustrates. The commercial success of the Stockton and Darlington and the Liverpool and Manchester railways resulted finally in the railway mania of 1844–46, after which ensued the financial crisis of 1847 and a keen desire to obtain the economies of railway amalgamation. Though the Houses of Parliament throughout the 19th century based their railway policy mainly on the necessity of keeping competition alive, the World War of 1914–18 finally broke down that policy and created a complete reversal of it in the Railways Act of 1921, which forcibly amalgamated practically all the railways into the present four great systems, in certain cases amalgamating lines which had been refused permission to do so some years before (see Sections D and E). Other than the four big railways there exist certain lines jointly owned, such as the Cheshire Lines Committee, to the extent of two-thirds L.N.E.R., and one-third L.M S R.; the Midland and Great Northern, half L.N.E.R. and half L.M.S.R.; and the Somerset and Dorset, half S.R. and half L.M.S.R. In the London area there is a group of electrified passenger traffic lines (see Sec. B), mainly constructed in tunnels and known collectively as the Underground, while there is also the Metropolitan, a line electrified within London itself but still worked by steam traction north of Rickmansworth; in 1933 these, with other public passenger-carrying undertakings in the London area, were amalgamated under the London Passenger Transport Board. Lastly there are certain small light railways in various parts of Great Britain, some of a gauge narrower than the standard of 4ft. 8½in., notably the Eskdale line in the Lake District, the Romney, Hythe and Dymchurch line in Kent and certain lines in North Wales, as the Snowdon Mountain railway are examples of the rack rail system. The steady growth of the British railways is seen in the following mileage statistics:

	Miles		*Miles*
1825	26	1890	20,073
1844	2,236	1900	21,855
1850	6,635	1910	23,387
1860	10,410	1920	23,734
1870	15,310	1926	20,395*
1880	17,935	1933	20,251*

*Not including Irish Free State.

Since 1890 there have only been comparatively small additions to the railway mileage, route mileage taking no account of the presence of second, third or fourth tracks, but widenings have taken place and the figures for track mileage, which measures all tracks and converts them to a basis of one track only, are: in 1913, 36,448 miles; in 1933 (including sidings), 52,900.

Railways of Continental Europe: France.—The first railway in France, opened in 1827 from Saint-Etienne to Andrézieux, was like early British lines mainly for the haulage of coal. Of single track, it used horse traction, and did not carry passengers until 1832; the Saint-Etienne-Lyon line of 1830 used steam locomotives from its opening. In 1833 the French Government began to encourage railway construction and amongst the earlier lines authorized were those from Paris to Saint Germain and Versailles. By 1842 the French railways totalled 360 miles, but an Act of the same year provided for the construction of lines which were later to form the great trunk railway routes from Paris to Nancy and Strasbourg, Lyon and Marseilles, Bourges and Toulouse, Tours, Bordeaux, Bayonne and Nantes, Rouen and Havre, and, finally, Lille and Belgium. In addition were cross country routes from Bordeaux to Marseilles, and Dijon to Mulhouse; thus, by Jan. 1, 1852, 3,125 route miles had been authorized and 2,185 were being operated. Rapid development occurred during the Empire, while the leases granted to the private companies to operate the railways were to last 99 years, and the companies operating in any one territory were amalgamated to reduce competition. By 1870, 16,685m. were authorized of which 11,250 were being operated, figures which by 1875 had become 21,375 and 13,562 respectively; soon afterwards a State operated system was created which was later destined to take over the Ouest Railway. The total mileage of the big French railways in 1902 was 26,375. The French railway net consists of 7 large systems: the Paris-Lyon-Méditerranée, the Paris-Orléans, Midi, the Est, and the Nord, which are companies operating under the terms of a long lease. In addition there are the État (*i.e.,* the State) and the Alsace-Lorraine railways, the latter becoming French national property as a result of the World War (1914–18). Each system is practically a rail monopoly in its own territory. As well as the 7 large railways there is an important mileage of narrow gauge lines of local importance only, which in Great Britain would be termed light railways.

Germany.—In Dec. 1835 the first German railway was opened between Nuremburg and Fiirth. Thanks to Friedrich List a systematic plan of German railway construction was designed, but the independence of the different States somewhat interfered with this programme. It is curious that uniformity of gauge resulted from the importation of British locomotives and rolling stock. The first inter-State line was that from Magdeburg in Prussia to Leipzig in Saxony, opened in 1840, and as early as 1847 an association was formed of German railway administrations. Strict State control was exercised throughout the period of rapid construction commencing in 1846 and by 1855 5,410m. had been completed. An important characteristic of German railways has been, from the first, the large part played by international traffic; a second characteristic has been the great degree of State construction and ownership. The first State line was opened in Brunswick in 1838; by 1855 throughout Germany nearly 50% of the railway mileage was State owned. The Prusso-Austrian War of 1866 strengthened the Prussian railway system, as also did the Franco-German War of 1870, and by the latter year the main trunk network was largely complete, though few branch lines had been constructed. The lines of the French Est railway in Alsace and Lorraine became the property of the German Empire in 1871, while 1873 saw the establishment of an Imperial Railway Department. From 1876 onwards the privately owned railways were gradually absorbed by the State, Prussia acquiring the Berlin-Stettin and Cologne-Minden lines amongst many others by an Act of 1879. Thus by 1885 private railways in Prussia were practically non-existent. Bavaria had always favoured State railways and finally bought up the Pfalz railway in 1908. Saxony had adopted the same policy and took over the Leipzig-Dresden line in 1876. In Hesse-Darmstadt, the Hesse-Ludvig railway became State owned in 1896, the Mecklenburg railways being purchased by the State in 1889. Oldenburg, Wiirtemburg and Baden owned and operated their railways from the first; 1885–1900 saw great developments in local lines, many of which may be regarded as light railways. Thus by 1900 the total route mileage of standard gauge lines in Germany was 31,205, and 1,125m. of narrow gauge. The total route mileage in 1909 was 35,625. In 1920 the various German State railways became the property of the Reich, but in 1924 consequent on the recommendation of the Dawes Peace Plan, their status was altered to a company basis, so far as operation was concerned, on a lease of 40 years (see SECTION D).

Other European Railways.—State owned railway systems exist in Russia, Italy, Switzerland and Denmark, dating back to the 'forties, in Sweden, Norway and Portugal, dating back to the 'fifties and in Turkey and Greece to the 'sixties of last century, although State ownership and operation usually came many years after the opening of the first lines. Belgium possesses a State owned system, leased for 75 years from 1926 to an operating National company; in Spain, where railways date back to 1848, the lines are mainly company operated but closely connected with the State, as is the case with the Nederland Railway in Holland, which goes back to the '30s. Rumania, Czechoslovakia, Bulgaria, Yugoslavia and Austria all own and operate their systems, but in the case of Austria the railway balance sheet is kept separately from that of the State budget. In the majority of cases small private lines also exist but they are usually only local in importance.

The European railway mileage at the end of 1934 may be seen in the following table based on a compilation made by the Archiv für Eisenbahnwesen (translated by the Bureau of Railway Economics at Washington). Other railway mileage tables in this article are based on the same source.

European Railway Mileage

Country	Miles of line at end of year 1934	Miles of line in 1934 per 10,000 population
Austria	4,174	6·1
Belgium	6,372	7·9
Bulgaria	1,917	3·1
Czechoslovakia	8,649	5·9
Denmark	3,326	9·4
Estonia	899	8·0
Finland	3,463	9·4
France	33,282	8·0
Germany	36,426	5·5
Great Britain	20,409	4·5
Greece	1,980	3·2
Hungary	5,935	6.8
Irish Free State	2,660	9·0
Italy	14,310	3'5
Latvia	1,836	9'7
Lithuania	1,152	4·7
Luxemburg	342	11·4
Netherlands	2,313	2·9
Northern Ireland	754	6·0
Norway	2,407	8·6
Poland	13,402	4·2
Portugal	2,129	3·1
Rumania	7,506	4·0
Russia (incl. Asiatic)	51,800	3·1
Spain	10,350	4'3
Sweden	10,890	17·7
Switzerland	3,740	9·2
Turkey (European)	210	1·5
Yugoslavia	6,500	4·7
Total (incl. Asiatic Russia)	235,719	Average 6.4

Railways **of North** America.—Apart from the railways of the United States, which are dealt with in a separate section (see Section F), the two great systems of North America are the Canadian National and the Canadian Pacific. The Canadian National resulted from an amalgamation of the Grand Trunk, the Grand Trunk Pacific, the Canadian Northern, the National Transcontinental and other smaller railways. St. Johns, Quebec, saw the opening of the first railway in 1836, horse traction giving way to steam engines the following year, but the Grand Trunk resulting from an Act passed in 1851 may be said to commence the railway era in Canada, the Montreal to Toronto line having been completed in 1856. Stretching from Halifax, N.S., to Vancouver and Prince Rupert, and serving Moncton, N.B., Montreal, Toronto, Ottawa, Windsor, Winnipeg, Saskatoon, Regina and Calgary, its enormous route mileage of 23,750, the second largest in the world, is administered from Montreal with regional headquarters at Toronto, Moncton and Winnipeg, whilst its extensive lines in the United States, worked from Detroit, known as the Grand Trunk Western, stretch across Michigan from Detroit to Chicago; it also reaches New London, Conn., and Portland, Me.

The Canadian Pacific Railway was formed in 1881 and took over about 700m. of railway built by the Government, in addition to a capital grant of over £5,000,000 together with a temporary loan and 25 million acres of land. In return it was to construct a transcontinental railway from Montreal to Vancouver, which was completed in May, 1887. Many famous figures are connected with its early development, notably Lords Strathcona, Mountstephen and Shaughnessy, and Sir William Van Home. Controlling the Dominion and Atlantic line in Nova Scotia, and the Minneapolis, St. Paul and Sault Ste. Marie which terminates at Chicago, its lines stretch from St. John, N.B., to Vancouver; steamer services connect St. John with Nova Scotia and Vancouver with its Vancouver Is. lines at Victoria. Its main trunk line serves Fredericton, Quebec, Montreal, Ottawa, Toronto, Windsor, Winnipeg, Regina, Saskatoon, Edmonton and Calgary; it also operates steamer routes on the Atlantic and Pacific Oceans. A very prosperous railway, it owns 21,234m. of line inclusive of controlled lines; its growth and commercial success have been interlocked for many years with the growth and prosperity of Canada and the Canadian nation. The remaining lines in Canada and Newfoundland are comparatively short and of only local importance, but railway construction continues northwards, chiefly in the provinces of Quebec, Manitoba, Alberta and Ontario.

The Mexican railways are mainly of standard 4ft. 8½in. gauge, and include sections of such American railroads as the Southern Pacific, and Kansas City, Mexico and Orient. The biggest system is, however, that of the National Railways, which includes a considerable mileage of 3ft. lines. It operates the mileage of this gauge for the Interoceanic, Mexican Southern and Mexican Eastern Railways, while the standard gauge Mexican Railway is a line controlled from London.

North American Railway Mileage

Country	Miles of line at end of year 1934	Miles of line in 1934 per 10,000 population
Canada	47,010	45·4
Costa Rica	416	8·5
Cuba	3,043	7·6
Dominican Republic	149	1·6
Guatemala	509	2·5
Haiti	176	0·7
Honduras	922	10·8
Jamaica	210	2·4
Mexico	19,288	11·6
Newfoundland	965	34·0
Nicaragua	150	2·5
Panama	210	4·5
Porto Rico	335	2·2
Salvador	385	2·6
United States (incl. Alaska)	258,465	21·0
Total	332,233	Average 10·9

Railways of Asia.—India possesses a very extensive railway system mainly constructed to the 5ft. 6in. and the metre gauges. The railways are divided into three classes based upon the gross earnings in any one, a similar method to the Class I. and Class II. systems of the United States. There are 16 Class I. lines, earning Rs. 50 lakhs or over per annum, of which the largest are the Great Indian Peninsula, the East Indian, the Bombay, Baroda and Central India, the North Western, the Bengal and North Western, the Bengal-Nagpur, the Eastern Bengal and the Madras and Southern Mahratta. Many of these lines are purely operating companies, the railways being owned by the Indian Government, and as the leases run out are taken over wholly by the State. Thus the East Indian, serving Calcutta, Allahabad, Agra and Delhi, the first section of which was opened in 1854, was taken over Dec. 31, 1924, being later amalgamated with the Oudh and Rohilkhund, serving Benares and Lucknow, also taken over. The Great Indian Peninsula serving Bombay, Agra, Delhi and Cawnpore. has been worked by the Government from June 30, 1925, while the North Western, with headquarters at Lahore and serving the port of Karachi, in view of its strategic nature has for many years been a State railway. The Bengal and North Western, serving Lucknow, Benares and Allahabad, includes the Tirhut State Railway, and is owned and operated by a company; while the Bengal-Nagpur, stretching from Nagpur to Calcutta, possesses a contract which will not lapse for some years. The Bombay, Baroda and Central India is also operated by a company and possesses an important metre gauge system, as do the Madras and Southern Mahratta and the South Indian. The Eastern Bengal, however, possesses lines of several gauges and is a State system, as is Burma Railways, which were company operated till the end of 1928.

Ceylon has possessed a railway system since 1865. The railway network of the Federated Malay States is based on Kuala Lumpur. Railways also exist in Iraq, Palestine, Turkey in Asia, North Borneo, Dutch East Indies, Indo-China and the Philippine Is. The State railways of Siam are of metre gauge and over 1,900m. in length. In Siberia are long mileages of Russian railways, built to the 5ft. gauge, while a narrow gauge line exists in Cyprus. China possesses State and company owned railways; the former Chinese Eastern. now North Manchurian. was transferred to Japan and Manchuria, March, 1935; the South Manchuria has been Japanese since 1906. Hongkong possesses a standard gauge railway. Next in importance to India among Asian railways stands Japan, with a State owned and operated system of the 3ft. 6in. gauge, with mileage of nearly 9,500. The first section was opened in 1872; during the succeeding 20 years privately owned lines grew side by side with the State railways, but by 1887 only 240m. of railway had been constructed. Between 1897 and 1906 a considerable reduction took place in the number of privately owned lines, but they had been responsible for the construction of over 3,200 miles. In 1906 when the route mileage was almost 4,800 a railway nationalization bill was passed and nearly £50 million paid for over 2,800 miles. In 1927 the Japanese Government Railways had 200,000 employees; in addition there were 4,900m. of privately owned lines. A feature of the Japanese railway system is the use of ferry steamers for connecting up the islands over which the railway system spreads; some of these steamers are train ferries.

Asian Railway Mileage

Country	Miles of line at end of year 1934	Miles of line in 1934 per 10,000 population
Arabia, Syria and Cyprus	1,106	8·4
British India	42,961	1·4
Ceylon	951	1·8
China	5,250	0·1
Cochin China, Cambodia, Annam, Tonkin	1,699	0·8
Dutch East Indies	4,617	0·8
Japan (incl. Korea, Formosa, and Kuantung)	16,670	1·8
Malay States	1,067	6·5
North Borneo	125	4·6
Palestine (incl. Hejaz and Sinai Sections)	756	3·0
Persia	460	0·5
Philippines	857	0·8
Pondicherry	43	2·0
Portuguese India	51	0·9
Russia (incl. European)	51,800	3·1
Siam	1,930	1·7
Turkey (Asiatic)	3,519	3·5
Total (incl. Eur. Russia)	133,862	Average 2.45

Railways of Africa.—The most important railway system in Africa is that of the South African Railways and Harbours Administration, a Government owned and operated system of 3ft. 6in. gauge in the Union of South Africa. In 1860 a standard gauge 4ft. 8½in. line was opened at Natal, followed by a line of similar gauge between Cape Town and Wellington, but by 1870 less than 70m. had been completed. By 1881 the gauge had been changed to 3ft. 6in. and Cape Colony and Natal had commenced State ownership. Kimberley could be reached by rail in 1885 and Bloemfontein in 1890, the Orange Free State taking control of this section in 1897, the year when the railway first reached Bulawayo. In 1902 there were 4,900 route miles of railway in what is now the Union of South Africa, and when the railways were amalgamated under the Union Government the mileage amounted to over 7,000, which had increased to 9,600 in 1920, and to 12,200 in 1927, including the New Cape Central Railway absorbed in 1925 and the railways in South West Africa. In addition there exist over 400m. of private railways in South Africa. The 600m. line northwards from Vryburg to Bulawayo, Southern Rhodesia, through British Bechuanaland, is also administered by the S A.Rlys., while the main ports are operated by the same organization; thus competition between ports is eliminated and the closest coordination obtained with the railway working.

The Rhodesian Railways of 3ft. 6in. gauge, consistng of several companies, operate lines from Bulawayo north west through Victoria Falls, Broken Hill, to the Belgian Congo border, and north east through Salisbury to the port of Beira in Portuguese East Africa. From Beira there runs north the 3ft. 6in. gauge Trans-Zambesia Railway, terminating at Murraça on the Zambesi; from Chindio, on the opposite bank, commences the 60m. Central Africa Railway, which connects with the more important Shiré Highlands line at Port Herald. Both these lines are 3ft. 6in. gauge, and the latter runs through Blantyre in Nyasaland and terminates at Domira Bay on the west shore of Lake Nyasa; thus, excepting the crossing of the Zambesi, there is through rail connection from Cape Town to the lake itself. North of Nyasaland run the metre gauge Tanganyika Railways, westwards from Dar-es-Salaam to Kigoma and Mwansa; a further line runs westwards from Tanga to Arusha. Near Moshi connection is made with the Kenya and Uganda Railway; this latter line, of metre gauge and over 1,000 route miles long, is based on Mombasa and penetrates to Kisumu, Uganda, on Lake Victoria, with many important branches as well as lake, river and motor services. Northwards to the Sudan Government line at El Obeid there is no railway connection. The Sudan system, of 1,725 miles of 3ft. 6in. gauge, stretches north through Khartoum to Halfa, whence Nile steamers offer connection with the Egyptian Railways near Assouan. Sudan railway branches stretch to Kassala, Port Sudan and Kareima.

The metre gauge Franco-Ethiopian line runs from Djibouti to Addis Ababa in Abyssinia, while small lines exist on the islands of Madagascar, Mauritius and Reunion, and on the mainland at Lourenço Marques, Quelimane, Lindi, Mozambique and Massawa in Eritrea, the last named an Italian State Railway, as are two small lines at Tripoli and Benghazi. In Morocco, Algeria and Tunisia there exist several railways of the 4ft. 8½in. and metre gauges, of which the most important are the Algerian State system of nearly 2,000m. and the Paris-Lyon-Méditerraneé African lines of 750m. On the west coast of Africa railway systems serve the ports of Dakar, Konakry, Freetown, Bingerville, Sekondi and Lome. The 3ft. 6in. Nigerian Railway system, based on Lagos and Port Harcourt, extends about 1,675m. to Nguru near the French West African border, while various small lines serve Brazzaville, Leopoldville, Matadi, St. Paulo de Loanda, Benguella and Mossamedes. In the Belgian Congo a 3ft. 6in. line (having connection with the line from Benguella) runs northwards from Ndola on the Rhodesian frontier to Port Francqui, and isolated railways serve Stanleyville and Albertville.

Railways **of South** America.—The most important railways of South America have been constructed in Argentina, largely with British capital, and in certain cases possessing close connection with Great Britain. On Buenos Ayres are based the 5ft. 6in. gauge Central Argentine, 3,442m.; Buenos Ayres Great Southern, 5,075m.; Buenos Ayres and Pacific, 2,806m.; and Buenos Ayres Western, 1,926m.; while from Rosario southwards to Puerto Belgrano runs a railway (513m.) of that name. The first named stretches as far north as Tucuman, while the Chilean traffic is handed over to the Transandine line at Mendoza, near the Chilean Border. The 4ft. 8½in. gauge is represented by the Argentine North Eastern, and Entre Rios, together 1,563m., and the Buenos Ayres Central, 292m., the first of which reaches north as far as Corientes and Posadas on the Paraguay border. Important sections of metre gauge lines exist in Argentina, notably the 1,218m. Cordoba Central, reaching Tucuman through Cordoba; the Buenos Ayres Midland, 320m.; and the Argentine State system, 3,520m., which also possesses some mileage of the 5ft. 6in. gauge. The Transandine Railway (888m.) is metre gauge through its two sections, Argentine and Chilean, though connecting with the wider gauge lines at its termini. It reaches a height of 10,452ft. above sea-level; certain of the steepest sections of line were worked on the Abt rack rail system, but electrification permits (1929) the elimination of the rack.

In Chile the State Railways possess 3,100 route miles, with the 5ft. 6in. gauge running from Puerto Montt through Pueblo Hundido to Chanaral, north of which is the metre gauge Northern system, State owned, which runs almost to Iquique, situated on the Nitrate Railway, as is also Pisagua. The Transandine line joins the south to north stem almost due east of Valparaiso, while the Arica-La Paz line crosses Chile to enter Bolivia as does the narrow gauge Antofagasta-Bolivia Railway with nearly 600m. in Chile and 320 in Bolivia. This latter company leases and works the Bolivia Railway lines serving Atocha, Potosi, Viacha and Cochabamba. Amongst other Chilean lines may be mentioned the Taltal Railway of 164 miles. In Peru are the Central of Peru, (298m.) serving Lima from Oroya, and the Southern Railway of 550m., running between Cuzco and Mollendo, both lines of standard gauge 4ft. 8½in.; a few other lines exist, some of narrow

African Railway Mileage

Country	Miles of line at end of year 1934	Miles of line in 1934 per 10,000 population
Abyssinia	487	0·9
Algiers and Tunis	4,287	6·4
Angola	1,425	4·6
Bechuanaland	425	27.8
Belgian Congo Colony	2,900	3·1
British Central Africa (Nyasaland)	174	1·1
British East Africa (incl. Zanzibar)	1,718	2·5
Egypt (incl. Sudan)	5,230	2·2
Equatorial Africa	318	1·0
French West Africa	2,800	2·0
Gold Coast	490	1·5
Kamerun	314	1·4
Madagascar	430	1·2
Mauritius	144	3·7
Morocco	1,690	3·2
Mozambique	765	1·9
Nigeria	1,772	0·9
Reunion	79	4·0
Rhodesia	2,211	8·8
Sierra Leone	330	2·1
Tanganyika	1,370	2·7
Togoland	261	3·5
Union of South Africa	13,130	15·0
Total	42,750	Average 4·4

South American Railway Mileage

Country	Miles of line at end of year 1934	Miles of line in 1934 per 10,000 population
Argentina	28,882	38·0
Barbados	24	1·5
Bolivia	1,390	8·3
Brazil	22,280	7·3
British Guiana	79	2·5
Chile	5,542	13·0
Colombia	1,513	1·9
Dutch Guiana	108	6·7
Ecuador	761	2·9
Paraguay	669	7·7
Peru	2,805	1·4
Trinidad	150	3·6
Uruguay	1,730	16·5
Venezuela	670	2.2
Total	66,603	Average 8·1

gauge. Colombia possesses nearly 2,000m. of railway, Venezuela nearly 700 and Ecuador over 700m., whilst Dutch and British Guiana both possess small railway mileages. Paraguay possesses a standard gauge Paraguay Central (274m.) based on Asuncion, whilst Uruguay has company and State-owned lines, all of standard gauge, totalling about 1,660 route miles. Brazil can boast of four important metre gauge railways of over 1,000 route miles, of which the biggest is the Leopoldina based on Rio de Janeiro; a second, the Great Western of Brazil based on Recife, carries much cane sugar. The San Paulo and Central of Brazil are two important lines built on the jft. 3in. gauge, the former serving the port of Santos and the latter Rio de Janeiro, while the Paulista Railway possesses both metre and 5ft. gin. gauge mileages.

Railways of Australasia. — The railways of Australasia are almost without exception government-owned systems, a feature of many newly developed countries where private capital is not easily available to construct new railways, which must be built before the hinterland is settled and brought into agricultural production. The first line was, however, opened as a result of private enterprise in 1854 in the vicinity of Melbourne, Victoria; almost all the private lines in Victoria were taken over by the government in 1878 and form the nucleus of the Victorian Government system centring on Melbourne. By 1910 the State possessed nearly 3,400 route miles of 5ft. gin. gauge acquired or constructed at an average cost of £12,550 per mile. The Victorian Railways connect at Albury with the New South Wales 4ft. 8½in. gauge system, dating back to 1855, from which date practically all railway mileage in this State has been government owned; thus all goods by rail between Melbourne and Sydney or the North must be transhipped. In 1910 the New South Wales system consisted of 3,650 route miles, having cost £13,430 per mile on the average. The N.S.W. railway network is based on Sydney; besides serving Newcastle and Canberra, it also makes contact with the South Australia system at Broken Hill, and in the north runs through Queensland territory into Brisbane. The mileage of the 3ft. 6in. Queensland Govt. railways is very great per head of population and consists of a long coast line route between Brisbane and Cairns, with long westward branches to Cloncurry, Winton and Quilpie. The first line was opened in Queensland in 1865. Exchange traffic with the New South Wales system is transhipped either at Brisbane or at Wallangarra. The Queensland route mileage in 1920 was 3,660 and had cost £6,648 per mile, but the mileage has since been extended to over 6,600. The South Australian Government railways possess mileages of line built to the jft. 3in. and the 3ft. 6in. gauges, and in 1910 the former extended to over 600 and the latter to over 1,300 route miles; as illustrating the difference in cost created by the variation in gauge, the former cost £11,136 per mile and the latter only £5,892 per mile. The earliest line in South Australia was opened in 1856 at Adelaide, in the neighbourhood of which city the lines are of the broader gauge, while the northern lines are of the narrow gauge. The main tranship point between the two gauges is at Terowie and at Broken Hill with the New South Wales lines, — there being no break of gauge between Adelaide and Melbourne.

From Port Augusta in South Australia the 4ft. 8½in. standard gauge Transaustralian line, built and operated by the Commonwealth, runs westwards to Kalgoorlie in Western Australia, through traffic being operated in 1917 over this 1,050 mile line, which possesses a stretch of zoo miles without a curve. At both termini there is a break of gauge, for Kalgoorlie is on the 3ft. 6in. Western Australian system, the first line of which was opened in 1871 at Locksville. Perth did not obtain railway facilities until 1881. The early railways due to private enterprise were acquired by the Government in 1896, although there remain two private company railways, namely the Jarrah Belt and the Midland Railway Companies' lines, also of 3ft. 6in. gauge in Western Australia. By 1910 the Western Australian Govt. owned and operated 2,144 route miles which had cost £5,305 per mile, but since then the mileage has increased to over 5,000. In North Australia exists a 3ft. 6in. gauge railway running southwards from Darwin towards Daly Waters, constructed for development purposes and owned and operated by the Commonwealth. Presumably this line will gradually be extended in the form of a north to south transcontinental track to join the 3ft. 6in. Oodnadatta Railway already owned by the Commonwealth, which now runs from Port Augusta to Alice Springs. The problem of the Australian railways is primarily one of a difference of gauges, for transhipment of passengers and freight is expensive, not only in money but in time.

Tasmania possesses a Govt. owned gft. 6in. gauge system of 650 route miles centred on Hobart, though this city obtained its first railway in 1876, five years after Launceston, the other Tasmanian port. The Government acquired the Launceston and Western Railway in 1872 and by 1910 the system had grown to 445 miles and had cost £8,860 per mile. There also exists in Tasmania the small Emu Bay Railway. The New Zealand Government Railway system, which adopted the 3ft. 6in. gauge in 1869, extends to 3,500m. divided between the North and South Islands, in both of which the first railways were opened in the '60s. It was not until 1895 that the policy of State ownership became pronounced; since then the State system has absorbed all railways of importance in New Zealand. The New Zealand railways prove a difficult operating problem in that many of their lines are unconnected and heavy expenditure and difficult construction work will be required to weld the system together, although much progress has been made since the war period 1914–18. Having to traverse mountain ranges, the railways have had to construct long tunnels and to operate over very heavy gradients.

Australasian Railway ***Mileage***

	Miles of line at end of year 1934	Miles of line in 1934 per 10,000 population
Australian Commonwealth Government Railways	2,144	3·2
New South Wales	6,197	24·0
North Territory (included in Government Railways above)		
Queensland . . .	6,669	70·5
South Australia . .	2,529	43·6
Tasmania . . .	770	34·0
Victoria	4,721	26·0
Western Australia .	5,055	115·0
Hawaii (incl. Mawi and Oahu)	371	10·1
New Caledonia . .	19	3·3
New Zealand . .	3,483	25·9
Total. . . .	31,958	Average 38·0

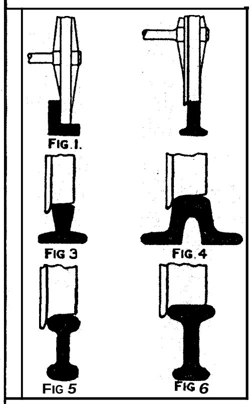
Railway Accidents. — In Great Britain and many other countries statistics are regularly published concerning the number of accidents occurring from the operation of railways. In general the casualties are divided into those suffered by passengers or employees and fatal or non-fatal accidents. Additionally, in Great Britain legislation (see Section D) has been passed ordering the railways to report accidents occurring to trains, but not necessarily resulting in injury to persons; and enquiries are held by Government Inspecting Officers, primarily in order to make recommendations to the railways so that similar occurrences may, so far as is possible, be avoided in the future. Great care must be exercised in any comparison between the railway accident statistics of various countries, the basis of compilation being different in almost every case, while frequently accidents which are reportable in one country would not be reportable in another. Difficulties also arise as to whether accidents between road vehicles and railway trains, as for instance at level crossings, should be included in the statistics of railway accidents or not. In certain countries figures are also available which show the casualties incurred not as a result of railway operation but which have taken place on railway property. In dealing with statistics of railway accidents the number of casualties should also be studied in relation to the amount of work done in the movement of passengers or freight, taking as an index the number of passengers or tons of goods carried in any one year, or the number of train miles operated by the railway.

The British railways have earned for themselves an enviable reputation for safety in view of the high average speed of the passenger trains, a position which has been obtained largely through very heavy capital expenditure ever since their original construction in the form of signalling equipment (see Railway *Signalling*, p. 950), very complete fencing of the track, raised platforms at stations and close and detailed examination of all rolling stock and locomotives. Strict Government regulation of railway construction coupled with the medical examination of employees have also assisted in attaining a very high safety record. In recent years also much stress has been laid upon the "Safety First" campaigns universally employed, not only in Great Britain but on many railways elsewhere, notably in Canada, South Africa, the United States and Germany. Campaigns of this nature have done meritorious work in reducing the number of accidents amongst employees as well as passengers, while the attention given by the British lines to ambulance work receives witness from the numerous competitions on each railway for challenge shields given to the most efficient ambulance team.

It will be seen that collisions and derailments are the main causes of train accidents. Both are preventable but the former, with the highly intricate signal devices which have been installed, are usually a result of a human failure or of the coincident failures of more than one piece of mechanism. Derailments may be due to an error of judgment resulting, for instance, in excessive speed on curves or mechanical defect in the train itself or a failure in the track. The most serious British railway accidents during the last sixty years were the collision of the L.N.W.R. Irish mail train with some wagons of petroleum at Abergele on Aug. 20, 1867, when 33 persons were killed; on Dec. 28, 1879, a North British Railway train was blown off the Tay Bridge and 73 persons were drowned; on July 1, 1906, a L.S.W.R. express was derailed owing to excessive speed at Salisbury, 28 persons being killed; and through a similar accident at Shrewsbury the following year, 18 lives were lost. The most terrible British railway accident occurred on May 22, 1915, on the Caledonian Railway at Gretna, when 2 passenger trains and a troop train special collided, with a loss of 227 lives, nearly all soldiers in the troop train. On Jan. 26, 1921, a head-on collision occurred in a single line section of the Cambrian Railway, 17 persons being killed, while later serious accidents are—a collision at Hull in Feb. 1927 on the L.N.E.R., and another at Darlington on the same line in June 1928. In the former 12 lives were lost, and in the latter 25. There has been a steadily decreasing trend of accidents over the last 70 years, although for a time after the war failures of material due to delayed repairs caused an increased number of breakages of couplings and similar parts. The Continental railways of Europe especially France and Germany suffered even more heavily in this respect owing to still greater arrears of maintenance, but this condition of affairs is being rapidly improved.

B. ENGINEERING AND GENERAL CONSTRUCTION

Track **or Permanent** Way.—The desire to move heavy minerals such as stone and coal more easily than by road led to the employment of "wagon-ways" in Great Britain during the 17th century. These "wagon-ways" merely consisted of wooden planks laid on the ruts caused by the cart wheels, but they enabled much greater loads to be hauled by horses, at that time the source of motive power. It soon became necessary to hold these planks in their proper position by means of sleepers or cross-ties, a name still used in America. Owing to the rapid wear of the planks it became the custom to cover them with metal plates, or strips, usually of iron, while the sleepers were covered with earth to prevent damage from the horses' hoofs. The use of metal on the planks in its turn created undue wear on the wooden wheels of the wagons, mainly of the chaldron type still visible on Tyneside; consequently iron wheels were adopted. Growth of traffic caused the strips to work loose, with the result that attempts were made to cast iron rails in 1767 at Coalbrookdale Iron Works. These rails were of the L type, namely a flat plate with a vertical section on the inner side to prevent the wheels from running off the rails (fig. 1). They were usually spiked to the wooden cross-ties, although in some cases they were mounted on stone blocks to reduce the wear on the cross-ties, which in that case were placed at much less frequent intervals. Plate rails of this type were used by Benjamin Outram on the Ticknall Tramway in 1799, and similar rails were used on the Surrey Iron Railway of 1801 and the Silkstone Railway of 1809. In order to hold the rail in position some of these plate rails were ⊢ shaped. In the north of England the edge type of rail (fig. 2) was preferred and became the prototype of the present railway rail. With the edge-rail the wheel rested on the top, with a flange to hold it to the rail designed as part of the wheel, and not as part of the rail, and running inside the latter. Blenkinsop's railway at Leeds in 1812 used rails of the edge type weighing 40lb. per yd., mounted upon pedestals. With the coming of steam traction the edge rail was almost universally adopted, except where the railway was of a tramway type designed to run along the highway. Cast iron rails of this date were usually about 3ft. long and were not connected at the ends. George Stephenson used the "half-lap" joint on his Killingworth Railway and, later, for the Stockton and Darlington line employed malleable iron rails weighing 28lb. per yd. The wrought iron edge-rail, often of the "fish bellied" type, was mainly used during the 'thirties of last century. In the case of the Liverpool and Manchester line it weighed 35lb. The pedestal of 1812 became the chair of the Liverpool and Manchester, which was spiked to the cross-ties and the rails wedged by compressed wooden keys into the chairs. On this line fish bellied rails gave place to parallel rails, namely, those of uniform cross section for all their length.



FIGS. 1–6.— RAIL TYPES **(1) Plate-rail, (2) edge-rail, (3) flat-bottomed rail, (4) bridge-rail, (5) double-headed rail. (6) bull-headed rail**

C. B. Vignoles (1793–1875) used the flat-bottomed rail (fig. 3) in England in 1836; it eliminated the chair since it could be spiked direct to the sleeper, while I. K. Brunel employed a bridge rail (fig. 4) on the Great Western Railway. Joseph Locke introduced the double-headed rail (fig. 5) in 1835, which theoretically enabled the rail to be reversed, but in practice damage caused to the base resting in the metal chair prevented this. The present design of "Lull," or single-headed rail (fig. 6) was evolved from the double-headed rail and has been standard in Great Britain for many years; the Great Western giving up its bridge-rail on the conversion of gauge in 1892. An important development was the adoption of the steel rail shortly after Bessemer invented his process of steel manufacture, though to-day many rails are manufactured by the open hearth process. During the 19th century the growth in length and weight of rails had been continuous and by 1894 the L.N.W.R. was using 60ft. rails, although in 1922 rails used by the other railways were mainly 40 or 45ft. long, and weighed between 90 and 100lb. per yd. In 1924 the British Standard Section Steel Rail weighed 95lb. per yd. with a lighter rail of 85lb. per yd. for branch lines. The L.M.S.R. uses 60ft. rails for its main line and this length is becoming more popular, although some railways still use 45ft. rails.

On Continental and other railways out of Great Britain the Vignoles, or flat-bottomed, rail holds almost universal sway since it requires less attention, but increased rail weights even up to 136lb. per yd. are used, and in many countries the rail is not spiked direct to the sleeper but rests on a metal plate. To join the rails a "fish plate" was designed, attributed to Stevens on the Camden and Amboy Railroad (U.S.), and adopted in England in 1847. These metal "fishes" were first wedged but later bolted on the inside to the two rails, making a suspended joint between two sleepers; for many years these two end sleepers were placed closer together than their neighbours. In British practice this policy still survives, although it is more widely prevalent in other countries. On British railways the rail joints are opposite but on other railways it is often the practice to stagger them, that is, place the rail joint of the left hand rail opposite to the centre of the right hand rail. The present British steel fish plate is held in position by four pear necked fish bolts. The design of the chair

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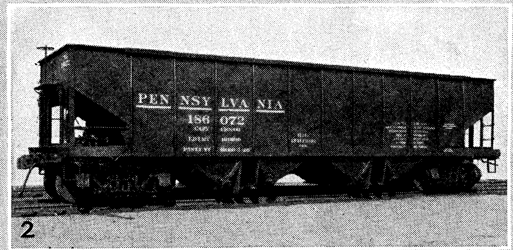

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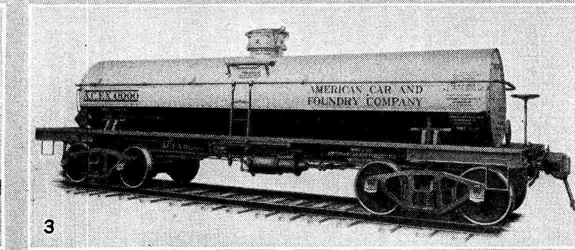

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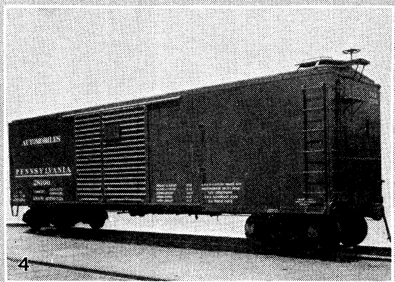
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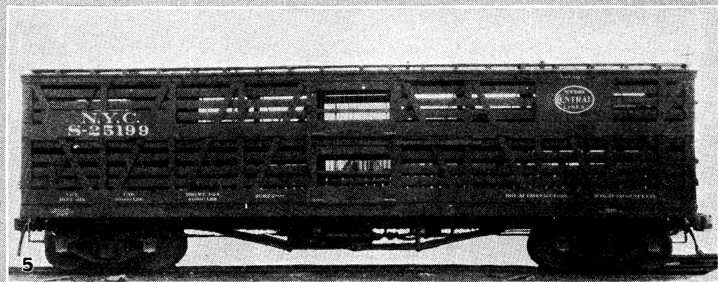

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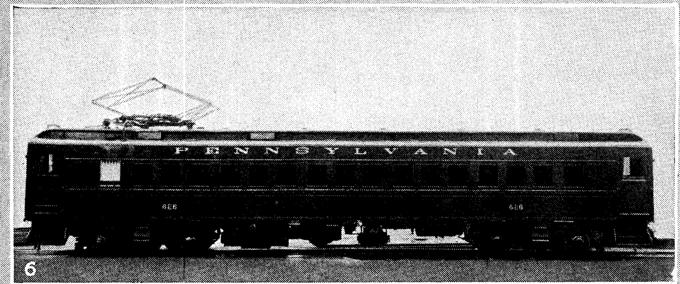

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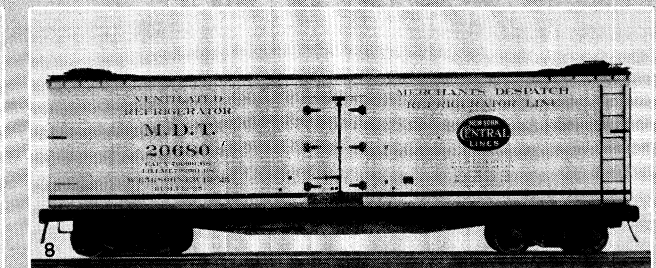

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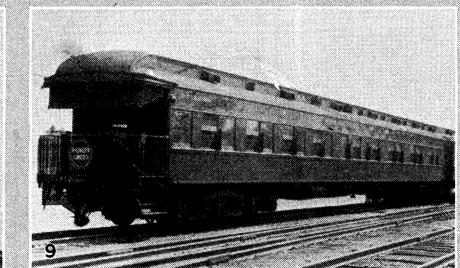
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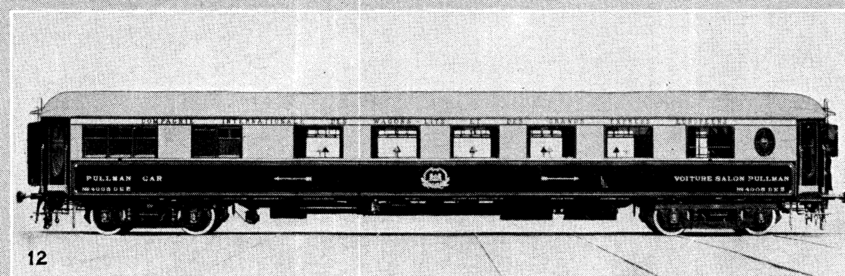


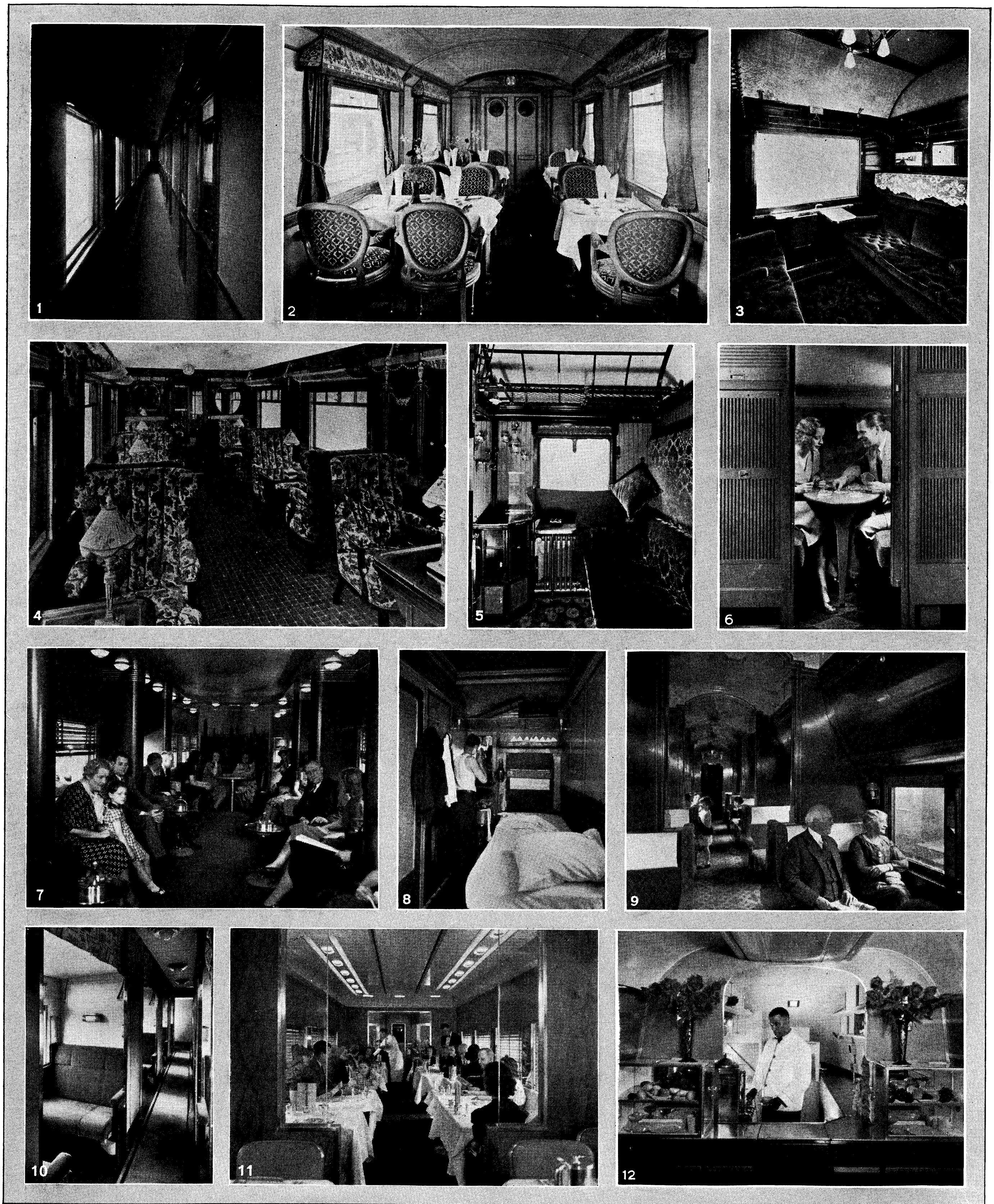
12

BY COURTESY OF (1) THE VIRGINIAN RAILWAY AND PRESSED STEEL CAR COMPANY, (2, 4, 6, 10) THE PENNSYLVANIA RAILROAD COMPANY, (3) THE AMERICAN CAR AND FOUNDRY COMPANY, (5, 7, 8) THE NEW YORK CENTRAL LINES, (9) THE CHICAGO, MILWAUKEE, ST. PAUL AND PACIFIC RAILROAD COMPANY, (11) THE TIMKEN ROLLER BEARING COMPANY, (12) THE INTERNATIONAL WAGON-LITS COMPANY

VARIOUS TYPES OF ROLLING STOCK

1. All steel, 120 ton, solid bottom gondola exemplifying modern construction. **2.** Hopper coal car, 140,000 pounds capacity. **3.** Railway tank car for transporting liquid chlorine. Safety release valves provide against excess pressure. **4.** Double-sheathed steel, 50-ton, automobile box car. **5.** Double-deck, 40-ton, live stock car. **6.** Multiple unit electric car, all-steel construction. **7.** Special flat car. **8.** Ventilated, 35-ton, refrigerator car, used extensively for protecting commodities, such as meat, milk, fruit and vegetables against changes of temperature. **9.** The "Pioneer Limited" of the Chicago, Milwaukee, St. Paul and Pacific Railroa the first completely roller bearing equipped Pullman train in the hi ry of American railroads. **10.** Pe nsylvania Railroad's streamlined coal-burning steam locomotive hauling ss-senger train. **11.** One of the fi st container cars in America, enabling the tran ference of portable contai rs directly from motor truck to ar, conveniently and without loss of time. **12.** Moder ly equipped Fre h Pullman train, of the Intern ional Wagon-Lits Company

RAILWAYS



BY COURTESY OF (1, 3, 5) THE GERMAN TOURIST INFORMATION BUREAU, (2) LONDON AND NORTH EASTERN RAILWAY, (4) THE INTERNATIONAL WAGON-LITS COMPANY, (6, 12) THE UNION PACIFIC RAILROAD, (7, 11) NEW YORK CENTRAL SYSTEM, (8, 9) THE PULLMAN COMPANY, (10) SANTA FE RAILWAY

RAILROAD PASSENGER ACCOMMODATIONS

1. Corridor of a German express train, showing private compartments
2. Interior of a first-class dining car, London and North Eastern Railway
3. A first-class compartment on a German express train
4. A salon on an International Wagon-Lits Company train, France
5. A private compartment on a German express
6. Cozy comfort in a streamlined American Pullman
7. Observation lounge in an American streamlined train
8. Stateroom on Pullman sleeping car, showing fixed bed, and individual toilet facilities
9. Standard Pullman sleeping car with semi-private compartments
10. Sectional berths on streamlined train
11. The dining car on a streamlined train
12. Novel buffet for meal service

with its attendant spikes for attaching it to the sleeper has suffered many modifications but the standard specification provides for a 46lb. chair with two galvanized coach screws driven through oak ferrules on the inner side of the rail and a similar one on the outside. Rails are slightly canted inwards in the chair and held by wooden keys, usually oak. In Great Britain wooden sleepers treated with creosote or some other preservative are universal although metal sleepers, largely used on railways of other countries, and concrete sleepers, have been used experimentally but do not last so well in Great Britain, or make for such smooth running. With the old bridge rail employed by Brunel, longitudinal sleepers underneath the rails were employed with fewer cross ties but the system died out with the conversion to the standard gauge of 4ft. 8½in. In America a reinforced concrete bed has been tried experimentally on the Père Marquette Railroad. The sleepers normally rest upon a bed of ballast with the top surface exposed so as to allow easy adjustments by the permanent way men. Granite or slag, broken into small pieces, is laid between the sleepers to ensure drainage and avoid dust. The depth of the road bed varies, but it should be wide enough to spread the weight and is often about 18in. deep, duly sloped to ensure draining the water outwards. A space of 6ft. has to be left between two pairs of rails, though in other countries than Great Britain this is wider, and consequently permits greater overhang of the rolling stock.

Construction. — The ideal location for a railway line is one which passes between two centres of trade in a straight line and over level country, thereby eliminating the need for extensive earthworks, whether to cut through a hill or to build up an embankment over a valley. In practice railways have to be constructed on the routes over which trade and commerce will flow and use has to be made of the best location available, bearing in mind the capital cost in relation to the traffic likely to be available after its completion. As a natural result of this position it is common to find in highly developed and industrialized countries railway locations which required considerable first cost and capital outlay to construct, with comparatively easy gradients and curves of a large radius, whilst in newly developed countries, where it is more problematical as to the amount of traffic which will be available for movement by rail, the line is constructed at first as cheaply as possible with heavy gradients and sharp curves, rendering it necessary at a later date to build expensive cut offs so that operating expenses may be reduced and the capacity of the railway increased. Where passenger traffic is expected to be an important source of revenue the railway must be designed to take passenger trains at high speeds. It will be realized that the location of a railway is necessarily a compromise between the desire to build the line as cheaply as possible and to construct it so that the costs of operation will be as low as possible. In hilly country the earth removed by the cuttings, or cuts, to permit the railway to pass through the higher ground, is used to form the embankments, or fills, upon which the track is enabled to cross the lower ground, while culverts, bridges and viaducts carry the railway over streams, rivers and depressions where an embankment would exceed 60ft. in height.

Gauges. — A railway may be constructed on one of several running gauges, this being the distance between the inner edges of the running rails. That which has come to be known as the standard gauge is 4ft. 8½in. This curious measurement was due to the transfer of the flange from the rail to the wheel when the plateways *(see* Track, page *922)* were abandoned, the old wagons of the 16th and 17th centuries being apparently 5ft. between wheels. This gauge is universal in Great Britain, except for a few light railways, and is practically universal for the United States and Canadian railways. On the Continent there are considerable mileages of metre and other smaller gauges, especially in mountainous districts, such as parts of Germany and Switzerland. The main trunk lines of Austria, Belgium, Bulgaria, Denmark, Czechoslovakia, France, Germany, Holland, Hungary, Italy, Jugo-Slavia, Norway and Sweden, are all approximately 4ft. 8½in., or so close to that gauge as to permit through running of locomotives and rolling stock. In Ireland the gauge is mainly 5ft. 3in. *(see* Section *A),* while in Spain and Portugal the lines are mainly jft. 6in. and in Russia 5ft.

In England the Eastern Counties line was originally built to a 5ft. gauge as was also the London and Blackwall, but these were later converted to the 4ft. 8½in. standard. When the Great Western was first constructed I. K. Brunel chose the 7ft., or broad gauge, but after a long drawn-out battle between the 4ft. 8½in. and the 7ft. gauges, the latter was in many places fitted with a third rail, or mixed gauge, to permit through running, and finally disappeared from the Great Western in May, 1892. It left as a legacy to the G.W.R., however, a wider loading gauge, namely, the maximum measurements to which rolling stock may be constructed or goods loaded. The importance of a standardized loading gauge, which unfortunately does not exist in Great Britain, is second only in importance to a standardized running gauge. By means of train ferry steamers, which carry locomotives and rolling stock on their decks, it is possible for British rolling stock to cross the Continent on the Harwich to Zeebrugge train ferry, traverse all central Europe, and by means of similar steamers between Sassnitz and Trelleborg to reach Scandinavia, or to cross the Straits of Messina to Sicily. Similarly continental railway rolling stock can arrive in England, if it is not too large for the smaller British loading gauge. Train ferry steamers are also used on the Great Lakes of North America, Japan and elsewhere. The running gauge in India is mainly 5ft. 6in., but there are large mileages of metre gauge lines as well as of other gauges, while in Japan the normal gauge is 3ft. 6in. The South African Railways are of the 3ft. 6in. gauge as is also the Sudan Government system, but the Egyptian State lines are built to the standard gauge, whilst the Kenya and Uganda railway is built to a metre gauge. The most important South American railways are based upon Buenos Aires and are mainly of the 5ft. 6in. gauge, though other gauges exist in Argentina, Brazil, Chile and Peru. The development of railways in Australia has suffered by the difference in the gauges adopted by the various State systems *(see* Section *A).*

ROLLING STOCK

Railway rolling stock comprises passenger carriages and goods or freight trucks, or wagons, both carriages and freight wagons being usually termed cars in Canada and the United States.

Passenger Carriages. — The earliest passenger carriages on the Stockton and Darlington and the Liverpool and Manchester railways were practically road coaches mounted on railway axles and wheels, and in the case of the former line were hauled by horses for some time after the line was opened. They were individually named, as were the road coaches of that date, as "Experiment," "Highflyer," and so forth, and the term passenger "coach" applied to railway passenger carriages still survives. The early carriages of about 1840 were 15ft. in length and weighed about 3 tons, with a width of about 7ft.; they were mounted on four wheels, and the majority of early railways catered for three classes of passengers. The first, who paid about 3d. per m., were carried in covered carriages corresponding to the interior of the road coach; the 2nd class passengers were usually provided with a roof, but the sides of the carriages were left open; whilst the 3rd class were carried in open wagons and provided with little or no seating accommodation. It was the normal practice to construct three "compartments" in each carriage, a first class in the centre and a second class at either end. Third class passengers were not conveyed by the more important trains.

Among the earliest improvements in construction was the introduction of spring buffers and screw couplings between the carriages, which tended to prevent jolts when the train was starting or stopping. About 1840 third class carriages began to have roofs, and by the Regulation of Railways Act 1844, the railways were ordered to provide sides to third class carriages, no mention being made of windows or lights. The same act compelled the railways to run one train per day at a minimum speed of 12 m.p.h., calling at every station and conveying passengers at a fare not greater than 1d. per mile. These trains became known as "Parliamentary" trains, and were the subject of much derision in the press of that period. Carriages which were nearly always constructed of wood gradually increased in length and were mounted on six in place of four wheels, while the width was gradually extended to 9ft. Further remnants of the old road coaching days lasted in the form of different coloured upper panels, while some lines painted the compartments different colours on the same carriage, a practice still employed by the Paris-Lyon-Méditerranée Railway of France, though for reasons of economy the majority of railways now paint their carriages a standard colour, throughout, a notable exception being the G.W.R. with its cream upper and chocolate lower panels.

By 1874 the carriages had increased so much in length that it became necessary to mount them on four axles, arranged in two pairs at either end of the carriage. Each pair was so designed as to swivel independently of the other pair, thus permitting a much easier passage of the curves owing to the carriage body remaining rigid while the bogie under-carriage turned in conformity with the rails on the curve. This system, in a very much improved form, is standard for nearly all railway passenger carriage construction throughout the world, by far the majority of new passenger rolling stock being built as 8-wheeled bogie carriages. Six-wheeled carriages continued to be built in Great Britain for suburban services until the end of the 19th century, but there have been very few 4 or 6-wheeled passenger carrying vehicles built for British railways since then, although on some Continental railways they remain the standard type for local trains. In France there exist some very long passenger coaches of about 60ft. mounted on two axles only, but such a design does not add to the comfort of the passenger on lines with sharp curves. In Canada and the United States all passenger cars have been mounted on two bogies with four or six wheels each from almost the commencement of the railway era. This policy was due to the less expensive permanent way provided in newly developed countries and the more usual presence of sharp curves. The addition of an extra axle to each bogie became necessary in North America on account of the great increase of weight consequent upon the adoption of steel carriage construction in the 20th century. On British and Continental railways the added weight caused by the two extra axles is not regarded as being balanced by the advantage of smoother running except in the case of dining or sleeping cars.

Sleeping Cars and Corridors.—British sleeping cars built by the Pullman Co. of America were used on the Midland Railway in 1874, the L.N.W.R. also using a sleeping car at that date. Pullman cars available for 1st and 3rd class passengers on payment of a supplementary charge are attached to many British railway trains, and sometimes form a whole train. They are also available for day use on the lines of the American "chair-cars." For many years all sleeping cars have been owned by the railway companies. In 1880 the G.N.R. provided dining cars on their London to Leeds trains; the Midland Railway was, however, the first company to offer these dining car facilities to third class passengers. The same railway in 1872 provided third class accommodation on all its trains, a policy which all the railways of the country were forced to adopt during the succeeding years. In 1875 the Midland Railway also abandoned the 2nd class, a policy which has become almost universal except on certain suburban and special services, such as boat trains. On French railways the three classes still exist but many fast trains are only provided with 1st and 2nd class carriages. The same is true of Belgium and Switzerland. In Germany there are four classes, but more than three are scarcely ever provided upon any one train, 1st and 2nd class on the fast main line trains, 2nd and 3rd on intermediate trains and 3rd and 4th on local slow trains.

The G.W.R. in 1890 put into service the first corridor trains, thereby permitting a passenger to reach the dining car by passing along a corridor usually placed on one side of the vehicle, and so also eliminating the special train stops made on nearly all the long distance runs to enable passengers to take their meals at the station restaurants. A movable covered gangway in the centre at the end of the coach is provided to ensure safety when passing from one carriage to another. Lavatory accommodation became standard in the case of corridor carriages during the early 'nineties. On certain railways, notably the Midland, the clerestory roof was introduced. It possessed a raised portion in the centre, and being fitted with glazed lights permitted increased light in the compartment and improved ventilation. It lasted on the M.R. until 1914 when it gave place to the British standard high rounded roof, technically known as the "semi-elliptical." The French and Belgian railways never adopted the clerestory, sometimes called the Pullman roof, but it was used in Germany for many years, and the vast majority of American and Canadian passenger cars are built with this design of roof.

All carriages built for long distance train services in Great Britain are designed to permit travellers to pass from one end of the train to the other, either by means of a side corridor or a centre vestibule. The former are known as compartment type corridor vehicles, while all dining cars are built to the latter design. Corridor trains permit the collection and examination of tickets by the railway officials while the journey is in progress, thereby also enabling time at stations to be cut down to a minimum, while permitting the passengers to distribute themselves more evenly throughout the train. On the other hand it lowers the seating capacity of the carriages by at least two seats per compartment, which constitutes a serious consideration in the case of suburban passenger traffic, especially during the hours of "peak" traffic, or "rush" hours, when seating capacity is strained to the uttermost. Consequently, suburban passenger trains in Europe are normally of the non-corridor type, though in certain countries, notably Switzerland, all the carriages are vestibuled.

Passenger Train Weights, Speeds.—The typical British corridor 8-wheel bogie carriage contains seven 1st class compartments or eight 3rd class compartments, seating respectively 42 and 64 persons on an empty, or "tare," weight of about 30 tons. It usually possesses a lavatory at either end and is about 60ft. long by 9ft. wide with a height from rail level to top of roof centre of about 13ft. Carriages usually possess steel frames and wooden bodies, sometimes metal sheeted, and in some cases a metal roof, but a wooden roof is more common. On Continental railways the modern all'steel express train carriage often weighs 40 to 45 tons; a greater degree of safety is claimed for that type of construction but the all-metal design is usually very much more noisy than the wooden type of carriage. The non-corridor bogie carriage for suburban service contains 8 or 9 compartments, seating 10 or 12 third class passengers and eight 1st class passengers on an empty or tare weight of 25 tons. A typical British express train often weighs between 400 and 500 tons empty, exclusive of the engine and tender; on the Continent a train of similar seating capacity would be heavier owing to the Continental carriage design. Pullman, dining and sleeping cars are the heaviest cars on European railways.

Oil was the earliest illuminant of railway carriages, giving way to gas lighting in the eighties, later improved by the addition of the incandescent gas mantle. Electric lighting was in use before the end of the century and is used for all new carriages, power being usually generated by a dynamo worked off the axle of the carriage when running. Carriages are heated by means of steam supplied by the engine, but in the case of electric traction other methods have to be employed. The steam heating system replaced the use of foot-warmers containing chemicals which gave off heat after being dipped in hot water. The screw coupling and side buffer are used on nearly all Western European carriages, the few exceptions in England being largely automatic centre couplings of the "buck-eye" type, the two jaws closing when the carriages are pushed together, but these are only fitted to Pullman or other carriages working in special trains. The L.N.E.R. has constructed many "articulated" sets of 2, 3 or 5 vehicles, the bogie being placed under two vehicles instead of at the ends of each. By this method weight is saved and, it is claimed, less oscillation and smoother running results.

In addition to passenger carrying vehicles there are many other railway vehicles which frequently form part of the composition of a passenger train; they consist of vans for luggage and parcels, horse boxes, vans for milk, fruit, theatrical scenery and motor cars. These vehicles are all fitted with the Westinghouse or vacuum automatic brakes for working on fast passenger trains. In Canada the passenger cars are very similar to those of the

United States, and the vestibuled centre corridor is universal; automatic couplings are standard on both passenger and freight trains in North America.

The fastest trains in Europe are found in Great Britain and France; high speeds in passenger traffic are also attained on the American railways, whilst the Australian, Canadian, Indian and Argentine railways offer high speed services with heavy trains. The fastest start-to-stop railway schedules in the world provide for a speed of about 60 or 61 m.p.h. but during the journey much greater speeds must necessarily be attained to offset the comparatively slow start and the low speeds caused by heavy gradients, curves, or the passage of junctions. In Great Britain fast passenger trains attain 90 m.p.h. and in March 1935 a L.N.E.R. train reached 108 m p.h. on the London-Newcastle run.

Wagons.—For the carriage of goods and mineral traffic a railway employs open or covered wagons, the latter sometimes known as box vans. The early British lines adopted for mineral traffic the chaldron wagon which had previously been in use on the "wagon-ways" drawn by horses. These wagons carried about 4 tons of coal and weighed between 2 and 3 tons empty. For general goods traffic the early wagons were less than 10ft. long. and if loaded with perishable traffic they were, and still are, often covered with creosoted tarpaulin sheets, a practice only used to any extensive degree in Great Britain where the use of covered vans is rendered difficult by the large percentage of traffic which has to be handled by crane at the numerous ports. The size of the British railway wagon has grown steadily but slowly as compared with foreign railway wagons; but the internal trade of the country is largely retail in its nature, while the average distance travelled by a consignment is comparatively small. The general practice of railway freight service is to offer a frequent service, as is done with passenger service, often with comparatively light trains. The average weight of consignments in a British freight train is about 140 tons, but the engine has also to haul the weight of the wagons themselves, hence the wagon designer is faced with the problem of constructing a wagon to hold the maximum weight and volume of capacity on the lightest tare, or empty, weight; with the increase of wagon capacity the less becomes the tare weight for each ton of capacity. Thus, a wagon to carry 6 tons may easily weigh 5 tons, but a wagon to carry 20 tons can be constructed to weigh only 10 tons; while in the United States there are many 100 ton coal cars weighing only 35 tons. The "high capacity wagon," as it is called, also occupies less space on the sidings, which is very important, but difficulties are experienced on the British railways in the use of such wagons by reason of the small clearances for such fixed structures as mine screens and the sharp curves on many sidings. It is an axiomatic rule of railway working that the most successful type of wagon is that which can circulate most freely and can, consequently, be carrying traffic for as many hours per week or month as possible. The average capacity of the railway-owned wagon in Great Britain is about 10½ tons, though the standard to which ali new wagons conform, other than "special wagons" for rails, boilers, plate glass and so forth, provides for a 12 ton capacity. Policies have been urged which aim at the adoption of a standard wagon of at least 20 tons, which would doubtless result in economies of railway operation, but it is very difficult for the railways to build a type of wagon which the trading community does not desire, and the latter in Great Britain has always insisted upon its preference for the small wagon unit in view of the retail nature of the country's trade.

Another characteristic of the British wagon position is the large number of privately owned wagons, that is to say, wagons owned by coal mining companies, coal merchants, quarry owners and others who provide their own wagons for the railway companies to haul. Each of these wagons is registered and there are middlemen in the form of wagon hiring firms who rent out their wagons to coal merchants and even railway companies, as required. Approximately 650,000 wagons are railway owned and about the same number it is believed are privately owned. On Continental and North American railways the percentage of privately owned wagons is very small, consisting mainly of wagons fitted as refrigerators, wagons carrying oil, petrol or acid tanks, or even wine tuns. While certain advantages are claimed for the system of extended ownership of privately owned wagons, nevertheless it adds considerably to the expense of railway operation consequent upon the added sorting and shunting of wagons in the various "marshalling yards."

Many important developments have taken place in wagon design beyond the steady growth in size. Spring buffers are now universal in Great Britain and on Continental railways, though the latter employ a screw coupling as with passenger trains, the British lines adhering to the "loose link" coupling which permits easier attaching or detaching of extra wagons. This difference is, once again, the result of the short average length of haul on British railways, and the frequency of junctions where the trains have to be reformed for the different sections of the line. British wagons are fitted with hand brakes, which according to a Government order of 1911, must be fitted on both sides of the wagons, but it will be many years before all wagons in circulation are fitted with a standard hand brake operated from both sides and applying to all four wheels. The modern wagon has almost invariably a metal frame though the body of the wagon is usually wooden, often on a metal frame-work; coal wagons in many countries are now made of metal. An important improvement which has very considerably assisted the running of the wagon itself has been the adoption of oil lubrication for the axle boxes instead of the solid grease previously universal. Comparatively few grease axle box wagons exist on the British railways, and none upon Continental or North American railways.

STATIONS AND TERMINALS

Passenger Stations.—A passenger station may be divided into three sections; the building which is to contain the booking and other offices necessary for the comfort of the passengers and the business of the railway staff, the platform by which the passengers enter or leave the trains, and the track lay-out at the platforms and in the yard outside the station. From the railway point of view the last is the most important, for upon it hinges the capacity of the station to deal with the maximum number of trains, especially at the hours of greatest traffic pressure. Few stations are exactly alike, and except for wayside stations, as for instance in Africa or on the Canadian prairie, no standard design can be adopted. In its simplest form the wayside station on a double track line in Great Britain, where all platforms are raised, consists of an "island" platform placed between the two lines, or two single sided platforms each serving one line. Intercommunication is provided by a footbridge or a subway, and on one platform is a booking office, where tickets are obtained, and other essential buildings. When trains can pass through a station the latter is known as the "through" type, and may consist of any number of platforms often with "bay," or "dead end," lines at one or each end of a wide platform. Amongst the largest "through" stations in Great Britain are the Waverley, Edinburgh (L.N.E.R.), with 1,390ft. platforms; Crewe (L.M.S.R.) with a platform of 1,509ft.; Snow Hill, Birmingham (G.W.R.) and Clapham Junction, London (S.R.) with 17 platforms.

The largest British stations are, however, the terminal, or "dead end," stations. In America these are often called terminals of the "stub end" design, and recent practice has tended towards a complete division of the station building with its circulating area (parcels, booking arid enquiry offices, and refreshment, cloak and waiting rooms, frequently including shops) from the platforms, termed technically the "train shed"; Windsor Station, Montreal (C.P.R.), is a typical instance of this design of station. In Great Britain, where coal of a less smoky nature is used by the locomotive, the need for this division has not been so important; thus the platforms are more closely connected with the station buildings, usually being joined in the case of modern designs by a wide concourse, with indicators showing the train departures and arrivals and newstands. Amongst the large London termini Waterloo, where reconstruction was completed in 1922, and Victoria (S.R.), with a 1,500ft. platform, are noteworthy in this respect, each possessing the arrangement by which a passenger arriving at the station on foot or by motor passes by way of the booking office through the circulating area, flanked by restaurant and cloak rooms, past the train indicator and timetables to the departure platforms. British railway stations are almost unique in that the majority of large termini are so arranged as to permit taxi cabs for hire to stand along a roadway provided by the side of the arrival platforms of the long distance trains. Gradually, in order to prevent the overcrowding of platforms, and the pilferage of luggage and parcels, the railways have extended the system of "closed" stations at all important centres, whereby access to the platforms is only permitted to those holding railway tickets or a platform ticket, for which a small charge, usually 1d., is made. Each platform usually accommodates only one train but where difficulty of obtaining land has elongated the station design very long platforms exist which can acccmmodate two trains; notable examples are Cambridge (L.N.E.R.), 1,375ft. long; Perth (L.N.E.R. and L.M.S.R.) of the "through" design, and Victoria Station above mentioned.

Another characteristic feature of large British and some Continental European railway stations are the great metal spans with glass roofs over several platforms and lines, of which notable examples exist in London at St. Pancras (L.M.S.R.), King's Cross (L.N.E.R.), and Paddington (G.W.R.). In Germany, Leipzig, claimed as the largest station in Europe, possesses this feature in a form of six arches, and with 26 platforms has a frontage of nearly 1,000ft. Hotel frontages form a further feature of British station planning in many of the more important stations. The Grand Central (1910) and Pennsylvania (1913) terminals in New York City demonstrated the advantages of electrification in permitting the development of building sights actually above the "train shed"; but the completion of the new Union Station at Chicago in 1925, serving four railways, has shown that such a development is possible even with the use of steam traction, in this latter case the station being designed to serve also as an office building. It is possible that the high land value in London may induce a similar policy there in connection with hotel developments. In South America one of the many fine stations is Retiro (1915), terminus of the Central Argentine at Buenos Aires, while Japan is justly proud of its Central Terminus at Tokyo, opened in 1913. It is, however, the track lay-out or design which determines the capacity of a busy station, and in the case of termini the yard where carriages may be stored, cleaned and examined, should be as close to the station as possible and preferably, though this is hardly ever possible, between the sets of inwards and outwards lines.

Layouts. — The lines leading into a terminus are often 6 or 8 in number, but 4 is more usual. In Great Britain, where trains keep to the left track and meet right side to right side, outwards traffic from a station will often be on the left hand side, but where the tracks enter a station sectionally, such as (1) down local line, (2) up local line, (3) down main line, (4) up main line, (5) down suburban line, (6) up suburban line, the platforms and station work can be divided sectionally, which is often advantageous. Where the entering or outside lines are in the order, down local, down main, up main, up local, it will be seen that every local train must cross both main lines either before entering or after leaving the terminal station; such a limiting design may, however, be offset by easier junction working outside the area of the terminus. It is the normal practice to place two lines between each platform, with the necessary cross over lines so that an engine may run round its train. The provision of three lines to allow for this movement is recognized as being wasteful of valued space. Short lines, where engines may wait to back on to their trains are necessary. Where electric traction is employed with multiple unit trains, engine movements are eliminated, thus increasing the platform capacity as measured by the number of trains dealt with each hour. Waterloo (London), excluding its tube station, possesses 21 platforms, and by means of electric and steam traction deals with about 1,200 trains every 24 hrs., carrying about 150,000 passengers in and out. Liverpool Street, London (L.N.E.R.), wholly operated by steam traction with only 18 platforms handles approximately the same number of trains per day, but nearly 250,000 passengers, of whom 85,000 arrive between 7 and 10 A.M. St. Lazare, Paris, with more platforms, and using steam and electric traction, deals with a roughly similar number of passengers. Notable stations in Canada are Windsor Street, Montreal, the new Toronto Union Station, and Winnipeg (C.N.R.), while in Australia, Flinders Street, Melbourne, is famous, as is the Central Station, Sydney, which possesses steam and electric traction and is one of the'most important railway stations in the world. The Ministry of Transport publishes the requirements for passenger lines in regard to railway construction and operation in Great Britain, which include important provisions as regards passenger stations, amongst which may be mentioned that trains should enter a station without reversing; that no fixed structure can be nearer than 6ft. from the platform edge, which must overhang not less than 12in.; the platform height must be not less than 2¾ft. nor more than 3ft.; while staircases of footbridges must have treads not less than 11in. and luggage lifts or subways must be provided at important stations. These regulations apply to new works and all reconstructed lines or stations; they set out also the requirements applying to bridges, level crossings, facing points and so forth.

Freight Stations. — These, for dealing with goods traffic, are of two main types; firstly, the town or city station, where goods are received for despatch by rail and inwards traffic by rail is dealt with, and secondly the tranship, or transfer, station, where wagons containing many small consignments for a large number of destinations are unloaded and reloaded so as to form a wagon load either for each station or a few adjoining stations, or for a second tranship station. By this method it is possible to reduce the delays incurred by waiting until a sufficient volume or tonnage of goods has been received at the originating station to warrant a through wagon, while it also minimizes the number of small wagon loads. One of the largest tranship stations is at Crewe (L.M.S.R.). Like many other tranship stations it adjoins a large "marshalling," or sorting yard. In certain cases the town freight station performs tranship work as well, there being certain advantages in, adopting this method where desirable, such as the more likely possibility of obtaining a full wagon load.

Reconstructed freight stations of modern design are those of the G.W.R. at Paddington and Lambeth (London) and Bristol. Present practice provides for two tracks between the platforms, which are E shaped so as to permit easy movement of the goods round the end of the platforms which consequently must not be too long; drop down bridges may be fitted to cross the tracks at intervals and motor or electrically driven trucks with trailers have largely replaced the manually pushed barrow where platforms are wide enough to accommodate them. Moveable cranes are frequently fitted on overhead runways, and where there is room the inwards traffic by rail is dealt with at different platforms from the outwards traffic. Where this is not possible the lines are said to be "set" with loaded inwards wagons in the morning, and after they have been dealt with the wagons are used for loading up traffic received by road for despatch during the late afternoon by rail. Adequate platforms for loading the road vehicles and turning space for the latter are important, as is also good lighting for night work and smooth platforms, now often of asphalt, on which the trucks may run easily. British town freight stations are often well provided with warehouse accommodation, especially at the ports, which enables them to be used as railhead distribution centres for large trading organizations. To save handling many small packages and to reduce pilferage a system of "containers" has been adopted which, in the form of large van bodies, can be wheeled or moved by crane to. and from railway wagons and road vehicles. These "containers," which can also be of an open type, useful for carrying bricks to avoid handling, are in use extensively in Great Britain and the United States, while their use is also spreading on Continental European railways. In Germany they sometimes take the form of milk or oil tanks.

The tranship station may consist merely of one or two island platforms, on to which the goods are unloaded, sorted and reloaded. The track connections serving the station should be very carefully studied in this case, to avoid the frequent use of locomotive power. Capstans worked electrically or hydraulically are often employed for this latter purpose. At every freight station, even of the smallest type, provision must be made for the loading and unloading of wagon load traffic, such as coal, stone and manure, direct to and from railways wagons and road vehicles.

Marshalling Yards.—While the tranship station acts as a kind of clearing house for the small consignments in the wagons,

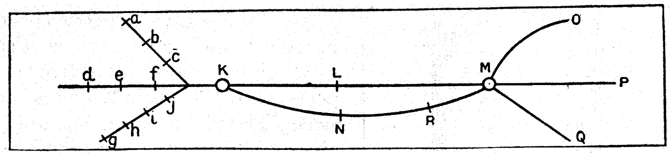


FIG. 7.—POSITION OF MARSHALLING YARDS

so the marshalling yard acts as a clearing house for the wagons of a train. It is customary for a large marshalling, or sorting, yard to be placed on the outskirts of a city such as Liverpool, or a coalfield such as that of South Yorkshire. The streams of traffic originating in the various docks, goods depots or mine sidings, are concentrated upon a large yard, as shown in the diagram at K (fig. 7), where the heavy trains are made up for the long main line haul to M, both through L and through N. At M may be situated another large yard where the trains are resorted for the stations on the lines MO, MP and MQ. Additionally, pick up trains will be formed at K, serving all stations on KLM, and possibly picking up traffic at L destined for R, which must be placed on a train for N or K when it reaches M.

There are many designs of marshalling yards such as might be required at M, but there are three main types: (1) the flat shunting yard, (2) the hump shunting yard, (3) the gravity shunting yard. The choice of design will rest upon the number of wagons to be dealt with in hours of greatest traffic, and also upon the physical characteristics of the ground which is available for use as a marshalling yard. In the case of a flat yard the train enters direct upon one of the sidings, and a shunting engine draws it out and proceeds to push the wagons, in "cuts" of one or more wagons at a time into the lines upon which trains for the varying destinations are being assembled. Flat shunting is in reality a pull and push system and bears hard on the couplings, on the engine brakes and on the rails. Where more wagons per hour must be sorted the train is usually left by the train engine on a reception siding outside the main "grid" of sorting sidings, and a powerful engine is attached to the rear of the train, which is then pushed over a "hump," or high shoulder of ground, and the cuts for each line are uncoupled as the wagons reach the crest of the hump, when the couplings are loose. The wagons thus released drop down by gravity on to the sorting sidings arranged in fan design from the bottom of the hump. One such hump line may serve 40 sorting sidings. An alternative system is to place the reception sidings upon a downward gradient leading to the sorting sidings, so that after the train engine has been uncoupled the wagons drop down by gravity themselves on to the various sorting sidings.

Wagons may be braked by hand or by means of rail brakes, or car retarders, operated by pneumatic or electrical power. These consist of rails placed inside the running rail so as to grip the flanges on the inside of the wheel. The Frolich system of rail brakes, as used in Germany, utilizes the weight of the wagon for braking purposes. In continuation of the sorting sidings, where possible it is desirable to have a few so-called departure sidings upon which the wagons on a train may be remarshalled into the order of the stations for which the wagons are destined. The marshalling yard is a nodal point in railway operating organization, and its working must be very carefully supervised.

SIGNALLING

Semaphore and Light Signals.—The signalling system is the means adopted to control the movements of a train by means of visible signals to the crew of the train. The signal may consist of an arm or other movement, replaced by lamp signals at night, and in the usually accepted sense of the term applies primarily to the signals fixed along the track. These fixed signals normally consist of discs, or semaphores, mounted on posts; the varying movements to indicate the two aspects of "danger" or "line clear" being replaced at night by a coloured light, red being standard for danger in Great Britain and green for "line clear." The improvement in electric lighting permits these red and green lights, known as "colour light" signals, to be seen clearly in daytime, and their use is increasing in preference to the semaphore and disc signs. Many early British signals were of the disc design, being placed at each station and road crossing gate. Space between trains was obtained by enforcing a time interval, often ten minutes, between the trains. The "semaphore arm" was used as early as 1845, while the use of more than one arm at junctions gave the engine driver a route indication. It has since become customary in Great Britain to place the semaphore signal for the less important lines on a bracket post, usually "stepped" so as to give the more important line the higher position.

With increasing speed it became necessary to give advance warning of a "stop" signal at danger; this signal in advance of the stop signal has come to be known as the "distant" signal, and being a warning only is fitted with a "fish tail" and shows a "yellow" light for the danger indication at night. Distant signals, usually about 600yd. ahead of the stop signal, the modern name of which is the "home" signal, are so "interlocked" that they cannot give a line clear aspect unless the stop signals are previously placed to give the "clear" indication. Before 1850, British railways began to adopt the system of working signals and points from a centralized frame in a cabin. In additiori to the distant and the stop signals, it has become customary to allow the trains to proceed beyond the home signal to the "starting" signal, also a stop signal (fig. 8), in that all trains must stop at it when it shows a danger indication. In time of fog, or in snowstorms, it is usual for trains to be stopped at the home signal, operation being assisted by the use of repeater signals, or miniature arms, which repeat the indication given by the semaphore arm, which may be invisible in thick fog. In England, where fog in winter often makes visibility of signals very difficult, fog signalling necessitates the employment of detonators which are placed on the track near semaphore signals to advise the engine crews of the signal indication. The engine explodes the detonators, or series of detonators, with a loud report. They are put in position by fogmen stationed at the foot of the signal, by means of detonator placing machines. On certain railways, notably in France, a detonator is frequently placed on the rail whenever the stop signal is placed at danger, being automatically withdrawn when the signal gives a "line clear" indication. This provides an engine driver, if he runs past his signal, with the knowledge that he has done so.

Ground signals showing the position of the points were often of the disc type, but the 20th century has seen a considerable adoption of the "banner" design, while the miniature semaphore arm is also employed. In Great Britain, because trains always run on the left hand track, the signals are placed, where visibility makes

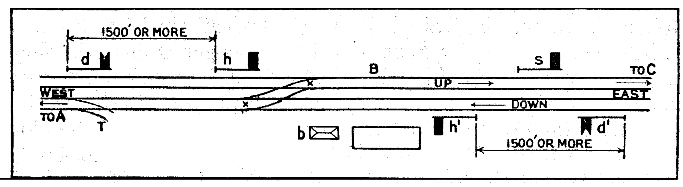


FIG. 8.—BLOCK SIGNALS: ENGLISH PRACTICE: TRAINS RUN ON LEFT-HAND TRACK, SIGNALS AT LEFT. ARMS ON LEFT OF POST

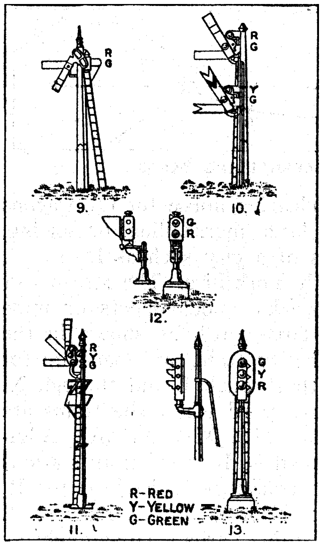
it possible, on the left hand side of the running line, although the railways differ in regard to whether the driver's position is on the left hand side of the engine or not. The signals are operated by means of levers in a signal cabin, which in turn pull a single wire, thus raising a balance weight on the signal, the latter falling through an angle of 60° in order to give a "line clear" indication. This type is known as the "lower quadrant" design (fig. 9). Manually operated signals in their normal position are kept "on," or at danger, namely at an angle of 90° with the signal post; if the wire should break, the balance weight carries the signal automatically to the "on" position. The use of double wires to operate the signals permits the elimination of balance weights, thus making the movement over a long distance easier for the signalman, but double wire signalling, which has been common on railways in Continental Europe and the Dominions, has not met with great favour in the past in Great Britain. The L.M.S.R. and the L.N.E.R. have expressed the intention of adopting "upper quadrant" signals (fig. 10 and 11), in the case of new construction, which to give the "off," or "clear" indication will be raised, instead of falling, through at least 60°. By the adoption of this "upper quadrant" design considerable economies are possible in connection with the rodding and balance weights on the signal post, which may be made of wood, reinforced concrete, metal poles or metal lattice work.

In addition to manual operation, points and signals may also be operated by electricity and compressed air, first used on the British railways by Sykes in 1875, or by a combination of both these systems. Meanwhile mechanical interlocking has given place in many installations to power interlocking of the all-electric or electro-pneumatic type, although in certain cases hydraulic power has been employed.

Block System.—This followed the inauguration of the electric telegraph line from Paddington to West Drayton in 1839, and was improved and extended to Slough by 1842, while two years later the single line Norfolk Railway was worked by telegraph from a central office. By 1854 the L.N.W.R. had adopted a three indication block signalling instrument which showed "line blocked," "line clear," and "train on line." The block system in essence consists of the refusal to permit a train to enter a successive section of line until the preceding train is clear of that section; with manual signal operation and control, movements in each section are controlled from one signal box. The block system, in replacing the time interval by a space interval, greatly increased the degree of safety. The simple block system was further improved and much greater safety obtained by the later adoption of the "lock and block" system, due largely to W. R. Sykes about 1875. The lock and block system prevented the signalman from placing the signals in the clear position for a second train until the preceding one was clear of the section; this was effected by means of locking the mechanical signals with electrical block instruments, which did not permit the movement of the starting signal at **A** until the lock was released by the signalman at the succeeding signal box B. In certain cases the wheels of the train, acting in connection with an electrical current passing through the rails and known as a "track circuit," releases by its own passage past a certain point the lock in the signal cabin. This "track circuit" is the essence of automatic signalling to be described later.

The lock and block system has contributed largely to the safety of British railways, the "absolute" block, namely rigid adherence to the block system, being standard on all passenger lines; the "permissive" block, which allows succeeding trains in the same section when under full control, is only admissible in stations and on lines used by freight trains. In countries other than Great Britain, including the United States, the "permissive" block system is, however, allowed on lines used by passenger trains. On single lines safety is obtained by the employment of a staff or "tablet" which is carried on the engine during its passage of the section. The Tyers tablet system of 1878 permitted, by means of the block system, the entry of a train at either end of the section, an impossibility where a single wooden staff was employed. By 1890 the "electric train staff" had been invented, which was an improvement on the tablet and permits successive trains to enter from either end of the section, but only one tablet can be withdrawn at a time, and that not until the preceding tablet for the section has been replaced at one end or the other.

Automatic Signalling was first installed by the Liverpool Overhead (of England) in 1893. At that time the track circuit (*see* Block System above) was hardly known. It consists in its simplest form of a section of the running rails, insulated from the rails on either side, being fitted with a battery at one end and a relay at the other, so connected that the current may circulate from the battery along one running rail through the relay and back to the battery along the other running rail. This current energizes the relay coils which pick up the armature, thus effecting contacts which remain closed until the two running rails are connected through the wheels and axle of a train. Signals controlled by circuits were first installed on the L.S.W.R. in 1902, and also adopted later on a section of the North Eastern Railway. Automatic signalling led to the use of day "colour light" signals (figs. 12 and 13) employed by the Liverpool Overhead in 1921; such a system is also used giving more than two aspects, thus the "light" signals between Marylebone and Wembley give a "danger," "caution" or "clear" indication; while the S.R. has gone one step further by providing a fourth aspect, namely two yellow lights on certain of its lines with the densest traffic. The semaphore signal can also give three aspects, namely 90°, 45°, and vertical, with the post, but in this case it must be of the "upper quadrant" type, such as has been in use at certain London stations and elsewhere since 1914.



FIGS. 9–13.— SEMAPHORES AND LIGHT SIGNALS
(9) "Lower Quadrant" semaphore, (10 & 11) "Upper Quadrant" semaphores, (12 & 13) types of light signals

Light signals are rapidly gaining in favour owing to their lower cost of installation, better visibility and identical aspect by day and night; also they require less space and can be placed on a level with the driver's eye. Modern signalling rests largely upon the use of the track circuit and electrical devices, which permit the use of long distance point and signal operation with adequate electrical "detectors" and "repeaters," while even level crossing gates are sometimes electrically operated and frequently electrically interlocked with the signals. One large electrically operated signal box may replace as many as five older mechanical manually operated boxes; thus, signalling is rapidly becoming one of the most important departments on a railway, partly owing to the great operating economies which it is able to make, and partly owing to the necessity of making the best use of tracks and rolling stock. Signals, at first installed to prevent collisions, have also become the means whereby a maximum traffic may be handled at a maximum speed with minimum costs, brought about by the aid they give in keeping the trains moving.

ELECTRIFICATION

The last decade of the 19th century saw the commencement of electric traction on railways and very considerable progress with railway electrification was made during the first twenty years of the 20th century, both in Europe and in the United States. Electrification for railway purposes possesses many advantages, amongst which the most important are the elimination of smoke and steam, the greater power which can be obtained from any given axle load, quicker acceleration and the rapid reversal of trains as a result of being able to drive electric trains of the "multiple unit" design from either end, thus eliminating engine movements in a terminus where space and time are strictly limited. The abolition of steam and smoke is most desirable where trains are running wholly or mainly in tunnels or within the limits of large cities, and especially in stations closely encompassed either by office or residential buildings. Greater power is most desired where gradients are heavy, as in Switzerland and other countries where important main lines cross mountain ranges, while quick acceleration and elimination of engine movements in a terminus are very advantageous in connection both with the suburban traffic of main line railways and the underground lines in large cities. **A** further important advantage accrues to electric traction in countries which possess practically no coalfields of their own, but frequently own important water power resources which can be harnessed to produce electricity, and consequently render them independent of other countries for the traction power used on their railways. Fortunately railway lines with heavy gradients naturally exist in many areas where there are swift flowing rivers.

Systems. — There exist several systems of utilizing the electricity generated at power stations for the movement of trains, and in Europe the choice of system has often resulted from a Government decision. Many considerations have to be taken into account, such as the first cost of construction, the operating and maintenance costs, the distance between the power stations and the electrified railway sections, speed and frequency of trains, as well as political considerations and the coordination of railway electrification with the supply of electrical power for industrial and domestic uses. The three main systems of railway electrification, each utilizing a different kind of current and possessing both advantages and disadvantages are (1) the continuous, or direct-current system; (2) the single phase alternating-current system; (3) the three phase alternating-current system. The direct-current system is that usually employed for suburban systems in connection with a comparatively low voltage, limited in early electrification schemes to 600 volts, in which case a third rail was used from which the current could be collected by shoes. This system required the construction of many substations, but permitted light weight and small dimensions, and is consequently well suited to adoption with multiple unit trains where the axles of many of the cars on the train can be used as driving axles, thus obtaining great adhesion and permitting the train to be driven from either end. In many modern installations voltages of 1,200, 1,500, 2,400 and 3,000 are now employed, in which case the current is collected from an overhead wire (while substations are designed to operate automatically, thus eliminating the need for attendants and can be shut down when not required); heavy currents can be collected from an overhead wire feed. Where traffic is dense a direct current of 1,500 volts is advantageous and is found in the United States, France, Japan, Holland, Czecho-Slovakia and Great Britain. In cases where traffic is less dense but the trains very heavy, such as on the Chicago, Milwaukee, St. Paul and Pacific in the United States and in South Africa, Chile, Mexico and Brazil, 3,000 volts is employed. The Chicago, Milwaukee, St. Paul and Pacific employs regenerative braking which utilizes the force of gravity on the downward gradients to generate current for return to the power stations.

The single phase alternating-current system possesses an important advantage in the use of comparatively little copper in the feeding circuits, through the use of a single contact wire overhead. Alternating current at high potentials, such as 16,500 volts, can be collected from this feeding wire, which receives the current from transformers frequently not protected from the weather. A small section of the S.R. in London was electrified on the 6,600 single phase A.C. system in 1909. The three-phase alternating-current system has been employed largely for main line use in Europe and is older than the high voltage direct current systems. The Italian State railways have adopted this system widely. Its advantage in part rests upon the three phase induction motor which can be wound for the full potential of 3,000 volts selected. Through the use of alternating current substations containing simple transformers only, requiring no attendance, economies were realized, but the necessity of utilizing double overhead contact wires with the low potentials of 3,000 or 4,000 volts has militated against the extensive adoption of the system, as has also the three phase motor with its characteristic of constant speed, though this latter is often useful in the case of lines with heavy gradients, since it permits the "regeneration" of electric power on falling gradients.

Main Line Electrification. — Amongst the great main line electrification schemes in Europe are those of the Swiss Federal railways; the Midi and the Paris-Orléans railways, and to a lesser extent the Paris-Lyon-MCditerranCe, in France; and important sections of the German Railway Company. In Spain, Norway, Czecho-Slovakia and Holland, there exist also important sections of main lines worked by electric traction. Steep gradients and the lack of coal resources were primarily responsible for the electrification schemes of Switzerland, Italy, Austria, Sweden, Norway, and the Midi Railway of France. The main coalfields of France are far distant from the territories served by the Midi and the Paris-Orléans lines, while the Paris-Lyon-Méditerranée scheme is connected with the operation of the Mont Cenis route to Italy with its long tunnel and steep gradients. Electrified sections of the German Railway in Bavaria, Baden, Silesia and Central Germany are largely those with heavy gradients at some considerable distance from the coalfields, while Spanish electrification was due to the same reason.

Apart from the Southern Railway, which, in recent years, has extended the electrification of its main lines as far afield as Hastings and Brighton, Great Britain does not possess any great main line electrification scheme, though the L.M.S.R. possesses important sections of electrified suburban traffic lines in the London, Liverpool and Manchester areas, while the L.N.E.R. at Newcastle has electrified certain of its suburban lines and a heavy traffic mineral line feeding Middlesborough. The G.W.R. in the London district runs electric trains in conjunction with the Metropolitan, a railway which possesses important electrified lines, parts of which are run in conjunction with the Metropolitan District Railway, a member of the Underground Group of electric lines to be mentioned later. Unlike the Metropolitan District, the Metropolitan caters for freight as well as passenger traffic and, consequently, may be classed with the four large British railways, whose electrified mileage in 1927 was as follows:—

Railway	Total route mileage	Electrified route mileage
G.W.R.	3,801	8·2
L.M.S.R.	6,942	104·2
L.N.E.R.	6,384	50·3
S.R.	2,194	361·5
Metropolitan .	52	31·9
Manchester, S. J. and A.	9·25	8·7

Electrified suburban sections of main line railways are found also on the German Railway at Berlin and on the State and the Paris-Orléans Railways at Paris, and in many other large cities.

In Asia electrified railways are found at Bombay in India, on the Great Indian Peninsula, and the Bombay, Baroda and Central India lines. Primarily of a suburban nature, the former is rapidly also becoming a main line electrification scheme. Japan possesses a large electrified mileage, being rapidly extended to embrace main line and suburban traffic on the 1,500 volt D.C. system; Java also has a small electrified section of the same type. In Australasia the New Zealand Railways have electrified a 5½m. tunnel section using 1,500 volt D.C.; whilst suburban electrification is being rapidly extended around the centres of Sydney and Melbourne. In Africa, the South African railways electrified a 175m. line section in Natal on the 3,000 volt D.C. system, and suburban electrified lines exist at Capetown. In South America, important electrified sections exist in Brazil (using 3,000 volt D.C.) and Chile, while Argentina employs 800 volt D.C.; the two first are of a main line character while the last deals with the suburban traffic of Buenos Aires. In North America, Mexico possesses a short electrified mileage on the 3,000 volt D.C. system; Canada employs electric traction mainly for tunnel sections, using 2,400 volt D.C. The United States possesses many noteworthy electrification schemes, notably the 660m. route mile section of the Chicago, Milwaukee, St. Paul and Pacific, and important mileages on the New York, New Haven and Hartford, the Virginian, the Norfolk and Western. the Illinois Central, the Pennsylvania, the Long Island, the Baltimore and Ohio, the Detroit, Toledo and Ironton, the Southern Pacific, the Erie, the Boston and Maine and the Great Northern railways.

Economies of Electric Traction.--On main line electrified sections it is normal to employ one or more electric locomotives which can be controlled by one driver, but for suburban traffic and almost universally on underground lines, except where steam trains are hauled over short electrified intermediate sections, it is usual to employ "multiple unit" trains, where the motors are

*Table showing the most important electrified sections of the World's Railways**

Country	Total route mileage	Route mileage electrified
Argentina	28,882	65·1
Australia	28,085	260·7
Austria	4,174	563·8
Brazil	22,280	251·0
Canada	47,010	31·2
Chile	5,542	218·4
Czecho-Slovakia	8,649	29·4
Estonia	899	5·0
France	33,282	1,307·3
Germany	36,426	1,079·1
Great Britain	20,409	556·1
Holland	2,313	119·2
Hungary	5,935	171·4
India	42,961	223·1
Italy	14,310	2,380·9
Japan	16,670	266.2
Java, Sumatra, etc.	4,617	70·0
Mexico	19,288	60·3
New Zealand	3,483	14·8
Norway	2,407	143·5
South Africa	13,130	222·7
Spain	10,350	376.4
Sweden	10,890	1,120·9
Switzerland	3,740	1,540·6
United States	258,465	2,133·2

*Underground, Light railway, and Inter-urban lines not included.

built into the passenger cars. Reversal of such trains may be cut down to about three minutes, where the trains are very short, or where a second driver is ready to enter the rear of the train as it arrives and drive it on the return journey. More rapid acceleration, together with the greater ease of fitting automatic stop signal devices, permits a closer headway than with steam trains, where frequent stops are concerned, whilst for tunnel sections and underground railways electric traction has come to be regarded as essential. The question as to whether to equip a steam railway for electrification is an ever present problem to many railway administrations and each individual case must be studied on its own merits. Against the advantages of electrification are high capital cost of equipping the line and adapting the rolling stock, while from the operating point of view it is a great advantage to possess each motive unit independent (as in the case of the steam locomotive) of any central power supply. The best method of comparing the two sorts of traction is by means of the net revenue, that is to say, the profit on operation. Electrification invariably attracts traffic, especially passengers, but it is usually more costly to operate, owing to the high interest charges on capital; hence its success will depend upon the amount of new revenue it can attract.

Underground and Elevated Electric City **Railways.**—City railways may be distinguished from tram or street railways in that they possess their own right of way, either above the streets in the form of elevated lines, or below ground in ordinary tunnels or, as in the case of many London railways, in tubes. Such railways normally only carry passengers. Their average journey is short, and the capital cost of construction per mile very high. The traffic is very unevenly spread throughout the day, and the speed and frequency of trains must be sufficiently great to enable them to compete with road services offered by omnibuses, tramways, or even walking. In Great Britain the only important elevated railway section is that of the Liverpool Overhead, claimed as the first electric overhead railway in the world and opened in 1893, 15 years after the elevated system appeared in New York. Sections of elevated lines also exist in other large cities, such as Paris, Berlin and Boston. Electric underground passenger railways exist in Great Britain almost wholly in the London area, an important exception being the Mersey Railway which, originally steam, adopted electric traction in 1903. The first London tunnel railway was the Metropolitan running between Bishop's Road and Farringdon Street and opened in 1863, from which the Metropolitan and the Metropolitan District lines of to-day, largely constructed on the "cut and cover" principle, developed. The "Inner Circle" section of these lines and the extension to Uxbridge was electrified in 1905, and since greatly extended. The City and South London, opened in 1890, was the first deep level line to be built in Great Britain on the "tube" principle, by means of shields invented by J. H. Greathead. Electric locomotives were used on the line, but like the later tubes, all trains are operated with multiple unit trains. In the case of the tube lines, amounting to about 50 route miles, each track runs in a single tube, with the stations built in tubes of large diameter. On the Central London gravity is used to assist the slowing and acceleration of the trains on arrival and departure at stations. New York, Paris, Berlin and Budapest all have underground electric railways, but London's system is primarily of the deep level type. Glasgow also has an underground line, while Chicago has a network of underground freight lines. London possesses a unique Post Office miniature underground electric railway, the system being worked from the stations with no crews on the trains. The cost of construction of such lines depends entirely upon geological strata and the extent to which sewers and underground streams are encountered, but in London it has varied between £250,000 and £1,000,000 a mile. The system of operation is quite distinctive from that of main line or even outer suburban railways, for speed and weight of trains are uniform at any one time, few trains pass stations without stopping, and the "headway" between trains is very close.

C. RAILWAY ECONOMICS

Capital. — Railway capital is the money expended upon the construction and equipment of the railway property, a railway company being permitted by its act of incorporation to raise capital for these purposes to the extent of a stated amount; in the case of the Great Northern Railway, as originally projected, the capital was to be £3,500,000 in shares of £100 with a deposit of £2 per share. The railways of Great Britain possess a high capitalization per route mile, resulting from the great opposition of landowners. Thus, in the case of the Liverpool and Manchester 86 landowners were opposed out of the 335 whose ground was required for constructing the lines. This has resulted in heavy legal costs and great difficulties in Parliament in obtaining the passing of the various railway acts. It has been estimated that in the case of the London and Brighton Railway the law charges alone averaged £3,400 per mile. The price of land in England at the time of railway construction 1825–70 was probably higher than in any other country, while the standard of construction was certainly second to none. Heavy traffic was visualized and many of the lines were built with double tracks, while no financial assistance was granted by the State either in the form of cash grants, loans at low rates of interest or in the form of free gifts of land, such as characterized so notably the construction of railways on the Continent of Europe and more especially in countries at that time practically undeveloped. Canada, perhaps, is one of the most extreme examples of this position, where the C.P.R. not only took over a State constructed railway, but received a cash grant as well as land, in return for constructing a line through to the Pacific Coast. In the United States, railways south and west of Chicago were granted Federal, State and municipal aids for construction in order to open up these territories.

The capital of the British railways was somewhat reduced as a result of amalgamation brought about by the Railways Act of 1921, owing to the exchange of shares and stock of the old companies for that of the new being based upon the market value of those stocks, which in reality meant the prospective earning power of the stocks in question. Thus, £100 of ordinary stock upon which, let us say, a dividend of 2% per annum had been made, and which was worth £40 at the time of amalgamation, was allotted £40 of the new stock which carried prospects of a 5% dividend. Thus large sums of nominal capital which had small earning power were converted into smaller sums of capital with more adequate earning power. By this process over £100 million of nominal railway capital was eliminated. The capital expenditure of all the large British railways at the end of 1933 was £1,149,892,098, a decrease of £56,324,625 on the total for 1926, and comparing with £1,141,543,561 in 1913. There are several measurements of British railway capital as shown in the annual returns of the Ministry of Transport. Thus:

	1913	1926
	£	£
Capital authorized	(not ascertained)	1,280,544,401
Capital created	(not ascertained)	1,198,193,149
Nominal capital	1,273,007,764	1,172,064,967

from which may be deducted the balance of nominal additions and deductions including those consequent upon the passing of the Railways Act 1921, namely,

	1913	1926
	£	£
	199,343,548	49,281,652
Issued capital	1,073,664,216	1,122,783,315
Add balance of premiums and discounts	29,485,626	30,046,880
Deduct calls in arrears and amount uncalled	106,548	27,517
Capital receipts from capital issued	1,103,043,294	1,152,802,678
Capital receipts from other sources	3,148,564	1,085,634
Total capital receipts	1,106,191,858	1,153,888,312
Total capital expenditure	1,141,543,561	1,206,216,723
Capital expenditure in excess of capital receipts	35,351,703	52,328,411

From these figures it will be seen that the British railways as a whole have been conservatively managed as regards finance, and there is no basis upon which to claim that watered capital has tended to increase the level of charges in the form of passenger fares and freight rates. It is noteworthy that the average rates of interest paid per cent of issued capital were 4.28% in 1913, 4·40% in 1925, and 3·73% in 1926, the last a year of acute industrial depression owing to the long drawn out deadlock in the coalfields and the general strike of that year. The capital of the four large railways at the end of 1927 was as follows:—

	Shares and stock	Loans or debenture stock	Total
	£	£	£
G.W.R.	112,561,194	39,881,299	152,442,493
L.M.S.R.	310,426,312	109,262,557	419,688,769
L.N.E.R.	259,413,404	114,163,817	373,577,221
S.R.	111,102,398	44,614,426	155,716,824

The percentage of shares and stock to total capital is much greater on British railways than in the case of the American railroads and is a source of financial strength.

While many attempts have been made to compare the capital per mile of the railways in different countries, such studies are made worthless through the divergence of political policies adopted with regard to early railway construction as earlier explained, through variations in the purchasing power of money at the different periods and wide differences in the number of tracks per route mile. The cost per route mile will naturally be greater in countries where there are long stretches of main lines with four or more tracks. Construction cost will also be greater in mountainous countries or on lines with an abundance of tunnels, on tube railways and on suburban lines where widenings are very costly. Frequently it may be profitable for a railway to widen a line, thus adding to capital expenditure, if by so doing maintenance and train operating charges are reduced; or if, by added facilities, it is possible through hauling more traffic to increase the net revenue. Denser traffic requires added signalling equipment which in turn forces expenditure in this direction. If comparisons are made between the capital per route or track mile between various countries care should be taken that the capital expenditure on ancillary services, such as hotels, steamboats and docks, are excluded from the British railway figure.

Expenditure and Receipts.—Apart from capital outlay which is expected to yield a return of interest in the form of added facilities or savings, operating expenses constitute the second type of railway expenditure. Of the total capital expenditure of the British railways, namely, £1,206,216,723 in 1926, £1,057,973,736 had been expended on the railway proper, such as lines open for traffic, rolling stock, land and buildings, and the balance of almost £50 million had been spent on road vehicles, docks, steamboats, hotels, canals, and so forth. Thus with 37,058 m. of line reduced to single track but excluding sidings, the capital per track mile in Great Britain has been about £28,550. "Expenditure in respect of railway working" on a British railway amounts to about 80% of the traffic receipts per annum. Variations exist between the companies but maintenance and renewal of way and works accounts for about 11%, of locomotives 6%, of carriages 4%, of wagons 4%, locomotive running expenses 20%, traffic expenses 28%, general charges including law and parliamentary expenses, compensation, national insurance and rates 7%. The ratio between expenditure on and the revenue derived from railway operation is known as the "operating ratio." In Great Britain as in many other countries the management has little power in the regulation of wage rates, which form a large proportion of total expenditure, and less as regards the level of freight rates which are determined by outside bodies. "Receipts in respect of railway working" are obtained from passenger and freight train traffic, the percentage from the former varying greatly between the four railways, being highest on the S.R. at 73½% and lowest on the L.N.E.R. at 354%.

Statistics.—Few branches of railway organization have extended more rapidly during the 20th century than that of statistics. With the growing size of railway administrations it has become necessary for those responsible for railway management to be able to visualize daily and weekly the degree of operating efficiency in each district of the railway, and to study the financial situation as it develops from day to day. Traffic when lost is hard to regain if the loss is only discovered some time afterwards. Similarly the unpunctuality of trains must be eliminated in the public interest as soon as possible. Railway statistics are also required by the Government departments responsible for the regulation of the railway industry, as well as by tribunals such as the Railway Rates Tribunal in Great Britain and the Interstate Commerce Commission in the United States, which are responsible for the regulation of railway charges scales. There are also large groups amongst the general public, such as financiers, bankers, economists and members of trade unions, to whom the figures of railway finance, traffic and general statistics are of the closest interest, while a nation has the right to know facts as to the physical condition of its most important form of land transport. Thus in each country there are published railway returns. In Great Britain they consist of annual returns and monthly statistics published by the Ministry of Transport; in the United States the Interstate Commerce Commission publishes an annual report and statistics concerning the American railroads, in addition to data on accidents, signalling, equipment, and so forth. In countries with State railways the annual reports usually give voluminous information, while in Germany the report of the Commissioner is a model for a report dealing with railway progress and finance. The statistics thus circulated to the public are usually termed *external* statistics, in addition to which. and wherever possible closely correlated to them, are figures dealing with railway operation which are primarily designed to help the railway management itself. These are known as *internal* statistics, and frequently deal with figures as to costs. In fact the development of cost statistics by railways has grown rapidly and with the fine margin existing between revenue and expenditure, as illustrated by the high operating ratio figure, continual stress is being laid upon accurate cost statistics. Unfortunately cost of movement of any one consignment by rail is difficult to arrive at in view of the large percentage of railway expenditure which is "fixed," that is to say. which continues irrespective of the amount of traffic hauled; one extra wagon on a freight train will add little to the cost of hauling the train. Each charge made for a passenger or a ton of freight should include an allowance to help to cover the fixed, or nearly fixed, items of expenditure.

Passenger Traffic.—Railway traffic may be divided into two main divisions: (1) that carried by passenger train, and (2) that carried by freight train. Passenger trains in Great Britain for many years carried three classes of passengers (see Section B: Rolling Stock), but the 2nd or intermediate class has gradually disappeared until it survives only on certain London suburban and Continental train services. The use of "Pullman" cars which cater for the 1st and 3rd class passenger upon payment of an extra charge has in practice added a "de luxe" class, but these cars are only used upon certain services of the L.M.S., L.N.E. and Southern railways. On the electric tube railways in London there is one class only, in order to assist rapid loading and unloading of passengers at the stations, where the stopping time is very short. An express train carries little besides the passengers, their luggage, post office mails and a certain amount of parcels traffic, but slower trains carry much milk traffic and sometimes horse boxes and wagons containing livestock, so that the revenue derived from a passenger train service may be varied. Special charges are made for luggage in excess of so many lb. weight per passenger, while workmen's tickets are issued for trains arriving at cities in the early morning, and special low rates charged for season tickets, which permit the holder an unlimited number of journeys within the period covered by the ticket.

Passengers are charged mileage rates of 1½d. for 3rd class, and half as much again for 1st class, but over 50% of passengers are carried at lower rates, either by means of season tickets, tourist, week-end, or other special tickets. Railways in nearly all countries where adequate road systems exist have lost traffic to road motor services to a serious extent, and in many cases are not carrying so many passengers as they did 10 years previously. In the South Western States of America, such as Texas, passenger traffic fell away by 60% in 8 years owing to the competition of the motor car, but that is a somewhat extreme case. Nevertheless railways throughout Europe and North America have been forced to exercise the maximum of effort to reduce their branch line costs, where much of the loss has taken place, and at the same time to make every effort to induce new passenger traffic. British railways have extended the use of road motor feeder services and have increased their train mileage, and while recent legislation has done much to stabilize the position, the tendency appears to be towards a decrease in short distance passengers and an increase in the number of passengers travelling longer distances. To provide an economical service on branch lines, certain railways employ rail motor cars, the engine forming part of the passenger car. These "rail motor cars" are light in weight, cheap to operate, and can carry a trailer when fitted with a high powered engine, which may be of steam, electric or petrol electric design. They can be operated from either end.

Freight Traffic.—Freight trains carry every kind of commodity, from perishable, such as fruit and meat, to manufactured products, such as machinery, etc., as well as bulk consignments of raw materials, as coal, iron ore, road stone, manure, grain and salt. Wherever possible train loads are made at the originating point, as in the case of coal from a mine, but the general tendency is for trade to become more retail as the transport service improves. Reliability of service enables reserve stocks to be cut down to a minimum, thus saving the interest charges on that stock, but entailing greater expense in handling as the average individual consignment grows smaller. The British railways carry over 350,000,000 tons of freight in a year of trade prosperity, the average revenue per ton for all classes of traffic amounting to about 7s., the revenue from freight traffic per route mile being about £5,000, and 15s. per train mile.

Freight traffic is divided into three main classes in the British official statistics, namely, general merchandise; coal, coke and patent fuel; and other minerals, all measured in tans, while livestock is measured by the number of animals. Great Britain is almost the only country which separates coal traffic from other freight traffic, due doubtless to the important percentage which that commodity forms of the total traffic carried. Since the average length of haul for all classes of freight traffic in Great Britain is only about 5jm., road motor services are able to compete successfully for the more valuable types of traffic. This may result in a dangerous condition of affairs, because to make good this loss of revenue, charges may have to be raised upon those heavy articles, such as heavy machinery, coal and raw materials, which are very unsuited for haulage by road. The freight rates or charges made for carrying consignments are closely regulated by the specially appointed Railway Rates Tribunal in Great Britain, where as in every other country the scale of charges is quoted on a mileage basis. For this purpose commodities are placed in classes according to intrinsic value, difficulty of handling, fragile nature or relation of volume to weight entailed. From the commencement of railway history it has been recognized that the greater the value of a commodity, the more it could afford to pay for haulage; thus silk is placed in a class where the goods have to pay more per mile than the scale in which cotton is found. Bulky and heavy articles, like bricks and coal, cannot afford to pay such high charges per mile as valuable metallic ores. In short, every article carried by a railway is to be found in the freight classification, the number of classes varying with each country, some only using 4 or 5 classes, others over a score. To obtain, therefore, the proper charge for haulage by rail, reference must first be made to the classification book, and then to the mileage charge made for that class of traffic. Freight rates are also said to "taper," that is the charge per mile grows less as the distance increases; this enables a commodity produced under the disadvantage of greater distance from the consuming centre to compete with commodities produced nearer at hand. Specially low rates, known as "exceptional rates" in Great Britain, are quoted by railways to allow producers served by their lines to compete with producers in other areas. Such special rates are found in almost every country, and frequently result in strong international competition, as in the case of coal produced in Great Britain, Germany, Poland and France.

Railway Organization— Many types of railway organization are in existence, owing to the problem that faces any two railways being different according to geographical or political conditions. A State owned and operated system will essentially have a different type of organization from a company owned and operated system. The former may be managed direct by a minister of railways or by a railway board, but in the majority of such cases the actual management is in the hands of one person, variously known as the director general, commissioner, president or general manager. The policy of a company owned railway is usually guided by a board of directors elected by the shareholders, the board appointing a president or general manager to organize and manage the system. The system will be divided into departments reporting to the general manager; the number and titles of such departments differ,but usually there are departments headed by:—(1) the chief engineer, who is responsible for the track and civil engineering work, (2) the mechanical engineer, responsible for rolling stock and locomotive design and maintenance, (3) the chief operating officer, responsible for operating the trains, mainly an expenditure department, and (4) the chief commercial officer, responsible for the charges made for passengers and freight carried, mainly a revenue department. In addition there are departments dealing with steamship services, hotels, docks, immigration, agricultural development, and so forth, depending upon the railway in question. Matters appertaining to labour relations, such as wage rates and the hours and conditions of work, are so important on British railways that the head of the staff department is usually a very high official and closely connected with the office of the general manager. Wage rates and hours and conditions of work are however primarily matters regulated by national agreements between the railways and the railway trades unions, of which the three important ones in Britain are the National Union of Railwaymen, the Associated Society of Locomotive Engineers and Firemen and the Railway Clerks Association. Disputes with the trades unions are the subject of negotiation by the Central Wages Board, and, failing agreement, by the National Wages Board, which includes in its composition reprzsentatives of the general public as well as of the railways and the trades unions. Increasing attention is being given to "relations with the public" and to advertising.

D. LEGISLATION

Great Britain.— Early railway legislation dealt primarily with the construction of railways and required the presentation of a bill to Parliament, which then authorized the company concerned to acquire the necessary lands, divert streams and possibly roads, and build tunnels, viaducts and embankments. Much of the earliest legislation was concerned with the question of adequate fencing of the right of way and protection of level crossings. Early railway bills were frequently opposed by rival railway bills and the opposition of landowners, which consequently increased the original cost of construction (see Section C). In return for the right to build a railway, which carried with it the understanding that no neighbouring parallel line would be constructed in such a manner as to divert all its revenue, it was realized at an early date that close regulation would have to be exercised on the charges which it made for carriage. Control of the standard of construction, so as to ensure safety both to passengers and to railway employees, stands out clearly throughout 19th century railway regulation in Great Britain, which consists of a series of acts resulting from the deliberations of select parliamentary committees, enquiries and royal commissions. An act of 1840 for regulating railways required returns concerning rates, fares, traffic carried and accidents, while a Regulation Act, 1842, made possible great improvements in rolling stock; that of 1844 is an important landmark as it visualized the possibility of State ownership 25 years later. In practice this never came about, but another of its provisions, relating to one train per day offering 3rd class accommodation, is the basis of cheap railway travel in Great Britain. The Railway Clauses Act, 1845, standardized railway bills, and the gauge commission of the same year did much to standardize the running gauge for the country. Amalgamation proved a difficult problem for Parliament for 70 years; until 1914, although hundreds of lines were gradually amalgamated, Parliamentary efforts were mainly directed towards the preservation of competition. The Railways Act, 1921, resulting from the upheaval of the World War largely reversed that position. The Act of 1850 recognized the Railway Clearing House formed 8 years previously, while the Railway and Canal Traffic Act, 1854, introduced the principle of prohibiting the bestowal of "undue preference" upon any trader by the railway, thereby creating a new era in railway regulation. During the ensuing 20 years various amending acts were passed, the amalgamation problem coming to the fore again during the '70s. Stricter government inspection of new lines was enforced in 1871, a law which still applies, in addition to the provisions it contained relative to the reporting of accidents involving loss of life, collision or derailment of a passenger train.

A Railway and Canal Traffic Act, 1873, of vital importance, forced the publication of the fares and rates schedules, which was followed by legislation of 1878 requiring the provision of continuous brakes on passenger trains; this latter resulted from a royal commissioll on railway accidents; the carriage of post office parcels by rail was the subject of an act of 1882. The Cheap Trains Act, 1883, made provision for the inauguration of cheap workmen's fares, a landmark in social, as well as railway, legislation; 6 years later came a law enforcing the use of the block system, interlocked signalling and automatic continuous brakes on passenger trains. Meanwhile a Railway and Canal Traffic Act, 1888, resulting from the long deliberations of a select committee, dealt with complaints of high railway charges. A uniform classification of freight was designed in connection with scales showing the maxima charges, upon which were based the Rates and Charges Confirmation Acts of 1891 and 1892. The form of maxima charges of 1893 lasted until 1928, although slight percentage advances were made in 1913 and further increased consequent on the higher prices ruling during and after the War. Labour conditions of railway employees received attention in 1891, introducing definite regulation of the hours of duty and rest periods, while the 20th century opened with the Railway Employment (Prevention of Accidents) Act, 1900, aimed at reducing accidents to employees. Working agreements between railways were discouraged by Parliament as late as 1911, as tending towards elimination of competition, but legislation was destined ten years later to amalgamate forcibly the companies in question. The Railway Companies (Returns and Accounts) Act, 1911, laid down rules of a more adequate presentation of the annual financial accounts and statistics, which still lasts in the form of a railway's annual report.

Railways Act, 1921.—An act of 1919 set up the Ministry of Transport, which took over the railway duties of the Board of Trade and the problem of the future policy with regard to the railways, which had been taken over by the Government at the commencement of the World War. During the war the railways were managed through an Executive Committee consisting of the existing general managers of the various railways; no praise could be too high for the splendid manner in which the railways carried enormous traffics during the war years, supplied large staffs, and much rolling stock and locomotives for work overseas, and while being unable to continue their normal repair and maintenance work built special ambulance trains and produced war stores from their own shops. The Railways Act, 1921. allotted £60,000,000 for division amongst the railways to make good arrears of maintenance and settle all claims against the Government, which had returned the railways to private ownership on Aug. 15, 1921. This important act, sometimes described as the Charter of the British Railways, (1) reorganized the railway system, (2) dealt with the regulation of the railways, (3) designed the principles upon which railway charges were to be based, (4) included important provisions concerning wages and conditions of the railway service, (5) touched on light railways, and (6) added certain general provisions. The first of these was brought about by the new grouping arrangements (*see* Section A), although, unlike the position in France and Germany, competition was retained, such as between London and Birmingham, The second aimed at economies brought about by standardization of rolling stock and physical equipment, such as electric traction. The third set up a Railway Rates Tribunal to be responsible for arranging the scales of rates and fares, and to be available for the reception of complaints by traders and the general public. The new scales came into force on Jan. 1, 1928, on the so-called "appointed day," and were based on a much enlarged freight classification. The Tribunal also was to design charges so as to yield a standard revenue to be earned by the railways, but in view of the competition of road vehicles this ideal is not an easy attainment. The fourth part of the act made provisions for the channels by which disputes regarding wages and conditions of work were to be discussed, namely, through a Central Wages Board and, failing agreement, a National Wages Board (*see* Section C: Railway Organization), though this arrangement did not succeed in preventing the withdrawal of the majority of railwaymen from work during the general strike in May, 1926. The fifth part, relating to light railways (*see* Section A), is comparatively unimportant, while the sixth made provision for the continuation of traffic facilities and flow of traffic, in addition to preserving the rights of those employed by the railways who might suffer from the results of railway amalgamation. The provisions of the Railways Act were far reaching and can only be judged over a long period of time. At one time nationalization was urged, and by some the act was regarded as a half-way measure, but reaction from Government control during the War was too strong to permit such a policy in 1921. Future legislation depends upon the degree of progress attained by the railways under the Act of 1921. Few railway laws in any country have been so far reaching in their provisions. (C. E. R. *S.*)

E. THE BRITISH RAILWAY GROUPS

The Four **Groups.—This** section describes briefly the part which is played by the railway systems of Great Britain in the economic life of its inhabitants. It will be shown that the services rendered by the several railway companies are concomitant with the present organization and distribution of industry. Attention will be mainly given to the four main-line railways of Great Britain, which were formed as a result of the Railways Act of 1921, namely, the London, Midland and Scottish Railway (L.M.S.R.), the London and North Eastern Railway (L.N.E.R.), the Great Western Railway (G.W.R.) and the Southern Railway (S. R.). Besides these, there are the London underground railways and Metropolitan Railway (all of which, since 1933, are amalgamated with the local omnibus, tramway, and motor-coach services in the London Passenger Transport Board), as well as a number of small railways in other parts of the country. Of the numerous classes of traffic carried by the four main line railways, the distinction between the carriage of passengers and of freight is fundamental. Contrary to popular expectation the latter is considerably more important, if measured in terms of revenue, than the former. In 1927, for example, the gross receipts earned by the railways for the carriage of passengers was approximately £70 million, whereas that earned for the carriage of freight, including mails, parcels and other articles carried in passenger trains, amounted to nearly £130 million. For this reason the carriage of freight will first be considered.

Since the beginning of the nineteenth century Great Britain has been under the sustained influence of those economic changes consequent upon the industrial revolution. These changes have been world-wide and can be described as a tendency towards the specialization of economic function, each person or group of persons producing or assisting in the production of some one particular article. Thus, whereas prior to these changes comparatively small areas were self-contained units, so far as their essential requirements were concerned, since that period there have developed large masses of population employed in industry and manufacture who are dependent for their existence upon commodities carried from distant lands, the sufficient growth or production of these commodities being, for all practical purposes, impossible near at hand. At the same time in other parts of the world are vast tracts of country whose inhabitants devote their entire energies to the pursuit of some particular form of agriculture. Between these two extremes are an indefinite number of producing areas all specializing in greater or lesser degrees. But in every case, not only must the surplus and specialized produce be carried away and distributed to those regions which are in need of them, but in exchange the requirements of those producers must be reclaimed from lands suited to the production of those requirements. Thus, an outstanding feature of the present industrial age is man's complete reliance upon long distance transport, whether it be by railway or by ocean going vessel; and the greater the degree of specialization of function, the greater the degree of his dependence.

In so far as the economic changes which have been taking place during the last hundred years have transformed Great Britain into a region, the inhabitants of which have become engaged very largely upon the manufacture and production of goods which are exported abroad in exchange for food and raw materials, her railways are engaged in the carriage of freight which is destined for export, or which has been imported. In this sense the railway systems of Great Britain should be looked upon as providing an essential link in the larger chain of communications by land and sea which enables not only the production of mines and factories to find their way into distant foreign markets, but in return, food and raw materials into the homes and factories of the land. In so far as Great Britain still produces to an important extent what is required by her own inhabitants, the railway systems are occupied in internal trade. Certain traffic that may appear to belong to the latter category, however, is in reality a part of the export trade; for example, the bringing together of raw materials and coal to be used in the manufacture of goods destined for export. Furthermore, shipment traffic is not in every case for export proper, a considerable quantity being carried to other ports of Great Britain. To illustrate the importance of this latter type of traffic, it may be cited that during the year 1925, 53% of the coal bought for use in Greater London came by rail; but of the 47% that came by sea, much the greater part also originated at British mines. The average length of rail haul for landsale coal during the month of January 1925 was 54·51m. whilst that for shipment was 24.26 miles. This brings out in sharp contrast the very different nature of the simple carriage of coal for export, from mine to port, and the wide distribution of landsale coal, not only to each and every gas works and factory, but to every coal consuming householder in the country.

The work of the British railway systems is not only then dependent upon the relative positions of areas of production and areas of consumption but also upon the position of ports. Areas of production differ widely according to the nature of the commodity produced. Certain specialized types of machinery may all be manufactured in a single factory, from which distribution is necessary either to the home market or to ports of export for the foreign market. Another type of product, notably that of agriculture, is grown over a widely diffused area. To illustrate the work undertaken by the railways in this connection, it is noteworthy that London draws her daily supply of milk from areas as far distant from herself and from one another as Norfolk, Lincolnshire, Shropshire, South Wales and Somerset. Similarly the market or consuming area may be widely diffused throughout the country, or may be one particular spot, as in the case of certain machinery required for further manufacture.

Thus, on the one hand there is the bringing together of commodities from a number of producing points scattered through the land to a single centre, and on the other hand the distribution of products from one or two manufacturing centres to a large number of places of consumption or ports. In this connection the position of the coal mining areas of Great Britain are of particular significance, for not only do coal fields directly give rise to the most important of all railway traffics, but their position has considerably influenced the whole distribution of industry, and therefore of population. The coal, coke and patent fuel exported from Great Britain and carried by the four main railway systems of Great Britain during the month of January 1925 (a month not unrepresentative of normal conditions) was shared as follows:—

British Railways Coal *Traffic:* Jan., *1925*

Railway	Tonnage	Average length of haul
		Miles
G.W.R.	2,640,112	21·31
L.N.E.R.	2,982,712	22.65
L.M.S.R.	871,187	39·09
S.R.	510	34·22

It will be seen from the average length of haul of the G.W.R. and L.N.E.R. that the coal fields served by these two railway systems, namely, the South Wales and the Northumberland and Durham areas respectively, enjoy special advantages for this traffic. The position of ports likewise is fundamentally controlled by the geographical factors which bring coast lines, estuaries, tides and rivers in suitable juxtaposition, while the distribution of population broadly coincides with the distribution of industry. No better summary of the general position is to be found than in a passage taken from Part II of the report published (1928) by a Government committee appointed in 1924, entitled Further Factors in Industrial and Commercial *Efficiency,* which reads as follows: "To sum up, the transport services have to provide for a population, nearly half of which is within fifteen miles of a large port, four-fifths of which is concentrated in or round towns, and more than half of which is grouped in five areas which between them comprise only one-tenth of the area of the country." Thus in so far as Great Britain's manufacturing centres are mainly localized around her great ports, the rail haul is often a matter of a few miles only. The Midland manufacturing area near Birmingham, as also Bradford, Leeds and Nottingham, are important exceptions to this generalization; furthermore, articles of value but of comparatively small bulk, such as the finished products of the cotton, woollen and artificial silk industries, are not necessarily exported from the port nearest at hand, but from the ports best situated as regards destination. Thus the manufactured products of the industrial North destined for Continental European markets find their way via Harwich, London, Dover and Southampton to the Continent. On the other hand, as regards imports, while wheat, sugar, tea and fruit arrive daily for distribution throughout the country, a classic example of the importation of raw material is that of raw cotton for the South Lancashire cotton industry, which, like so many other industries in Great Britain, is within easy reach of port facilities at Liverpool and Manchester.

With regard to the carriage of passengers, broadly speaking passenger travel is undertaken either for pleasure or for business purposes. So far as the latter is concerned there are certain outstanding characteristics of modern industry which give rise to passenger travel. The distribution of the numerous branches of many large firms throughout the country, the specialization of function as between different firms, the need of constant consultation, the personal negotiation of important contracts, or the exhibition of his samples by the commercial traveller, are all factors promoting travel. But undoubtedly the chief form of travel essential to modern industry is that between the worker's home and his place of work. Notably round London, but to a lesser degree round most business and manufacturing centres, many hundreds of thousands of people travel daily by railway to and from their homes situated in suburban or rural districts. While as regards passenger travel for pleasure, there is sufficient variety both of scenery and climate within Great Britain to engender considerable travel on this account. Furthermore, the very fact of the intense concentration of population leads men and women of all classes to leave the great cities for sea-side or country-side resorts. The eastern side of England, with its drier climate, the comparatively warm south and south-west coast, the beauties of the Lake District and Scotland, each gives rise to considerable holiday traffic. Last, but not least, the Continent itself is a large source of attraction, resulting in travel to those ports facing the Continent. (G. J. P.)

BIBLIOGRAPHY.—H. G. Lewin, *Early British Railways, 1801–1844* (1925); W. H. Cole, *Permanent Way* (1915), a comprehensive field manual; A. M. Wellington, *The Economic Theory of Railway Location* (1887); C. Stephens, *English Railways, Their Development and Their Relation to the State* (1915); W. M. Acworth, *The Elements of Railway Economics* (1924); A. E. Tattersall, *Modern Development in Railway Signalling* (1921); C. E. R. Sherrington, *Economics of Rail Transport in Great Britain* (1928); *Modern Railway Administration* (1925), a practical treatise by railway experts; *Railway Year Book*, giving particulars of British and other railways; *Centenary number of the Railway Gazette*, June 22nd, 1925, an outline history of British systems; *Special Supplement of the Railway Gazette, South America*, Nov. 22, 1926 and Dec. 6, 1926; *Special Supplement of the Railway Gazette, South Africa*, Dec. 26, 1927 and Dec 5, 1927; Report of the Government Committee appointed in 1924 entitled *Further Factors in Industrial and Commercial Efficiency, Pt. II.* (1928); *Railway Returns of the Railway Companies of Great Britain*, published annually by the Ministry of Transport; *Archiv fur Eisenbahnwesen*, translated by the Bureau of Railway Economics at Washington.

F. THE UNITED STATES RAILROADS

With less than one-twelfth of the world's population and little more than one-third of its area, North America has nearly one-half of the world's railway mileage and far more than one-half of the aggregate railway capacity to move passengers and freight. The United States leads the countries of North America with about five-sixths of the railway mileage of the grand division. Per 100 sq.m. of land area, the United States has 20·8 m. of railway line while the rest of North America has 1·3 m. and the world (exclusive of North America) 1·1 miles. Compared with population, the world, not including North America, has 2.7 m. of railway line per 10,000 inhabitants; North America, excluding the United States, has 17·1 miles; the United States has 23.6 miles. The whole of Europe has 5·1 m. of railway per 10,000 inhabitants and 5·6 m. per 100 sq.m. of area.

The modern railroad, wherever it exists, is a result of the progressive development and reciprocal adaptation of the roadway, or track, and the motive power, under the stimulus of expanding demand for transportation. Historically, an expanding and effective demand has been generated only by rapidly diminishing charges for the services sought and this diminution has been obtainable only by improvements in methods and mechanism producing commensurate reductions in unit costs of rendering service.

John Stevens (*q.v.*), called in the United States "the father of the railroads," and his associates, received the first American railroad charter from the State of New Jersey on February 6, 1815. At that time approximately eight-tenths of the total population of 8,350,000 resided in New England and in States adjacent to the Atlantic ocean. Most of the balance were situated in Ohio, Kentucky or Tennessee, but scattering and growing settlements were to be found in the Mississippi valley. Within this last named region and in the South there were great areas occupied solely by Indians organized in tribes which were treated as sovereign within their localities.

The War of 1812, the Napoleonic wars, and the Tariff of 1816, had given an impulse to domestic manufactures and to internal trade and had created aspirations towards an economic progress that would require transportation facilities far in excess of any then existing. The conditions creating, in the United States, an exceptional demand for transportation, as they existed on the eve of railway development, can obviousiy be described oniy in very general terms. The picture is that of a growing number of economically detached communities; increasing rapidly in population and industrial importance-each possessing the foundation for profitable commercial ,interchanges, if only the machinery for interchange could be created; and united under one flag. Territorial division of labor had commenced, promising an enormous expansion of internal commerce. Machinery, iron products and textiles for use west of the Allegheny mountains were being manufactured in the Atlantic states; western farms produced grain and food supplies for the South. The East, owing to the increased population of industrial centers following a flood of foreign immigration, had become dependent upon the West for food supplies; the Southern states were experiencing a rapid expansion of the cotton growing industry, and their exports made up two-thirds of the total exports of the United States. The great obstacle to interstate trade and internal development with resulting prosperity was slow and costly transportation. The routes of movement had assumed sharply defined lines. At first following natural waterways, sections not served by such channels had demanded facilities to enable them to compete with their more fortunate neighbors. Turnpikes and canals had been constructed, but the services of these two agencies were sharply restricted by geographic and climatic conditions.

The First Railroads.—The Delaware and Hudson's gravity railroad, in Pennsylvania, was not only the first on which a locomotive was ever operated in the Western Hemisphere but was also the first that was constructed with locomotive operation in view. It began operation in 1829 and only a few months after, tracklaying began, in February, 1829, on the Charleston and Hamburg, later the South Carolina, railroad, the first railroad intended both for general public transportation and for locomotive operation. Prior to 1829, however, there was considerable use of tracks of wood, stone or iron over which cars were drawn by horses or stationary engines, the latter used principally in the operation of inclined planes. Probably, the first of such tramways was an inclined plane in use in Boston in 1795, and operated for moving brick. The next tramway, constructed by Silas Whitney. was also in Boston. It was formerly supposed that the line built by Thomas Lieper, in Delaware county, Pennsylvania, preceded Whitney's, but investigation has disclosed that it was not until 1809 that Lieper constructed an experimental road which was soon followed by another used for transporting stone. The fourth railroad was, apparently, one constructed soon after 1810, at Fallings Creek, Virginia. It was about a mile long and extended from a powder magazine to a mill. These roads were followed by a wooden-rail tramway at Bear Creek, Pennsylvania, in 1818; a short road at Nashua, New Hampshire, in 1825, and the Quincy railroad, in Massachusetts, constructed in 1826. The latter was used to move stone for the construction of Bunker Hill monument from the quarries to the wharf on the Neponset river, about four miles.

In 1827, the Mauch Chunk railroad, in Pennsylvania, 9 mi. long, was built and used in the transportation of anthracite. It was then the longest and most important railroad operating in the United States. Another short road, half a mile long, was constructed in 1827 to connect coal mines with the Schuylkill canal. The Mill Creek Railroad, extending from Port Carbon to the present site of the town of St. Clair, a distance of 3 mi., was also built in 1829. The Delaware and Hudson Company was chartered on April 23, 1823, and its gravity railroad, from Carbondale to Honesdale, connecting its mines with its canal, was actually operated from August 8, 1829, when over it the first locomotive test ever attempted in the United States was made. The use of steam locomotives on this railroad was first advocated by John B. Jervis. Except for the Charleston and Hamburg, none of these early railroads was intended for passenger traffic. The other railways were built to transport freight and natural products in a single direction to a place of trans-shipment, manufacture or use.

The Charleston and Hamburg.—In February, 1829, 150 ft of track, the beginning of the Charleston and Hamburg, were laid on Wentworth street, in Charleston, South Carolina. This railroad was completed to Hamburg, South Carolina, across the Savannah river from Augusta, Georgia, in 1833, and was then the longest in the World, having a length of 135 miles.

The Baltimore and Ohio, the first railrpad built in the United States for the general transportation of passengers and freight, but not projected specifically as a locomotive railroad, was chartered by the State of Maryland, and construction was commenced on July 4, 1828. On May 24, 1830, 13 mi were opened to Ellicott's Mills; on Dec. 1, 1831, it was extended to Frederick City; in 1832 to Point of Rocks, Maryland, in 1834 to Harper's Ferry; to Cumberland in 1852, and to Wheeling in 1853. The branch from Relay to Bladensburg (near Washington) was opened on August 25, 1834.

The Mohawk and Hudson Railroad Company was chartered by the legislature of New York on April 17, 1826, to build a railroad between the Hudson and Mohawk rivers, and after legal delays construction began in July, 1830. Operation began on August 10, 1831, the travel between the termini, Albany and Schenectady, amounting at the outset to from 200 to 300 passengers per day Other sections of the present New York Central were later incorporated and opened for operation: the Utica and Schenectady, opened in 1836, the Syracuse and Utica, in 1839; the Auburn and Syracuse, in 1838; the Auburn and Rochester, opened from Rochester to Canandaigua, in 1840, to Seneca Falls, in 1841, to Cayuga, in 1841, and to Auburn in 1841; the Rochester and Syracuse, in 1853; the Tonawanda Railroad, to Batavia in 1837, and to Attica in 1842; the Attica and Buffalo, to Darien, and to Attica in 1842. These eight railroads together constituted the first railroad connecting the Atlantic ocean or any of its tributary waters with the Great Lakes or rivers flowing to them or into the Mississippi river.

Boston and Albany were also connected by railroads completed in 1842; New York and Boston, in 1849, by the completion of the New York and New Haven; Ogdensburg and Lake Champlain, in 1850; Boston and the Saint Lawrence river, by the building of the Vermont Central and the Vermont and Canada, in 1851. Also, in 1851, the Erie Railroad was completed from Weehawken, New Jersey, on New York tidewater, to Lake Erie, and the Hudson River Railroad, paralleling the Hudson river to Troy was opened in 1852, but the west shore of the Hudson river was not occupied by a trunk line until the construction of the West Shore Railroad, which was opened in 1883. The New York, Westchester and Putnam Railway, now the fourth line of the New York Central to New York City and tidewater was opened in 1880.

Several independent railways formed a line from the Ohio river to Lake Erie in 1848. These lines, with the road from Toledo to Buffalo, the last section of which was finished in 1853, opened practically the whole State of Ohio to railroad transportation. Chicago was reached by rail in 1852 and in 1854 the Chicago and Rock Island Railroad was extended to the Mississippi river. As a result of these extensions much of the trade of the west bank of the Mississippi and of that part of Illinois which is contiguous to the navigable portion of the Illinois river was diverted from New Orleans which had been its only outlet. By 1856 two more lines were built from Chicago to the Mississippi river, in addition to the Illinois Central which was completed to the junction of the Mississippi with the Ohio in the same year. In 1859, the railway system of the country was carried to the Missouri river, by the completion of the Hannibal and Saint Joseph Railroad; in 1866 the Galena and Chicago Railroad was extended to Council Bluffs.

A railway journey across the continent first became possible in 1869 when the Union Pacific, building from the Missouri river at Omaha, met the Central Pacific, built from San Francisco, making a line 1,848 mi. long. Construction was started in 1864 by the Central Pacific. In the following year the Union Pacific began its progress westward. Many hardships and difficulties were encountered in completing this feat of railroad engineering and with its achievement the general outline of the railway system of the United States was formulated. Filling in this outline has been the task of the extensive construction work that has ensued, reaching regions that were left intermediate or at one side, by building cross lines, branches and additional trunk lines. Plans for the Northern Pacific were first developed in 1864, but work was not begun until 1870; it was completed to Portland in 1883. Work on the Atchison, Topeka and Santa Fe was commenced in 1869 and by 1873 450 mi. were in operation. The Southern Pacific, originally intended to join the Texas and Pacific at the Colorado river, had built 102 mi. by 1869, and, in the subsequent four years 172 additional miles were constructed; the year 1881 marked its completion from San Francisco to New Orleans, 2,489 miles. The Atchison's line, from Kansas City to San Diego, and that of the Great Northern, from Saint Paul to Seattle were finished in 1893. Other transcontinental lines, subsequently built, are the Chicago, Milwaukee and Saint Paul; San Pedro, and Western Pacific.

Construction of railways, considering the limited capital resources of the earlier periods, became rapid throughout the more developed portions of the country after the close of the decade that ended with 1830. In that year the total length of railway lines was just under 40 miles; in 1831, it had increased to 98.7 miles; in 1832, to 229 miles; and by 1835, to 1,098 miles. The growth of mileage, by sections, from 1840 to the latest date for which data are available is shown in Table I.

TABLE I. ***Length** of Railway Lines in 1927.*

Year	New England	Middle Atlantic	North Central	South, East of Missis-sippi river*	West of Missis-sippi river†	**Total length of line at end of each decade**
1840	517	1,566	80	636	None	2,799
1850	2,507	3,105	1,272	1,799	None	8,683
1860	3,660	6,353	9,592	8,838	1,840	30,283
1870	4,494	10,991	14,701	11,501	12,191	53,878
1880	5,997	15,949	26,382	14,908	31,435	94,671
1890	6,718	19,842	36,923	29,492	70,622	163,597
1900	7,521	24,691	41,006	35,546	84,582	193,346
1910	7,922	27,379	44,929	47,025	113,184	240,439
1920	7,941	28,096	44,905	49,556	122,347	252,845
1927	7,636	27,741	43,684	48,392	121,678	249,131

*Includes Louisiana †Includes Minnesota. (H. T. N.)

Railroad Consolidation.— The processes of consolidation have acted upon railroads from their earliest days with the result that the thousands of independent companies have been reduced to less than 100 unified systems. As a single and not unusual example, the present New Haven Railroad is composed of what were once about 200 separate enterprises. The decision of the Supreme Court of the United States, in the Northern Securities Case (1904), that the Sherman Anti-Trust Act applied to railroad consolidation, retarded such projects, especially those motivated by the desire to reduce competition.

After two years of war-time operation of all railroads as a single system by the government, the properties were returned to independent operation under the Transportation Act of 1920. That act, among other things, promulgated a new rule of rate-making which directed the Interstate Commerce Commission to set rates so that railroads as a whole might earn a fair return on property value. Congress recognized the fact that, under uniform rates on competitive traffic, a scale which would yield a fair return to railroads collectively would yield more than that return to the strong and less to the weak.

To solve the problem of the weak road the act directed the Commission to prepare a plan under which the many roads would, without undue reduction in competition, be consolidated into a limited number of large systems of fairly equal earning power, so that, under uniform rates on competitive traffic, each would earn approximately the same rate of return.

The tentative plan, published in 1921, had prolonged discussion and the final plan was not published until December, 1929. It called for 21 consolidated systems. The depression was then in its first stages and diverted attention from the plan, and the severity of the losses in earnings through 1931–1935 threw many properties into the hands of receivers or trustees. In the meantime, in 1933, Congress changed the rule of rate-making by eliminating any reference to fair return on value.

It now appears that there is little likelihood of a revival of interest in a country-wide, comprehensive plan of consolidation, but consolidations, along natural lines, will be made here and there as in the past, whenever the proposal is found by the Commission to be sound and in public interest.

Railroad Electrification. — The predictions of 25 years ago, that electricity would soon displace steam as railroad motive power, have not been fulfilled. The miles of electrified railroads (2,686) are now, 40 years after the first installation, little more than one percent of the total.

Because of the elimination of smoke, electrification is especially suitable in tunnels. A serious accident in the smoke-filled Park Avenue tunnel forced the electrification of the Grand Central Terminal in New York. Electrification has been found well suited also to suburban rail service and on heavy mountain grades, and experience has indicated that it brings substantial increases in capacity where traffic is unusually heavy. The factor of increased capacity was given much weight in the decision of the Pennsylvania Railroad, to extend its electrification from New York to Philadelphia and Washington.

There are, however, few railroad divisions which have traffic in volume sufficient to justify the high capital expenditures. When a railroad is electrified the additional capital cost adds as much as or more than 50 percent to the investment in fixed property, and electric locomotives now cost twice as much as steam locomotives of equal power. The economies in locomotive fuel and maintenance are substantial, and there are many other advantages in electrification, but the carrying charges on the additional investment are usually in excess of the economies.

Number of Railways and Mileage. — For statistical purposes the Interstate Commerce Commission divides the railways of the United States into four groups: Classes I, II and III, and Switching and Terminal.

In class I are railways with operating revenues in excess of $1,000,000 annually. In class II are railways earning from $100,000 to $1,000,000. Railways earning less than $100,000 are in class III.

TABLE II. *Number of Railway Companies and Their Classification (1934)*

Item	Class I	Class II	Class III	Switching and Terminal	Total
No. of operating companies	144	206	263	250	863
Road miles operated	238,555	11,821	4,506	*	254,882
% total revenues	96.83	1.10	.24	1.83	100
% total revenue ton-miles	99.42	.52	.06	*	100
% total revenue pass'r-miles	99.80	.18	.02	*	100

*Not reported

While the table shows 144 class I operating companies, many of the separately organized railways are operated as parts of systems under unified managements. The number of unified operating systems and smaller independent railways in class I is about 60.

Because the data for class I railways are much more complete than those pertaining to classes II and III, and because classes II and III are so relatively unimportant, the facts and figures in the following text will, unless otherwise stated, apply to class I railways only.

The road mileage shown in the table does not include multiple running tracks or tracks in yards and sidings. The total miles of trackage of class I railways in 1934 was 402,431, of which 238,555 was first main track, 36,313 second main track, 5,685 other multiple main tracks, and 121,878 yards, sidings and industrial tracks. For every road mile in 1934, therefore, there were 1.68 miles of track, including yards and sidings. The ratio of track miles to road miles has been increasing slightly.

The total railway route miles in recent years has been declining inasmuch as the miles abandoned have exceeded the miles of new railway constructed. The abandoned mileage consisted mainly of unprofitable branch lines, on which the volume of traffic, adversely affected by depletion of natural resources or by competition of motor vehicles, had been so seriously diminished as to yield operating revenues less than the cost of operation. From 1921 to 1934, inclusive, the total road miles constructed were 7,075 and the miles abandoned were 13,866.

Number of Locomotives and Cars. — The numbers of locomotives and cars have recently declined. The increases in the tractive capacity and the efficiency of locomotives, and the increases in capacity of freight cars and their mileage per car day, have enabled the railways to handle a given volume of traffic with a smaller number of units. The decline in number had set in about 1923 and was accelerated during the depression by losses in traffic and earnings, and inability financially to keep up the former programme of replacement of obsolete units.

TABLE III. *Locomotives and Rolling Stock, Class I Railways*

Year	Steam Locomotives: Number in Service	Steam Locomotives: Average Tractive Capacity (lbs.)	Cars: Passenger Train cars	Cars: Freight Train Cars	Cars: Average Capacity per Freight Car (tons)
1935	45,614	48,367	41,584	1,835,736	48.3
1930	55,875	45,225	52,130	2,276,867	46.6
1920	64,368	36,365	53,501	2,322,025	42.4

In addition to the steam locomotives shown in the table for 1935 there were 980 electric and internal combustion locomotives. The comparable figures for 1930 and 1920 were 707 and 364. In addition to the railway-owned freight cars the railways use over 300,000 private freight cars owned by packers, oil companies, coal companies and other large shippers, and the railways own 76,955 company service cars. To the railroad-owned passenger train cars should be added about 8,000 Pullman sleepers and parlor cars owned by the Pullman Company and operated by the railways under contracts.

Investment in Road and Equipment. — The combined balance sheet of all railways on December 31, 1935, shows an investment of $25,500,335,062 in road and equipment. This is the so-called "book value," the integrity of which has frequently been challenged because of a widely held belief that it had been inflated by questionable financial practices in earlier years. The principal purpose of the Valuation Act of 1913 was to determine the validity of the investment account. The figures now available indicate that the book value exceeds the estimated cost of reproduction, less accrued depreciation. The inflation of years ago, when the books did not accurately reflect the facts, had been offset by the many reorganizations of the weak lines and by earnings plowed into the property by the strong lines.

Against this investment there was, on December 31, 1934, an outstanding net capitalization of $18,652,491,252, of which $11,613,527,983 was in bonds or other funded debt, and $7,038,963,269 was in capital stock. The capitalization above noted is that outstanding in the hands of the public and excludes securities held by or for the issuing companies.

While it is true that the actual investment in rail ay properties is slightly in excess of the book value entered as an asset on the balance sheet, and that the capital obligations outstanding in the hands of the public are substantially less than the book value, it does not necessarily follow that the railroads collectively are not overcapitalized, if earning power rather than physical value is taken as the criterion. The book value includes the cost of many facilities not now used, or used in but small degree, and the cost of many locomotives and cars which are so highly obsolescent as to be worth no more than their scrap value. Sooner or later the railways will be forced to recognize that obsolescence, restate their investment account and adjust their capital structure accordingly. No one can now state with authority what that obsolescence amounts to in definite figures.

The weakness in railway financial organization is not so much in the relation between capitalization and investment as in the composition of that capitalization and in inadequate reserves for depreciation and obsolescence. The figures in the preceding paragraph indicate that over 62% of the capitalization is in funded debt and that the stockholders' stake in the enterprise is but 38%. The fixed charges for interest on funded debt are such a burden on net income that substantial losses in gross earnings, as in the period of the depression, result in financial distress. Conservatism demands that the capital raised by the sale of bonds should be no greater than that raised by the sale of stock.

Since 1907, under the regulations of the Interstate Commerce Commission the railways have been required to accrue depreciation reserves on locomotives and rolling stock, but as to such reserves on physical structures there has been no such requirement. Very few railways have made such depreciation charges on physical structures and, moreover, the rates charged on locomotives and rolling stock have been inadequate. The Commission had not, until very recently, specified the rates to be charged. As a consequence the depreciation reserve (in 193j) on roadway and structures was less than 1% of that part of the investment, and the depreciation reserve on locomotives and rolling stock was 45% of the investment in equipment. The total reserve was but 10% of the total investment in road and equipment.

TABLE IV. Condensed Income *Account*, Class *I* Railways (in millions)

Item	1926	1933	1935
1. Operating revenues:			
Freight	$4,809.6	$2,492.7	$2,790.6
Passenger	1,043.1	329.3	357.9
Other	530.2	273.4	303.4
Total	6,382.9	3,095.4	3,451.9
2. Operating expenses:			
Maintenance of ways & structures	866.8	322.3	394.0
Maintenance of equipment	1,283.1	598.7	681.9
Transportation	2,181.5	1,078.0	1,253.1
Other	337.9	250.2	263.7
Total	4,669.3	2,249.2	2,592.7
3. Net operating revenue	1,713.6	846.2	859.2
4. Taxes	388.9	249.6	236.9
5. Uncollectable railway revenues	1.9	1.2	1.2
6. Hire of equipment—net Dr.	82.9	85.0	85.7
7. Joint facility rents—net Dr.	26.8	36.0	35.6
8. Net railway operating income	1,213.1	474.3	499.8
9. Other (non-operating) income	297.9	211.0	187.7
10. Gross income	1,511.0	685.3	687.5
11. Deductions from income:			
Rent for leased roads	166.5	150.2	149.3
Interest on funded debt	496.5	498.3	476.5
Interest on unfunded debt	12.1	26.2	32.5
Other deductions	26.9	16.5	21.7
Total deductions	702.0	691.2	680.0
12. Net corporate income	809.0	Deficit 5.9	7.5
13. Dividend appropriations:			
From income	224.4	28.0	38.2
From surplus	174.8	67.7	88.1
Total	399.2	95.7	126.3
14. Investment in road & equipment	23,204.2	25,345.9	25,025.7
15. Return on investment (per cent) (Item 8 ÷ Item 14)	5.23	1.87	2.00

Similar in principle is the failure of railways, except in isolated instances, to provide sinking funds for the retirement of bonds. As such bonds matured they were refunded, with no reduction in funded debt. The Interstate Commerce Commission has recently advocated that the railways provide for sinking funds on new or refunding issues with a view to the gradual liquidation of debt. The failure to make such provision heretofore has been justified by the theory that investment in railroad physical structures and equipment, if properly maintained, is more or less permanent. This view had force in the earlier days, when railroads had a virtual monopoly of inland transportation, but is not sound today when alternative methods of transportation are available and there is a substantial surplus in transportation facilities.

Revenues, Expenses and Net Income. — The gross earnings and net income of railways may be indicated by the returns for the years 1926, 1933 and 1935. The first was the year of greatest gross earnings. The low spot during the depression was reached in 1933. In 1935 better business conditions brought an upturn which continued in 1936.

The apparent inconsistency in an excess of dividends over income in 1933 and 1935 is explained by the fact that these figures in Table IV. are the aggregates of all railways, some of which earned much more than the dividends paid and some of which failed to earn enough to pay all of their deductions from income.

Volume of Traffic. — The tonnage and passengers carried and the ton-miles and passenger-miles produced by railways during 1926, 1933 and 1935 are given in Table V.

TABLE V. *Traffic* Statistics—Class I Railways

Item	1926	1933	1935
Revenue tons originated: (*thousands*)			
Products of agriculture	111,787	81,702	76,338
Animals and products	26,243	17,651	15,125
Products of mines	757,703	395,065	445,136
Products of forests	104,850	33,165	42,483
Manufactures and miscellaneous	296,068	157,009	196,506
Less than carload	39,491	14,351	14,039
Total	1,336,142	698,943	789,627
Revenue tons transported (inc. tons from connections)	2,465,369	1,258,823	1,427,042
Revenue ton-miles (millions)	443,746	249,223	282,037
Revenue passengers (*thousands*)	862,361	432,980	445,872
Revenue passenger-miles (millions)	35,478	16,341	18,476
Miles per ton per railway	180	198	198
Miles per passenger per railway	41	38	41
Revenue per ton-mile (cents)	1.081	0.999	0.988
Revenue per passenger-mile (cents)	2.936	2.013	1.940

The decline in the volume of railway freight traffic since 1929 was due in by far the greater part to the depression but the competition of other agencies of transportation was a contributing factor. The motor truck began to make inroads on rail tonnage shortly after the service effectiveness of the truck had been demonstrated during the war-time congestion in railway service, and during the depression the trucks' share of the total freight traffic increased while the railway share diminished. The continuing expansion in the national system of improved waterways resulted in further diversions from the rails and a substantial part of rail traffic in carloads of oil and gasolene was lost to the extended system of pipe lines. High-tension power lines displaced coal or oil formerly carried by rail to power plants. In addition to these losses the railways suffered from the growing tendency of shippers to provide their own transportation by operating their own trucks on the improved highways and their own vessels on the improved waterways. The effect of these forms of competition was to cause a shrinkage in the railway share of the total traffic, and at the same time influences were at work which caused a slowing up in the total transportation demand by all agencies. These influences were (a) no new territories to develop; (b) slower growth in population; (c) shrinkage in exports and imports; (d) relocation of factories and warehouses nearer to the sources of raw materials and markets; and (e) technological advances which reduce the amount of raw materials needed for a unit of finished product.

In the field of passenger service the loss to the railways was even greater than that in the freight service. The greater use of the private automobile was the principal cause, but in addition thereto the bus (motor coach) and the aeroplane have taken many passengers from the railways.

The competition of highway, pipe line, waterway and airway services has had the effect of reducing railway rates in both freight and passenger services. Table V. shows that the average revenue per ton-mile fell from 1·081 cents in 1926 to 0.988 cents in 1935. The revenue per passenger-mile was reduced from 2.936 cents in 1926 to 1·940 cents in 1935.

This competition has also had the effect of shifting the emphasis in rail rate-making from the "value of service" principle to that of "cost of service." Railway rates traditionally were built on the principle that low-grade commodities, which would move only under low freight rates, could properly be charged less than the total cost. so long as the charge was more than the direct or "out-of-pocket" cost, and that the indirect or overhead costs not borne by the low-grade commodities could be assessed against the commodities of high value which could bear a charge in excess of total cost. The "value of service" theory has but slight recognition in the tariffs of the truckmen and since their lower charges have appealed especially to the shippers of high-grade commodities, on which the railway rates are high, the railways have been forced to depart in substantial degree from the value principle and meet competition on a cost basis. To the shipper that basis is controlling, as he will not now pay more for carrier service than the cost to him of providing his own transportation in his own trucks, vessels or pipe lines.

Having lost their ability to charge abnormal rates on high-grade commodities to offset the deficiencies in revenue on low-grade freight carried at sub-normal rates, the railways have had even greater incentive than ever before to hold down their costs, increase their operating efficiency, and improve the quality of their service. That they were fairly successful in their efforts is indicated by the fact that the 45·9% decrease in revenues, 1935 under 1926, was met by a 44.5% decrease in operating expenses. This is noteworthy in view of the fact that something like one-half of operating expenses are normally fairly constant and fluctuate but slightly with moderate variations in volume of traffic.

Number of Employees. — Inasmuch as labour costs make up nearly 60% of total operating expenses, the recent heavy reductions in such expenses have meant drastic cuts in number of employees, employee-hours and wages. The data for 1926, 1933 and 1935 are shown in Table VI.

TABLE VI. *Employees and Their Compensation, Class I Railways*

Item	1926	1933	1935
Number of employees	1,779,275	971,196	994,371
Employee-hours (thousands)	4,671,736	2,233,045	2,397,353
Hours per employee	2,626	2,299	2,411
Aggregate compensation (thousands)	$2,946,114	$1,403,841	$1,643,879
Average compensation:			
Per employee-hour	$0.631	$0.629	$0.686
Per employee-year	$1,656	$1,445	$1,653

The railway "brotherhoods," often referred to as the "Big Four," are among the oldest and strongest of labour unions. In the order of seniority in date of organization they are the Brotherhood of Locomotive Engineers, the Order of Railroad Conductors, the Brotherhood of Locomotive Enginemen and Firemen, and the Brotherhood of Railroad Trainmen. Practically all of the eligible employees are members of their respective unions, which are more or less knit together by common ties and working agreements. They are not affiliated with the American Federation of Labor.

In addition to the train and yard service brotherhoods there are many other unions of railway workers, comprising the railway department of the American Federation of Labor. The employees in the locomotive and car shops have several separate unions acting together in matters of common interest as the Federated Shops Crafts. The telegraph and telephone operators belong to the Order of Railroad Telegraphers. The section foremen and labourers have their Maintenance of Way Brotherhood. The clerical forces are represented by the Brotherhood of Railway Clerks.

For a time many railway companies had so-called company unions embracing several classes of employees other than those in train and yard service but very few of those unions have survived the opposition of the national unions. Every union has its contract or working agreement, covering wage rates and rules, with each individual railroad, and for each brotherhood or craft there is substantial standardization as between railways in rates of pay and other conditions of employment.

TABLE VII. *Number of Officers and Employees, Class I Railways, August 15, 1936*

Class	Number
Executives, officials and staif assistants	12,053
Professional, clerical and general:	
Clerks	88,631
Others	80,061
Total	168,692
Maintenance of way and structures:	
Bridge and building workers	18,086
Gang and section foremen	26,021
Section men and extragangs	163,669
Others	40,207
Total	247,983
Maintenance of equipment:	
Skilled craftsmen	202,776
Unskilled labourers	54,597
Others	37,500
Total	294,873
Transportation:	
Stationmen (other than labourers)	39,370
Station labourers	23,752
Yardmasters, switch tenders and hostlers	12,921
Yardconductorsand brakemen	52,641
Yardenginemen and firemen	29,220
Roadconductorsand trainmen	79,724
Road enginemenand firemen	63,004
Others	66,252
Total	366,884
Grand total	1,090,485

Official Organization. — In addition to the officers which are common to any corporate organization — the president, the treasurer and the secretary — a railway corporation has an official organization peculiar to its needs. Below the board of directors. which is elected by the stockholders at the annual meeting, and the president, who is selected by the board, there are several departments, each in charge of a general officer who may also hold the rank of vice-president. To the operating department, headed by a vice-president and general manager, is entrusted the maintenance of way, structures and equipment, and the operation of stations, yards and trains. The traffic department, in charge of a vice-president and traffic manager, makes rates and solicits traffic. The legal department, whose head is the vice-president and general counsel, furnishes legal advice to the board, the president, and to all other officers who may need it, supervises the execution of contracts and agreements, deals in general with the regulatory authorities, institutes legal proceedings, protects the company against suits, and handles all claims for personal injury and damage to property. The department of accounting and finance is headed by a vice-president, assisted by a general auditor or comptroller and a treasurer. The former takes care of the accounting and auditing; the latter is the custodian of funds and makes disbursements on vouchers drawn by the authorized officers and approved by the comptroller.

Besides these general officers there are other departmental heads. The purchasing agent is a specialist in the markets and purchases materials on requisitions drawn by the departmental officers and approved by the general manager. To him, may report the general storekeeper who has charge of the materials and supplies and disburses them to the using departments, but he may report instead to the general manager or to the comptroller. The chief engineer usually confines his attention to construction and to the formulation of standards and instructions governing maintenance of way and structures. He is usually assisted by a bridge engineer, a signal engineer, and other staff officers. The chief of motive power or chief mechanical engineer reports to the general manager and is in charge of general repair shops for locomotives and cars, decides upon standards, and outlines the practices to be followed at engine houses or divisional car repair points. He is assisted by an engineer of tests and other staff officers.

The secretary of an American railway is essentially the keeper of the corporate records and performs the duties legally required in attending meetings of the board or its committees and the annual meeting of the company.

Beyond the officers hereinbefore mentioned there may be others, depending upon the size or complexity of the railway and the individual views of the president. Sometimes there is a vice-president in charge of personnel work, or there may be an executive assistant in charge of public relations, but ordinarily these functions are left to officers with other duties as well. An examination of the charts of several railroads will reveal wide differences, not only in detail but also in the fundamental conception of good organization.

For operating purposes a large railway is divided into districts and each district is partitioned into divisions. The districts. ordinarily, are in charge of general superintendents and the divisions are headed by the division superintendents. The typical railroad uses what is known as the divisional system under which the superintendent is in charge of maintaining way, structures, loco-' motives and cars, as well as of operating stations, yards and trains. To him report a division engineer, controlling maintenance of way and structures, a division master mechanic, responsible for locomotive and car running repairs, and a train-master, who supervises station agents, and yardmasters as well as train and engine crews. The division engineer and the division master mechanic are told by the division superintendent what to do and they do it according to standards promulgated by the chief engineer and chief mechanical officer, who are staff officers.

Governmental Regulation.—Railway companies are incorporated under the laws of a state or states. With few exceptions class I railways operate in more than one state. From the beginnings of railways in the late 1820s until the end of the Civil War period, railways were subjected to little governmental regulation and were given substantial land grants and other forms of financial aid by the Federal Government, states, counties and cities. The building of railways was publicly encouraged and there was keen competition between localities in securing railway service. But as the economic importance of the new form of transportation became apparent, and abuse of power and disregard of broad public interest by railway managers became common, the need of effective regulation in public interest was realized. The initial steps were taken by the individual states, first by .enacting general statutes for the incorporation of railway companies and next by the creation of railway commissions with supervisory powers. In the early 1870s this tendency received an impetus in the central western states in what was known as the Granger Movement to curb undue discrimination in rates and service, and the newly created state commissions were clothed with extensive powers over railway management. Experience indicated, however, that regulation by individual states, over operations which were preponderately interstate in character, was ineffective, and the demand for interstate regulation was met in 1887 by the Federal enactment of the Interstate Commerce Act, based on the constitutional power of Congress to regulate commerce between states. The original act was found by experience to be defective and several amendments were adopted, notably the Elkins Act of 1903, the Hepburn Act of 1906, the Mann-Elkins Act of 1910, the Panama Canal Act of 1912, the Valuation Act of 1913, the Clayton Anti-Trust Act of 1914, the Transportation Act of 1920, the Railway Labor Act of 1926 and the Emergency Transportation Act of 1933. In addition several laws, generally designated as the Safety Appliances Acts, were from time to time enacted in the interest of safety of employees.

The nature and degree of regulation by the Interstate Commerce Commission and the commissions of the several states may be indicated by a summary of present conditions. No railway may be constructed or operated without a certificate of public convenience and necessity, nor may any railway or any part of a railway be abandoned without the permission of the regulatory authority. Inasmuch as all but a small fraction of railway mileage carries traffic which in some degree is interstate in character, the Interstate Commerce Commission is virtually the supreme regulatory authority but its functions are shared or duplicated in certain respects by the individual states.

Existing railways may not issue new securities nor borrow money for longer than two years without the approval of regulatory authority. A certificate of public convenience and necessity will not be issued unless, in the judgment of regulatory authority, the proposed line will meet a real public need not already met reasonably by existing transportation service, and unless the proposed line will not unduly injure existing service to the detriment of public interest. The promoters of the project must satisfy the regulatory authority that it is bona *fide* in nature, that it is likely to earn enough to be self-supporting and give reasonably adequate service, and that the promoters have sufficient financial capacity to complete and operate the railway.

Railways are obliged to furnish transportation upon reasonable request therefor, to provide reasonably adequate facilities, and to furnish safe and adequate car service.

Rates and rules affecting public service must be just and reasonable, and must not be unduly discriminatory as between persons, localities and commodities. The rate for a shorter distance may not be more than that for a longer distance over the same route in the same direction. Rebates or similar devices are prohibited. Rates proposed by a carrier must be publicly filed. They may not become effective in less than thirty days, except under special authority. If objection is made the proposed rate may be suspended for months and the burden of proof placed upon the railway to justify the rate at public hearings. All tariffs must be available at stations for public inspection and the rates must be strictly adhered to. Railways are prohibited from transporting commodities (except lumber) which they themselves produce.

Prior to 1920 the regulatory authority, in its control over rates, was specifically instructed to consider only the factors of justness, reasonableness and freedom from undue discrimination. The Interstate Commerce Act said nothing about protecting the railway against the imposition of rates which might be confiscatory. In the Transportation Act of 1920 a new rule of rate making was enacted. Under it the Commission was directed to set rates so that the railways, as a whole or in territorial groups, should be able, under honest, efficient and economical operation, to earn a fair return on the value of property devoted to public service, such value to be determined by the Commission. The fair return originally set at 6% was, in 1922, reduced to $5\frac{3}{4}$%, but the railways as a whole actually earned considerably less, even in the prosperous years 1926–1929. The rule might have been workable if railways had continued to hold their former virtual monopoly of inland transportation, but since 1920 that monopoly has been lost as a result of the intensive development of competitors by highway, inland waterway, pipe line and air. Railway rates, since 1920, therefore, have had to take account of competition of other agencies, and the return on investment has ceased to be controlling.

The futility of the 1920 rule of rate making was recognized in the Emergency Transportation Act of 1933 when a new and somewhat vague substitute was adopted. Under it, rates are to be set so that traffic may move freely and so that the railways may earn enough, under efficient management and reasonable expenditures for maintenance, to keep their properties in such condition as reasonably to meet public demands for transportation. The new rule, adopted during the depression. has not (1937) had a fair trial and has yet to meet the test of normal business conditions.

All railways are required to keep their accounts and to make periodical and special reports in form and manner prescribed by regulatory authority. All accounts and all correspondence and other files may be inspected at any time by representatives of the regulatory authority and that body is required to publish the accounting and statistical returns in such detail as it may deem expedient. The monthly and annual reports of the carriers to the regulatory authority are available for public inspection.

The regulatory authority has power to inquire into any phase of management and to pass judgment on the degree of honesty, efficiency and economy in administration. It may prohibit a director or officer of one railway from serving in similar capacity with another company. Railways are required under certain conditions to advertise for bids on materials to be purchased and there are restrictions upon purchasing materials from a concern in which a director or officer of the railway has an interest.

The regulatory authority has power to require one railway to permit another railway to use its terminal facilities, under reasonable terms, when the company owning the facilities can grant such use without undue detriment to its own business. The regulatory authority has power also to determine the division of through rates between railways participating in interline traffic.

Railways are prohibited from unduly stifling competition by pooling of traffic, by restricting the free interchange with competitors, by controlling water lines with which they compete, by refusing to make physical connection with other railways or water lines, and by any form of undue discrimination; provided, however, that when the regulatory authority believes that public interest will be served, pooling may be authorized. The regulatory authority may require a railway to join with other railways in the establishment of through routes and publication of through rates.

The Railroad Labor Act of 1926 sets up a procedure that must be followed in disputes with employees as to wages or conditions of employment. Under the Hours of Service law an 8-hour basic day has been established, with a limitation of 16 hours during which certain employees may be continuously employed. Under the Safety Appliances Acts, and other requirements of regulatory authority, certain devices, such as automatic train control apparatus, cab curtains, power reverse gears, and automatic fire-box doors, must be installed and maintained. Locomotive boilers must conform to prescribed standards and be inspected periodically. Car equipment, in such things as couplers, ladders, hand holds, running boards and brake apparatus, must conform to specified standards and the adequacy of the maintenance of such equipment is checked by governmental inspection.

The degree of public regulation of railways is much greater than that applying to competing forms of transportation, especially by water and air. Commercial motor carriers by highway have been subjected for several years to varying degrees of state regulation of intrastate traffic and since 1935 their interstate operations have been regulated by federal law. (W. J. C.)

ROADBEDS AND STRUCTURES

Of the two major classifications of railway property, stationary or fixed property (including roadway and structures) and rolling stock (cars and locomotives), the former comprises somewhat more than 75% of the total investment. Comprehended under the subject of roadway and its construction are the important topics of clearance, roadbed design and construction, culverts, and the ballast bed. Track structure and special trackwork embracing ties, rails, fastenings, etc., are also here treated with relation to present and future design. Signs, fences, crossings, labour-saving equipment, railway timbers, water stations, are likewise discussed briefly as integral parts of the subject of stationary property. (*See* also BRIDGES.)

An increasing concentration of traffic, greater individual axle loads, and the higher speeds of freight trains have imposed heavier burdens upon the roadway and track structure. The ton miles per mile of road were 100% more in 1928 than in 1903 on American railroads. Driving axle loads, which in 1900 did not average more than 30,000 lb., are now in excess of 70,000 lb. in some cases.

The development of a more stable roadbed structure bas been dictated by necessity as well as to reduce track maintenance cost, to increase the margin of safety for anticipated heavier driving axle loads, and to effect a decrease in train resistance. Practically all American railroads have strengthened the roadway by widening it, increased the depth of the ballast, the number of ties in a panel, the weights of rail, as well as making greater use of tie plates, anti-creepers and other auxiliary fastenings.

Clearance.—Since 1918 changes have been made in the dimensions and types of equipment, in the sizes and weights of shipments, and in the clearances fixed by legislative acts in many of the States. The magnitude of the problems involved has led to the standardization of clearances for new (single) track construction, for bridges and tunnels, and for the third rail of electrical tracks; and a minimum distance between tracks has also been established. Consideration has likewise been given to structures placed along side tracks, a minimum distance being established from the gauge line of the rail on tangents.

Roadbed Design.—Roadbed design includes both the roadbed and ballast sections, which together form the foundation of the track, made up of the ties, rails and required fastenings. While the improvement of the roadbed with its cushion of ballast has been in progress since the beginning of railways, its most marked developments have taken place since the beginning of the present century. The minimum width (1929) for both excavations and embankments is 20 ft., with the added provision that a roadbed shoulder of not less than 18 in. be maintained outside of the toe of the ballast slope. Crowning of the roadway is a common practice to facilitate drainage; while the making of fills of clay or other impervious materials is avoided. Ditches have been deepened to provide for sub-draining the roadbed, as well as for discharging the storm water. Intercepting ditches are coming more into use for diverting from cuts water which is collected over a considerable drainage area, and for conveying it along the foot of embankments, avoiding in the first case the deposit of material which may interfere with traffic, and, in the second case, erosion which may endanger the stability of the roadway. Sub-drainage of cuts, by means of vitrified pipes laid with open joints and fed by perforated transverse pipes, small tiles or cinder-filled trenches, is being more generally employed as a means of effecting large savings in track surfacing costs.

Culverts.—While the original box culvert still finds use, its construction is no longer of rubble stone or wood, but is now almost always of concrete, either mass or reinforced. Where the extent of the openings is not prohibitive, pipes of concrete, cast iron or corrugated metal have largely replaced the box culvert, their cost being comparatively low and their service life practically unlimited. The majority of culverts are being provided with both a headwall and an apron at the discharge end, each serving the double purpose of preventing erosion and holding the embankment against sliding. Cast iron pipes (*see* PIPE), have been improved in design as well as in the method of casting and production so that they may be employed for openings of a diameter as great as 90 inches. Pipes fabricated of corrugated corrosion-resisting metal, which provide light and easily installed structures, are being employed frequently.

Ballast Section.—Standard ballast sections have been adopted in recent years which provide a greatly increased depth of material beneath the ties. For the heaviest service this depth is now no less than 24 in., which is based on the principle that a roadbed material subject to deformation by the application of a live load should have a depth sufficient to produce approximately uniform pressure on the roadbed, which is thus the maximum spacing between ties. The heavy expense for ballast of this depth is avoided by the use of a sub-ballast of a material superior to that of the roadbed, and often equally efficient with the ballast in its two functions of drainage and distribution of the lead. Crushed stone and gravel are the materials most generally employed for ballast. The former is regarded as superior to all other materials for this purpose, since its angular fragments bind together so as to distribute the load over the largest area, and it affords the best drainage for the longest period without cleaning or renewing. Washed gravel is nearly as effective for ballast as crushed stone, and is much cheaper where it is available. Burnt clay, slag and cinders are materials in common use for ballasting the less important tracks. The cleaning of ballast, which was formerly done by hand labour with ballast forks, is frequently done with mechanical equipment.

Track Structure. Ties.—While the general design of the track has not changed materially since the early days of railroads, the size and spacing of the ties, the weight and length of the rails, the strength and rigidity of the rail fastenings, and the designs of standard and special trackwork, have undergone a progressive development. Among the earlier expedients for strengthening the track structure was a closer spacing of the ties and, more recently, the specifying of wider ties than those standard in previous years. Whereas 7 in. ties were considered adequate 25 years ago (although doubtless many wider ones were used) present practice favours an 8 or 9 in. width for heavy-traffic main tracks. Similarly, a spacing of 16 ties to the 33 ft. panel was then customary, while 20 ties to 33 ft. is now nearly universal. These two features have increased by about 50% the extent of the rail directly supported on the ties. Probably no fact regarding ties is more striking than the attention which is being given to their conservation by an increasing use of tie plates to protect them against mechanical wear and by a more extensive use of chemical preservatives, approximately three-fourths of all ties used by steam railroads now being so treated. These protective measures have also conserved timber (see TIMBER PRESERVATION) by enabling the faster-growing woods to be used for ties.

Rail and Fastenings.—Development in this field has been outstanding in recent years. The weight of rail, which about 1900 was frequently no heavier than 60 lb., has been more than doubled. Recent studies have shown the trend on the part of the railways toward heavier sections for their main-line tracks. The 136 lb. rail is the heaviest section used in any main-line American track. Important changes have also taken place in the design of the rail section, as well as in the composition of the steel from which the rails are rolled. In American Railway Association sections, developed in 1905, the height was generally one-tenth greater than the base, with the sides sloped on an angle of 1 in 16, which slope is retained in the designs recently adopted by the American Railway Association and known as the R. E. sections. By reason of the uniformity now possible in its manufacture, rail steel has tended toward a generally higher carbon content than formerly, the specifications adopted by the American Railway Association permitting as high as 0·89%. (See IRON AND STEEL for a discussion of manufacture.) The standard length of rails, which formerly was 30 ft., is now 39 feet. While rails as long as 60 ft. were laid 25 years ago, the practicability of the longer rails has only been possible through the development of an improved joint structure, together with devices for restraining the creeping of the rails, along with a higher standard of roadway design and better maintenance of the roadbed structure. Joint fastenings, which formerly were of light angle bars, with fish plates not uncommon in certain tracks, have had their section greatly increased, while a number of designs have been developed looking to a closer approach of the joint to the strength of the unbroken rail. The general use of heat-treated or high-tensile bolts, and of spring washers of the higher tensions, has also contributed greatly to the rigidity of the joint structure. Auxiliary track fastenings, such as tie plates and anti-creepers, are being made in heavier designs and used more plentifully in all classes of railway tracks.

Trackwork.—An outstanding development has been the consideration given to the distribution of metal in switches, frogs and crossings to provide uniform strength throughout. Heat-treated and high-tensile bolts are frequently specified for the assembly of frogs and crossings. Heavier track structures are being laid in terminal yards, while increased attention is being given to the selection of frogs and switches of smaller angles, so as to provide a greater margin of safety.

Wooden signs are fast being replaced with those made of concrete or iron and of more attractive appearance, while stronger types of woven wire fencing, with treated wood, steel or concrete posts, are being used to fence the right of way. Many wooden plank crossings are being relaid with other more lasting materials.

Water Stations.—The increased number of locomotives, and their greater size and power, the extending use of larger engine tanks as a means of accelerating train movement—these frequently having capacities of from 16,000 to 21,000 gal.—and the growing recognition of the value of improved quality of feed waters in promoting increased locomotive efficiency, has made the water an important factor among the other items of the fixed property. Railway water supply has become a highly specialized branch of operation, including at many plants treatment of the waters. The greater quantity of water required has made necessary the installation of larger pumps and pumping combinations, while the need for uninterrupted service has shown the desirability of ample storage capacity, with duplicate pumping units in some instances. Increased interest has been shown in the turbine, among other deep wells and systems. While the steam plant predominates, the use of oil engines has grown greatly, and electric drive for pumps is advancing rapidly wherever current is available, particularly by reason of the advantages obtained through float switches, pressure gauges and remote control. Tanks for the storage of water, which are of wood, steel and sometimes concrete, are of greater capacities, commonly as high as 100,000 gallons. Where track tanks are used to avoid delays due to stops for water, they are being lengthened to supply double-headed trains or those following each other at close intervals. While the essential features of the exterior treatment of locomotive waters has not changed greatly in recent years, and the precipitating and neutralizing of the harmful solids by lime and soda ash remain accepted practice, increasing use is being made of other chemicals to supplement this basic treatment. Definite progress has also been made in interior treatments by the development of new chemical compounds for introduction into the tender or directly into the locomotive boiler.

Passenger and freight stations, engine terminals, shops and powerhouses are essential to the operation of railways. (See the sections on Freight, Passenger and Water terminals for a discussion of these subjects.)

The present design of track will continue substantially unchanged for many years, although the economic advantages of heavy track construction will be increasingly appreciated and utilized. Advances will continue to be made in rails. Although the general use of the 150 lb. section is far in the future, its ultimate adoption is inevitable as wheel loads continue to increase. Mill practice in the manufacture of rail will be further improved, providing enhanced wearing qualities with a reduction in failures. (E. T. H.)

RAILWAY FREIGHT TERMINALS

According to the definition agreed upon by the American Railway Engineering Association, a railway terminal is, "An assemblage of facilities provided by a railway at a terminus or at intermediate points on its line for the purpose of assembling, assorting, classifying and relaying trains." In its larger usage the word is sometimes applied to an entire district or zone, such as Chicago, St. Louis or New York.

Importance of Terminals.—The importance of terminal tracks for classifying, switching and assembling freight may be judged by the statistics published by the Interstate Commerce commission, Dec. 31, 1937, which showed that out of 414,572 m. of track in the United States, 122,411 m. consisted of yard track and sidings.

The importance of terminal operation may also be measured in the use of freight equipment. Studies of the St. Louis Engineers Committee in 1922 showed that the average time in handling a car between an industry and the beginning of the road-haul in St. Louis was four days, and that this terminal-handling time was quite frequently six and seven days, and in extreme instances 30 days.

Costs of acquiring and operating terminals are perhaps the most important elements of railway expense. The Erie railroad estimated the terminal cost of handling its trans-continental fruit traffic at New York in 1922 to be $40 or 30% of the total revenue derived from the 1,000 m. haul east of Chicago. Costs of handling import, export and intercoastal freight at the port of New York were calculated in 1924 by the railroads at $2.75 per ton, exclusive of rail switching.

Types of Railroad Terminals. — Railroad terminals may be generally classified into two groups: (a) intermediate or division yards, primarily for the purpose of classifying and forwarding freight to destination beyond, and (b) delivery terminals serving local areas. The nucleus of an intermediate railroad freight terminal is a receiving yard, classification yard and departure yard. In the receiving yard, road engines and cabooses are detached and trains made ready for classification. In the classification yard are the tracks upon which most of the actual switching takes place. The departure yard contains the tracks where cars are reassembled after classification and made up into road trains for further dispatch. These intermediate terminals are located at strategic junction points for the purpose of maintaining full train loads en route. A feature of many such yards is a transfer platform for handling less than carload freight from local or "ferry" cars to "destination" cars.

Classification Yards. — The classification yards of the intermediate terminals are of two main types; flat and hump switching. Flat switching is accomplished by engine power, either by steam or Diesel switch engines, with the latter in favour because of their faster and more economical operation. Gravity switching is done by pushing cars over a summit or hump to achieve the necessary velocity for movement down into the tracks beyond.

Construction of a hump yard in place of a flat switching yard is economically justified when the volume of cars handled amounts to 800 daily, and when 20 classifications are necessary among every 100 cars handled. The grades upon which hump switching is conducted vary somewhat with the type of traffic handled, and the climatic conditions. The usual grade for the first 100 to 200 ft. from the summit is 3 to 4 per cent. Beyond that the grades to the classification track switches are 1 to 2 per cent. Cars attain a speed of 15 to 20 m. an hour and must be controlled by brakemen, car riders or automatic retarding equipment.

In a typical classification yard, tracks are laid out parallel to each other and are connected by diagonal "ladder" tracks at each end leading to a throat at the hump. In addition, there are running tracks reserved for through movement through the yard. The operation of classification in the hump yard involves pushing the road train over the hump, uncoupling each "cut" of cars in accordance with classification instructions, riding these cars by brakemen down into the designated track and braking the car to a stop at that point. Prior to the actual humping, the yard master lays out separate tracks in the classification yard for each destination or division into which the cars will be segregated for movement beyond the terminal. In addition to the classification tracks themselves there are special service tracks for caboose storage, repair of cars in bad order, coaling and ash dumping. Special icing tracks for replenishing bunkers of refrigerator cars, feed tracks and stock tracks for animals are set aside in the classification yard.

Some of the mechanical devices which have been introduced for more efficient handling and classifying of freight cars are automatic switch control, car retarders and flood lighting. In some yards complete systems of centrally operated switches are used. These are electro-pneumatic, air being admitted hy electrically controlled valves to a cylinder which throws the point of the switch. An operator in a tower throws the switches by pushing a button. An indicator in circuit with the rails of the switch shows on the operating board when a car has cleared the switch. Further progress in classification yard design and practice has been achieved by the installation of car retarders which eliminate the car riders, reduce car damage and speed up operation. Car retarders are often castiron shoes placed along both sides of each rail which when operated by electro-pneumatic valves grip the car wheels and reduce speed.

Studies of car retarder operations indicate that the classification track grades should be decreased to between ·2% and ·3% so that cars entering the tracks will proceed at a speed of from three to five m.p.h. without accelerating or decelerating, and continue at this speed to the end of the track.

Flood lighting permits operation without headlights and switch lamps. The primary benefits are safety to employees, reduction of damage to equipment, and decrease of theft.

Less-than-carload Transfer Houses. — Freight loaded at smaller shipping stations or for less important destinations is stowed in local peddler or ferry cars, as they are known, and hauled to transfer stations at strategic junctions. At these intermediate transfer stations the package freight is sorted and consolidated into destination cars or cars for transfer stations at more distant division points. Such transfer stations are maintained at important division points by all carriers handling any considerable volume of less-than-carload freight.

Delivery Terminals. — Yards serving a terminus are often located near important intermediate yards but have facilities for delivering freight which are not found in the intermediate yards. Delivery terminals are made up of team track yards, freight houses, and specialized freight facilities such as live stock yards, produce terminals and grain elevators.

Team Track Yards. — The ordinary method of delivering carload freight is at team track yards. Such yards are of various designs depending upon the size of the property available. They consist of stub-end tracks laid out in pairs with paved roadways between. Most team track yards are equipped with scales and with cranes for lifting heavy freight.

Freight Houses. — Numerous freight houses are maintained in important terminal centres for the handling of package freight in less-than-carload lots and sometimes in carloads as well. Freight houses have a driveway on one side accessible to trucks of shippers and consignees, and rails on the other side. Often the inbound and outbound platforms face on separate driveways with four or five tracks between them. Many modern freight houses are constructed in two levels or more. In many stations the freight is unloaded by the shipper's teamster straight into wheeled trucks, manually operated or hauled by tractors. Where the volume of package freight is sufficient, cars are loaded to destination, otherwise they are sent to the division transfer houses for reclassification.

Produce *Terminals*.—Perishable freight, particularly the fresh fruit and vegetable traffic, has reached such a volume that special handling facilities have been provided in important delivery yards. In 1927 over one million cars of fresh fruits and vegetables alone were originated by the railroads of the United States. A typical produce terminal consists of a special section in the classification yard for the purpose of holding and re-icing cars for consignee's order; a team track yard where cars are spotted alongside narrow platforms permitting inspection of contents and reconsignment or local distribution after sale; and a heated freight house where display and sale of produce and consolidation of buyers' truck loads takes place. The newer terminals in New York, Philadelphia, Boston and Chicago provide space for auction rooms within the freight house.

Live Stock Yards. — The movement of live stock is an important feature of railroad operation, particularly in the territory of Chicago and west. In the Kansas City, Mo., stock yards 7,000,000 head of live stock are handled in a single year; at Chicago 15,000,000. The Union stock yards at Chicago cover 500 ac. and 13,000 enclosures. Chutes and runways are provided for the unloading of the live stock into pens. The Federal law passed in 1906 provides that live stock must not be confined for longer than 28 consecutive hours without unloading for rest, water and feeding. Therefore pens must be maintained en route at intermediate yards for accommodation of the cattle on long runs. In addition to the pens and corrals, facilities for watering and feeding, including storage tanks, troughs and hose connections, are maintained.

Grain Elevators. — Grain elevators are maintained at shipping points, primary markets and at lake and ocean ports. Few local shipping point elevators are owned or operated by railroads. However, in a primary market such as Chicago or St. Louis, the railroads maintain large elevators for the storage, cleaning and drying of grain. (See GRANARIES AND GRAIN ELEVATORS.)

Waterfront Terminals.—A number of important terminal areas, notably New York, Baltimore, Norfolk and San Francisco, are so divided by waterways that a considerable part of the delivery even of local freight is most economically accomplished by marine equipment.

Belt Lines.—Belt lines connecting the terminal yards of two or more railroads and local industries in the terminal area are frequently found in the important terminal districts of the United States. Belt lines are utilized for two purposes; first, to accomplish interchange between the railroads themselves on through traffic; and second, to make delivery to industrial sidings, team tracks and piers not reached by the rails of the delivering carrier itself.

In the Chicago district the Belt railway is the inner belt line used primarily for reaching industries. This line is 25 m. long and is owned jointly by a number of the important railways serving Chicago.

The Indiana Harbor Belt railway, 120 m. long, and owned by the New York Central lines, is an outer belt line extending from Indiana Harbor, Ind., to Franklin Park, Ill. This line forms a connection with virtually all the lines serving Chicago, and constitutes the principal interchange route between the eastern and western lines.

In some cities public belt line railways have been built and operated municipally or leased to railroad operators. The best known example of this type in the United States is the New Orleans Public Belt railroad. owned and operated by the City of New Orleans. Outer belt lines have been instrumental in diverting large amounts of through or overhead traffic away from congested terminal centres. The inner type of belt line is an important factor in linking up industrial districts into a common unit for freight operation.

Off-track Stations and the Use of Motor Truck Equipment.—Interchange of package freight requiring rapid service has in several instances been accomplished more satisfactorily by motor equipment than by rail switching.

The use of motor equipment as an auxiliary to the railroads in terminal operation has been further extended to the pickup and delivery of local package freight.

The direct delivery of freight by truck to the consignee's door was practised during the early part of the 20th century, especially in Washington and Baltimore, but was abandoned in 1911 after litigation before the Interstate Commerce commission concerning the permissible extent of this service without extra charge. After 1930 the practice was revived throughout the U.S. and extended to include "pick-up" service from the consignor. Carloading companies also introduced the practice of picking up less-than-carload freight, consolidating it into "merchandise" or "package" cars with a number of individual containers, and separating it for delivery at the various terminating points.

Freight Terminals and City Planning.—The integration of terminal facilities into a comprehensive plan, particularly in the metropolitan districts surrounding such large centres of population as New York, Chicago and St. Louis, commands the greatest ability not only of railroad engineers but of city planning experts as well. A few of the common problems faced by both parties are electrified operation, separation of grade crossings, capitalization of air rights and joint use of trackage and terminals. The railroads entering the heart of large communities are beginning to electrify both freight and passenger operations, either voluntarily or under mandate of law.

The increasing activity of public authorities in requiring separation of grade crossings to eliminate the chances of accident in highway traffic is exemplified by recent amendment to the New York State Constitution. Under this amendment, voted in Nov. 1925, a State bond issue of $300,000,000 was authorized to finance grade crossing elimination. The capitalization of air rights by construction of massive buildings over passenger tracks and terminals in large cities has become a well-established practice. As grade separation and electrification extend to freight trackage and the cost of land occupied by freight terminals rises, vertical development of multiple-storey stations and lease of upper floors to manufacturing and warehousing tenants follow.

The establishment of adequate railway terminals is no longer regarded purely as a railroad function. Public authorities have found it necessary to persuade or force carriers into joint use of terminal facilities, and to provide public belt lines to insure industrial and pier siding connection with all trunk lines serving a terminal area. Public interest in efficient use of terminal facilities may compel proprietary monopolies to give way to a greater degree of common or joint operation,

BIBLIOGRAPHY.—C. E. Smith, "East St. Louis Terminal Situation" in *Report of Engineers Committee on St. Louis* (St. Louis, 1922); J. A. Droege, *Freight Terminals and Trains* (1925); R. S. McElwer, *Ports and Terminal Facilities* (1926); "Planning for City Traffic," in *Annals Amer. Acad. Polit. and Soc. Science*, vol. cxxxiii. (Philadelphia, 1927); G. Hannauer, "Freight Classification Yards," in *Proc. New Eng. R.R. Club* (1928); H. C. Yost, *Freight Handling and Terminal Engineering;* American Railway Engineering Association, *Proceedings on Design of Freight* Houses. (W. P. H.; X.)

RAILWAY PASSENGER TERMINALS

Most large passenger stations are popularly referred to as "terminals," even though, strictly speaking, they actually are not terminals, that is, the end or terminus of the railroad. Specifically, a passenger station consists of the group of tracks, platforms, buildings, etc., which furnish the means of contact between the railroad and the public for the purposes of travel. Where more than one railroad is so served the term "union station" is often used. In addition to the building for the waiting room and other station facilities, the platforms also are housed. This housing in many earlier stations was a high shed covering both tracks and platforms. Later this type was practically abandoned in favour of a low shed over each platform. Many large passenger stations are constructed in combination with office buildings or hotels—an arrangement which increases the station's concession business.

Classification into Types.—The types resulting from the arrangement of the tracks and from the manner of operation or working are as follows:—Through type is that where the tracks and trains run and are operated through the station to points beyond. Most stations are of this type. Stub type is that where the tracks terminate in or near the station. Loop.—At stations which would be normally of the stub type, a loop arrangement of one or more tracks is sometimes made, thus permitting a train, by running around the loop either before or after entering the station, to move forward at all times. This operation results in the conversion of the stub type into the through type, in principle, so that suburban or other trains carrying passengers only, can proceed through the station with the same despatch that would obtain in a normal through station. But for through or long distance trains made up of passenger cars and cars carrying other kinds of traffic, it is found that the advantages of the train being moved in one direction are largely offset by the delay occasioned in handling the traffic other than passengers (mail and express) on the platforms and in shifting and classifying the cars containing the non-passenger traffic. Composite.—As most stations where the loop principle is applied must handle a mixture of suburban and through traffic, the composite type which is a combination of the stub and through, is used. The suburban part of the traffic is handled around the loop and the through traffic largely on stub tracks. Where suburban and through traffic are handled together, and the suburban business is large, there is a tendency to handicap seriously the through traffic; this fact suggests the desirability of their segregation either in the same or separate stations.

Types resulting from the topography or the relative levels of the track and streets, are: *Single* Leuel.—This type, representative of the early stations built when low costs were vital and grade crossings permissible, has the tracks and adjoining streets at the same level. Double *Level.*—This type has the tracks and adjoining streets at different levels. The gradual elimination of grade crossings increases the number of this type. The better arrangement is afforded with the streets below rather than above the track level *Multi-level.*—The multi-level type is a combination of three or more levels and usually results either from the topography or from the area available being limited by physical conditions or high land values. This type lends itself to the segregation of suburban traffic.

The types based on the arrangement of the principal station facilities are: — Waiting Room Type. — A general waiting room is made the focus of the station traffic, the major facilities opening therefrom. Concourse Type. — A general concourse is made the focus of the station traffic and facilities, the ticket offices, train gates and major facilities opening therefrom. Composite Type. — A service lobby is provided for sale of tickets, checking baggage, etc., with waiting rooms and passenger train concourse separate therefrom.

Conditions Influencing Location. — The features or conditions which influence the choice of the site are: — (I) The location of existing trackage and working or operating necessities of the railroad. (2) Consolidation with other railroads or the establishment of a "union station." **(3)** Co-ordination with the city street plan. (4) Off line passenger stations. — These are local stations for the assemblage and distribution of passengers to be transported to and from a principal large station by motor bus as a part of the contract service rendered by the railroad. This subordinate service permits the location of the main station beyond the business centre or, if the main station is at the business centre, it provides contact with outlying centres of population. (5) Location and adequacy of the urban and suburban transit facilities. — If these outside agencies of transportation are developed or may be developed and relied upon to collect and distribute passengers locally, they have weight in fixing the station site. (6) Motive power, *i.e.*, steam or electric, used to work or operate the line. — Electric operation usually permits a location nearer the business centre than would be possible with steam.

Parking facilities are an important consideration in the location of a passenger station, not only for the convenience of the railways' patrons but also for that of employees. Complete garages are installed in some stations.

Size of Facilities — The size of facilities is related to the volume of business handled. In rebuilding or enlarging existing stations, due weight should be given to obtainable facts and records of actual performance in the old stations.

The elements influencing the size of the station facilities are: — Methods of operation. — The length and frequency of the trains generally determines the length of station platforms and the number of tracks. Single trains of from 12 to 16 cars (1,000 to 1,300 ft.) are now usual, with a tendency to greater length. The placing of sleeping cars for the reception of passengers in advance of leaving time is an important item in determining the number of station tracks required. Volume of future business. — The ultimate number of trains and passengers determines the size of most of the facilities to be provided.

Classes of *traffic* served, such as through or *suburban* passenger, baggage, mail and express. — Station facilities for all through passenger service or all suburban service can be made more compact when treated separately than when combined. The handling of baggage, mail and express traffic combined with the passenger business also affects the size. As the volume of each class of traffic increases, the tendency to provide separate facilities therefor becomes stronger. Daily and yearly *traffic distribution.* — Suburban traffic has hourly fluctuations with morning and afternoon peaks, and some seasonal variations. Through traffic has some hourly and seasonal variations. Mail and express show considerable seasonal variations. All such variations influence the size of facilities required. Facilities, once tentatively determined in size, are co-ordinated or balanced one against the other to avoid over or under capacity in any particular.

Necessary Facilities. — Perhaps the most important feature of a large modern station is the concourse. It is the place where most of the services and conveniences required by the traveller are found. It gives access to the train platforms and communication from one platform to another. It is usually the station thoroughfare. When enclosed on all sides it becomes in effect an auxiliary waiting room. Where the concourse is either in whole or part a passenger bridge or a subway, a generous width may be provided permitting the placing of seating facilities. The floor areas involved are usually large.

Waiting Rooms. — The sizes and accessories of waiting rooms are influenced by local traffic necessities, such as the proportion of passengers changing from one train to another, the relative volume of suburban or long-distance traffic. The reliability of local transportation to and from terminals has had its effect in reducing the size of these rooms. The tendency is to more compact waiting rooms, concourses, toilets, and other facilities.

Ticket *Office.* — This feature is the salesroom of the station's chief commodity, "transport." It should front on the maximum channel of traffic through the station. The ticket windows and counters should be set back from the main current of traffic affording room for lines at windows so that they do not interfere with the general circulation. In the earlier stations the ticket office was segregated into separate selling units for the various classes of tickets, and in many stations entirely separate rooms were so used. The modern tendency is towards general selling, that is, all tickets at all windows.

Tracks. — The through station yard has switching ladders at both ends. The stub station yard has a single throat, the tracks of the approach iadders being used in both directions. The stub end tracks terminate at the station end of platforms and are often provided with run-around switches near the dead end so that locomotives and cars on inbound trains can be released. In some cases trains are turned on "Y" tracks before entering the station for the same reason or to proceed further. The loop station yard is a stub yard converted in principle into a through yard by the looping of some or all of the dead end tracks. The composite station yard is any combination of the above types, with the tracks on one or more levels.

Train Platforms and Shelter Sheds. — The platforms vary in height from rail to car floor level. Where rapid exit of passengers from cars is required, the high or car floor level platform is used. Elsewhere the lower level platform is found. Usually one platform serves two tracks, one at either side, the passenger, baggage, mail and express traffic, all being handled thereon. At some stations separate baggage platforms are provided. The train platforms are usually protected from the weather by a continuous roof or by so-called umbrella sheds over each platform, which sometimes extend over the adjacent tracks.

Stairways, Elevators and *Ramps.* — When the tracks are at a different level from the station and streets, stairways are generally used to connect them. In addition, elevators or lifts and escalators are used, and in recent stations the incline or ramp has been introduced. Passenger and Baggage Bridges or Subways. — These features are required to eliminate the necessity of passengers, baggage, mail and express traffic crossing the tracks at grade. The bridges and subways also furnish the means of intercommunication and interchange between the several train platforms. At stub stations, this interchange is secured through an intercommunicating platform or "midway" placed between the ends of the stub tracks and the train gates of the concourse. *Offices,* Railroad and Station Staff. — Adequate office space conveniently located and arranged is provided for the station and railroad staff.

Baggage. — Baggage is handled in space accessible to passengers and in communicating contact with the train platform. In large modern stations the rooms for checking hand baggage, inbound and outbound, and for baggage transfer are located in contact with the station proper rather than the baggage room. Checks and pieces of baggage are handled between the checking rooms and the baggage rooms by pneumatic tubes and mechanical conveyors.

Mail. — This traffic is handled in three ways according to its volume: in small lots occupying a portion of a baggage car and the station baggage room; by car ioad lots in mail cars and in separate mail rooms at stations; and by solid train lots and in separate buildings. In large stations all three ways are used.

Express. — This traffic is classified and handled in essentially the same way as the mail. Toilets. — These are provided usually adjacent to women's rest rooms and men's smoking rooms. The tendency is to place these services on a revenue basis. Baths and dressing rooms are sometimes made a part of the revenue toilet facilities. *Information.*—In order to relieve the ticket sellers of the miscellaneous inquiries, separate bureaux of information are provided. At some of the largest stations, in addition to the ordinary service a travel or touring bureau is maintained.

(A. FE.; X.)

WATER TERMINALS

In the United States adequate water terminal facilities are of great economic importance in railroad transportation. The proper co-ordination of rail and water facilities to insure the rapid transport of freight and passengers, both inland and on the high seas, is a problem of increasing importance. A water terminal can be defined by the single word "Port," a port being a harbour properly equipped with the terminal facilities necessary to handle the freight passing through the port as well as the passenger traffic.

Handling of Freight and Merchandise.—Originally the ship's tackle alone was used, later this was supplemented by movable derricks and cranes.

The freight is discharged to the dock or directly on trucks or cars; at times it is loaded on lighters and carfloats lying alongside the ship.

For handling abnormal weights, floating derricks of large capacity are available.

Small electric motor trucks are used in many terminals for hauling the freight to the warehouses and are very efficient. They can haul several trailers at about 10 m.p.h. and can be driven into the car and there loaded or unloaded.

Overhead conveyors, either the telfer type or belt, facilitate the moving of cargoes such as bales of cotton, chests of tea, leaving the deck of the pier clear to be used by trucks and railroad cars.

Sea-trains.— Train-ferries have been operated for many years between Italy and Sicily, Hamburg and Denmark, and Denmark and Sweden. In the U.S.A. sea-trains operate between New York city and Cuba. Other such ferries are primarily for passengers.

The transporting of freight trains over the ocean was inaugurated by the Sea-train Lines about seven years ago. The steamers are regular deepsea ships and not just glorified car-floats.

They have a capacity of one hundred freight cars and when fully loaded each ship carries 26 cars in the hold, 26 between deck, 30 on the main deck, and 18 on the super-structure.

In order to load and unload the cars to and from the vessel, a 125-car elevator is used.

The car is run onto a cradle which is raised and moved over one of the ship's hatches, then lowered to its proper deck, then moved forward or aft as the ship's plan may call for; once in place the car is securely bolted down.

Bulk Freight.—Ore is a very important freight carried on the water routes of the Great Lakes. The operating season is comparatively short and it is imperative that the ore carriers make as many trips as possible each year. Therefore a ship must remain in port as short a time as possible. This has led to loading by gravity and emptying by special machinery. The ore-carrying trains are hauled on top of a trestle pier with numerous pockets or hoppers. The cars dump directly into these. The ore ship is run alongside of the pier and its hold is filled by gravity, the ore flowing into the ship through chutes. Ten thousand tons of ore are often loaded into a ship in about 90 minutes, and unloaded in about 4 hours. Large installations like this are found at Duluth and Two Harbors, Minn. At Erie, Conneaut, Ashtabula, Cleveland and many other unloading points, the ship is run under a series of ore-unloaders which dredge the ship out. These ore-unloaders, without the aid of shovellers, have an efficiency of about 98%.

Coal.—Coal piers are very similar to those handling ore—a trestle, and ramp hoppers into which the coal is dumped directly from the cars, or into which the coal is unloaded from the ship. The emptying of the hoppers is done by gravity. Installations are found at Chicago, St Louis, Philadelphia, Newport News, New York and numerous other points. Coal car dumpers are used at various places. This apparatus lifts the car up and turns it over through an angle of 160°, dumping the load into a pan from which it is allowed to run into the coal barge. The machinery is placed on top of a trestle. At such places where it is necessary to have a large supply of coal, it is often stored on the ground.

Grain.—Large grain elevators have been erected at many points. Among these are Buffalo, Quebec, Montreal, New York, New Orleans. In fact, most of the American ports are equipped with such reservoirs. The grain is sucked out of the ship or cars and deposited on conveyors, passing through the drier to the bins. The loading of ships or cars is done by gravity, the grain flowing through chutes leading to the hold or car. Floating elevators are used in many harbours to transfer the grain directly from the barges to ships. The airveyor installed in many terminals handles certain bulk cargoes most efficiently and economically. Suction produced by a partial vacuum raises the material from the ship to receiver and separator, whence it is deposited in the bins

Oil.—The storage of oil, crude or manufactured, is of extreme importance. Increasing use of oil-burning ships and internal combustion engines necessitates the establishment of oil terminals. These are usually located in some outlying district where a fire will do little to shipping. Huge tanks containing 55,000 bbl. and more are erected, leaving sufficient space between them to erect a fire wall around each unit to prevent the spread of the burning oil. In case of a fire, adjoining tanks are immediately pumped out into others further away, and the oil in the burning tank is transferred as far as possibte to minimize the loss. The fire hazard is great and at times considerable losses are experienced although they are not as great as one might expect. The oil is pumped from the wells directly to the oil plant on the seaboard or brought in tankers. It is distributed to the ships by means of steam barges, to the factories in oil trucks or cars.

Connecting Railroads and Belt Lines.—Direct connection with the railroads is essential to a modern water terminal; a belt line connecting the various water front units is required Such connecting links have been installed in many cities. In New York, the Bush Terminal, American Dock Company and Pouch Terminal have installed tracks as part of their systems. These local tracks have direct connections with the railroad feeding that part of the harbour. The belt lines are used to collect freight, which is then hauled to the classification yard and there made up into trains. As it is frequently required to handle heavy pieces and other bulky freight, locomotive cranes of various types are used to load the cars. For a discussion of Air Terminals *see* TRANSPORT BY AIR; AERODROME, AIR PORT OR AIR STATION.

BIBLIOGRAPHY.—*Reports* of the Chief of Engineers, U.S. army; Transactions of the American Society of Civil Engineers; Minutes of Proceedings of the Institute of Civil Engineers, London; World *Ports,* American Association of Port Authorities; Books and Reports of Wm. H. Burr, Elmer Corthell, G. S. Greene, Jr., L. M. Cox, Elihu C. Church, Brysson Cunningham (London); Luigi Luiggi (Rome). See also McElwee, Ports and *Terminal* Facilities.

(CH. D.; X.)

ROLLING STOCK

To furnish transportation and to provide for all the requirements governing the handling of traffic it is necessary, among other things, for railroads to maintain various and distinct designs of freight and passenger cars for revenue-producing service and equipment for its own use. The prosperity of a railroad depends to a great extent upon the efficiency and condition of its rolling stock. Regular service is dependent upon the number and types of cars and the proper maintenance of this equipment.

The outstanding developments in railway rolling stock during the past few years have been the increased size of cars, both freight and passenger, the gradual substitution of steel and aluminium for wood as the chief material of construction, the use of roller-bearing journals, air-conditioning, the rapid advances made in the use of high-speed light-weight streamlined trains and container cars.

In America the long hauls and the interstate commerce require for most economical service that freight be moved in large units, making it necessary to provide cars of large cubical capacity. Modern cars range in load capacity up to 70 tons or more. This increase in size and weight of freight cars with an accompanying increase in the size and weight of passenger cars and of the locomotives required to haul them, has called for heavier construction.

Heavy rolling stock has also required improvements in the construction and maintenance of road bed, track and bridges.

Passenger Train Cars.—Passenger train equipment is defined as rolling stock suitably constructed to operate at high speeds in passenger trains; its general characteristics being passenger type of truck, passenger type of brake, air signal, steam heat equipment and interior arrangement to suit the class of traffic for which it is intended. Passenger train car equipment in America includes coaches, observation, sleeping, dining, buffet, cafe, club, parlor and business cars for carrying passengers and baggage, express and postal cars for handling baggage, merchandise and mail in passenger trains. At the end of 1936 there were over 70,000 passenger train cars owned by the railways of the United States, Canada and Mexico. This includes over 8,500 Pullman owned cars and a number of privately owned cars.

Construction and Equipment.—Railroad passenger train cars are designed according to the various kinds of service for which they are to be used. With the exception of Pullman cars, and a small number of express-baggage cars, few passenger cars enter into general interchange traffic. As a consequence, on American railroads, there is less uniformity in the design of passenger train cars than in that of freight cars. Pullman cars enter into general interchange traffic in order to permit the operation of through sleeping car lines between large cities.

During the three years 1933–36 there were some spectacular developments in new railway passenger car equipment by the railroads and car builders, one of the most important being high-speed light-weight streamlined trains with every possible passenger convenience. Some of these trains have been of the articulated type and others of the individual car type. Several railroads have modernized and streamlined some of their existing passenger car equipment. The new light-weight trains have been constructed of stainless steel and aluminium alloys, and the railroads and car builders are striving to reduce weight throughout their passenger equipment. These new high-speed trains have reached speeds as high as 120 miles an hour at times and have made non-stop test runs of over 1,000 miles.

The construction, finish and equipment of passenger train cars have been steadily modified. In 1929 few passenger cars were built which were not of all-steel construction. The substitution of steel for wood has meant the replacement of wood trimming and cabinet work by sheet steel doors, windows and interior finish. Plainness, neatness and sanitary conditions are now sought, while much has also been done to add to convenience and comfort. A typical modern passenger coach is about 70 ft. long, over the body, seats from 60 to 84 passengers, weighs from 100,000 to 140,000 lb., is of steel construction, has vestibuled platforms, is carried on 4 or 6 wheel roller-bearing trucks, and is lighted by electricity, heated by steam and air-conditioned. The future will doubtless see better insulation and weight ratio. Practically all sleeping cars now in use on the railroads of the United States are owned and operated by the Pullman company. For the operation of the Pullman-owned cars over 2,800 conductors and 12,000 porters are required. Annually the cars have a car mileage of 1,140,476,000 m. to carry over 31,000,000 passengers, which means that every night more than 55,000 people sleep in the Pullman berths. There are various types of Pullman sleeping cars, among those in most common use being the following: 16 section car, each with an upper and a lower berth; 12 section car, with drawing room and compartment; 10 section car, with two drawing rooms; 8 section car, with four compartments; 10 section car, with an observation parlor; 10 section car, with drawing room and two compartments; 10 section car, with three compartments; drawing room and compartment cars containing three drawing rooms and six compartments, arid cars with various other combinations of drawing rooms and compartments, and cars containing compartments only. The latest Pullman car, known as the "overnight car," contains 14 rooms, each equipped with a bed and complete toilet and lavatory facilities. The Pullman Company is now putting new light-weight cars in service.

Observation cars are a distinctive feature of American railroading. They are of various types. Some contain a number of rooms, others a few sections, others smoking rooms, ladies' lounges, refreshment stands, baths for men and women, but in each case the rear of the car is a commodious lounge room with seats, sofas, radios, telephones for use at terminals, writing tables, and other conveniences, with a commodious rear platform equipped with chairs. Smoking cars are used on practically all passenger trains and may be devoted entirely to passenger service or be built with an express or baggage compartment. Club smoking cars on limited trains usually have card tables, writing desk, reading matter and an attendant.

Buffet or cafe cars are provided with facilities for serving a simpler class of meal than that affordedin dining cars. The business or private car is provided with sleeping and dining accommodations and also desks, tables and stationery. Business cars are used to a great extent by railroad officialsin transacting railroad business on the lines. Private cars are sometimes used by persons of prominence and wealth. Baggage, mail and express cars are designed to carry the commodities indicated by the classification of the cars themselves. Special postal cars for carrying mail are designed and equipped for operation in passenger trains. These cars are provided with interior fittings especially arranged to facilitate the handlixg of mail. Some cars are provided with facilities for sorting mail en route; other cars are designed only for the transporting of mail and express in bulk. Various other special types of passenger train cars are used.

Air-Conditioning.—Air-conditioning has been one of the most outstanding railway developments during recent years and has increased materially railroad passenger travel. Air-conditioning directly affects the passengers and adds much to their comfort, both in summer and winter.

It is the function of an air-conditioning system to control scientifically the temperature and humidity of a car in winter as well as in summer, and the heating control is a very important part of an air-conditioning system, thereby differing from a strictly cooling system for use in hot weather only. Ideal air-conditioning for railway cars is the simultaneous control of the factors affecting both the physical and chemical conditions of the atmosphere within the railway car. These factors include temperature, humidity, air motion, air distribution. ionization and elimination of dust, bacteria, odours and toxicity. A dependable power supply is necessary to provide for the equipment involved in the proper air-conditioning of a railway car. This equipment controls the ventilation, filtering, heating, cooling and humidity.

The principal methods of air-conditioning railway passenger cars are mechanical (both electro and direct), steam ejector and ice activated. The refrigerant most commonly used in the mechanical type of cooling system is "dichlorodifluoromethane." There are several types of drive mechanisms through which power is transmitted from the car axle to the cooling equipment. These comprise the gear type of drive using either hypoid, spur or bevel gears; the belt and gear type of drive using a V-belt and bevelled gear; the belt type of drive using a "V" or flat belt without a gear, and the friction type of drive. Generators where used with an electro-mechanical system will range upwards from 5-kw. There is also one system using an internal combustion engine driving a directly connected compressor.

The insulation of railway cars is very important when considering air-conditioning. To maintain a differenceof 20° between the outside and inside temperature of a car with 3″ of insulation and double windows will require about 1·3 tons of refrigeration, whereas a car with only ½″ of insulation and single windows will require 3·1 tons of refrigeration. An air-conditioned car will use from 100,000 to 125,000 cu. ft. of air per hour. This will approximate 25% fresh air and 75% re-circulated air. It is important that proper ducts be provided to permit the intake of fresh air and control the escape of air to the outside atmosphere. The Association of American Railroads has determined by tests that the minimum air change required in an air-conditioned railway car is 10 cu. ft. of air per minute, per passenger. Therefore, an air-conditioning installation on a 60-passenger car should be so designed as to deliver not less than 600 cubic feet of air per minute. The total cost of air-conditioning consists of four items; namely,

(1) cost of installation; (2) cost of terminal facilities; (3) cost of maintenance and (4) cost of operation.

The economics of air-conditioning from an operating standpoint is affected by a number of factors; namely, the length of the cooling period and the atmospheric conditions prevailing during that period, the average speed in miles per hour and the total car miles per year. These factors must be considered in order to select a system from the standpoint of economy.

Rolling Stock Prices.—During the year 1927 the average purchase prices for freight cars were $1,800.00 to $2,200.00. During 1926 the average price of all steel freight cars averaged 4.734 a pound, and composite wood and steel freight cars averaged 4.93¢ a pound. Seventy ton all steel hopper cars cost from $2,200.00 to $2,500 00, while a 50 ton box car cost $2,200.00. The price of an ordinary coach with 6-wheel trucks ranged from $27,000.00 to $33,000.00. Dining cars ranged from $43,000.00 to $51,000.00, depending upon the interior furnishings. Baggage cars ranged from $18,000.00 to $20,000.00.

Weight of Passenger Train Equipment.—Main line passenger equipment cars in America weigh from 100,000 to 150,000 pounds. The average Pullman car varies between 150,000 and 160,000 pounds. Suburban cars weigh between 80,000 and 120,000 pounds. Dining cars on American railroads weigh between 160,000 and 175,000 pounds. The American railroads have to haul twice as many pounds of equipment per Pullman passenger as per day coach passenger. In the United States this condition has been brought about by demands of the travelling public for a more luxurious and convenient mode of transportation. The limits seem to have been reached as far as dead weight and size are concerned and the trend is now to reduce weight. What seems to be excessive weight is also the outcome of the desire on the part of railroad officials to provide as safe a means of transportation as possible. Any reduction in weight should not be made at the sacrifice of strength and safety. Some experiments have been made with the use of aluminium in car construction. Designers have tried to produce double deck cars in order to decrease the dead weight per passenger. Alloy steel is also coming into general use in car construction.

Roller Bearings.—A large number of passenger train cars were in 1928 equipped with roller bearings and all modern cars are now roller bearing equipped. Practically all of the new designs of the electric cars are fully roller bearing equipped. These applications exist not only on the journals but also on the armature shafts of the motors and in the speed reduction units. Roller bearings have also been applied to freight cars, locomotive tenders, driving axles, engine trucks and trailing axles. A roller bearing equipped train can be started with one-eighth the power required to start a train equipped with plain journals.

For a discussion of Electric Motor Cars and Self Propelled Equipment see ELECTRIC TRACTION; LOCOMOTIVES.

Articulated Cars.—An articulated car consists of two or more car bodies flexibly coupled together and operating as a single unit by necessity of its truck arrangement. Each articulation or joint in the car is supported by only one truck. The number of trucks is one more than the number of bodies permanently coupled. The use of articulated cars in America is limited mainly to elevated and subway service in cities, to electric railway cars and to self-propelled rail motor cars, as the articulated principle must be used in trains kept as one unit during their entire trip.

Freight Train Cars.—Rolling stock for use in handling freight in America are termed "freight cars" and are divided into several general classes. The cars generally in use are of either the enclosed type, which includes box, refrigerator, stock and other house cars; or of the open type which include flat cars, gondolas, both high and low side, hopper and other cars of open construction. Tank cars for conveying oil and other liquids in bulk are used; as are also many types of special cars.

Design.—The operation of freight cars on American railroads has resulted in the adoption of certain fundamentals of design which experience has shown to be the most practicable. (See "Standards and Recommended Practices" and "Supplement," American Railway Association.) The materials that are used in the construction and maintenance of freight and passenger train cars may with few exceptions be divided into four general classes, as follows: (1) metal materials; (2) lumber; (3) paints and varnishes; (4) various complete devices or specialties. The requirements to be met in the design of freight rolling stock are protection of the contents (when required) from weather; facilities for loading, packing and unloading; strength of underframe and body to withstand severe service, and the largest available capacity consistent with requirements of construction.

In the early days of development freight cars were constructed more strongly than passenger cars and a freight car 28 ft. long with a capacity of g ton, weighed 6 ton. In existing designs of open top cars the ratio of dead weight to pay load is approximately 1 to 3. The types of cars now in use on American railroads are developments from the early crude forms. Wooden freight cars are being rapidly replaced by all steel or steel underframe cars.

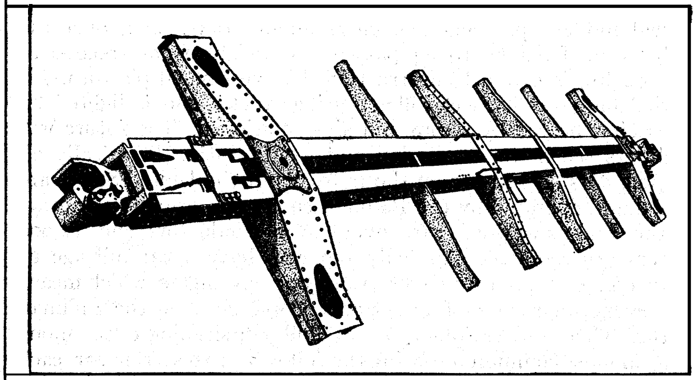
Nearly all coal cars, either gondola or hopper, are now being made of steel. After Jan. 1, 1931, no wooden cars were accepted in interchange on American railroads. Early in this century the combination of pressed steel and structural steel was used in car construction and this is the type of construction most commonly used today. The 70 ton hopper cars have come into general use and also 90 ton, 100 ton and 120 ton capacity coal cars are in operation. The largest freight car in commercial use at present is the 120 ton capacity steel coal car. This is a type of gondola of which the most novel feature is its size.

A large number of "automobile" or box cars with large cubical capacity are in use in the United States. Many have end doors and all have wide side doors.

The number of freight train cars in service (1935) on railroads in the United States was as follows: (1) railroad owned or leased 1,596,711; (2) privately owned 295,664; total 1,892,375. Freight train cars installed in major steam railways during the year 1935 totalled 18,496, a very low figure due to the depression.

The average mileage made by a freight car in America is approximately 30 m. in 24 hours. The railroads of America are constantly speeding up train operation. It is predicted that in a few years freight trains will be operated at passenger train speeds. In America the percentage of empty to loaded car miles has run about 30% during the past few years. Freight car heavy repairs become due in periods of about once every 8 or 10 years, whereas running repairs and inspections are a continuous necessity.

The average freight car earnings per year in America are approximately $2,200. The average life of a freight car is from 20 to 25



BY COURTESY OF SIMMONS-BOARDMAN PUB CO

FIG. 15.—UNDERFRAME OF STANDARD AMERICAN FREIGHT CAR VIEW OF UNDERSIDE

years. To whatever extent the unproductive weight of a train can be diminished, to that extent the productive weight may be increased by the absorption of the same amount of energy of locomotive tractive power without reduction of the rate of speed. The expenditure of fuel in hauling a ton is about the same whether or not it is paying freight. The smaller the percentage of non-paying or dead weight to total weight moved, the smaller will be the cost of hauling the paying freight

On American class 1 railroads the cost of hauling one ton of dead weight 1 mile varies from $0 004 to $0.007. The cost of hauling a ton of weight is not directly proportional to the weight carried but rather the relation of the full tonnage possibilities to actual tonnage hauled. A railroad having full tonnage trains will have a lower cost per ton-mile than one with variable loads of less than full tonnage.

Great progress has been made by American railroads in the standardization of freight equipment. The following table shows a comparison of a few representative car parts necessary to keep on hand at railway shops for repairs and represents the progress made in standardization in 41 years.

	1882	1923
Axles, different kinds	56	5
Journal boxes, different kinds	58	5
Couplers, different kinds	26	1
Brake shoes, different kinds	20	1
Brake heads, different kinds	27	1

Car Trucks.—Car trucks in use on American railways are built in accordance with general requirements specified by the American Railway Association. The cast iron wheel 33 in. diameter, with a chilled tread, is in use under freight cars of a capacity of 50 ton and under. On nearly all passenger equipment and on a few freight cars of high capacity steel wheels are used. For 1929 the side frames of all new freight car trucks are commonly of cast steel. Pedestal type trucks are used for passenger equipment and to a limited extent for freight equipment.

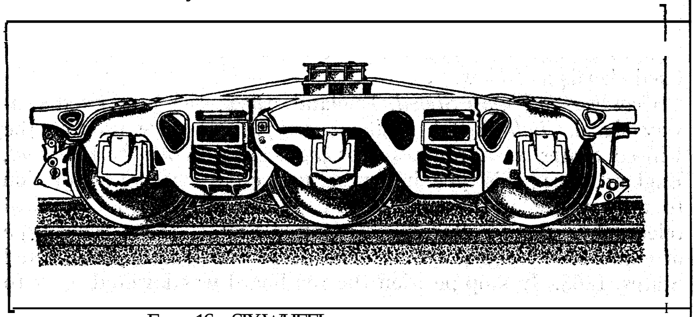


FIG. 16.—SIX-WHEEL FREIGHT CAR TRUCK

Tractive Resistance of freight and passenger cars is very important because of its relation to tonnage ratings of locomotives and to questions of economies of operation. The resistance of a car to movement on a straight level track may be divided into the following components: (a) journal friction, (b) rolling of the wheel on the rail; track resistance due to compression of the track, concussions, and miscellaneous losses due to oscillation and vibration that absorb energy from which no return can be obtained; (c) flange friction due to the pressure of the wheel flange against the rail; (d) atmospheric resistance; still air and wind. Plain bearing friction varies within certain limitations of speed while roller bearing friction is fairly constant from zero up to high speeds. Rolling of the wheel on the rail and the flange friction increase with the speed and also vary materially with the condition of the track and stiffness of the rail. The atmospheric resistance increases as the square of the speed. Rolling of the wheel and flange friction are reduced to a minimum by the use of heavy rails well supported and with proper alignment.

Container Car.—The container car system is now coming into popular use on American railroads. This system provides that portable containers shall be loaded and locked at the shipper's own plant, conveyed by motor truck to the railroad yard and lifted by crane aboard the container car where steel bulkheads and sides form absolute protection against opening the container in transit. At its destination the locked container is unloaded by crane and carried by motor truck directly to the warehouse or consignee's door to be unloaded at his convenience. One of the principal advantages of the container car system is the greatly increased use of container car rolling stock in moving service which is particularly important when traffic expands to its "peak" and the prime need is to shorten lay-overs of cars in yards and stations for loading and unloading and to limit their idleness and obstruction through misuse for storage purposes. (*See* American Society Mechanical Engineers, paper by Walter C. Sanders presented at annual meeting, New York, Dec. 6, 1921.)

Refrigerator and Heater Cars.—The need for protection in transit against all ranges of temperature of such commodities as meat, milk, fruit and vegetables, has led to the design of various types of refrigerator and heater cars. A large number of refrigerator cars are designed for both passenger and freight train operation. Some cars used for transporting semi-perishable commodities not requiring refrigeration or heating are insulated and ventilated to protect the loading against extreme outside temperatures and the heat of the product itself. The principal means of obtaining refrigeration in transit is by circulated air, cooled by contact with ice, or mixtures of ice and salt. Some modifications of this system and others differing radically such as mechanical refrigeration or iceless cars are in use to a small extent and may be more generally adopted in the future.

All refrigerator cars are insulated. One type is equipped with brine tanks at each end and used for carrying eggs, butter, vegetables and fruits. Some refrigerator cars are equipped so that they may be converted into heater cars during the winter. Heating systems employing coal, charcoal, alcohol and kerosene as well as steam have been developed.

Tank Cars.—Tank cars are used to transport gasoline and other inflammables, acids, alcohol, ammonia, oils, paints, milk, vinegar, pickles and other liquid and semi-liquid products. The most common design is the tank car for general oil or liquid service. It consists of a steel tank mounted on a frame, or mounted directly on cradles over truck bolsters. Safety release valves are provided and it is emptied by valves at the bottom. At the top is a dome, with or without manhole, and the openings through which the tank may be filled. Milk in bulk is transported in cars equipped with glass lined tanks.

Railway Service Cars.—Many types of special cars for maintenance of the track, and general construction work in connection with railroad operations are necessary. These include dump cars, motor and hand cars, locomotive cranes, steam shovels, pile drivers, ditchers, dangers, snow plows, sweepers, supply cars, air-brake instruction cars. This rolling stock is known as non-revenue equipment. Wrecking, instruction and dynamometer cars are included in the non-revenue group. Section or inspection cars are used to convey the section men to and from their work and to conserve the time of other maintenance employees.

Passenger Car Lighting.—Three general systems of electric car lighting are in service as follows: Axle-generator system, head-end system, storage battery system. The axle-generator system is the most commonly used, and provides for lighting each individual car by means of a storage battery charged by a generator under the car, and driven by a belt from one of the axles. The head-end system requires a generator located in a car at the head of the train where it may receive steam from the locomotive. The generator may also be driven by an internal combustion engine. This generator furnishes current for lighting the entire train. In some cases the generator may be driven by a belt from the axle or it may be mounted on the locomotive. The straight storage battery system has a storage battery under each car as an individual unit or one battery for lighting several cars. The batteries are charged at terminals during a lay-over period.

Passenger Train Heating.—Heating is accomplished by steam or electric heating apparatus. On steam operated railways vapor heating systems are usually used. Other systems employed are direct steam or pressure and combination vapor and pressure. At terminals when a locomotive is not available until leaving time cars are heated from a central heating plant. The heating elements of a steam heated car consist of iron pipes placed along each side wall near the floor and protected by a grill. Live steam is supplied by the locomotive. Where cars are subject to isolation, a coal fired heater is installed in each car. Electrically operated cars are usually heated by resistors taking current from the power source.

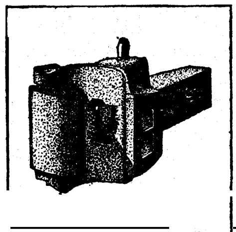
Car Ventilation.—Until the recent improvements in air-conditioning, explained above, nearly all types of car ventilators in passenger cars were (and, in many cars in use in 1937, are) located either in the deck sash or in the main roof of the car. Their action was to admit or exhaust air to or from the car and depended upon the motion of the car for full action. This was later helped by the action of electric fans. Freight cars employed in handling certain commodities used a simpler system of ventilation consisting usually of a series of slots at each end of the car and sometimes of ventilator side doors. For Air-Conditioning, see above.

Inspection. — To facilitate the economical movement of traffic in America the railroads have for many years permitted car load freight to be shipped from consignor to consignee without the expense and inconvenience of trans-shipment at junction points. This has resulted in a vast interchange of traffic between the various railroad systems and in the gradual formation of the restrictions or rules under which this traffic interchange is conducted. One railroad will repair the rolling stock of another railroad under a code of rules which governs this practice.

Draft Gear. — A draft gear is an apparatus which connects the coupler to the car sills or underframe of the car. Its function is to receive the shocks transmitted by the coupler and to dissipate them without damage to the rolling stock. The friction type of draft gear is gradually superseding the spring type on American railways. Draft gear yokes, arms and various attachments are necessary to connect the draft gear to the coupler, and then to the car. The constant increase in the length of the trains and in the size and weight of rolling stock in America has made it extremely difficult for draft gear development to keep pace with these conditions.

No standard design of draft gear has been established except for certain limitations of space in the car underframe into which the draft gear must be assembled.

Couplers. — Couplers are the mechanisms by which cars are connected together. The standard American Railway Association (Master Car Builders) "D" coupler is in general use on American and Canadian railroads and also a few foreign railroads. Before the advent of the M.C.B. type coupler in the United States the connection between the cars of a train and locomotive were made with the "link and pin." This was a very hazardous practice and resulted in many injuries and automatic Master Car Builders Association couplers were subsequently developed, and are now required by law.



BY COURTESY OF SIMMONS-BOARDMAN PUB CO.
FIG. 17.—STANDARD COUPLER WITH KNUCKLE CLOSED

Buffers. — Buffers are applied to the ends of passenger train equipment to provide smoothness of handling. This additional cushioning is obtained by the use of buffers in addition to the ordinary draft gear. Buffers are of both the spring type and friction type design.

All American railway rolling stock is equipped with safety appliances in accordance with instructions and specifications from the Interstate Commerce Commission of the United States Government.

Air Brakes. — The air brake is a brake operated by compressed air which was invented in its first form by George Westinghouse in 1869. In an air brake, the air is compressed by some form of a pump on the steam locomotive or by a motor compressor on electric or internal combustion locomotives or cars, and is conveyed by pipes and flexible hose between the cars to cylinders and pistons under each car, by which the pressure is transmitted by brake levers and thence to the brake shoes against the wheels. The adhesion of the wheels to the rails governs the amount of pressure that may be applied by the brake shoes.

A combination of straight air and automatic air brake has also come into use and is known as the automatic straight air brake. Other types of brakes are: the quick action automatic air brake, high speed brake, empty and load brake, vacuum brake, electro-pneumatic brake and the traction air brake. The automatic air brake is in general service under American rolling stock. This system is designed so that the brakes will be applied automatically in case air escapes from the system or the train breaks in two.

Industrial Rolling Stock. — Industrial cars are used in almost every branch of industrial activity; in manufacturing plants, mines, lumber operations, sugar cane plantations, and in construction work. They are also used in quarries, sand and gravel plants, brick and clay works, steel mills, smelters, foundries, machine shops and in many other places for handling all classes of loose or package materials. (*See* LOCOMOTIVE; ELECTRIC TRACTION.)

BIBLIOGRAPHY.—W. C. Sanders, "Railway Car Design and Construction," *Car Builders Cyclopaedia; Science of Railways Cyclopaedia,* Railway Training Institute. (W. C. S.)

RAILWAY SIGNALLING

Railway Signalling has passed through a long period of development and is to-day an efficient means for safeguarding and expediting the movement of railway trains. This article traces this development from a crude type of fixed signal in use in the early days of railways to the perfected systems of to-day.

Fixed Signals are signals of fixed location used to govern trains by displaying aspects whose indications show when, where and how to go and when and where to stop. The principal types of fixed signals as follows:

Crossbar-and-lamp Signal, England, 1834; the first fixed railway signal. *Ball Signal,* England, 1837; type once used in the United States as a railway crossing signal. *Semaphore Signal,* England, 1841; this type, in general use to-day, was an adaptation to railway use of the Chappe semaphore, 1793, used in optical telegraphy. *Banner Box Signal,* United States, 1863; early type of manual block signal. *"Smashboard" Drawbridge Signal,* United States, 1868. In stop position the red board was lowered so as to strike the locomotive stack should the signal be overrun. *"Banjo" Signal,* United States, 1871, type of first electrically operated automatic block signal. *Clockwork Signal,* United States, 1879, mechanically operated automatic block signal with electric control. *Semaphore Signals: Electro-pneumatic* type, United States, 1881, the first power operated semaphore; *Electric* type, United States, 1893, the forerunner of present day electric motor semaphore signals; *Upper Quadrant* type, United States, 1908, for both manual and power operation. Previous types operated in lower quadrant.

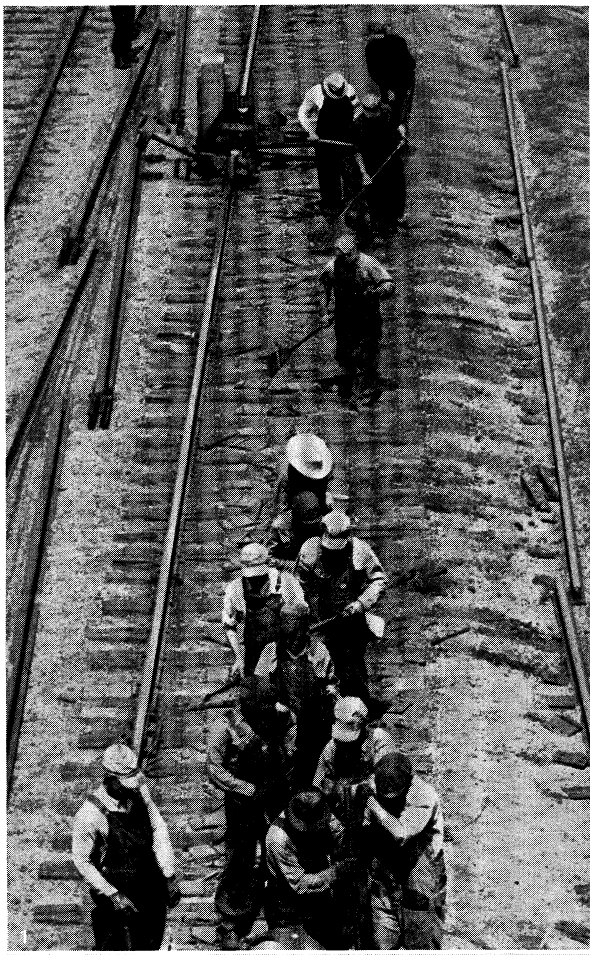
Light Signals displaying coloured electric lights for both day and night indications: *Colour Light* type, United States, 1908; *Position Light* type, United States, 1915; *Colour-position Light* type, United States, 1921.

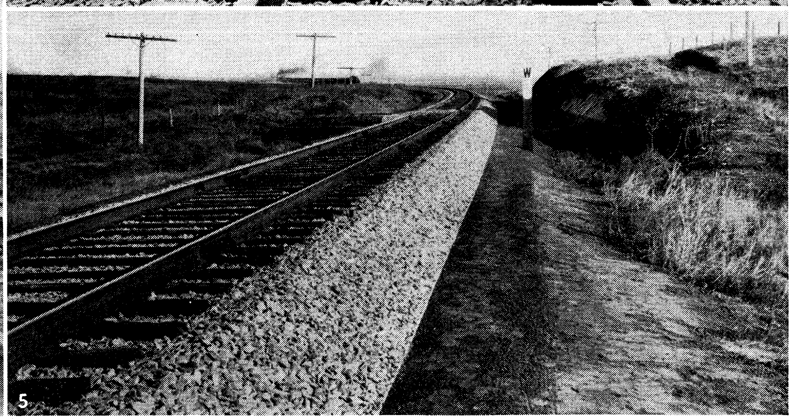
Train Dispatching in the United States is a highly developed method of directing train movement by the use of general rules time-tables (with special instructions), train orders, or by signals in place of written train orders.

Rules and time-tables are the plans for directing train movement. Train orders are to meet conditions which cannot always be anticipated. If train operation could be conducted by time-tables without delay, train orders would not be necessary. Such precision being impossible, train orders are used to supplement the time-table.

Train dispatching has reached the third stage of its development. The first, when the time-table was the sole authority for train movement, was the "time-table" stage. The second or "train order" stage began in 1851 when the electric telegraph was first used for sending train orders. The written train order is now being superseded by the unmistakable indication of the signal, and train dispatching is entering the third or "signal indication" stage. (*See* the section on *Train Operation* by *Signal Indication* on p. 951.)

Block Systems were developed in England to provide for safe travel by rail. At first the signals were used in much the same way that signals are used to-day by policemen for controlling street traffic. Signalmen known as policemen, stationed along the railroad at hazardous locations (stations, tunnels, etc.) warned the trains by signals of danger ahead. As trains increased in number, signals were next used in an effort to maintain a *time* interval between trains; protection from rear collisions depending





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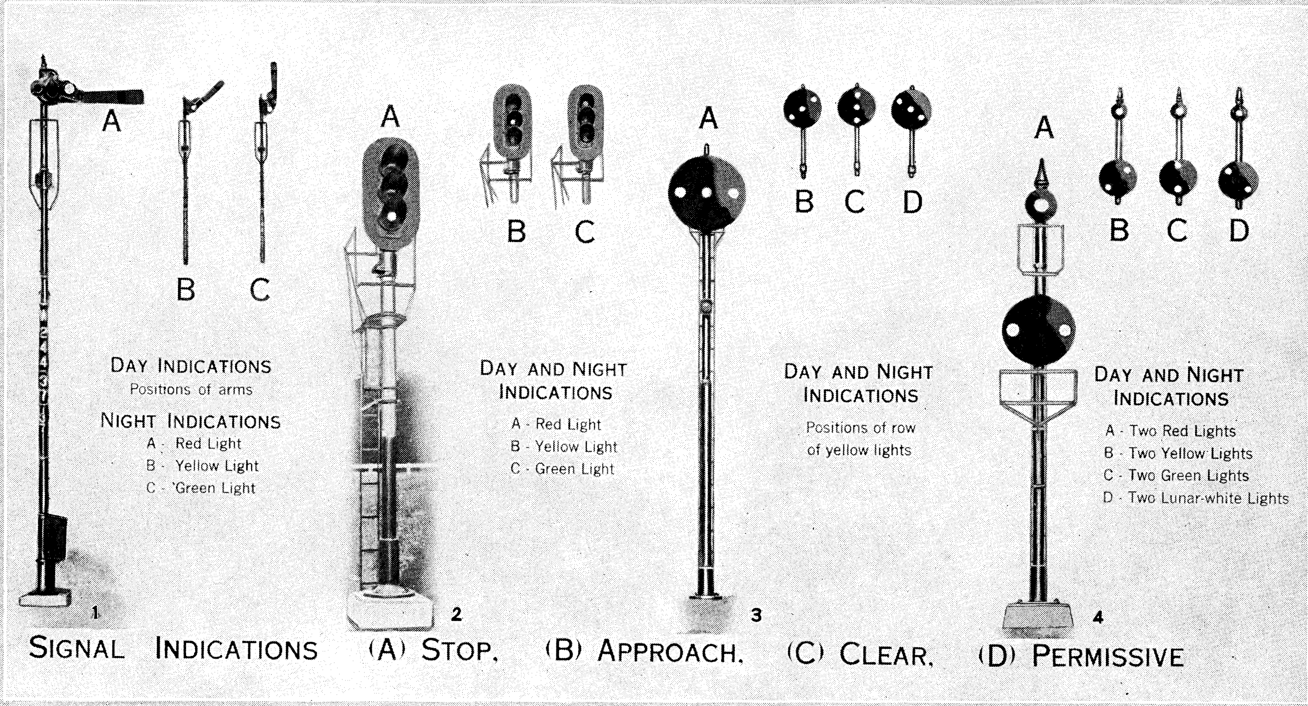
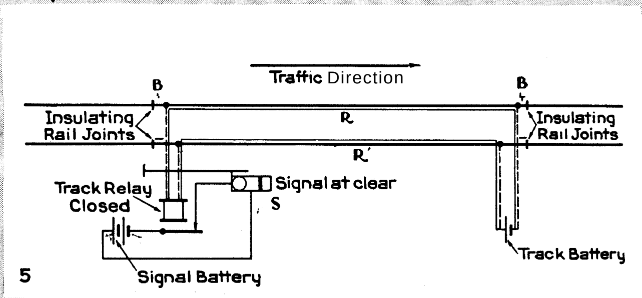
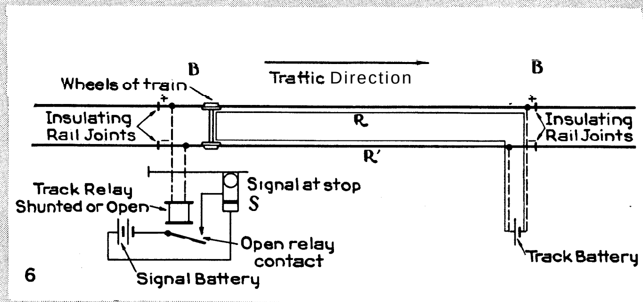
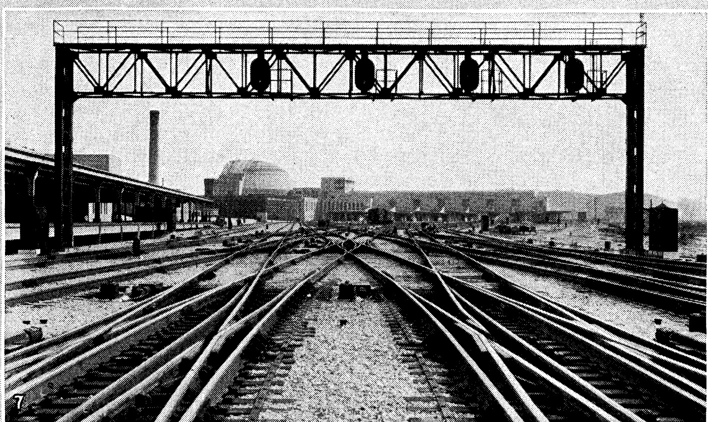
TRACK LAYING AND MAINTENANCE

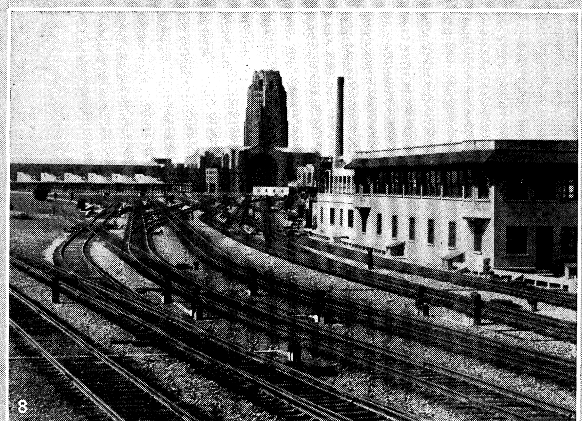
1. Removing old rail from a track
2. Crane setting new rail onto tie plates
3. Automatic spike drivers sinking spikes into hardwood ties (sleepers)
4. Compacting ballast under the ties with pneumatic tampers
5. Completed track with ballast in place











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RAILWAY SIGNALS

1. Semaphore signal, upper quadrant type, **1908**
2. Colour light type, **1908**
3. Position light type, **1915**
4. Colour-position light type, **1921**
5. Automatic block system, block section **B** to B' unoccupied. Track circuit current flows from track battery through rail **R** to track relay and back through rail R' to track battery. Track relay is closed, closing circuit to signal battery and holding signal **S** at "clear"
6. Automatic block system, block section B to B' occupied. Track circuit current by-passed by wheels of train. Track relay is opened, opening circuit to signal battery, and moving signal S to "stop"
7. Electro-pneumatic interlocking, Union Station, Cincinnati, Ohio. Switches and signals operated from an electro-pneumatic interlocking machine
8. Electric interlocking, Buffalo Central Terminal, Buffalo, N. Y. Looking west toward Tower **48,** New York Central Railroad. Signals and switches are operated from an electric interlocking machine

on the continuous maintenance of this time interval between moving trains and the use and observance of red flags, lanterns, torpedoes and fusees for the protection of standing trains; protection from head-on collisions (on single-track lines) depending on the exercise by enginemen and conductors of most intelligent and unceasing vigilance in the observance of rules and written orders and on the exercise of the utmost care by the train dispatcher. As it is not always possible to move trains on schedule time, this method fails to prevent occasional collisions.

The third step provides a *space* interval between trains moving on the same track by dividing the track into a series of consecutive block sections by the use of fixed signals to govern the movement of trains, no train being permitted to enter an occupied block section except under certain restrictions.

Manual Block is a system in which the block signals are operated manually upon information by electric communication: first used in England, 1839 and in the United States, 1863.

Controlled Manual Block is a manual block system with an electric control of the signals, used to increase the safety of their operation: first used in England, 1875.

Automatic Rlork is a system, developed in the United States. defined by the American Railway Association as "a series of consecutive blocks governed by block signals operated by electric, pneumatic or other agency actuated by a train, or by certain conditions affecting the use of a block." When a train enters a block section the signals governing the block automatically move to and remain in the stop position until the train leaves the section controlling the signals. The signals are thus actuated not by human agency but automatically by the train through the medium of a closed track circuit.

The Interstate Commerce Commission has said: "Perhaps no single invention in the history of the development of railway transportation has contributed more toward safety and despatch in that field than the track circuit." The closed track circuit, invented by Dr. William Robinson, was first put in use in the United States in 1872.

The automatic block system is in general use on the railroads of the United States. Its value as a means for protecting and expediting the movement of trains received world-wide recognition.

Interlocking is an arrangement of switch and signal appliances so interconnected that their movements must succeed each other in a predetermined order. Its purpose is to provide a safe path for the movement of trains through switches. junctions, railroad grade crossings, stations and over drawbridges.

Mechanical Interlocking is a manually operated system which had its inception in the crude machine put in use at Bricklayer's Arms Junction, England, 1843. Thirteen years later a mechanical machine was put in use in England by John Saxby that included the essential principles of the later interlocking systems. This type of machine was put in use in the United States at Trenton, N J., 1870. Mechanical interlocking is in extensive use on the railways of Great Britain. In the United States the tendency is toward the use of power interlocking.

Electro-pneumatic Interlocking is a power system, the switches and signals operated by pneumatic power with electrical control of the valves of the pneumatic cylinders: first used in the United States, 1891, and invented by George Westinghouse. the inventor of the air brake.

Electric Interlocking is also a power system. the switches and signals operated by electric motors with electrical control. The system now in general use and first used in the United States, 1889, was invented by John D. Taylor.

Power Interlocking is used for the operation, as one plant, of what would otherwise require two or more mechanical interlocking plants. The principal terminal stations in the United States are all equipped with power interlocking.

Electro-mechanical Interlocking is a system that was developed for use with automatic block signalling; the switches are operated by mechanical interlocking and the signals by power interlocking: first put in use in the United States in 1906.

Remote Power Switch Machines are used for the operation of outlying main track switches located at too great a distance from either train order, block or interlocking stations to permit of their operation from these stations by mechanical or power interlocking. The operation of switches that would otherwise be hand-thrown by trainmen eliminates making train stops for trainmen to throw switches. Eliminating train stops decreases train delay.

Automatic Interlocking is a power operated system for junctions and grade crossings, automatically actuated by a train and not by operators as in other systems of interlocking.

Train Operation by **Signal Indication** was first put in use in the United States, 1882, at Louisville, Ky. Train movement was directed without the use of written train orders by signal indications given under the instructions of the dispatcher. A large number of installations of train operation by signal indication without train orders were placed in use in the United States on single-track lines and for "either-direction" operation on multiple-track lines.

Later, an improved system was developed that further simplified the work of the train dispatcher and enabled him to increase substantially the output of transportation, especially on single-track lines. The signals and switches of a district are operated and controlled from a central point by a dispatcher solely by the use of electric actuating devices and without the aid of operators. The dispatcher directs the movement of trains by operating the signals and by direct operation of the switches, also sets up the routes.

Train Orders and signal indications differ greatly as a means for directing train movements. Train orders are written instructions that must be delivered to the conductor and engineman of the train. They must be correctly prepared. transmitted, delivered and understood. They must not be forgotten. On roads not equipped with modern signalling systems, safety of operation depends entirely upon the human element, for there is no check either electrical or mechanical to prevent an improper train movement should an error occur in the preparation, transmittal or delivery of the order, or should the order be misunderstood or forgotten.

Signal Indications are simplified instructions for directing train movement given by the aspects of fixed wayside or cab signals. The train order calls for deferred action, whereas the signal indication, conveying instructions at the points where they are to be executed, calls for immediate action. Hence there is no lapse of time in which to forget the instructions.

Operation by train orders requires delivery of the order to the train. If in motion, the train must slacken speed or stop to receive the train order instructions as to how to proceed. As train orders are for the ultimate purpose of keeping trains moving, this slowing down or stopping for the delivery of orders in a measure defeats this purpose. Train orders when they retard the movement of trains cause loss of time. To produce transportation, trains must be kept moving; hence when train orders unnecessarily retard or stop the movement of trains, they tend to limit the production of transportation.

Train operation by signal indication on the contrary does not require the train to stop for proceed instructions and therefore tends to increase the production of transportation.

Classification Yards located at important freight centres are for sorting and grouping cars for their respective destinations and for making up trains with the cars in destination order to expedite the road movement. These yards consist of a number of parallel tracks each assigned to a particular destination. The cars are sorted by switching them into these tracks. In flat or level yards, switch engines switch the cars. In modern yards, built on an inclined grade, hump or gravity type, cars are pushed to the top of the hump or incline and then move down by gravity into their respective tracks. Hand operated switches acd switchmen have been replaced by power operated switches using either compressed air or electric motor-switch machines controlled by operators from central towers. These operators also control the power operated car retarders or track brakes which control the speed of cars moving by gravity into the classification tracks.

Prior to the use of car retarders, speed of the cars was controlled by hand brakes operated by car riders.

Classification yards equipped with power switches and car retarders are worked at maximum capacity with minimum labour costs as switchmen and car riders are not required.

Highway Grade Crossing Signals are for the protection of highway traffic crossing railway tracks at grades. The Interstate Commerce Commission lists for 1927 a total of 236,283 grade crossings in the United States: 12% of these crossings equipped with watchmen, gates or signals, 86% equipped with "railroad crossing" signs only and 2% not so equipped. The signals are largely of two types: a swinging disc and a red light or two flashing red lights.

The remarkable increase in motor-car traffic and the expanding net work of improved highways in the United States has made highway grade crossing protection a most pressing safety problem. (H. M. SP.)

AUTOMATIC TRAIN CONTROL

Automatic train control is a term commonly used to describe a method of stopping or reducing the speed of a train without the intervention of the engineman, and, as generally employed, covers either an automatic train stop or a speed control system. In the first instance the brakes are applied until the train is brought to a stop; in the second, the brakes are applied if the speed of the train exceeds a certain designated limit, but may be released by the engineman after the speed has been reduced. These actions may take place at a designated point or at any point on the equipped territory depending on whether an intermittent or a continuous type is in use.

These devices provide means for transferring to the locomotive an indication of conditions existing on the track and furnish the connecting link between the track circuit and the air brake system of the train. The track circuit is really the block system or "train spacing" feature and the cab signals, train control, or roadside signals are merely the means of indicating to the engineman the conditions of the track as to occupancy by trains, open switches, broken rails, or some other obstruction.

There must be, therefore, apparatus, on the roadside to co-act with the locomotive apparatus, which may be a special adjunct, or the contact may be through the running rails. The locomotive must be provided not only with some device for receiving the indication from the track by electrical means or by mechanical contact, but also some method must be employed for exhausting the brake pipe air to atmosphere, and so causing the brake (or triple) valves on each car to function and apply the brakes. This is done either by a special valve opening directly to the atmosphere, or by apparatus which automatically operates the engineer's brake valve Special appliances must be provided for the release of the brakes after the stop has been made. A "forestalling" device is also used except with speed control, which permits an alert engineman to prevent an automatic brake application

The Intermittent Type — Automatic train stop and train control devices have been classified according to the type of communication between the track and the engine. The simplest form, the plain automatic trip, consists of a contact member, or trip, along the track which is brought into a position, when a stop is desired, to make contact with a trigger or projecting arm on the locomotive which, when moved, will open the air brake pipe and cause the brakes to be set; the trip may be set electrically or mechanically. This type is in use on elevated roads and subways.

The ramp type has for its roadside element a length of iron of "L" or "T" section placed parallel to and outside the rail on the end of the ties and extending 5 or 6 inches above the top of the rail at its highest point in the centre of its length. Electric energy from a roadside source is supplied to it, controlled by connections to the signal system. The engine carries a shoe adjusted to engage the ramp through a vertically moving member that, to secure proper electrical contact, is held down by air pressure or spring. As the engine circuits are opened every time a ramp is engaged, thus producing a potential stop condition, means must be provided for holding closed the engine circuit by energy collected from the ramp, if a stop is not intended. This is accomplished through electrical contacts, or switches, attached to the moving member of the shoe.

The devices just described are known as the intermittent contact type, that is, physical contact is required between the track and engine elements, but to avoid this, the non-contact type has been developed. One form of this type uses permanent magnets located in the track between the rails, and associated with large coils which are designed, when carrying an electric current, to neutralize or deflect the magnetic field of the permanent magnets normally extending above the road bed to such a height that the engine apparatus will pass through it. During this passage, the lines of force either neutralize the lines of force of a small magnet carried on the engine or open contacts which control the electric circuits, thus initiating a brake application.

Another form is known as the inductor type, and so far as the track element is concerned, consists of specially wound coils in a non-magnetic casing secured to the ends of the ties. These coils are connected to the signal system in such a way that a complete electric circuit is formed when the signal is in a "proceed" position. The engine apparatus or receiver consists of coils in a casing usually attached to the tender truck and adjusted to register with the track inductors but with a clearance of abut two inches. When passing over an inductor with a closed circuit there is no effect, but if the circuit is open, the current flow through the engine apparatus is so reduced as to permit the opening of a special valve, directly resulting in an application of the brakes. Nearly all of the intermittent train stop devices now in service are of the inductor type.

The Continuous System.——In this type a flow of alternating current through the rails is provided, resulting in an electrical field being produced around each rail. Collecting coils on the engine are so designed as to be sensitive to this field, and when passing through or near it the action is somewhat similar to that of a transformer, the rails being the primary, resulting in a flow of current from the receiver coils to the locomotive apparatus. This is amplified by means similar to that used in radio, and sufficient current is produced to operate a relay, which, in turn, controls the circuits of the engine apparatus. A notable development, the code system provides for the use of interrupted currents of varying frequencies in the rails, which, when picked up by the receiver coils and passed through selective apparatus on the locomotive, permit a number of indications to be transmitted.

Continuous train stop and speed control systems include audible and visible cab signals, the latter usually taking the form of coloured lights or rows of small white lights simulating the position of the wayside signal. Cab signals provide a continuous indication of the track ahead and afford protection at all times against a switch being opened or a car or train fouling the main track even after the automatic signal has been passed. They increase the safety of train operation during fogs and storms when the wayside signals cannot readily be observed and permit regular schedules with full knowledge of the signal indications. Some railroads have installed two cab signals, one for the engineman and'fireman, and an acknowledger, these in lieu of automatic train control devices. A failure to observe a restrictive cab signal results in a whistle sounding until acknowledged.

Speed control devices are used to require definite speeds as a maximum under certain conditions. These generally are in the form of a centrifugal device, attached to one of the locomotive wheels, and are capable of application to most of the systems in use. By means of electrical contacts closed or open at certain speeds, the brake controlling apparatus may be operated.

Automatic train stop devices are not new, but the first permanent installation in the United States was on the Boston Elevated in 1899. In 1906, an investigation of this subject was started by a special board appointed by Congress, which work was carried on later under the Interstate Commerce Commission. This Commission issued orders in 1922 and 1924, requiring 80 passenger divisions on certain railroads to be installed. Some voluntary installations have been made with the result that over 10,250 miles of road and 9.120 locomotives have been equipped with automatic train control or continuous cab signal devices. (*G. E. E.*)

RAILWAYS, TUBE. The term "Tube Railways" is applied generally in Britain to deep-level underground railways constructed with a metallic lining and usually of round section. For the construction and the ventilation of the tube, see the article TUNNEL. The Tube Railway is a form of Subway. The latter is discussed under TUNNEL and ELECTRIC TRACTION. (See also TRAMWAYS.)

Stations are constructed, as a rule, by building a tunnel of twice the dimensions of the running tunnels. The station tunnel is sufficiently large to accommodate the platform as well as the track. Tube railways are generally operated at about 600 volts, direct current being fed to the conductor rails from substations. The substations are usually of the rotary converter type. High tension current is supplied from a central power station. From the substations also run cables sgpplying current for station lighting, lifts, escalators, and pumps.

In the London area. Metrooolitan and District lines are shallow sub-surface railways; the other underground lines, also owned by the London Passenger Transport Board, and the Southern Railway's line from Waterloo to the city, are tube railways proper.

RAIN: see RAINFALL; METEOROLOGY.

RAINBOW, formerly known as the iris, the coloured rings seen in the heavens when the light from the sun or moon shines on falling rain; on a smaller scale they may be observed when sunshine falls on the spray of a waterfall or fountain. The bows assume the form of concentric circular arcs, having their common centre on the line joining the eye of the observer to the sun. Generally only one bow is clearly seen; this is known as the *primary* rainbow; it has an angular radius of about 42°, and exhibits a fine display of the colours of the spectrum, being red on the outside and violet on the inside. Sometimes an outer bow, the secondary rainbow, is observed; this is much fainter than the primary bow, and it exhibits the same play of colours, with the important distinction that the order is reversed, the red being inside and the violet outside. Its angular radius is about 54°.

Among the Greeks and Romans various speculations as to the cause of the bow were indulged in; Aristotle, in his Meteors, erroneously ascribes it to the reflection of the sun's rays by the rain; Seneca adopted the same view. The introduction of the idea that the phenomenon was caused by refraction is to be assigned to Vitellio.

The most valuable of all the earlier contributions to the scientific explanation of rainbows is undoubtedly a treatise by Marco Antonio de Dominis (1566–1624), archbishop of Spalato. This work, De *radiis visus* et *lucis* in *vitris perspectivis* et *iride,* published at Venice in 1611 by J. Bartolus, although written some twenty years previously, contains a chapter entitled "Vera iridis tota generatio explicatur," in which it is shown how the primary bow is formed by two refractions and one reflection, and the secondary bow by two refractions and two reflections. Descartes strengthened these views, both by experiments and geometrical investigations, in his Meteors (Leyden, 1637). Descartes could advance no satisfactory explanation of the chromatic displays; this was effected by Sir Isaac Newton. (See Newton's *Opticks,* book i. part 2, prop. 9.)

The geometrical theory, which formed the basis of the investigations of Descartes and Newton, afforded no explanation of the supernumerary bows, and about a century elapsed before an explanation was forthcoming. This was given by Thomas Young, who, in the Bakerian lecture delivered before the Royal Society on the 24th of November 1803, applied his principle of the interference of light to this phenomenon. His not wholly satisfactory explanation was mathematically examined in 1835 by Richard Potter (*Camb. Phil.* Trans., 1838, 6, 141), who, while improving the theory, left a more complete solution to be made in 1838 by Sir George Biddell Airy (*Camb. Phil.* Trans., 1838, 6, 379).

Geometrical Theory.—The geometrical theory first requires a consideration of the path of a ray of light falling upon a transparent sphere. Of the total amount of light falling on such a sphere, part is reflected or scattered at the incident surface, so rendering the drop visible, while a part will enter the drop. Confining our attention to a ray entering in a principal plane, we will determine its deviation, *i.e.,* the angle between its directions of incidence and emergence, after one, two, three or more internal reflections. Let EA be a ray incident at an angle i (fig. 1); let AD be the refracted ray, and r the angle of refraction. Then the deviation experienced by the ray at A is $i-r$. If the ray suffers one internal reflection at D, then it is readily seen that, if DB be the path of the reflected ray, the angle ADB equals $2r$, *i.e.,* the deviation of the ray at D is $\pi-2r$. At B, where the ray leaves the drop, the deviation is the same as at A, viz., $i-r$. The total deviation of the ray is consequently $D=2(i-r)+\pi-2r$.

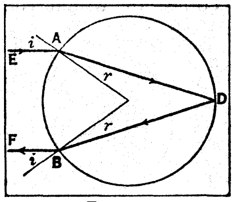

FIG. 1

Similarly it may be shown that each internal reflection introduces a supplementary deviation of $\pi-2r$; hence, if the ray be reflected n times, the total deviation will be $D=2(i-r)+n(\pi-2r)$.

The deviation is thus seen to vary with the angle of incidence; and by considering a set of parallel rays passing through the same principal plane of the sphere and incident at all angles, it can be readily shown that more rays will pass in the neighbourhood of the position of minimum deviation than in any other position. (See REFRACTION.) The drop will consequently be more intensely illuminated when viewed along these directions of minimum deviation, and since it is these rays with which we are primarily concerned, we shall proceed to the determination of these directions.

Since the angles of incidence and refraction are connected by the relation $\sin i=\mu \sin r$ (Snell's Law), μ being the index of refraction of the medium, then the problem may be stated as follows; to determine the value of the angle i which makes $D=2(i-r)+n(\pi-2r)$ a maximum or minimum, in which i and r are connected by the relation $\sin i=\mu \sin r$, μ being a constant. By applying the method of the differential calculus, we obtain $\cos i=\sqrt{\{(\mu^2-1)/(n^2+2n)\}}$ as the required value; it may be readily shown either geometrically or analytically that this is a minimum. For the angle i to be real, $\cos i$ must be a fraction; that is, $n^2+2n>\mu^2-1$, or $(n+1)^2>\mu^2$. Since the value of μ for water is about $\frac{4}{3}$, it follows that n must be at least unity for a rainbow to be formed; there is obviously no theoretical limit to the value of n, and hence rainbows of higher orders are possible.

So far we have only considered rays of homogeneous light, and it remains to investigate how lights of varying refrangibilities will be transmitted. It can be shown, by the methods of the differential calculus or geometrically, that the deviation increases with the refractive index, the angle of incidence remaining constant, Taking the refractive index of water for the red rays as $\frac{108}{81}$ and for the violet rays as $\frac{109}{81}$ we can calculate the following values for the minimum deviations corresponding to certain assigned values of n.

n	Red	Violet
1	$\pi-42°\cdot1$	$\pi-40°\cdot22$
2	$2\pi-129°\cdot2$	$2\pi-125°\cdot48$
3	$3\pi-231°\cdot4$	$3\pi-227°\cdot08$
4	$4\pi-317°\cdot07$	$4\pi-310°\cdot07$

To this point we have only considered rays passing through a principal section of the drop; in nature, however, the rays impinge at every point of the surface facing the sun. It may be readily deduced that the directions of minimum deviation for a pencil of parallel rays lie on the surface of cones, the semi-vertical angles of which are equal to the values given in the above table. Thus, rays suffering one internal reflection will all lie within a cone of about 42°; in this direction the illumination will be most intense; within the cone the illumination will be fainter, while, outside of it, no light will be transmitted to the eye.

Fig. 2 represents sections of the drop and the cones containing the minimum deviation rays after 1, 2, 3 and 4 reflections; the order of the colours is shown by the letters R (red) and V (violet). It is apparent, therefore, that all drops transmitting intense light after one internal reflection to the eye will lie on the surfaces of cones having the eye for their common vertex, the line joining the eye to the sun for their axis, and their semi-vertical angles equal to about 41° for the violet rays and 43° for the red rays. The observer will, therefore, see a coloured band, about 2" in width, and coloured violet inside and red outside. Within the band, the illumination will be faint; outside the band there will be perceptible darkening until the second bow comes into view. Similarly, drops transmitting rays after two internal reflections will be situated on covertical and coaxial cones, of which the

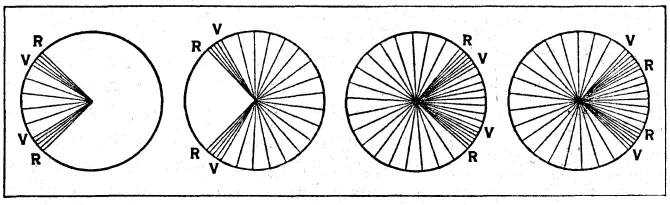

FIG. 2

semi-vertical angles are 51° for the red rays and 54° for the violet. Outside the cone of 54° there will be faint illumination; within it, no secondary rays will be transmitted to the eye. We thus see that the order of colours in the secondary bow is the reverse of that in the primary; the secondary is half as broad again (3°), and is much fainter, owing to the longer path of the ray in the drop, and the increased dispersion.

Similarly, the third, fourth and higher orders of bows may be investigated. The third and fourth bows are situated between the observer and the sun, and hence, to see them, the observer must face the sun when looking at the water drops which produce the bows. But the illumination of the bow is so weakened by the repeated reflections, and the light of the sun is generally so bright, that these bows are rarely, if ever, observed except in artificial rainbows. The same remarks apply to the fifth bow, which differs from the third and fourth in being situated in the same part of the sky as the primary and secondary bows, being just above the secondary.

Physical Theory.—Usually the most conspicuous colour in the principal rainbow is the red; but wide variations are noted from one bow to another not only in the brightness and purity of the different colours, but also in their angular width. This is not in accordance with the elementary theory, which would require all rainbows to be similar in the distribution of colours as well as in their relative intensity. The fuller treatment of the theory which is based on the undulatory theory of light will be found in Pernter-Exner's *Meteorologische Optik*, or in Humphreys' *Physics of the Air.* It can be shown that the phenomena depend in a very marked way on the size of the water drops, and that the width of the coloured bands increases as the size of the drop decreases. The elementary theory leads to the result that there is a direction of maximum illumination along the direction of minimum deviation, but the more detailed theory leads to the result that there are other directions along which there is considerable illumination. The subsidiary maxima account for the *spurious* bows, whose distance from the main bow is greater for small drops than for larger drops. The actual primary rainbow observed is thus the effect of the superposition of a number of bows. If the red of the second bow falls upon the green of the first, the result is to give a bow with an abnormally wide yellow band, since red and green lights when mixed form yellow. This is a very common type of bow, one showing mainly red and yellow, with little or no green or blue. If the drops are smaller the red of the second bow may fall within the blue of the first bow, so that we should then see a second bow (spurious bow) within the first. The phenomena are further complicated by the variation in the size of raindrops within the cloud. Since the smaller drops occur in the upper levels, the spurious bow is generally observable only near the top of the bow.

With very small drops, whose diameter is 0·1 mm. or less, the colours become superimposed, and the rainbow becomes almost a pure white. This type of rainbow, sometimes known as Ulloa's Ring or as a fog-bow, is only seen distinctly when the observer is very near the cloud which produces it.

The centre of a rainbow is at the same angular distance below the horizon as the sun is above the horizon. Rainbows can be formed by light coming from the reflection of sunlight in a water surface. The observer then sees more than a semicircle of this rainbow, the centre being above the horizon; and he will at the same time see the rainbow formed in the usual way by direct rays from the sun. The two rainbows intersect, and are commonly referred to as *intersecting rainbows.*

Rainbows can also be formed by moonlight, but the colours are then very faint, and difficult to distinguish.

The physical theory of rainbows is given in R. W. Wood's Optics; Preston's *Theory of Light;* Humphreys' *Physics of the Air;* and Pernter-Exner's *Meteorologiche Optik.* (D. Bru.)

RAINBOW TROUT (*Salmo irideus*): *see* **Trout.**

RAINER, ARCHDUKE OF AUSTRIA (1827–1913), was born on Jan. 11, 1827. His father, Rainer, the eighth son of the Emperor Leopold II. and of his consort Maria Luisa of Spain, was born in Florence in 1783, and from 1818–48 was viceroy of the kingdom of Lombardo-Venetia; his mother was the Princess Elizabeth, sister of Charles Albert, King of Sardinia. The Archduke was in 1857 placed at the head of the permanent Imperial Council organized in 1851, which stood immediately under the Emperor and had among its functions the preparation of laws, and his experience in this office convinced him that the transition to a constitutional form of government on a liberal and centralized basis was necessary. In 1860 he conducted the negotiations for a strengthened Imperial Council; in 1861 he was associated with the promulgation of the charter of the Constitution of Feb. 26, 1861, elaborated by the liberal Schmerling administration. In the same year he became curator of the Academy of Sciences. In 1865 he retired from public affairs. In 1872 he was appointed to the supreme command of the newly established Austrian *Landwehr,* to the organization of which he devoted many years. The archduke purchased the papyrus discovered at Fayum, which was called, after him, the "Rainer Papyrus." He married in 1852 Marie Caroline, daughter of the Archduke Charles, the victor of Aspern, but died childless on Feb. 27, 1913.

RAINFALL is produced when damp air rises, and cools as it expands. The ascent may be due to (a) simple convection due to surface heating, (b) the effect of upward sloping ground in causing the air motion to follow the slope, or (c) the action at a front, where a warm current is forced to ascend over a wedge of cold air. Most rain in middle latitudes is due to the third of these causes, but the amount of rainfall is increased where the air is forced to rise over ground. Heavy rain due to the forced ascent of damp air over high ground is most strongly exemplified by the rain of the south-west monsoon of India, and that of the western slopes of the Rocky mountains. The rainfall on the lee slopes of the mountains is very much less than that on the windward slopes. Similar, but less marked effects are shown by lower hills, such as the Pennine Range in Northern England.

Rainfall is slight in the central regions of the sub-tropical anticyclones, which are therefore the desert regions of the earth. In parts of the deserts no appreciable rain has ever been observed. Over most of Europe the annual rainfall exceeds 20 inches, while over most of Asia, excluding India, Tibet, and China, the annual rainfall is less than 20 inches, being less than 10 inches in a long tongue extending from Arabia across to N.E. Mongolia. The central regions of Australia, a part of S.W. Africa, and a small area of Arizona, U.S.A., also have less than 10 inches of rain in the year. Portions. of the West coast of Africa, between the equator and 10° N., a strip of the West coast of India, parts of Assam, and a coastal strip of Burma all have more than 100 inches of rain in the year.

The following are some of the heaviest rainfalls recorded within 24 hours:

Berlin, Apr. 14, 1902, 6·6in.; Alexandria, Dec. 9, 1888, 9·6in.; Bruton, England, June 28, 1917, 9·7in., Cherrapunji, June 14, 1876, 41·4in.; Baguio, Philippines, July 14–15, 1911, 46·7in.; Fiji, Aug. 8, 1906, 37·6in.

In still shorter periods, rainfall at heavier rates has been observed. Campo, U.S.A., Aug. 12, 1891, 11·7in. in 80 minutes. Rumania, July 7, 1889, 8·2in. in 20 minutes. Portobello, Panama, Nov. 29,1911, 2·5in. in 3 minutes. Norwich, England, July 14, 1917, 0·48 in. in 2 min. Kew observatory, 0·2 in. in 1 min.

Possibly the wettest part of the globe is Mount Waialeale in Hawaii, where the average annual rainfall, 1928–39, was 505 in. At Cherrapunji, Assam, the annual rainfall has averaged 428 in., while at Mavijuram, in Assam, 270 in. of rain fell in the month of August 1841. The average rainfall or rainfall plus snow melted to water of each month, and of the year, is given in the following table for some of the chief cities of the world, together with the average number of days in the year on which snow or measurable rain fell. where such data are available. Further data for other places will be found in any standard textbook on climatology, such as Kendrew's Climates *of* the *Continents* (Oxford, 1936).

	London	Paris	Berlin	Rome	Moscow	Tokyo	Bombay	New York	Capetown	Sydney
Jan.	1.9	1.5	1.5	3.2	1.1	2.2	0.1	3.3	0.7	3.7
Feb.	1.7	1.2	1.3	2.7	0.9	2.8	0.0	3.3	0.6	4.2
Mar.	1.8	1.6	1.7	2.9	1.2	4.4	0.1	3.4	0.9	4.8
Apr.	1.5	1.7	1.4	2.6	1.5	4.9	0.0	3.3		5.6
May	1.8	2.1	2.0	2.2	1.9	5.7	0.7	3.5	3.8	5.1
June	2.0	2.3	2.0	1.5	2.0	6.5	20.6	3.5	4.5	4.8
July		2.2	3.1	0.7	2.8	5.3	27.3	4.1	3.7	4.8
Aug.	2.2	2.2	2.2	1.0	2.9	5.7	16.0	4.3	3.4	3.0
Sept.	1.8	2.0	1.8	2.5	2.2	8.7	11.8	3.4	2.3	2.9
Oct.	2.6	2.3	1.8	5.0	1.4	7.4	2.4	3.4	1.6	3.2
Nov.	2.4	1.8	1.6	4.4	1.6	4.2	0.4	3.3	1.1	2.8
Dec.	2.4	1.7	1.7	3.9	1.5	2.1	0.0	3.3	0.8	2.9
Year	24.5	22.6	22.2	32.7	21.0	59.9	79.4	42.1	25.3	47.9
Days of rain	167	162	152	102		147		123	104	156
Days of snow	13	14	34	2		16		20	0	0

(D. Bru; X.)

RAINIER, MOUNT, a peak of the Cascade Range in Pierce county, Washington, about 60m. from Seattle, and 50m. from Tacoma. It is about 14,408ft. above sea-level, the third highest peak in the United States, excluding Alaska. Rainier, as are the other peaks of the Cascade Range, was built up by successive layers of material (chiefly andesite) thrown out of its crater. The volcano has long been extinct, but small craters still give forth steam and sulphurous fumes. Its base is set in the green of the wonderful Puget Sound forest and its snowy cone rises 10,000ft. Along its sides are 28 glaciers and a number of permanent ice-fields, the largest in the United States, which extend down the scarred slopes to the forests, below which they give rise to dashing streams. Beautiful sub-alpine wild-flower fields follow the receding snow in summer.

Mt. Rainier was first discovered by Vancouver, who, disregarding the Indian name "Tacoma," named the peak in honour of Rear Admiral Rainier of the British Navy. The first successful ascent was made in 1870 by Gen. Hazard Stevens and P. V. van Trump.

Mt. Rainier national park (325 sq.m. in area) was set aside by the U.S. Government to preserve the wild mountain scenery in its natural beauties and to make the mountain accessible to the public. Entrances to the park can be reached from Seattle or Tacoma in a few hours by automobile or railway.

See F. W. Schmoe, *Our Greatest Mountain; Mount Rainier* (1925); E. S. Meany, *Mount Rainier,* a *Record of Exploration* (1916); and *Information Circulars* issued by the US. Dept. of the Interior.

RAINIS, JÓZSEF, see Plieksans, Jan.

RAIN-PROOF FABRICS. Rain-proof fabrics can be divided into two general classes — apparel fabrics and non-apparel fabrics. Included in the first group are fabrics used in raincoats, slickers, umbrellas, etc. Among those in the second group are fabrics employed in making tents, tarpaulins and automobile tops. Rain-proof fabrics may be actually waterproof or merely water-repellent. Waterproof fabrics are impervious to water, the interstices or pores in the cloth being completely covered or filled by the waterproofing agent or sufficiently stopped up that water will not pass through them at the maximum pressure to which the fabric is exposed under conditions of use.

Water-repellent fabrics, on the other hand, are not impervious to water, the repellent effect being obtained not by closing or materially reducing the size of the interstices or pores, but by treating the cloth with a compound which increases the surface tension between the fibres and the mater and thus makes it more difficult for the water to penetrate into and through the fabric.

Thus, a raincoat made from a lightweight water-repellent fabric may withstand a light shower, but not a heavy, driving rain. The degree of water-repellency depends on the type and twist of yarn, weight and closeness of weave, and efficacy of the water-repellent compound.

In general, heavy, closely woven fabrics are more water-repellent than are light, loosely woven fabrics.

Other important applications of waterproof and water-repellent fabrics, in addition to those mentioned above, include shower-bath curtains, spot-proof table covers, and sheetings for hospital use. Fabrics which are both waterproof and chemical-resistant find use in such applications as protective clothing for workers engaged in the handling of chemicals.

Fabrics which are both waterproof and gasproof or air-tight are employed in the aeronautical industry and as a protection againstnoxiousgases.

Many different processes are employed for rendering fabrics waterproof or water-repellent. In general, truly waterproof fabrics are obtained by impregnating or coating the cloth with rubber, synthetic rubber, pyroxylin (cellulose nitrate solution), cellulose acetate, linseed oil, tar, or synthetic resins. Various degrees of water-repellency can be imparted to fabrics by treating them with such materials as aluminium acetate, paraffin wax emulsions, metallic soaps, cuprammonium solution, or quaternary ammonium compounds.

Raincoats are made from cotton, silk, rayon, or wool fabrics which have been rendered rain-proof or showerproof by any one of several processes. One of the earliest methods employed was that invented by Charles Macintosh, which made use of rubber as a waterproofing agent; raincoats made from cloth treated in this way were known as macintoshes. Oilskins are made by applying boiled linseed oil, together with a suitable drier and pigments to give the desired colour, to light- or medium-weight cotton fabrics. Silk fabrics treated in a similar manner, and known as oiled-silk fabrics, are being rapidly superseded for use as raincoats by silk or rayon fabrics which have been waterproofed by treatment with a vinyl resin lacquer or another synthetic resin. Another type of waterproof raincoating is made by rubberizing cotton fabrics.

Water-repellent fabrics employed for raincoats are usually made from cotton or wool. One of the best known methods is to treat the fabric in solution of aluminium acetate and then in a soap solution or an emulsion containing soap and paraffin or Japan wax. A newer method makes use of a water-repellent agent consisting essentially of a solution of aluminium acetate containing paraffin wax in colloidal dispersion.

A still newer process employs long-chain quaternary ammonium compounds that actually combine with the fibre to form a durable, water-repellent coating.

Mixtures of various materials are employed for coating canvas, duck, and other heavy cotton fabrics used for tents, tarpaulins, etc. Among these are included asphalt, paraffin, tar, beeswax, and lead oleate. An effective method for waterproofing cotton fabrics, which also renders the fabric mildew-resistant, makes use of cuprammonium solution.

Bibliography.—Herbert P. Pearson, *Waterproofing Textile Fabrics;* and S. Mierzinski, *The Waterproofing of Fabrics.* (W. W. Ch.)

RAIN-TREE (Pithecellobiurn saman), a tropical South American tree, so called from the fact that the ejection of juice by cicadas (*q.v.*) upon it causes it to appear to be always raining under its branches. *Andira inermis,* which belongs to the same family (Leguminosae), is also called rain-tree for the same reason.

RAIPUR, a town and district of British India in the Chhattisgarh division (*q.v.*) of the Central Provinces. The town is 188m. E. of Nagpur and has a station on the Bengal-Nagpur railway. There are ruins of an immense fort with many tanks and old temples. The town and civil station is situated on a red laterite plain and the climate is extremely hot. Besides the usual institutions at the headquarters of a division and district, there is the Rajkumar college, where the sons of the chiefs of Chhattisgarh, as well as of chiefs of Orissa, are educated under a European principal. The college also admits sons of the greater landholders.

The DISTRICT OF RAIPUR (area 9,717 sq.m.; pop. [1931], 1,527,573) occupies the south and centre of the Chhattisgarh rice plain (*see* CHHATTISGARH, DIVISION). The district is traversed by the Bengal-Nagpur railway from Bombay to Calcutta, and numerous roads were constructed in the famines. Raipur will now shortly be connected by rail with Vizianagram on the east coast section of the Bengal-Nagpur railway and from there with the port of Vizagapatam.

RAIS (or RETZ), **GILLES** DE (1404–1440), marshal of France, the central figure of a 15th-century *cause célèbre,* was the son of Guy de Montmorency-Laval, the adopted son and heir of Jeanne de Rais, and of Marie de Craon. He was born at Machecoul in September or October 1404, and was brought up by his grandfather, Jean de Craon. Chief among his great possessions was the barony of Rais (erected in the 16th century into the peerage-duchy of Retz), south of the Loire, on the marches of Brittany. He joined the Montforts, supporting Jean V. of Brittany against the house of Penthikvre. He helped to release Duke John from Olivier de Blois, count of Penthibvre, and was rewarded by extensive grants of land, subsequently commuted by the Breton parliament for money payments. In 1420 he married Katherine of Thouars, a great heiress in Brittany, La Vendée and Poitou. In 1426 he raised seven companies of men-at-arms, and began active warfare against the English under Artus de Richemont. He accompanied Joan of Arc to Orleans, fighting by her side at Orleans, and afterwards at Jargeau and Patay. He had advocated further measures against the English on the Loire before carrying out the coronation of Charles VII. at Reims. On July 17 he was made marshal of France at Reims. In the winter he was in Normandy at Louviers whether with a view to the release of Joan, then a prisoner at Rouen, cannot be stated. He expended great sums in the king's service and maintained a court more suited to royal than baronial rank. He was a munificent patron of literature and of music, and his library contained many valuable works, he himself being a skilled illuminator and binder. At the chief festivals he gave performances of mysteries and moralities, and it has been asserted that the *Mystkre de* la *Passion,* acted at Angers in 1420, was staged by him in honour of his own marriage. The original draft of the *Mystery* of *Orleans* was probably written under his direction. In his financial difficulties he began to alienate his lands, selling his estates for small sums, providing his heirs with material for many lawsuits. Among those who profited by his prodigality were the duke of Brittany, and his chancellor, Jean de Malestroit, bishop of Nantes, but in 1436 his kinsfolk appealed to Charles VII., who proclaimed further sales to be illegal. Jean V. refused to acknowledge the king's right to promulgate a decree of this kind in Brittany, and replied by making Gilles de Rais lieutenant of Brittany and by acknowledging him as a brother-in-arms.

Gilles hoped to redeem his fortunes by alchemy, and also spent large sums on necromancers, seeking to guarantee himself from evil consequences by extravagant charity and a splendid celebration of the rites of the church. The abominable practices of which he was really guilty seem to have escaped the notice of his equals or superiors, though suspected by the peasantry. His wife left him in 1434–35; and when his brother René de la Suze seized Champtocé, family considerations no doubt imposed silence. His servants kidnapped children, generally boys, whom he tortured and murdered. The number of his victims was stated in the ecclesiastical trial to have been 140. In 1440 he came into conflict with the church by an act of violence which involved sacrilege and infringement of clerical immunity, and in the autumn he was arrested and cited before the bishop of Nantes on various charges, the chief of which were heresy and murder. With the latter count the ecclesiastical court was incompetent to deal, and Gilles refused to accept its jurisdiction (Oet. 8). Terrified by excommunication, however, he secured absolution by confession.

A parallel inquiry was made by Pierre de l'Hôpital, president of the Breton parliament, by whose sentence he was hanged (not burned alive as is sometimes stated), on Oct. 26, 1440, with two of his accomplices. In view of his confessions his guilt seems certain, but the irregularities of the proceedings, the fact that his chief accomplices went unpunished, taken together with the financial interest of Jean V. in his ruin, have left a certain mystery over a trial, which, with the exception of the process of Joan of Arc, was the most famous in 15th-century France. His name is connected with the tale of Bluebeard (*q.v.*) in local tradition at Machecoul, Tiffauges, Pornic and Chéméré. The records of the trial are preserved in the Bibliothkque Nationale in Paris, at Nantes and elsewhere.

RAISIN, the name given to the dried fruits of certain varieties of the grape vine, which grow principally in the warm climate of central California and the Mediterranean coasts. Leading countries of production are the United States, Turkey, Australia, Persia, Greece, and Spain. Dried grapes, or raisins, are rich in fruit sugar, which acts as a natural preservative of the product, and are of great antiquity as a human food (Num. vi. 3; I Sam. xxv. 18). "Raisins of the sun" are obtained by letting the fruit remain on the vines after it has come to maturity, where there is sufficient sunshine and heat in the autumn, till the clusters dry on the stalks. The more usual process, however, is to cut the fully ripened clusters and expose them, spread out, for several days in the rays of the sun. In unfavourable weather, they may be dried in a heated chamber, but are then inferior in quality. Sun-drying may be hastened by first dipping the grapes in a soda or lye bath to puncture the skin, but this process is not generally followed in growing areas that afford a drying season free from rainfall, such as the interior valleys of California. Some varieties are dried and retained on their stems and sent into the market as clusters for table use; but the greater part are separated from their stems in the process of drying and cleaning.

Raisins are of three types: (1) large seeded raisins made from the Muscat of Alexandria variety of grape, or Gordo Blanco, called Malagas in general world commerce and muscats in California; (2) small seedless raisins made from the Sultanina grape, called sultanas in most parts of Europe and Thompson seedless in California; (3) very small seedless raisins made from a black grape known in most countries as the Black Corinth. In commerce they appear as Zante currants or Greek currants. There are also miscellaneous varieties of grapes dried in some countries, especially in those bordering on the eastern end of the Mediterranean, which are inferior as raisins and are termed "dried grapes."

Malaga type raisins of commerce come chiefly from the provinces of Malaga, Valencia, and Alicante, in Spain, and from California and Australia. The variety grown in California, called the muscat, is sweet and extensively used in desserts. It is packed for household purposes by the removal of seeds by automatic machinery, and so processed that the raisins can be separated easily as they come from the box.

Sultana type raisins are cultivated extensively in California, Smyrna, and Australia. Those grown in Smyrna are soda-dipped in the curing process, having a golden-yellow colour, and a thin, translucent skin. Those grown in Australia are also usually dipped in the curing process; but those grown in California are exclusively sun-dried except for a limited quantity intended principally for certain portions of the export market. Zante currants are grown in small quantities in a number of countries, but the principal world supply comes from Greece and Australia.

After 1918, world demand for raisins shifted from seeded to seedless varieties. Seedless varieties are successfully cultivated in California and in Australia, and the United States and Australia are large exporters. Practically all of the raisins grown in the United States are produced in the San Joaquin valley of California within a radius of roo mi. of the city of Fresno. Approximately 10.000 growers are engaged in the production of raisins in this district and the processing of these raisins centres in Fresno, where there is the largest dried fruit plant in the world. (W.N.K.)

RAJAH, a Hindu title for a chief, or prince, derived from the same root as the Latin *rex.* Other forms are rao, rana and rawal, while chiefs of high rank are styled maharaja, maharao and maharana. The Hindustani form is rai, and the title of the Hindu emperor of Vijayanagar in South India was raya.

RAJAHMUNDRY, a town of British India, in the Godavari district of Madras. Pop. (1931) 63,526. It is a growing place on the left bank of the river Godavari, at the head of the delta, 360 m. N. of Madras, and has a station on the East Coast railway, which is here carried across the river by a bridge of 56 spans.

Tradition divides the merit of founding Rajahmundry between the Orissa and Chalukya princes. In 1470 it was wrested from Orissa by the Mohammedans, but early in the 16th century it was retaken by Krishna Raja. It continued under Hindu rule till 1572, when it yielded to the Mohammedans of the Deccan under Rafat Khan. It passed into the possession of the French in 1753, but they were driven out by the British in 1758.

RAJASTHANI LANGUAGE, the language of Rājasthān of Rajputana, an Indo-Aryan vernacular closely related to Gujarati (*q.v.*). It is spoken in Rajputana and the adjoining parts of central India, and has several dialects, the principal of which are Jaipuri, Mārwāṛī, Mēwātī and Mālvī. Hāṛautī, an important variety of Jaipuri, is spoken in the states of Kota and Bundi.

See vol. *IX.* of the ***Linguistic Survey of India*** for a full account, *s.v.* GUJARATI.

RAJGARH, an Indian State in the Bhopal agency of central India. Area, 962 sq. miles. Pop. (1931), 134,891. The chief, who has the title of rajah and a salute of 11 guns, is a Rajput of the Ponwar clan. This State and Narsingarh were the result of a partition in the 17th century. It afterwards became tributary to Scindia, but fell under the general settlement of Malwa in 1818. The town of Rajgarh had a population of 6,759 in 1931.

RAJGIR HILLS, a range of hills in British India, in the south of the Patna district of Behar and Orissa. They form part of a range, extending N.E. from near Bodh-Gaya for 40 miles, and at one place rise to 1,472 ft, but elsewhere seldom exceed 1,000 ft. in height. The hills in Patna district consist of two parallel ridges. In the valley between, south of the village of Rajgir, was built the old city of Rajagriha, "the royal residence." Legend ascribes it to Jarasandha, king of Magadha (south Behar), who had his capital at Giribraja, "the city of hills." The outer fortifications can be traced on the crests of the hills over a distance of more than 25 miles; they are 17½ ft. thick, built of massive undressed stones without mortar. According to Sir John Marshall, we can assign these ruins only to "some uncertain age before the dawn of history and rank them, as their stupendousness entitles them to be ranked, among the greatest wonders which primeval man has bequeathed to us." The remains of New Rajagriha, the reputed capital of Bimbisara (*c.* 520–490 B.C.), lie two-thirds of a mile N. of the valley.

The Rajgir hills are associated with the life of Buddha, who often taught here. Chhatagiri is the old Gridhrakuta, or vulture's peak, which was one of his favourite resorts. One of the towers on the Baibhar hill (Vaibhargiri) has been identified as the Pipara stone house in which Buddha lived. The Sattapanni, the cave in which after his death the council of his disciples was held to record the tenets of the faith, has been identified with different sites on this hill and with the Soubhandar cave at its foot: the latter is now believed to have been excavated by Jains in the 3rd or 4th century A.D. A brick mound, topped by a Jain shrine, stands in the centre of the valley. Rajgir is a place of pilgrimage. There are modern Jain temples built on the hills round the valley. There are also hot springs in the valleys surrounded by Hindu shrines.

See M. A. Stein, "Notes on an Archaeological Tour in South Bihar and Hazaribagh," ***Indian Antiquary,*** 1901; Sir J. Marshall, "Rajagriha and its Remains," ***Report Arch. Surv. India,*** 1905–06; V. H. Jackson, "Notes on old Rajagriha," ***Report Arch. Surv. India,*** 1913–14; ***District Gazetteer of Patna*** (Patna, 1924).

RAJKOT, a town in India, capital of a native state, the western India States Agency, in Bombay, and headquarters of the western division of the political agent of Kathiawar. Pop. (1931) 47 485. It is situated in the middle of the peninsula of Kathiawar, is the centre of the railway system, and a civil and military station. The town contains the Rajkumar college, for the education of the sons of princes, on the lines of an English public school, two hospitals, a library and museum. It is the chief educational centre of Kathiawar. In the civil station are the Jubilee gardens and Memorial institute. There are waterworks for the civil station and irrigation works for the town. The state of Rajkot has an area of 282 sq.m. Pop. (1931) 75,540.

RAJMAHAL, a former capital of Bengal, India, now a village in the district of the Santal Parganas, situated on the right bank of the Ganges, where that river makes a turn to the south. Pop. (1921), 3,454. It was chosen for his capital by Man Singh, Akbar's governor, in 1595–96, but in 1608 the seat of government was transferred to Dacca. It was again made the seat of government by prince Shah Shuja in 1639, and was a second time superseded by Dacca 20 years later. Even in 1665 Manucci found that it had fallen into ruin, being full of dilapidated palaces, great fallen mansions and neglected gardens. A pavilion called the Sangi Dalan is all that survives of Shah Shuja's palace. Rajmahal has given its name to a range of hills, comprising an area of some 2,000 sq.m. which rise to a height of about 2,000 feet. They are inhabited by an aboriginal race known as Maler (the Malli of Megasthenes) or Sauria Paharias, *i.e.,* "hill-men." The approach to their villages often consists merely of great boulders piled one upon another. The valleys are inhabited and cultivated by the Santals, a different aboriginal race, who have immigrated in large numbers.

RAJPIPLA, a native state of India, in the Rewa Kantha agency, Bombay, occupying a hilly tract between the rivers Narbada and Tapti; area, 1,518 sq.m. Pop. (1931) 206,114; tribute (to Gaekwar of Baroda), £3,300. The chief, whose title is maharana, is a Gohel Rajput, of the same family as the thakor sahib of Bhavnagar. The soil is fertile, cotton being the chief crop, and there are teak forests in the hills. A light railway, constructed at the cost of the state, connects Nandod with Anklesvar in Broach district. The old fort of Rajpipla, in the hills, is now deserted. The modern capital is Nandod, situated on the river Karjan, 32 m. from Surat. Pop. (1931) 13,302.

RAJPUT, the generic term for a number of castes, which gives Rājpūtāna (*q.v.*) its name, and is widely spread over the rest of northern India. Claiming to have replaced the ancient Kshattriyas (*q.v.*), the Rajputs are a dominant, fighting, landowning class. Of Indo-Aryan type, they have been also recruited from earlier ethnic elements which rose to power and from invading races, notably the Huns. As a body they are physically robust, brave and chivalrous, cherishing the feudal spirit and traditions. Pride of birth makes them punctilious in questions of honour, but poor cultivators when in reduced circumstances. They still hold somewhat aloof from the civil professions, regarding military service as their proper *métier.* Rājpūt history is a bardic adaptation of myth to courtly adulation. It asserts that to their two original races, the Solar and the Lunar, were added four, the Agnikula, "Fire-sprung," purified by Brahmans in the great agnikunda, "fire-pit" on Mt. Abu to fight the Daityas, "Titans." Being interpreted, this must mean that the four clans were Brahmanised, or Hinduised, to suppress some anti-Brahmanical people or foreign foes. The four were the Chalukya, modern Solanki, a Sanskritized patronymic of Chalkya, a dynasty in the Deccan, but immigrant from Kashmir and probably Gurjara by race: the Pratihāra, now Parihār, "durward," known to be Gurjaras: the Pramāra, now Panwār; and Chāhamāna, now Chauhān. These became eponyms of leading Rājpūt tribes, and the legend traced their origin to Rudra, Brahma, Indra and Vishnu. Folketymology also derived Chāhamāna from Chatur-

BY COURTESY OF DR. COOMARASWAMY
A RAJPUT PEASANT

bhuja, "four-armed." From these, by some incoherent process, were derived 36 "royal races," never the same in any two versions of their names, but in some including the Jāt, Hun, Ahir and Bar-Giijar clans. To these must be added clans like Chandēl, doubtless of Gond origin. Below them were ranged the 84 mercantile tribes, chiefly of Rājpūt origin, in whom we may see the Bhātias and recall the ancient Vaisyas.

RAJPUTANA, a collection of Indian states, under the political charge of an agent to the governor-general. It lies between 23" and 30° N. and between 69° 30' and 75° 15′ E., and includes 18 states, 2 chiefships and the small estate of Lawa. For political purposes the agent to the governor-general, with his headquarters at Ajmere and Mount Abu, is himself in charge of Sirohi and Bikaner. Then there are three residencies and four agencies. These are as follows: (1) Mewar residency, with headquarters at Udaipur, comprising the state of Udaipur (Mewar); (2) Jaipur residency, with headquarters at Jaipur, comprising the states of Jaipur and Kishangarh, with the estate of Lawa; (3) Western Rajputana states residency, with headquarters at Jodhpur, comprising the states of Jodhpur and Jaisalmer; (4) Eastern Rajputana states agency, with headquarters at Bharatpur, comprising the states of Alwar, Bharatpur, Dholpur, and Karauli; (5) Haraoti-Tonk agency, with headquarters at Dcoli, comprising the states of Tonk and Bundi, with the estate of Shahpura; (6) Kotah agency, with headquarters at Kotah, comprising the states of Kotah and Jhalawar; and (7) Southern Rajputana states agency, comprising Dungarpur, Banswara, Partabgarh and Kushalgarh. All of these states are under Rajput rulers, except Tonk, which is Mohammedan, and Bharatpur and Dholpur, which are Jat. The small British province of Ajmere-Merwara is also included within the geographical area of Rajputana.

Physical Features.—The total area of Rajputana is about 129,059 sq.m. It is bounded on the west by Sind, and on the north-west by the Punjab state of Bahawalpur. Thence its northern and north-eastern frontier marches with the Punjab and the United Provinces until it touches the river Chambal, where it turns south-eastward for about 200 m. The southern boundary runs in a very irregular line across the central region of India. The Aravalli range of mountains intersects the country in a line running from south-west to north-east. About three-fifths of Rajputana lies north-west of the range, and comprises the states of Bikaner, Jaisalmer and Jodhpur. With the exception of the districts of Jodhpur which lie immediately below the Aravallis, this division is sandy, ill-watered and unproductive, improving gradually from a desert in the north-west and west to comparatively fertile land in the east. The country to the east and south-east of the Aravallis is blessed with fertile lands, hill-ranges and long stretches of forest, where fuel and fodder are abundant.

The chief rivers are the Luni, the Chambal and the Banas. The Chambal rises in the highlands of the Vindhyas, anddischarges itself into the Jumna after a course of 560 m. There are several important artificial lakes, constructed for storing water. The only basin of any extent is the Sambhar salt lake, of about 50 m. in circuit.

Geology.—Geologically considered, the country may be divided into three regions—the central, and largest, comprising the whole width of the Aravalli system, formed of very old sub-metamorphic and gneissic rocks; an eastern region, with sharply defined boundary, along which the most ancient formations are abruptly replaced by the great basin of the Vindhyan strata, or are overlaid by the still more extensive spread of the Deccan trap, forming the plateau of Malwa; and a western region, of very ill-defined margin, in which, besides some rocks of undetermined age, it is more or less known or suspected that Tertiary and Secondary strata stretch across from Sind, beneath the sands of the desert, towards the flanks of the Aravallis. Rajputana produces a variety of metals. Ore of cobalt and zinc blende are peculiar to it. Copper and lead are found in several parts of the Aravalli range and of the minor ridges in Alwar and Shaikhawati, and iron ores abound in several states. Alum and blue vitriol (sulphate of copper) are manufactured from decomposed schists at Khetri in Shaikhawati.

Climate.--The climate throughout Rajputana is very dry and hot during the summer; while in the winter it is much colder in the north than in the lower districts, with hard frost and ice on the Bikaner borders. The rainfall is very unequally distributed: but on the whole Rajputana is reckoned one of the healthiest countries in India.

Population.—In 1931 the population was 11,225,712. The territory is called Rajputana because it is politically possessed by Rajputs. The whole number of this race is only 620,229, and nowhere do they form a majority of the whole population in a state; but they are strongest, numerically, in the northern states and in Udaipur. The Brahmans rank first; with them may be classed the Bhats, the keepers of secular tradition and of the genealogies. Next come the mercantile castes, mostly belonging to the Jain sect; these are followed by the powerful cultivating tribes, such as the Jats and Gujars, and then come the so-called aboriginal tribes, chief of whom are the Minas, Bhils and Meos. Rajasthani is the chief language of the country, one or other of its dialects being spoken by more than 70% of the total population.

BY COURTESY OF DR. COOMARASWAMY

MOHAMMEDAN WOMEN OF RAJPUTANA TERRITORY CARRYING WATER JARS ON THEIR HEADS

The mass of the people are occupied in agriculture. The chief manufactures are cotton and woollen goods, carvings in ivory and working in metals, etc., all of which handicrafts are chiefly carried on in the eastern states. The system of agriculture is very simple; in the country west of the Aravallis only one crop is raised in the year, while in other parts south and east of the Aravallis two crops are raised annually, and various kinds of cereals, pulses and fibres are grown. Jaipur had 144,179 pop.

History.—Previous to the invasion of Upper India by the Mohammedans, Rajputana was subject for the most part to two or three powerful tribal dynasties. Chief of these were the Rahtors, who ruled at Kanauj; the Chauhans of Ajmere; the Solankis of Anhilwara, in Gujarat; the Gehlots with the Sisodhyia sept, still in Mewar or Udaipur; and the Kachwaha clan, still in Jaipur. These tribal dynasties of Rajputs were gradually supplanted by the Moslem invaders of the 11th century and weakened by internal feuds. The clans were finally either conquered, overawed or conciliated by Akbar—all except the distant Sisodhyia clan, which, however, submitted to Jehangir in 1616. The Mahrattas, having been called in by the Rahtors to aid them, took possession of Ajmere about 1756; thenceforward Rajputana became involved in the general disorganization of India. By the end of the century nearly the whole of Rajputana had been virtually subdued by the Mahrattas. On the outbreak of the Pindari War in 1817 the British government offered its protection. The Pindaris were put down, Amir Khan submitting and signing a treaty which constituted him the first ruler of the existing state of Tonk. By the end of 1818 similar treaties had been executed by the other Rajput states with the paramount power. Since then the political history of Rajputana has been comparatively uneventful. The great storm of the Mutiny of 1857, though dangerous while it lasted, was short, as most of the rajas remained loyal.

Rajputana is of great archaeological interest, possessing some fine religious buildings in ruins and others in excellent preservation Among the latter are the mosques at Ajmere and the temples on Abu. But the most characteristic features of architecture in the country are shown in the forts and palaces of the chiefs.

RAJSHAHI, a district and division of British India. in the Province of Bengal. The administrative headquarters are at Rampur Boalia. Area 2,609 sq.m.; pop. (1931) 1,429,013. Rajshahi comprises an alluvial plain seamed with old river-beds and studded with marshes, but on the north and west a slightly elevated country is found in the Barind Rice is the staple crop, with pulses, oilseeds and jute. Indigo has disappeared and the silk industry is moribund. The hemp grown on a small tract in the north of the district supplies all the *ganja* that is consumed in Bengal. The district is traversed from south to north by the main line of the Eastern Bengal state railway.

The DIVISION OF RAJSHAHI is coextensive with northern Bengal, from the Ganges to the mountains It comprises the eight districts of Rajshahi, Dinajpur, Jalpaiguri, Malda, Darjeeling, Rangpur, Bogra and Pabna. Total area, 19,163 sq. miles. Pop. (1931) 10,668,066.

RÁKÓCZY, the name of a noble Hungarian family, which in the 10th century was settled in the county of Zemplén, members of which played an important part in the history of Hungary during the 17th century.

GEORGE I., prince of Transylvania (1591–1648), who began his career as governor of Onod, was the youngest son of Sigismund Rákóczy (1544–1608), who was for a short time prince of Transylvania. He took a leading part in the rebellion of Bethlen Garbo, who made him commandant of Kassa, and was elected prince of Transylvania by the diet of Segesvár on Nov 26, 1630. He followed Bethlen's national Hungarian policy, allied himself with Gustavus Adolphus of Sweden and on Feb 2, 1644, with the consent of the Pope, declared war on the Emperor Ferdinand III., drove him out of most of Hungary, and forced him to conclude the Peace of Linz (Sept. 16, 1645), which accorded full religious liberty to the Magyars, and ceded to Rákóczy the fortress of Regéc and the Tokaj district. On the death of Wladislaus IV. (1648) Rákóczy aimed at the Polish throne also, but died before he could accomplish his design. His capital, Gyula Fehérvár, was a great Protestant resort and asylum.

See Sándor Szilagyi, ***The Rdkdczy Family in the 18th Century*** (Hung) (Pest, 1861).

GEORGE II., prince of Transylvania (1621–1660), was the eldest son of George I. and Susannah Lorántffy. He was elected prince of Transylvania during his father's lifetime (Feb. 19, 1642), and married (Feb 3, 1643), Sophia Báthory. On ascending the throne (Oct. 11, 1648), he hoped to realize his father's Polish ambitions, and he allied himself, in 1649, with the Cossack hetman, Bogdan Chmielnicki, and the hospodars of Moldavia and Wallachia In 1657, as the ally of Gustavus Adolphus, he led his allies against the Polish king, John Casimir, took Cracow and entered Warsaw with the Swedes; but the moment his allies withdrew the whole scheme collapsed, and it was only on the most humiliating terms that the Poles finally allowed him to return to Transylvania. Here (Nov. 3, 1657) the diet, at the command of the Porte, deposed him for undertaking an unauthorized war, but in January 1658 he was reinstated by the Medgyes Diet. Again he was deposed by the grand vizier, and again reinstated. The Turks again invaded Transylvania, and Rákóczy died at Nagyvárad of the wounds received at the battle of Gyula (May 1660).

See ***Imre*** Bethlen, ***Life and Times of George Rákóczy II.*** (Hung.) (Nagy-Enyed, 1829); ***Life*** (Hung.) in SQndor Szilagyi's ***Hungarian Historical Biographies*** (Budapest, 1891).

FRANCIS I., prince of Transylvania (1645–1676), was the only son of George Rákóczy II. and Sophia Báthory. He was elected prince of Transylvania during his father's lifetime (Feb. 18, 1652), but lost both crown and father at the same time, and withdrew to the family estates, where, at Patak and Makovica, he kept a splendid court. His mother converted him to Catholicism, and on March 1, 1666 he married Helen Zrinyi. In 1670 he was implicated in the Zrinyi-Frangepán conspiracy, and only saved his life by the interposition of the Jesuits on the payment of an enormous ransom.

See Sándor Szilagyi, ***The Rdkdczy Family in the 17th Century*** (Hung.) (Pest, 1861).

FRANCIS II., prince of Transylvania (1676–1735), was born at Borsi, Zemplén, on March 2, 1676. Having lost his father during infancy, he was educated under the guardianship of his mother, Helen Zrinyi, in an ultra-patriotic Magyar environment, though the Emperor Leopold I. claimed a share in his tutelage. In 1682 his mother married Imre Thokoly, through whose speculations Rákóczy lost the greater part of his estates. As a child of eleven he witnessed the heroic defence by his mother of his ancestral castle of Munkács against Count Antonio Caraffa (d 1693). On its surrender (Jan. 7, 1688) the child was transferred to Vienna that he might be isolated from the Hungarian nation and brought up as an Austrian magnate Cardinal Kollonics, the sworn enemy of Magyar separatism, now became his governor, and sent him to the Jesuit college at Neuhaus in Bohemia. In 1690 he completed his course at Prague, and in 1694 he married Maria Amelia of Hesse-Rheinfels, and lived for the next few years on his Hungarian estates. Rákóczy's birth, rank, wealth and brilliant qualities made him the natural leader of the Magyar nation. On the eve of the war of the Spanish Succession Rákóczy, with some other magnates, entered into correspondence with Louis XIV. for assistance through one Longueval, a Belgian general in the Austrian service. Longueval betrayed his trust, and Rákóczy was arrested and imprisoned at Eperjes. His wife saved him from certain death by enabling him to escape to Poland in the uniform of a dragoon officer. On June 18, 1703 he openly took up arms against the emperor; but the Magyar gentry stood aloof, and his ill-supported peasant levies (the Kuruczes) were repeatedly scattered. He had, indeed, some initial success; but the battle of Blenheim made any direct help from France impossible, and on June 13, 1704 his little army of 7,000 men was routed by the imperialists at Koronco and subsequently at Nagyszombat Want of arms, money, native officers and infantry, made, indeed, any permanent success in the open field impossible; yet he drilled his army into some degree of efficiency, and even after the rout of Pudmerics (Aug. 11, 1705), disposed of 100,000 men.

Rákóczy, who had already been elected Prince of Transylvania (July 6, 1704), now surrounded himself with a council of state of 24 members. But his efforts to secure toleration for his Calvinist followers alienated the pope, who dissuaded Louis XIV. from assisting him. Peace negotiations with the emperor during 1705 came to nothing, the latter refusing to acknowledge the independence of Transylvania, while France would not recognize the rebels officially till they had formally proclaimed the deposition of the Habsburgs, which last desperate measure was actually accomplished by the Onod diet on June 13, 1707. This measure, however, alienated both the emperor's foreign allies and the majority of the Magyar gentry, while, after all, Louis XIV sent no effective help. On Aug. 3, 1708 Rákóczy was heavily defeated at Trencsen (Trenčin), and again at Romhány (Jan. 22, 1710). A desperate effort to secure the help of Peter the Great also failing, Rákóczy quitted his country for ever on Feb. 21, 1711, refusing to accept the general amnesty conceded after the peace of Szatmár. (See HUNGARY, *History*) He lived for a time in France on the bounty of Louis XIV, finally entering the Carmelite Order. In 1717, with forty comrades, he volunteered to assist the Turks against the Austrians, but his services were not utilized. He lived for the rest of his life at Rodostó, where he died on April 8, 1735.

See ***Autobiography*** of ***Prince Francis Rdkdczy*** (Hung.) (Miskolcz, 1903); E Jurkovich, ***The Liberation*** Wars ***of Prince Francis Rdkdczy***

(Hung.) (Beszterczebánya, 1903); S. Endrödi, *Kurucz Notes, 1700–1720* (Hung.) (Budapest, 1897).

RAKOVSKY, CHRISTIAN GEORGIEVICH (1873–), Russian politician and diplomat, of Bulgarian descent and Rumanian nationality, was born on Aug. 13, 1873 at Kotel, Bulgaria. His father's home in the Dobruja passed after the Russo-Turkish war to Rumania, and the family became Rumanian. Rakovsky's Bulgarian ancestors, especially his grandfather, had organized risings against the Turkish rule, and the revolutionary traditions of the family were revived in Christian Rakovsky. In 1890 on account of his socialist activities all appointments in Bulgarian schools were closed to him. He therefore went to Geneva, where he joined the international social democratic student movement, and came in contact with Plekhanov and other Russian social democrats; and also to Germany, where he met Liebknecht. He was expelled from Prussia in 1894; went to France, where he graduated as a doctor of medicine at Montpellier, and wrote his thesis on *The Etiology of Criminality and Degeneration* (1897). Returning to Bulgaria, he recommenced revolutionary activities, and in *Russia in the East* (1898) denounced Tsarist politics. In 1900 he served as an officer in the Rumanian army. During the peasant riots of 1907 he was expelled from Rumania, his title to Rumanian citizenship not being considered adequate, and his civil rights were only restored in 1912. The five years of Rakovsky's exile were interrupted by illicit homecomings and consequent labour troubles.

After Rumania entered the World War Rakovsky was arrested and imprisoned in various places, and finally at Jassy, whence he was released by the Russians on May 1, 1917. After the Soviets came into power in November he became a member of the central executive committee of the Union, and in 1919 he became a member of the central committee of the Communist party. Rakovsky was well known as a writer on political and economic subjects under the pen name of "Insarov," and a number of his books were written and published in Russia *(Modern France,* 1900; *Metternich and His Time,* etc.).

Rakovsky's diplomatic career began with his appointment as head of the delegation entrusted with the peace negotiations with the Ukrainian central rada. In 1919 he was appointed president of the soviet of people's commissars of the Ukraine, and in 1922 represented Russia at the conference of Genoa. In 1924 he was the Soviet chargé d'affaires in London. and in 1926–27 he was Soviet ambassador to France. His support of Trotsky led, in 1928, to his expulsion from the Communist party and exile to Stalingrad. He was re-admitted in 1934, and was a departmental chief in the Commissariat of Health until 1937, when he was dismissed. He was among the 21 members of the "Right Trotskyist bloc" arrested in Feb. and tried in March 1938. Rakovsky was sentenced to 20 years' imprisonment.

RALEIGH, SIR WALTER (c. 1552–1618), British explorer, was born about 1552, the son of Walter Raleigh, of Fardell, and Catherine, daughter of Sir Philip Champernown of Modbury. He was born at the farmhouse of Hayes near Budleigh Salterton Bay. In 1568 he was entered as a commoner of Oriel College, Oxford. In 1569 he followed his cousin Henry Champernown, who took over a body of English volunteers to serve with the French Huguenots and was perhaps present at the battle of Jarnac (Mar. 13, 1569) Nothing is known with certainty of his life until February, 1575, when he was resident in the Temple. In June 1578 his half-brother Sir Humphrey Gilbert obtained a patent for six years authorizing him to take possession of "any remote barbarous and heathen lands not possessed by any Christian prince or people." During 1578 Gilbert led a piratical expedition against the Spaniards. Raleigh accompanied his half-brother as captain of the "Falcon," and was perhaps with him in an unsuccessful voyage in 1579. In 1580 Raleigh was twice arrested for duels, and he attached himself to the earl of Leicester, and to the earl of Oxford. Late in 1580 he was serving as captain of a company of foot in Munster. He took an active part in suppressing the rebellion of the Desmonds; he advocated a ruthless policy against the Irish, and recommended assassination as a means of getting rid of their leaders.

In December 1581 he was sent home with despatches and his great fortune dates from his arrival at court, where he was already known through his correspondence with Walsingham. He had corresponded with Walsingham for some time. It is possible that Raleigh did throw his mantle on the ground to help the queen to walk dry-shod over a puddle, and that he scribbled verses with a diamond on a pane of glass to attract her attention. His tall and handsome person, his caressing manners and his quick wit certainly pleased the queen, and the stories in Sir Robert Naunton's *Fragmenta Regalia* and in Fuller's *Worthies* represent at least the mythical truth as to his rise into favour. The rewards showered on him were out of all proportion to his services in Ireland. In February 1583 he accompanied the duke of Anjou to Flanders. In 1583 he received the grant of Durham House, Strand, and in the same year the queen's influence secured him two beneficial leases from All Souls, Oxford, which he sold to his advantage, and a patent to grant licences to "vintners" — that is, tavern keepers, which he subleased. In 1584 he had a licence for exporting woollen cloths. He was knighted in 1584. In 1585 he succeeded the earl of Bedford as Warden of the Stannaries. Raleigh made a good use of his new powers in the mining districts of the west. He reduced the old customs to order, and showed himself fair to the workers. In 1586 he was given 40,000 acres of the forfeited lands of the Desmonds, on the Blackwater in Ireland. He planted English settlers, and introduced the potato and tobacco. In 1587 he received a grant of part of Babington's forfeited land.

Raleigh was now at the height of his favour; Queen Elizabeth always had several favourites at once, lest any one might be supposed to influence her. She treated Raleigh exclusively as a court favourite, but never gave him any great office, nor admitted him to the council. Even his post of captain of the Guard, given in 1587, was mainly ornamental. The patent given to his half-brother Sir Humphrey Gilbert ran out in 1584. To avert this loss Raleigh, partly out of his own pocket, provided the means for the expedition to Newfoundland in 1583, in which Gilbert died. The patent was renewed in Raleigh's favour in March 1584.

Raleigh now began the series of ventures in the colonization of Virginia. His patent gave him and his heirs the proprietary right over all territory they occupied on payment of one-fifth of the produce of all mines of precious metals to the crown. In April 1584 Raleigh sent out two captains, Philip Amadas and Arthur Barlowe, on a voyage of exploration. They sailed by the Canaries to Florida, and followed the coast of North America as far as the inlet between Albemarle and Pamlico sounds in modern North Carolina. The name of Virginia was given to a vast and undefined territory, but none of Raleigh's captains or settlers reached the state of Virginia. In the same year he became M.P. for Devonshire. His first body of settlers, sent out in 1585 under Sir Richard Grenville, landed on what is now Roanoke Island in North Carolina. The settlers got on bad terms with the natives, and deserted the colony when Drake visited the coast in 1586. Attempts at colonization at the same place in 1586 and 1587 failed *(see* NORTH CAROLINA), and in 1589 Raleigh resigned his rights to a company of merchants, preserving to himself a rent, and a fifth of whatever gold might be discovered.

After 1587 Sir Walter Raleigh's position as favourite was challenged by the earl of Essex. *(See* ESSEX, 2nd *EARL* OF.) In 1588 he was in eclipse. He was in Ireland for part of the year with Sir R. Grenville, and as vice-admiral of Devon looked after the coast-defences and militia levy of the county. In 1589 he was again in Ireland, visiting Edmund Spenser at Kilcolman. It was by Raleigh's help that Spenser obtained a pension, and royal aid to publish the first three books of the *Faerie Queen.* In 1589 Raleigh accompanied the expedition to the coast of Portugal which failed to raise a revolt against Philip II. In 1591 he was at the last moment forbidden to take part in the voyage to the Azores, being replaced by his cousin Sir R. Grenville. In 1592 he was again at sea with an expedition to intercept the Spanish trade, but was recalled by the queen, having seduced one of her maids of honour, Elizabeth Thtogmorton Raleigh denied the stories in a letter to Robert Cecil. On his return he was put into the Tower, and if he was not already married was married there. To placate the queen he made a fantastic display of despair at the loss of her favour. The maids of honour could not marry without the queen's consent, which Elizabeth was always reluctant to give and would be particularly unwilling to give when the husband was an old favourite of her own. Raleigh proved a good husband and his wife was devoted to him through life. He superintencied the distribution of the booty from the Portuguese carrack "Madre de Dios." He had provided large sums for the expedition, but the queen left him barely enough to cover his expenses.

Raleigh now retired to an estate at Sherborne in Dorsetshire, which he had extorted from the bishop of Salisbury by unscrupulous use of the royal influence. A son was born to him here in 1593. But a retired life did not suit Raleigh, and in 1595 he sailed on a voyage of exploration to the coast of South America. The object was undoubtedly to find gold mines, and Raleigh had heard the wild stories of El Dorado. His account of his voyage, *The Discoverie of Guiana,* published on his return, is brilliant, but contains much manifest romance and was received with incredulity. He was now the most unpopular man in England for his greed, arrogance and scepticism in religion. In 1590 he was named with Marlowe and others as an atheist. The share he took in the capture of Cadiz in 1596, where he was wounded, was followed by a return to favour, and he was apparently reconciled to Essex, whom he accompanied to the Azores in 1597. This co-operation led to a renewal of the quarrel, and Raleigh became still more unpopular. In 1600 he obtained the governorship of Jersey, and in 1601 took a part in suppressing the rebellion of Essex, at whose execution he presided as captain of the Guard. In 1600 he sat as member for Penzance in Elizabeth's last parliament. He was a steady friend of religious toleration, and a bold critic of the fiscal and agrarian legislation of the time.

James I., who regarded Essex as his partisan, had been prejudiced, and Raleigh's desire for war with Spain was against James's peace policy. Raleigh sold his Irish estates to Richard Boyle in 1602. He was expelled from Durham House, which was reclaimed by the bishop, dismissed from the captaincy of the Guard, deprived of his monopolies and of the government of Jersey. He was concerned in the complication of conspiracies of the first months of James's reign, and was committed to the Tower on July 19, 1603. Here he tried to stab himself, but only inflicted a small wound. His trial at Winchester, November 1603, was conducted with outrageous unfairness, and his gallant bearing in face of the brutality of the Attorney-General, Sir Edward Coke, turned public opinion in his favour. Raleigh was probably cognizant of the conspiracies, though the evidence against him was insufficient to prove his guilt. Much was kept back by the council, and the jury was influenced by knowing that the council thought him guilty.

The sentence of death passed on Raleigh was not carried out, but he was sent to the Tower, where he remained till March 19, 1616. His estate of Sherborne, which he had transferred to his son, was taken by the king. A sum of £8,000 offered in compensation was only paid in part. Raleigh's confinement was easy, and he turned to chemical experiments and literature. He had been known as a minor poet, and in prison he composed the only volume of his vast *History of the World* published. He invented an elixir, a very formidable quack stimulant. Hope of release never deserted him, and he secured his freedom in a way discreditable to all concerned. He promised the king to find a gold mine in Guiana without entrenching on a Spanish possession. It must have been obvious that this was impossible, and the Spanish ambassador, Gondomar, warned the king that the Spaniards had settlements on the coast. The king, who was in need of money, replied that if Raleigh was guilty of piracy he should be executed on his return. Raleigh gave promises he obviously knew he could not keep and sailed on March 17, 1617, relying on the chapter of accidents, and on vague intrigues he had entered into in Savoy and France. The ill-equipped expedition reached the mouth of the Orinoco on Dec. 31, 1617. Raleigh was ill with fever, and remained at Trinidad. He sent five small vessels up the Orinoco under Lawrence Keymis, with whom went his son Walter and a nephew. The expedition found a Spanish settlement on the way to the supposed mine, and a fight ensued in which Sir Walter's son and several Spaniards were killed. Keymis returned to Sir Walter with the news of his son's death and his own utter ruin, and killed himself as a result of Raleigh's reproaches. After a miserable scene of recriminations and mutiny, the expedition returned home. Raleigh was arrested, and in pursuance of the king's promise to Gondomar was executed under his old sentence on Oct. 29, 1618. When he knew his end to be inevitable he died with serenity and dignity. His wife survived him, and he left a son, Carew Raleigh. His enmity to Spain made him a popular hero.

AUTHORITIES.—An edition of his *Works* in eight volumes was published in London in 1829. It contains a *Life* by Oldys and Birch, written with all the knowledge then available. *A Life of Sir Walter Raleigh* (1806, 2nd ed.) was much used by Southey in his biography of Sir Walter Raleigh in vol. iv. of *The British Admirals* in the *Cabinet Cyclopaedia* (1837). Two biographies appeared simultaneously, *Life of Sir Walter Raleigh* by J. A. Saint John, and *Life of Sir Walter Raleigh* by E. Edwards (1868). E. Edwards's work is in two volumes, of which the second contains the correspondence, and is still the best authority. Smaller lives, which in some cases contain new matter, are those by E. W. Gosse, "Raleigh" in *English Worthies* (1886); W. Stebbing, *Sir W. Raleigh* (1891 and 1899); Martin Hume, *Sir Walter Raleigh* (1897); H. de Selincourt, *Great Ralegh* (1908); and M. Waldman, *Sir Walter Raleigh* (1928). For special episodes *see* Sir John Pope Hennessy, *Sir Walter Raleigh in Ireland* (1883), and T. N. Brushfield, *Raleghana* (Ashburton, 1896). Two separate editions of Raleigh's poems have been published, *Poems, with biography and critical introduction* by Sir F. Brydges (London, 1813), and *Poems of Raleigh with those of Sir H. Wotton, etc.*, edited by J. Hannah (London, 1892). S. R. Gardiner made a careful examination of the events of Raleigh's life after 1603 in his *History of England from the Accession of James I. to the Outbreak of the Civil War* (1883–84). *See* also C. H. Firth, *Sir Walter Raleigh's History of the World* (1918); and L. Cust, *Portraits of Sir Walter Raleigh* (1920).

RALEIGH (raw'lĭ), **SIR WALTER** (1861–1922), English man of letters, born on Sept. 6, 1861, in London, was educated at University college, London, and King's college, Cambridge. He was professor of modern literature at University college, Liverpool, and professor of English literature at Glasgow. In 1904 he was appointed professor of English literature at Oxford. He was knighted in 1911, and elected to a fellowship at Merton college in 1914. He died on May 13, 1922.

Raleigh was a good critic, and a stimulating teacher. He was not bound by the accepted judgments on individual writers, but brought a fresh and original mind to bear on literature. He did as much as any man of his time to break with what may be called the "dry-as-dust" school. His publications include *The English Novel* (1894), *Style* (1897), *Wordsworth* (1903), *The English Voyagers* (1904), *Shakespeare* (1907), Six *Essays on Johnson* (1910), *Romance* (1917), and many essays on literary subjects.

RALEIGH, the capital of North Carolina, U.S.A., and also the county seat of Wake county; in the heart of the eastern part of the State, on Federal highways 1 and 70, and served by the Norfolk Southern, the Seaboard Air Line, and the Southern railways. Pop. 22,418 in 1920 (35% Negroes); 46,897 in 1940 by the Federal census. The city has an altitude of 360 ft. and an area of 7 sq.mi. In the centre, on the highest ground, is the beautiful Capitol park of 4 ac., from which lead four broad streets, named for earlier capitals of the State. The present capitol building (completed 1840) of granite from a near-by quarry owned by the State, has a Doric portico and an octagonal dome. In the immediate neighbourhood are the State supreme court, the State Office building, the Justice building, the State Law library, the State museum, the Administration building, the Agricultural building, and the Highway Commission; and not far away is the Governor's mansion (1889), set in 4 ac. of grounds. In Pullen park is the house in which Andrew Johnson was born. Among the numerous antebellum mansions still standing is that of Joel Lane (built in 1760), from whom in 1792 the State purchased the site of the city. Most of the State institutions are located at Raleigh: the hospital for the insane and epileptics (established in 1856, through the efforts of Dorothea Lynde Dix), the prison (1869), the schools for the white blind (1845) and the coioured deaf and blind (1867), the Confederate soldiers' home (1891), and the laboratory of hygiene. Raleigh is an important educational centre, with some 5,000 students in the colleges and other schools under private auspices. The North Carolina State College of Agriculture and Engineering (1889) with the affiliated experimental farms, occupies 486 ac. in the western part of the city. Meredith college for women (Baptist; chartered 1891) moved in 1924 to a suburban campus of 130 acres. Shaw university (Baptist; 1865) and St. Augustine's college (Protestant Episcopal; 1868) are two of the oldest institutions in the South for the higher education of negroes. Seventeen miles north is Wake Forest college (Baptist) opened as an institute in 1834 and chartered as a college in 1838. Raleigh has a large wholesale and retail trade. Hydro-electric power (60,000 h.p.) is available from three sources. The diversified manufacturing industries (with an output valued at $6,500,000 in 1940) include railway shops of two roads, with an annual payroll of $800,000, and printing and publishing plants employing 500 persons. Five insurance companies have their home offices here. The assessed valuation of property for 1940 was about $51,000,000.

In 1787 the State convention decreed that there should be a "fixed and unalterable seat of government," and that it should be named in honour of Sir Walter Raleigh; in 1788 the site (Wake Court House) was chosen; in 1792 the land was bought and the city was laid out, with wide streets and large public squares; and in 1793 it was incorporated. Sherman's army passed through Raleigh on April 13, 1865.

RALPH (d. 1122), archbishop of Canterbury, called Ralph de Turbine, or Ralph d'Escures from his father's estate of Escures, near Séez in Normandy, entered the abbey of St. Martin at Séez in 1079, and ten years later became abbot of this house. After Anselm's death in April 1109 Ralph acted as administrator of the see of Canterbury until April 1114, when he himself was chosen archbishop at Windsor. Claiming authority in Wales and Scotland, he refused to consecrate Thurstan as archbishop of York because the latter prelate declined to profess obedience to the archbishop of Canterbury. This step involved him in a quarrel with the papacy, and he visited Rome, but was unable to obtain an interview with pope Paschal II., who had left the city. In spite of peremptory orders from Paschal's successors, Gelasius II. and Calixtus II., the archbishop still refused to consecrate Thurstan, and the dispute was unsettled when he died on Oct. 20, 1122.

RALPH OF COGGESHALL (d. after 1227), English chronicler, was at first a monk and afterwards sixth abbot (1207–1218) of Coggeshall, an Essex foundation of the Cistercian order. Ralph himself tells us these facts; and that his resignation of the abbacy was made against the wishes of the brethren, in consequence of his bad health. He took up and continued a Chronicon Anglicanum belonging to his house; the original work begins at 1066, his own share at 1187. He hoped to reach the year 1227, but his autograph copy breaks off three years earlier. The tone of the chronicle is usually dispassionate; but the original text contained some personal strictures upon Prince John, which are reproduced in Roger of Wendover. He wrote a continuation of Niger's chronicle, extending from 1162 to 1178 (printed in R. Anstruther's edition of Niger, London, 1851), and short annals from 1066 to 1223.

The autograph manuscript of the Chronicon *Anglicanum* is to be found in the British Museum (Cotton, Vespasian D. X.). The same volume contains the continuation of Ralph Niger. The *Chronicon* Terrae Sanctae, formerly attributed to Ralph, is by another hand; it was among the sources on which he drew for the Chronicon *Anglicanum*. The so-called *Libellus* de *motibus* anglicanis sub *rege Johanne* (printed by Martene and Durand, *Ampl. Collectio,* v. pp. 871–882) is merely an excerpt from the *Chronicon Anglicanum.* This latter work was edited for the Rolls series in 1875 by J. Stevenson.

RAM. A male sheep, one kept for breeding purposes in domestication and not castrated, as opposed to the castrated wether. (*See* SHEEP.) For the ram as one of the signs of the zodiac, see ARIES. The word may be connected with O.Nor. *ramme,* strong, or with Skt. ram, to sport. The butting propensities of the ram have given rise to the many transferred senses of the word, chief and earliest of which is that of a battering implement used before the days of cannon for beating in the gates and breaching the walls of fortified places. (See BATTERING RAM.) Many technical uses of the term have been developed from this, *e.g.,* the weight of a pile-driving machine, the piston ot a hydraulic press and other machines or portions of machines worked by water power. (See HYDRAULICS.) The ancient war-vessels were fitted with a beak (Lat. rostrum, Gr. ἔκβολον), projecting from the bows, and used to ram or crush in the sides of an opposing vessel; for the development of this in the modern battleship see SHIP.

RAMA, an almost extinct Indian tribe who live on Rama key in Bluefields lagoon on the east coast of Nicaragua. Formerly they occupied the north bank of the San Juan river. Linguistically the Rama are allied to the Chibchan peoples of South America. Their material culture suggests a South American connection.

See C. de Kalb, Bibliography of the Mosquito Coast of Nicaragua (Bulletin of the American Geographical Society, vol. xxvi. No. 2, 1894); D. E. Harrower, *Rama, Mosquito,* and *Sumu* of *Nicaragua* (Indian Notes, vol. ii., 1925).

RAMADAN (rah-mah-dahn'), the Muslim month in which absolute fasting from dawn to sunset is required. The law is based on Qur'ān ii. 179–184, and is as follows: A fast has always been a part of religion. In Islām it falls in this month because in it the Qur'ān was revealed, and it is holier than the others. It begins when the new moon is actually seen, and lasts until sight of the next new moon; it extends each day from the time when a white thread can be distinguished from a black one and until nightfall; it is absolute in that time as to food, drink, women. The sick and those on a journey may be excused, but should fast thereafter an equivalent number of days. The last ten days of the month are regarded as especially sacred; in the course of them falls the "Night of Decree," or "of Power" (Qur'ān xc. 1), but its exact date is not known. Fasting in Ramadān is reckoned one of the five pillars, or absolute requirements, of Islam. It is followed by the Lesser Festival, the first three days of the month Shawwāl (see BAIRAM).

BIBLIOGRAPHY.—T. P. Hughes, Dictionary of *Islam, s.v.* (1885); Snouck Hurgronje, Mekka, 51, 77 ff. (1889); E. W. Lane, *The* manners *and customs of the* modern Egyptians, chap. xxv.; Th. W. Juynboll, *Handbuch* des islamischen *Gesetzes,* chap. iii. (1910).

RAMADI, a town in Iraq in 33° 30' N. 43° 30' E. about 80 m. by road from Baghdad. The town lies on both sides of the Euphrates, which is here crossed by a bridge of boats, and in the 20th century became of some importance as an airport and as the point at which the overland mail leaves the cultivated area and starts its journey over the desert.

RAMAN EFFECT. When a beam of monochromatic light passes through a transparent substance a certain amount of light is scattered from the path of the original beam which is of greater wave-length than the incident light. This effect was discovered by Raman in 1928, and is known by his name. It must be distinguished from the Tyndall effect and from ordinary fluorescence. In the Tyndall cone (see COLLOIDS) the scattered light is of exactly the same wave-length as the primary beam, supposing monochromatic light to be used: if mixed light is used each wave-length is scattered without change of frequency, but the fact that the short wave-lengths are scattered in greater intensity than the longer wave-lengths leads to an apparent modification of colour. With fluorescence the light scattered in all directions is, except in a few exceptional cases, of wave-length greater than that of the primary beam (*see* FLUORESCENCE AND PHOSPHORESCENCE, where the exceptions to Stokes' law are discussed), but this wave-length is characteristic of the particular fluorescent substance, and does not change with the wave-length of the incident light, so long as this is short enough to excite fluorescence at all. The Raman effect is distinguished by the fact that the frequency of the scattered light changes with that of the primary beam, the difference of frequency between the primary beam and the scattered light being independent of the frequency of the primary beam. Thus, with the light from a mercury arc as the exciting radiation, each strong line is accompanied by a group of scattered lines, the frequency intervals from the primary line being the same within each group. Further, certain classes of chemical substances, such as different organic liquids each containing the same chemical group (*e.g.,* the CH group), give in the scattered light groups of lines whose frequency intervals from the primary line are the same for all substances of the class, but these intervals vary from substance to substance in other cases. The Raman radiation resembles the Tyndall scattered light in that it is, in general, strongly polarised.

The effect is observed by illuminating pure dust-free liquids with an intense beam of light containing approximately monochromatic radiations, *e.g.*, the light from a mercury vapour lamp, and photographing the scattered light from a direction more or less at right angles to the original beam. The magnitude of the shift is of the order of 100 Angstrom units: it is not a question of a minute modification of frequency. The scattered light always contains the original frequency in comparatively great intensity, the modified lines often requiring a long exposure.

The interpretation of the effect is a matter of great theoretical importance. On the quantum theory of radiation (see QUANTUM THEORY) a certain quantum of energy $h\nu$ is to be attributed to the incident radiation, and a quantum of energy $h\nu'$ to the scattered radiation, h being Planck's constant and ν and ν' the respective frequencies. The difference $h(\nu-\nu')$ must be absorbed by the molecule in sume quantum change, and the order of magnitude of this difference corresponds to an infra-red frequency. There is strong support for the view that the energy communicated to the molecule appears as energy of vibration of the nuclei of certain atoms in it, that is, the distance between the nuclei of these atoms varies periodically, the energy of the oscillations being governed by quantum conditions. Thus, associated with the strong mercury line 4,358A in the incident light, there is a scattered line at 5,000A with organic compounds containing the CH group: the difference of wave-number is $10^8\left(\frac{1}{4358}-\frac{1}{5000}\right)=2946\text{cm.}^{-1}$, which corresponds to an infra-red line at $3{\cdot}4\mu$. Such a line is present in the infra-red spectra of these compounds, and is attributed to nuclear oscillation. (*See* BAND SPECTRUM.) Other scattered lines lead to other infra-red frequencies characteristic of the molecules in question. The Raman effect thus furnishes spectroscopy with a new and very powerful weapon for investigating the infra-red spectra of determined molecules without the very troublesome technique of infra-red measurements. In the case of complicated molecules the vibrations can be traced to simple groups within them, as exemplified by the CH group.

Besides the lines of lower frequency than the exciting light a few lines are found in the scattered light which have a higher frequency, and thus correspond to a contribution of energy by the molecule to the quantum of energy of the incident light. Such lines find a natural explanation in the existence of molecules which, as regards the nuclear vibrations, are in one of the excited quantum states of higher energy: a quantum jump to a state of lower energy occurring in conjunction with the scattering process provides the necessary increment of energy to the scattered quant.

The Raman effect shows an interesting similarity to the Compton effect (*q.v.*). In the Compton effect the incident light-quant communicates part of its energy to a free, or loosely bound, electron, which energy appears as kinetic energy of this electron, the light quant of diminished energy being scattered as radiation of greater wave-length than that of the incident quant. The Compton effect is observed with hard X-rays, the magnitude to be anticipated for the effect with optical frequencies being too small for experimental observation. In the Raman effect the incident radiation sacrifices part of its energy in an interaction with matter, and reappears as a radiation of diminished frequency, just as in the Compton effect, but the energy lost as radiation appears as energy of molecular vibration instead of as kinetic energy of an electron.

BIBLIOGRAPHY.—The discovery of the effect was first announced by C. V. Raman in the *Indian Journal of Physics*, ii., 387, 1928, and by Raman and K. S. Krishnan in *Nature*, CXXI., 501, 1928. Other papers on the subject are: Raman and Krishnan, *Indian Joural of Physics*, II., 399, 1928; Cabannes and Daure, *Comptes Rendus de l'Académie des Sciences*, CLXXXVI. 1533, 1928; G. Rogard, *Comptes Rendus*, CLXXXVI., 1107, 1928; P. Pringsheim, *Die Naturwissenschaften*, XVI., 597, 1928; R. W. Wood, *Philosophical Magazine*, VI., 729, 1928.

(E. N. DA C. A.)

RAMANUJAN, SRINIVASA (1887–1920), Indian mathematician, whose correct name was Srinivasa Ramanuja Tyengar, was born at Erode, southern India, on Dec. 22, 1887. He was educated at the Town High school and at the Government college at Kumbakonan. He obtained a scholarship from the University of Madras, but after his marriage, in 1909, became a clerk in the Madras Port Trust. Correspondence with Prof. G. H. Hardy, of Cambridge, led to his obtaining a further scholarship from Madras university, and an exhibition from Trinity college, Cambridge. In spite of religious difficulties arising from the fact that he was a Brahmin, he came to England in April 1914, where Hardy, by private teaching, helped to provide the necessary mathematical background for his original work. His mathematical work is on the theory of numbers, theory of partitions and the theory of continued fractions. He became ill in 1917, returned to India in 1919, when he resumed some of his mathematical work, but died on April 26, 1920, at Kumbakonan. He was elected F.R.S. in 1918 and fellow of Trinity college later in the same year.

Most of his papers, edited by G. H. Hardy, P. V. Seshu Aiyar and B. M. Wilson, were published under the title of *Collected Papers of Srinivasa Ramanujan* (1927). *See* also obituary notice, with a list of Ramanujan's papers, by G. H. Hardy, in *Proceedings of the Royal Society*, vol. xcix. (1921).

RAMANUJAS, followers of Ramanuja, a southern Brahmin of the 12th century. Sri Vaishnavas, as they are usually called, worship Vishnu (Narayana) with his consort Sri or Lakshmi (the goddess of beauty and fortune), or their incarnations Rama with Sita and Krishna with Rukmini. Ramanuja's doctrine is essentially based on the tenets of an old Vaishnava sect, the Bhagavatas or Pancharatras, who worshipped the Supreme Being under the name of Vasudeva (later identified with Krishna, as the son of Vasudeva). They have shrines at Srirangam near Trichinopoly, Mailkote in Mysore, Dvaraka (the city of Krishna) on the Kathiawar coast, and Jagannath in Orissa; all of them decorated with Vishnu's emblems, the tulasi plant and salagram stone. Whilst Sankara's mendicant followers were prohibited to touch fire and had to subsist entirely on the charity of Brahman householders, Ramanuja, on the contrary, not only allowed his followers to use fire, but strictly forbade their eating any food cooked, or even seen, by a stranger. On the speculative side, Ramanuja met Sankara's strictly monistic theory by another, recognizing Vishnu as identical with Brahma, the Supreme Spirit animating the material world as well as the individual souls which have become estranged from God through unbelief, and can only attain again conscious union with him through devotion or love (bhakti). His tenets are expounded in various works, especially in his commentaries on the Vedantasutras and the Bhagavadgita. The followers of Ramanuja have split into two sects, a northern one, recognizing the Vedas as their chief authority, and a southern one, basing their tenets on the Nalayir, a Tamil work of the Upanishad order. (*See* RAMATS.)

See E. Thurston, *Tribes and Castes of India*, s.v.

RAMATS, a numerous north Indian sect (*Ramanandis* or *Ramavats*). Its founder, Ramananda, flourished in the latter part of the 14th century, according to tradition.

He was originally a Sri-Vaishnava monk, who, having come under the suspicion of laxity in observing the strict rules of food during his peregrinations, and having been ordered by his superior (Mahant) to take his meals apart from his brethren, left the monastery in a huff and set up a schismatic math of his own at Benares. The main distinctive features of their creed consist in their making Rama and Sita, either singly or conjointly, the chief objects of their adoration, instead of Vishnu and Lakshmi, and their attaching little or no importance to the observance of privacy in the cooking and eating of their food. Their mendicant members, usually known as Vairagis, are, like the general body of the sect, drawn from all castes without distinction. Thus, the founder's twelve chief disciples include, besides Brahmans, a weaver, a currier, a Rajput, a Jat and a barber —for, they argue, seeing that Bhagavan, the Holy One (Vishnu), became incarnate even in animal form, a Bhakta (believer) may be born even in the lowest of castes. Ramananda's teaching was thus of a popular character. The Bhakta-malā and other authoritative writings of the sect are composed in the popular dialects.

A follower of this creed was the poet Tulsidas, the author of the Hindi version of the Ramayana. *(See* RAMANUJAS.)

RAMBAUD, ALFRED NICOLAS (1842–1905), French historian, was born at Besançon on July 2, 1842. After studying at the Bcole normale supérieure, he completed his studies in Germany. He was appointed *répétiteur* at the École des Hautes Études on its foundation in 1868. His earlier historical work was done in Byzantine and Russian history. Probably his study of Russia was motived partly by his sense of the desirability of a Franco-Russian entente. Rambaud was *chef de cabinet* to Jules Ferry (1879–81), and in 1883 became professor of contemporary history at the Sorbonne.

He now wrote his *Histoire de la civilisation française* (2 vols., 1885, 1887; 9th ed., 1901) and his *Histoire de la civilisation contemporaine en France* (1888; new ed. entirely revised, 1906), and undertook the general editorship of the *Histoire générale du IVe siècle jusqu'à nos jours.* The plan of this great work had been drawn up with the aid of Ernest Lavisse, but the entire supervision of its execution was carried out by Rambaud. Rambaud held the position of minisler of Public Instruction from 1896 to 1898, and sought to carry on the educational work of Jules Ferry. He died in Paris on Nov. 10, 1905.

See the notices by E. Lavisse in the *Revue de Paris* for January 15th, 1906, and G. Monod in the *Revue historique* (vol. xc., pp. 344–348).

RAMBOUILLET, CATHERINE DE VIVONNE, MARQUISE DE (1588–1665), French *salonnière,* was the daughter and heiress of Jean de Vivonne, marquis of Pisani, and Giulia Savelli. She was married at twelve to Charles d'Angennes, vidame of Le Mans, and afterwards marquis of Rambouillet. The young marquise found the coarseness and intrigue that then reigned in the French court little to her taste, and after the birth of her eldest daughter, Julie d'Angennes, in 1607, she began to gather round her the circle afterwards so famous. She established herself at the HBtel Pisani, called later the HBtel de Rambouillet. Almost all the more remarkable personages in French society and French literature frequented it, especially during the second quarter of the 17th century. Madame de Rambouillet's natural abilities had been carefully trained, but were not extraordinary. She had genuine kindness and a lack of prejudice that enabled her to entertain on the same footing princes and princesses of the blood royal, and men of letters, while among her intimate friends was the beautiful Angélique Paulet. The respect paid to ability in her salon effected a great advancement in the position of French men of letters. The almost uniform excellence of the memoirs and letters of the period may be traced largely to the development of conversation as a fine art at the HBtel de Rambouillet, and the consequent establishment of a standard of clear and adequate expression. Mme. de Rambouillet was known as the "incomparable Arthénice," the name being an anagram for Catherine, devised by Malherbe and Racan. Among the famous incidents in the story of the Hôtel are the sonnet war between the Uranistes and the Jobistes—partisans of two famous sonnets by Voiture and Benserade—and the composition by all the famous poets of the day of the *Guirlande de Julie,* a collection of poems on different flowers, addressed in 1641 to Julie d'Angennes, afterwards duchesse de Montausier. Julie herself was responsible for a good deal of the preciosity for which the Hôtel was later ridiculed.

The *Prkcieuses,* who are usually associated with Molière's avowed caricatures and with the extravagances of Mlle. de Scudéry, but whose name, it must be remembered, Madame de Sévigné herself was proud to bear—insisted on a ceremonious gallantry from their suitors and friends, though it seems from the account given by Tallemant des Réaux that practical jokes of a mild kind were by no means excluded from the HBtel de Rambouillet. They especially favoured an elaborate and quintessenced kind of colloquial and literary expression, imitated from Marini and Gongora, and then fashionable throughout Europe. Molière's attack was probably levelled not at the Hôtel de Rambouillet itself, but at the numerous coteries which in the course of years had sprung up in imitation of it. But the satire did in truth touch the originators as well as the imitators,—the former more closely perhaps than they perceived. The HBtel de Rambouillet continued open till the death of its mistress, on Dec. 2, 1665, but the troubles of the Fronde diminished its influence.

The chief original authorities respecting Madame de Rambouillet and her set are Tallemant des Réaux in his *Historiettes,* and Antoine Baudeau de Somaize in his *Grand Dictionnazre des Précieuses* (1660). Many modern writers have treated the subject, notably Victor Cousin, *La Société française au xviie siècle* (2 vols., 1856), and C. L. Livet, *Précieux et Précieuses . . .* (1859). There is an admirable edition (1875) of the *Guirlande de Julie* by O. Uzanne.

RAMBOUILLET, a town of France, capital of an arrondissement in the department of Seine-et-Oise, 30 m. S.W. of Paris on the railway to Chartres. Pop. (1936) 6,908. Rambouillet derives its interest from the associations connected with the ancient château. Originally a royal domain, the lands of Rambouillet passed in the 14th century to the D'Angennes family, who held them for 300 years and built the château. Francis I died there in 1547; and Charles IX and Catherine de Medici found a refuge there in the Wars of Religion, as Henry III did after them. The title became a marquisate in 1612, and a dukedom under Louis XIV. It was here that in 1830 Charles X signed his abdication. The shooting of the famous coverts of Rambouillet was reserved for French presidents. There is a military preparatory school.

RAMEAU, JEAN PHILIPPE (1683–1764), French musical theorist and composer, was born at Dijon, the son of an organist, on Oct. 23, 1683. His father wished him to study law, but the boy's head was full of music, which he could only pursue in haphazard fashion. In 1701 his father sent him to Milan to break off a foolish love-match. But he learned little in Italy, and soon returned in company with a wandering theatrical manager, for whom he played the second violin. He next settled in Paris, where he published his *Premier livre de pièces de clavecin,* in 1706. He succeeded his father as organist of Notre Dame, Dijon, in 1709, and in 1714 removed to Lyons, where he was organist at the Jacobins. In 1715 he was organist at Clermont-Ferrand and working on his *Traité de l'harmonie.* There he remained until 1722. He studied the writings of Zarlino, Descartes and other theorists.

Rameau's keen insight into the constitution of certain chords, which in early life he had studied only by ear, enabled him to propound a series of hypotheses, many of which are now accepted. While the older contrapuntists were perfectly satisfied with the laws which regulated the melodious involutions of their vocal and instrumental parts, Rameau demonstrated the possibility of building up a natural harmony upon a fundamental bass, and of using that harmony as an authority for the enactment of whatever laws might be considered necessary for the guidance either of the contrapuntist or the less ambitious general composer. And in this he first explained the distinction between two styles, which have been called the "horizontal and vertical systems," the "horizontal system" being that by which the older contrapuntists regulated the onward motion of their several parts, and the "vertical system" being that which is built up perpendicularly from the bass. From fundamental harmonies he passed to inverted chords, to which he was the first to call attention; and the value of this discovery fully compensates for his erroneous theory concerning the chords of the eleventh and the great (Angl. "added") sixth. *(See* HARMONY.)

Rameau first set forth his new theory in his *Traité de l'harmonie* (Paris, 1722), and followed it up in his *Nouveau systkme* (1726), *Génération harmonique* (1737), *Démonstration* (1750) and *Nouvelles réflexions* (1752). After his return to Paris in 1722 he produced some light dramatic pieces, and then showed his real powers in his opera, *Hippolyte et Aricie,* founded on Racine's *Phèdre* and produced at the Acadkmie in 1733. He wrote more than twenty operas, the most successful of which were *Dardanus, Castor et Pollux, Les Indes galantes* and *La princesse de Navarre.* Honours were showered upon him. He died in Paris on Sept. 12, 1764. Rameau was undoubtedly the greatest French musician of his day.

See biographies by Charles Poisset (1864), Nisard (1867), Pougin (1876), and L. de la Laurencie (1908); also Chabanon, *Eloge* (1764); Paul-Marie Masson, *L'Opéra de Rameau* (1926). His *Oeuvres complètes,* ed. Saint-Saëns *(1894 seq.),* had reached the 18th vol. in 1924.

RAMEK, RUDOLF (1881–   ), Austrian statesman, was born at Teschen on April 12, 1881, and served in the Austrian army in World War I. In the Renner cabinet of 1919 he was state secretary for justice, and in 1921 minister of the interior in the Mayr cabinet. Dr. Ramek, a member of the Christian Socialist party, formed a coalition government in Nov. 1924. The chief problems before the chancellor were the strengthening of the federal principle of the constitution and the completion of the Austrian reconstruction scheme under the League of Nations. With the re-establishment of Austrian finance the League of Nations control was withdrawn, and at the end of 1925 the chancellor found it necessary to reconstruct his ministry. He kept foreign affairs in his own hands and appointed Kollmann as finance minister. Involved in controversy with Mussolini over the latter's reference to "carrying the Italian standard if necessary beyond the Brenner," an explanation was given and the incident regarded as closed, but in Austria the chancellor was criticized as having been too lukewarm in his defense of Tyrolese interests. The fall of his government (Oct. 15, 1926) was immediately due to his refusal of any increase of pay to civil servants. He was succeeded by Dr. Ignaz Seipel (*q.v.*).

RAMESES or **RAMESSES** (Gen. xlvii, 11; Exod. xii, 37; Num. xxxiii, 3), or, with a slight change in the vowel points, RAAMSES (Exod. i, 11), the name of a district and town in Lower Egypt, is notable as affording the mainstay of the current theory that King Rameses II was the Pharaoh of the oppression and his successor Merneptah the Pharaoh of the exodus. The first three passages cited above are all by the priestly (post-exile) author and go together. Jacob is settled by his son Joseph in the land of Rameses and from the same Rameses the exodus naturally takes place. The older narrative speaks not of the land of Rameses but of the land of Goshen; it seems probable, therefore, that the later author interprets an obsolete term by one current in his own day, just as the Septuagint in Gen. xlvi, 28 names instead of Goshen Heroopolis and the land of Rameses. Heroopolis lay on the canal connecting the Nile and the Red sea, and not far from the head of the latter, so that the land of Rameses must be sought in Wādi Tūmīlāt near the line of the modern fresh-water canal. In Exod. i, 11, again, the store-cities or arsenals which the Hebrews built for Pharaoh are specified as Pithom and Raamses, to which the Septuagint adds Heliopolis. Pithom also takes us to the Wādi Tūmīlāt. It is possible that these names were added by a writer who knew what fortified places were in his own time to be seen in Wādi Tūmīlāt; for the form of the story of the Hebrews in Egypt is throughout deficient in precise geographical data. The post-exile or priestly author indeed gives a detailed route for the exodus (which is lacking in the older story), but he, we know, was a student of geography and might supplement tradition by what he could gather from traders as to the caravan routes.

It appears, however, from remains and inscriptions that Rameses II did build in Wadi Tūmīlāt, especially at Tell Maskhūta, which Lepsius therefore identified with the Raamses of Exodus. But Naville's excavations found that the ruins were those of Pithom and that Pithom was identical with the later Heroopolis. Petrie found sculptures of the age of Rameses II at Tel Rotāb, in the Wadi Tūmīlāt west of Pithom, and concludes that this was Rameses. The Biblical city is probably one of those named Prameses, "House of Ramesses," in the Egyptian texts.

RAMESWARAM, a town of British India, in the Madura district of Madras, on an island in Palk straits and on the line of the South Indian railway from Madura. It has one of the most venerable Hindu shrines, founded, according to tradition, by Rama himself, and the resort of thousands of pilgrims.

RAMIE, RHEA or CHINA-GRASS, the product of species of the genus Boehmeria, a member of the family Urticaceae and nearly allied to the stinging nettle genus (*Urtica*), from which, however, it differs in absence of stinging hairs. Some confusion has arisen in the use of the various terms Ramie, Rhea, and China-grass. Ramie is generally used by English speaking people to designate the plant Boehmeria *nivea,* with leaves snow white on the under surface, and also the fibre obtained from this plant. The name is of East Indian or Malay origin and is said to have been used originally to designate *Boehmeria nivea tenacissima,* a tropical form with thin leaves, green on both surfaces. Rhea is used in India to designate both forms, but more especially the introduced form with leaves white on the under side, known elsewhere as ramie. Formerly in the London fibre market the name ramie was used to designate the fibre from China and Japan, and the name rhea for the fibre from all other sources. China-grass is the hand-cleaned but not degummed fibre as it comes on the market. The name has been incorrectly used to designate the plant.

B. nivea is a shrubby plant with the growth of the common nettle but without stinging hairs, sending up each season a number of straight shoots from a perennial underground rootstock. The plant leaves remind one of the nettle in their shape and serrated margin, but their backs are clothed with a downy substance and have a silvery appearance. The minute greenish-brown flowers are closely arranged along a slender axis. This variety has been cultivated by the Chinese for many years, and the fibre has been used more or less as a substitute for linen. Ramie is grown commercially in China, Formosa, Japan and the Philippine Islands. It has been grown experimentally in most temperate and subtropical countries throughout the world. About 1855, ramie was first introduced into the United States, and shortly thereafter it found its way into a number of Central American countries. A number of attempts have been made to start a ramie industry in the United States, Central America and South America, but no industry has developed.

In the United States experiments have been conducted along the South Atlantic coast, the Gulf of Mexico coast, and in California by individuals, by state agricultural experiment stations and by the United States department of agriculture. The most extensive plantings have been made by companies interested in testing new machines and methods of preparation. Between 1935 and 1943 the acreage of ramie in the U.S. has varied from approximately 100 to 300 ac. but only a few tons of ramie fibre have been prepared. It is questionable if ramie can be grown and prepared in countries having high labour wage scales to compete with fibre prepared with the cheap labour of the orient.

Cultivation.—The plant, which attains a height of from 3 to 8 ft., is grown from seed, cuttings or layers, or by division of the roots. From two to four crops per season may be obtained on suitable ground, each crop yielding up to four tons or more of green moist stems per acre. The yield of crude China-grass fibre is approximately $2\frac{1}{2}\%$ of the green plant material as cut in harvesting. When proper attention is given to the choice of ground, and to planting, there is not much difficulty in raising a good crop: the trouble arises in the extraction of the fibre.

The stems when ripe are cut down, and after the leaves and small branches have been removed, the outer cover and the layers of fibre are stripped off in the form of ribbons. These ribbons contain the bark, the fibre and a quantity of very adhesive gum. The Chinese remove this bark and as much of the gum as possible before the plant has dried. When it has dried this fibre is called China-grass. This hand-process is naturally slow and tedious.

Properties.—The fibre possesses some very valuable properties; it is not only much stronger than any other known fibre, but almost equals some kinds of silk in its brilliance. Its lustre is about equal to that of mercerized cotton but much inferior to that of artificial silk. Ramie successfully resists atmospheric changes, is easily dyed and is affected but little by moisture. On the other hand, articles manufactured from it on account of their hairy character have not the same smart appearance as those made from flax. Although the fibre is in some cases 12 in. long, it varies considerably in length, and this handicaps the operations of preparing and spinning. It is impossible to make perfect yarns from fibres of various lengths; hence it is necessary either to separate the fibres into reasonable groups, or to cut them into satisfactory lengths.

Manufacture.—In general, after decortication, the first process is that of degumming. This is usually done by immersing the fibre in a hot caustic soda or patented chemical solution. After the gum is removed, the material is lifted out, the alkali or chemical neutralized, and the fibre thoroughly washed. The bulk of the water may be removed by a hydro-extractor, and the fibre is then dried. To facilitate the subsequent process, the fibre may be softened by passing it through a machine fitted with fluted rollers. Then follow the operations of dressing, roving, wet spinning and doubling, and finally the twisted thread may be passed through a flame to remove superfluous hairs.

Ramie has been in the past used for gas mantles, for which it is particularly well adapted, for paper-making, ropes, linens, nets, underwear, and for canvas and several other fabrics. If only a good dependable supply of clean uniform low valued fibre could be obtained, there is not much doubt but that manufacturers and machine-makers would quickly provide means for utilizing it on an extensive scale. (B. B. R.)

RAMILLIES, a village of Belgium, in the province of Brabant, 13 miles N. by E. of Namur, between the sources of the Little Gheete and of the Mehaigne. It is famous for the victory of the Allies under the duke of Marlborough over the French commanded by Marshal Villeroi on May 12–23, 1706 in the War of the Spanish Succession (*q.v.*). The position of the French on the high ground about Ramillies was marked by the villages of Autréglise (Anderkirch) on the left, Offuz on the left centre, Ramillies on the right centre and Taviers on the right close to the river Mehaigne. In front of the last was a smaller village, Franquenay, which was held as an advanced post. Between these *points d'appui* the ground was mostly open upland, and the position as a whole was defective in so far that the villages were barely within cannon-shot of each other. It was particularly strong on the flanks, which were protected by the marshy beds of the Mehaigne and the Little Gheete. Ramillies stands almost on the watershed of these adjacent valleys, and here Marlborough decided to deliver his main attack. The forces were about equal, and were at first equally distributed along the whole line of each army. Marlborough's local concentration of force at the spot where the attack was to be pressed home was made not before, but after the action had opened (cf NEERWINDEN). Villeroi's left wing of cavalry and infantry was secure — and at the same time immobilized — behind the upper course of the Little Gheete, and the French commander allowed himself to be imposed upon by a demonstration in this quarter, convinced perhaps by the presence of the British contingent that a serious attack was intended. The morning was spent in arraying the lines of battle, and it was about 1·30 when the cannonade opened. Soon the first lines of infantry of the Allied centre and left (Dutch) opened the attacks on Franquenay and Taviers and on Ramillies, and, when after a severe struggle Taviers fell into the hands of the Dutch, their commander, Marshal Overkirk, led forward the whole of the left wing cavalry and fiercely engaged the French cavalry opposed to it. The ground was open, both parties had placed the greater part of their horse on this side, and it was only after a severe and prolonged engagement (in which Marlborough himself took part like a trooper and was unhorsed) that the Allies were definitely victorious, thanks to the arrival of a force of cavalry brought over from the Allied right wing. Meanwhile the principal attack on Ramillies had been successfully pressed home, the necessary concentration of force being secured by secretly and skilfully withdrawing some British battalions from the right wing. While Villeroi was trying to bring up supports from the left to take part in the cavalry battle, the French in Ramillies were driven out into the open, where the Allied cavalry, having now gained the upper hand, rode down many battalions. Most of the French cavalry from the other wing, having to force its way through the baggage trains of the army (these had been placed too near the fighting lines), arrived too late, and once Ramillies had fallen the whole line of the Allies gradually took up the offensive. It was not long before the French line was rolled up from right to left, and the retreat of the French was only effected in considerable confusion. Then followed for once a relentless pursuit, carried on by the British cavalry (which had scarcely been engaged) to Louvain, 20m. from the field of battle. Marlborough's unequalled tactical skill and judgment thus sufficed not merely to win the battle, but to win it with so large a margin of force unexpended that the fruits of his victory could be gathered. The French army lost, in killed, wounded and missing, some 15,000 men, the Allies (amongst whom the Dutch had borne the brunt of the fighting) scarcely one-third as many.

RAM MOHAN ROY (1774–1833), Indian religious reformer, and founder of the Brahma Samaj (*q.v.*) or Theistic Church, was born at Radhanagar, in the district of Hugli, Bengal, in May 1774. He was the son of a small landowner, and in his early life acquired a knowledge of Persian, Arabic and Sanskrit, besides his own vernacular, Bengali. At the age of sixteen he first assailed idolatry in his Bengali work, entitled *The* Idolatrous *Religious* System of the *Hindus*. This gave offence to his orthodox father, and Ram Mohan left home and spent some years in travel. He was a clerk in the British service from 1800 to 1814, when he settled in Calcutta to devote himself to religious reform. Ram Mohan wrote Bengali works on the Vedanta philosophy, translated some of the *Upanishads,* and on Jan. 23, 1830. definitely established the Brahma Samaj "for the worship and adoration of the Eternal, Unsearchable, Immutable Being who is the Author and Preserver of the Universe." In 1830 the emperor of Delhi bestowed on Ram Mohan the title of raja, and sent him to England as his agent. He presented petitions to the House of Commons in support of the abolition of the suttee rite. He died on Sept. 27, 1833.

RAMNAD, a town and district of Madras, British India, at the base of the spit of land that projects towards the island of Pamban in Palk strait. The town (pop. 1931, 16,817) is the residence of a raja of old family, head of the Maravar caste, whose title is setupathi, or lord of Adam's Bridge. It is a desolate and generally barren tract, traversed by the South Indian railway. The district has an area of 4,819 sq.m., and a pop. (1931) of 1,838,95j. Fishing is carried on.

RÂMNICU SARAT, the capital of the department of Râmnicu Sărat, Rumania; on the railway from Buzau to Focşani, and on the left bank of the Râmnicu, a tributary of the Sereth. Pop. (1930) 15,013, about 1,500 being Jews. The town rises from a marshy plain, east of the Carpathians, and west of the cornlands of southern Moldavia. Râmnicu Sărat was the scene of battles between the Moldavians and the Walachians in 1434 and 1573, and between the Walachians and Turks in 1634. Here also, in 1789, an Austro-Russian army defeated the Turks. In 1854 the town was almost destroyed by fire and was rebuilt.

RÂMNICU-VÂLCEA, an episcopal city and the capital of the department of Vâlcea, Rumania; situated at the foot of the Carpathians, on the right bank of the river Olt, and on the railway from Caracal to Sibin. Pop. (1930) 15,162, including many "Saxons." The district contains the famous monasteries of Arnota, Bistrita, Cotia and Moret. Besides wine, fruit, grain and timber, the surrounding uplands yield petroleum and salt. Within a few miles are the thermal springs of Olănestzi and Calimanesti and the salt mines of Ocnele Mari, with deposits estimated at 330 million tons. The city is said to be the ancient Castra Traiana.

RAMON Y CAJAL SANTIAGO (1852–1934), Spanish histologist, was born May 1, 1852, at Petilla de Aragon (Pamplona). He graduated at the University of Saragossa, and went in 1881 as professor to the University of Valencia, and in 1886 to Barcelona, publishing in 1889 his first important work (*Elementos* de Histologia normal y de *Técnica Micrográfica*). In that year he discovered "the laws which govern the morphology and the connections of the nerve cells in the grey substance." In 1890 and 1891 he discovered the primary changes of the neurin, and the genetic unity of the nerve fibres and the protoplasmic appendices. During this period also he discovered the axis cylinder of the fibres of the cerebellum and their continuity with the parallel fibrillae of the molecular covering, formulated the principle of the dynamic polarisation of the neurins, aided by Van Gehuchten, and worked upon the analysis of the sympathetic ganglia. In 1892 he took the chair of normal histology and pathological anatomy in the University of Madrid. In 1894, on the invitation of the Royal Society of London, he developed systematically his views on morphology and connections of the nervous cells of the spinal medulla, ganglions, cerebellum, retina and olfactory bulb. He was called upon by the Clark University (Worcester) in 1899 to give an exposition of his investigations regarding the cerebral tegumen, and in 1900 the International Congress of Medicine, which met in Paris, gave him the Moscow International Award. He was awarded half the Nobel Prize for medicine in 1906. His work in three volumes, *Histologia del Sistema Nervioso de Hombre y de los Vertebrados,* appeared between the years 1897 and 1904. In May 1922 he was exempted, on account of long service, from his duties in connection with the chair which he held, and, on the initiative of the Government, he founded the Cajal Institute in Madrid.

RAMPION, the name given to herbs of the genus *Phyteuma,* belonging to the family Campanulaceae. There are 45 species, which inhabit Europe, Asia and the Mediterranean region; two are native to the British Isles. The flowers are small, usually blue, and are massed together in heads. The pollen is driven out of the narrow tube, formed by the corolla, by the elongation of the style, and is thereby exposed to visiting insects.

RAMPOLLA, COUNT MARIANO DEL TINDARO (1843–1913), Italian cardinal, was born on Aug. 17, 1843, at Polizzi, in the Sicilian diocese of Cefalù. Having completed his studies in the Capranica College at Rome, and having taken holy orders, he studied diplomacy at the College of Ecclesiastical Nobles, and in 1875 was appointed councillor to the papal nunciature at Madrid. Two years later he was recalled to Rome and received high office. After another brief stay in Madrid as nuncio he was created cardinal, and became papal secretary of State. New to the Sacred College and free from traditional preconceptions, he was admirably fitted to carry out the papal policy under Leo XIII. (*See* PAPACY.) Rightly or wrongly, he was held personally responsible for the *rapprochement* with France and Russia and the opposition to the Powers of the Triple Alliance; and this attitude had its effect on his career when Leo XIII. died. Rampolla was not selected as pope owing to the veto of Austria, and resigned his office as secretary of State. He died in Rome on Dec. 17, 1913.

RAMPUR, an Indian state, lying within the United Provinces, between the British districts of Moradabad and Pilibhit. Area, 893 sq.m. The country is level and generally fertile; being watered in the north by the rivers Kosila and Nahul, and in the south by the Ramganga. The chief crops are wheat, barley, maize, rice and sugar cane. Pop. (1931) 465,225. The chief, whose title is nawab and who enjoys a salute of 15 guns, is a Rohilla Pathan, representing the family which established their power over this part of the country in the 18th century. When the Rohillas were subjugated by the nawab of Oudh, with the assistance of a force lent by Warren Hastings, one of their number, Faiz-ullah Khan, from whom the present nawab traces his descent, was permitted to retain possession of Rampur. During the Mutiny of 1857 the n & ~ & of Rampur rendered important services to the British. The town of Rampur is on the left bank of the river Kosila. Pop. (1931) 74,216. There are manufactures of damask, pottery, sword-blades and sugar. It was once completely surrounded by a broad bamboo hedge, which formed a strong defence. In addition to a modern fort and several fine buildings, it contains an Arabic college, which attracts students from all parts of India.

RAMPUR BOALIA, a town of British India, the administrative headquarters of Rajshahi district in Bengal, on the left bank of the Ganges. Pop. (1931), 27,064. It is 28 m. by road from the Nator station of the Eastern Bengal State railway and has a steamer station on the Ganges. The town contains a Government college, and the museum of the Varendra Research Society.

RAMSAY, ALLAN (1686–1758), Scottish poet, was born at Leadhills, Lanarkshire, on Oct. 15, 1686. He was educated at the parish school of Crawford, and in 1701 was apprenticed to a wig-maker in Edinburgh. He married Christian Ross in 1712; a few years after he had established himself as a wig-maker (not as a barber, as has been often said) in the High Street, and soon found himself in comfortable circumstances. His first efforts in verse-making were inspired by the meetings of the Easy Club (founded in 1712), of which he was an original member; and in 1715 he became the Club Laureate. In the society of the members he assumed the name of "Isaac Bickerstaff," and later of "Gawin Douglas." By 1718 he had some reputation for occasional verse, which he published in broadsheets, and then (or a year earlier) he turned bookseller. A rough transcript (1716) of *Christ's Kirk 072 the Green* from the Bannatyne ms., with some additions of his own, was followed in 1718 by a new edition with supplementary verses. In the following year he printed a collection of *Scots Songs.* The success of these ventures prompted him to collect his poems in 1722. The volume was issued by subscription, and brought in the sum of 400 guineas. He then opened a circulating library (the first in Scotland) in new premises, and extended his business as a bookseller.

Meanwhile he had issued the first instalments of *The Tea-Table Miscellany* and *The Ever Green* (both 1724–27). *The Tea-Table Miscellany* is "A Collection of Choice Songs Scots and English," containing some of Ramsay's own, some by his friends, several well-known ballads and songs, and some Caroline verse. In *The Ever Green, being a Collection of Scots Poems wrote by the Ingenious before 1600,* Ramsay sought to reawaken an interest in the older national literature. He produced, in 1725, his dramatic pastoral *The Gentle Shepherd,* which passed through several editions, and was performed at the theatre in Edinburgh; its title is still known in every corner of Scotland, even if it be no longer read. Ramsay wrote little afterwards, though he published a few shorter poems, and new editions of his earlier work. A complete edition of his *Poems* appeared in London in 1731 and in Dublin in 1733. In 1736 he set about the erection of a new theatre, "at vast expense," in Carrubber's Close, Edinburgh, but the opposition was too strong, and the new house was closed in 1737. In 1755 he retired from his shop to the house on the Castle Rock, still known as Ramsay lodge where he died on Jan. 7, 1758.

The Tea-Table Miscellany was reprinted in 1871; *The Ever Green* in 1875; *The Poems of Allan Ramsay* in 1877. A selection of the *Poems* appeared in 1887. There are many popular reprints of *The Gentle Shepherd.*

RAMSAY, ALLAN (1713–1784), Scotch portrait-painter, the eldest son of the author of *The Gentle Shepherd,* was born in Edinburgh in 1713. He studied in London under the Swedish painter Hans Huyssing, and at the St. Martin's Lane Academy; and in 1736 he left for Rome, where he worked for three years under Solimena and Imperiali (Fernandi). In 1767 he succeeded Shakelton as principal painter to the king; and he painted the royal portraits which the king presented to ambassadors and colonial governors, employing a number of assistants—of whom David Martin and Philip Reinagle are the best known. But this prosperous career came to an end through an accidental dislocation of his right arm. He died at Dover on Aug. 10, 1784.

His bust-portraits of Scottish gentlemen and their ladies, which he executed before settling in London, are full of grace and individuality; the features show excellent draughtsmanship, and the flesh-painting is firm and sound in method, though frequently tending a little to hardness and opacity. His work is seen at its best in the portrait of his wife, in the Scottish National Gallery.

RAMSAY, SIR ANDREW CROMBIE, knighted 1881 (1814–1891), British geologist, was born at Glasgow on Jan. 31, 1814, the son of William Ramsay, manufacturing chemist. He served for forty years (1841–81) on the geological survey. To the first volume of the *Memoirs of the Geological Survey* (1846) he contributed a now classic essay, "On the Denudation of South Wales and the Adjacent Counties of England," in which he advocated the power of the sea to form great plains of denudation. In 1866 he published *The Geology of North Wales.* He became professor of geology at University College, London, in 1848, and lecturer in the same subject at the School of Mines in 1851. In 1872 he succeeded Murchison as director-general of the geological survey.

His best known work was his *Physical Geology and Geography of Great Britain* (5th ed., 1878). He became F.R.S. in 1862. He died at Beaumaris on Dec. 9, 1891.

His publications include: *The Old Glaciers of Switzerland and North Wales* (1860); *The Red Rocks of England* (1871); *The River Courses of England and Wales* (1872).

See *Memoir* by Sir. A. Geikie (1895).

RAMSAY, ANDREW MICHAEL (1686–1743), French writer, of Scottish birth, commonly called the "Chevalier Ramsay," was born at Ayr on Jan, g, 1686. Ramsay served with the English auxiliaries in the Netherlands, and in 1710 visited Fénelon, who converted him to Roman Catholicism. He remained in France until 1724, when he was sent to Rome as tutor to the Stuart princes, Charles Edward and Henry, the future cardinal of York. He was driven by intrigue from this post, and returned to Paris. He died at St. Germain-en-Laye (Seine-et-Oise) on May 6, 1743. The best known of Ramsay's many works is *Les voyages de Cyrus* (London, 1728; Paris, 1727), written in imitation of *Télémaque.*

RAMSAY, SIR WILLIAM (1852–1916), British chemist, was born in Glasgow on Oct. 2, 1852. From 1866 to 1870 he studied in his native city, and in 1871 went to work under R. Fittig at Tiibingen. In 1872 he became assistant in the Young laboratory of technical chemistry at Anderson's college, Glasgow, and from 1874 was tutorial assistant in the university. In 1880 he was appointed to the chair of chemistry at University college, Bristol, and made principal in the following year. In 1887 he succeeded A. W. Williamson as professor at University college, London, a position which he resigned in 1913. He was awarded the Davy medal of the Royal Society in 1895 and the Nobel prize for chemistry in 1904. He was made a K.C.B. in 1902 and died at High Wycombe, Eucks, on July 23, 1916.

Ramsay's earliest investigations covered a wide field—from a new bismuth mineral to the physiological action of certain alkaloids —in the course of which he showed that the alkaloids are related to pyridine; later he specialized definitely on inorganic and physical chemistry. With S. Young and others, he investigated the critical state, the relationship between vapour pressure and temperature and other properties of liquids. With J. Shields he verified the Eotvos law of the constancy of the rate of change of molecular surface energy with temperature, and obtained evidence concerning the molecular complexity of certain liquids. In 1892 Lord Rayleigh had asked for suggestions from chemists to account for the difference between the densities of chemical and atmospheric nitrogen, and Ramsay became interested in the problem. He devised methods for removing oxygen and nitrogen completely from air, and found that there was present in addition a small quantity of an hitherto unknown gas; in Aug. 1894 Ramsay and Rayleigh announced the discovery of this new gas, afterwards called "argon," present to the extent of almost 1% in the atmosphere. The high density of this gas accounted for the atmospheric nitrogen having a greater density than the chemical variety. In 1895, whilst searching for new sources of argon, Ramsay heated the mineral cleveite with acid and obtained a gas which gave a spectrum identical with that of helium, detected in the sun by Sir J. N. Lockyer and Sir E. Frankland in 1868; in this way helium was first obtained, but it was later found to be present in the air to the extent of about one part in 250,000.

Both helium and argon were found to be absolutely inactive chemically, and so were called the "inert gases." A study of their position in the periodic table led to the belief that at least three more such gases should exist, and Ramsay, with M. Travers, found them in 1898 in the liquid air residues from which oxygen and nitrogen had been removed; they were called neon, krypton and xenon, and were found to be present in the air only to an extremely minute extent (*e.g.,* xenon, one part in 170 million). Ramsay next turned to radioactivity since he noted the association of helium with radioactive minerals, and with F. Soddy (*q.v.*) he found in 1903 that helium was continuously produced as a disintegration product of radium emanation; this discovery led to the transmutation theory and its important consequences. In 1910 Ramsay obtained a small quantity of radium, and with D. Whytlaw Gray he was able, as a result of a wonderful piece of experimental work, to determine the density, and incidentally the atomic weight, of about one three-millionth part of a cubic inch of radium emanation. The atomic weight showed that this gas was the last of the "inert gas" series and it was called "niton."

Ramsay's eminence, and his interest in educational matters, resulted in his being asked by the Indian Government to advise on the best way to utilize the Tata bequest; as a consequence the Indian Institute of Science was founded at Bangalore, During World War I he was an active member of the Royal Society Committee for the pooling of scientific knowledge, to be placed at the command of the Government. He made strong representations on the necessity of preventing cotton and fats from reaching central Europe. Ramsay was an inspiring teacher as well as a brilliant researcher; he had remarkable skill as a manipulator, and this, as well as his spirit of enthusiasm for research, contributed to his success as an investigator.

Sir W. Ramsay's works include: *A System of Chemistry* (1891); *The Gases of the Atmosphere* (1896); *Modern Chemistry* (2 vols,, 1901); and *Essays Biographical* and *Chemical* (1908).

See Sir William Tilden, *Sir William Ramsay: Memorials of his Life and Work* (1918), and *Famous Chemists* (1921); Obituary notice, *Proceedings Royal Soc.* (1916–17).

RAMSBOTTOM, urban district, Lancashire, England, 4 mi. N. of Bury on L.M.S.R. Pop. (1938) 14,940. Area 14.9 sq.mi. It has iron and brass foundries, machine factories and textile establishments. Municipal transport connects it with Bury and Rawtenstall.

RAMSDEN, JESSE (1735–1800), English astronomical instrument maker, was born at Salterhebble near Halifax, Yorkshire, on Oct. 6, 1735. After serving his apprenticeship with a cloth-worker in Halifax, he went in 1755 to London, where in 1758 he was apprenticed to a mathematical instrument maker. About four years afterwards he started business on his own account and secured a great reputation with his products. He died at Brighton on Nov. 5, 1800. Ramsden's speciality was divided circles, which began to supersede the quadrants in observatories towards the end of the 18th century. His most celebrated work was a 5-foot vertical circle, which was finished in 1789 and was used by G. Piazzi at Palermo in constructing his well-known catalogue of stars.

RAMSEY, a market-town in Huntingdonshire, England, on the south-western border of the Fen country, on branch lines of the L.N.E. railway, 13 mi. S.S.E. of Peterborough. Pop. of urban district (est. 1938) 5,219. Area 27 sq.mi. According to a 12th century chronicle of one of the monks, the name Ramsey is derived from "ram," referring to the tradition of a solitary ram's having taken up its abode here, and "ey" meaning an island. Ramsey, however, was not completely insulated. The abbey was founded by Ailwin, earl of the East Angles, in 969, and a charter of King Edgar granted lands and privileges for the purpose. Ramsey abbey was noted for the school established within its walls and for its library of Hebrew works. Its abbot was mitred. The lands were granted after the dissolution to Sir Richard Cromwell. The church of St. Thomas à Becket is transitional between Norman and Early English, and has a Norman east end. The tower was built in 1672 of stone from Ramsey abbey. An oak lectern, dating from the 15th century, carries a chained copy, in a Tudor binding of brass, of Dean Comber's (1655–99) book on the Common Prayer, and a black-letter copy of Erasmus' Paraphrase of the Gospels. There are many interesting tombs in the churchyard, and the church register contains several entries relating to the Cromwell family, who removed to Ramsey from Huntingdon and owned the abbey estates till 1674. Of the ancient Benedictine abbey, the only remains are a part of a gateway, a lodge and some buttresses, while some broken stone arches and walls remain of the conventual buildings. Ramsey has a market for agricultural produce, potatoes being the chief product of the district, and Ramsey mere, now entirely drained, forms excellent wheat land.

RAMSGATE, a municipal borough, watering-place, seaport and member of the Cinque Port of Sandwich, in the Isle of Thanet parliamentary division of Kent, England, 79 mi. S.E. of London by the S.R. Pop. (est. 1938) 34,390. Area, 5.7 sq.mi. Ramsgate (Ramesgate) was originally a small but comparatively prosperous place united until 1827 to the parish of St. Lawrence. The charter of Charles II mentions it as a member of Sandwich. In 1884 it was incorporated by royal charter, and a commission of the peace was granted in 1893. The jurisdiction of the Cinque Ports' justices thereupon ceased within its limits, which include the parishes of Ramsgate and St. Lawrence Intra. Under Elizabeth, Ramsgate was still unimportant, though possessed of a fair before the reign of Henry VIII. After 1668 the growth of trade increased its prosperity, and at the beginning of the reign of George I the pier was enlarged and pier-wardens appointed to collect the *droits*. In 1749, having been selected as a harbour of refuge for the Downs, it underwent great improvements, and henceforward paid £200 yearly to Sandwich out of the *droits* for clearing the Channel and repairing the banks of the river Stour within the Liberty; but by 1790 the harbour was of small account. During World War I, a large aerodrome was established at Manston, two miles from Ramsgate and considerable damage was done by bombs dropped on the town. In World War II 8,500 houses were damaged in the German raids of 1940–41. The conversion of $3\frac{3}{4}$ mi. of abandoned railway tunnels provided an air-raid shelter with accommodation for 60,000 persons. Ramsgate is practically contiguous with Broadstairs to the north. Before World War II the corporation, to improve the town as a seaside resort, undertook large works, including a new bathing pool (1935), tennis courts, bowling and putting greens, and ornamental gardens. The cliff promenades were extended by about a mile. The harbour, of 42 ac., was acquired by the town in 1934. During the season steamers connect it with London and the intermediate watering-places on the north coast, and with Calais and Boulogne. A fair coasting and fishing trade is carried on. Pegwell bay, famed for its shrimps, is supposed to have been the scene of the landing of Hengest and Horsa, and at Cliff's End (Ebbs Fleet) a monolithic cross marks the landing-place of St. Augustine in 596.

RAMUS, PETRUS or **PIERRE DE LA RAMEE** (1515–1572), French humanist, was born at the village of Cuth in Picardy in 1515, a member of a noble but impoverished family; his father was a charcoal-burner. Having gained admission, in a menial capacity, to the college of Navarre, he worked with his hands by day and carried on his studies at night. The reaction against scholasticism was still in full tide, and Ramus outdid his predecessors in the impetuosity of his revolt. On the occasion of taking his degree (1536) he actually took as his thesis "Everything that Aristotle taught is false." This *tour de force* was followed up by the publication in 1543 of *Aristotelicae Animadversiones* and *Dialecticae Partitiones,* the former a criticism on the old logic and the latter a new textbook of the science. What are substantially fresh editions of the *Partitiones* appeared in 1547 as *Institutiones Dialecticae,* and in 1548 as *Scholae Dialecticae;* his *Dialectique* (1555), a French version of his system, is the earliest work on the subject in French. Meanwhile Ramus had opened courses of lectures, but was interdicted (1544) on the ground of undermining the foundations of philosophy and religion. The decree against him was presently cancelled, and in 1551 Henry II. made him professor of philosophy and rhetoric at the Collège de France. But in 1561 he embraced Protestantism, and was compelled to flee from Paris, and in 1568 from France. But he returned before the massacre of St. Bartholomew (1572), of which he was one of the victims.

The logic of Ramus enjoyed a great celebrity for a time, and there existed a school of Ramists boasting numerous adherents in France, Germany and Holland. There is even a little treatise from the hand of Milton, published two years before his death, called *Artis Logicae Plenior Institutio ad Petri Rami Methodum concinnata.*

See Waddington-Kastus, *De Petri Rami vita, scriptis, philosophia* (1848), and *Ramus, sa vie, ses écrits et ses opinions* (1855), in which a list of 50 writings by Ramus is given; C. Desmaze, *Petrus Ramus, professeur au Collège de France, sa vie, ses tcrits, sa mort* (1864); P. Lobstein, *P. Ramus als Theolog* (Strasbourg, 1878); E. Saisset, *Les précurseurs de Descartes* (1862); J Owen, *French Skeptics of the Renaissance* (1893); Voigt, *Über den Ramismus der Universität Leipzig* (Leipzig, 1888); F. P. Graves, *Peter Ramus and tke Educational Reformation of the 16th Century* (1912).

RAMUSIO, GIAN BATTISTA (1485–1557), geographer, was born at Treviso in 1485 (June 20), the son of Paolo the Elder (c. 1443–1506). Gian Battista was educated at Venice and at Padua and entered the public service (1505), becoming in 1515 secretary of the senate and in 1533 secretary of the Council of Ten. He served the republic in various missions to foreign states, *e.g.,* Rome, Switzerland and France. He died on July 10, 1557.

Ramusio had witnessed from his boyhood the unrolling of that great series of discoveries by Portugal and Spain in East and West, and geography was his chief study and delight. It appears from a letter addressed to him by his friend Andrea Navagero, that as early as 1523 the preparation of material for his great work, *Navigationi e Viaggi,* had already begun. The task had been suggested by Girolamo Fracastoro, his lifelong friend. Among Ramusio's correspondents were Cardinal Pietro Bembo, Damiano de Goez and Sebastian Cabot; among lesser lights, Vettor Fausto, Daniel Barbaro, Paolo Manuzio, Andrea Navagero, the cardinals Gasparo Contarini and Gregorio Cortese, and the printer Tommaso Giunti, editor after Ramusio's death of the *Navigationi.*

Two volumes only of the *Navigationi e Viaggi* were published during his lifetime, vol. i. in 1550, vol. iii. in 1556; vol. ii. did not appear till 1559, two years after his death. Ramusio had intended to publish a fourth volume, containing, as he mentions himself, documents relating to the Andes, and, as appears from one of the prefaces of Giunti, others relating to explorations towards the Antarctic. Ramusio ransacked Italy and the Spanish peninsula for contributions, and translated them when needful into the racy Italian of his day. The invaluable travels of Barbosa and Pigafetta's account of Magellan's voyage were not publicly known in complete form till the present century. Of two important articles at least the originals have never been otherwise printed or discovered; one of these is the *Summary of all the Kingdoms, Cities, and Nations from the Red Sea to China,* a work translated from the Portuguese, and dating apparently from about 1535; the other, the remarkable Ramusian redaction of Marco Polo (*q.v.*). The *Prefatione, Espositione* and *Dichiarazione,* which precede this version of Marco Polo's book, are the best and amplest examples of Ramusio's own style.

There were several editions of the *Navigationi e Viaggi,* and its bibliography is extremely complicated and the contents of the editions vary. It must suffice here to say that a set of Ramusio, to be as complete as possible, should embrace—for vol. i., 1563 or any subsequent edition; for vol. ii., 1583 or 1606; for vol. iii., 1606.

Besides the circumstances to be gathered from the *Navigationi* regarding the Ramusio family, *see* the *Iscrizioni Venete* of Emanuele Cigogna. There is also in the British Museum *Monografia letta il 14 Marzo 1883 . . .* by Guglielmo Carradori (Rimini, 1883); but little has been found in this.

RAMUZ, CHARLES FERDINAND (1878–), French-Swiss author, born at Cully, in the canton of Vaud. In the opening years of the 20th century he gained a well-merited reputation in a restricted circle; but nearly 25 years were to pass before proper appreciation was accorded by foreign critics to a writer of rare talent with a purely original style owing nothing to the "Latin" and "Classical" tradition. In his numerous works (from *Aline,* 1903, to *La Beautk sur la Terre,* 1927, including *Samuel Belet, Aimk Pache, Le Règne de l'esprit malin, La Guérison des .maladies, Passage du poète,* etc.) Ramuz gives, with broad and simple strokes, a picture of primitive human sentiments in language, the rhythm and phrasing of which intimately recall a definite district—namely, the Leman basin above Lausanne—a narrow strip of vineyard country backed by mountains and looking out over the Rhone and the luminous expanse of Lake Geneva. Though his outlook on the world and mankind is restricted to and conditioned by the influences of this district. Ramuz is the very opposite of a regionalist. In a country where so many others have abused the facile picturesque and have used "local colour" without distinction, his originality is the more striking. No one has approached him in his humble self-subjection to the spirit of the country; he is completely under the spell of nature seen at close quarters and under its daily changing aspects. His own thoughts and aspirations are expressed in his characters; nevertheless his work is a most varied and representative picture gallery of a well-defined race, universal in its appeal though in appearance exclusively *Vaudois.* (C. CL.)

RANADE, MAHADEO GOVIND (1842–1901), Indian lawyer, reformer and author, was born on Jan. 16, 1842, at Niphad, in Nasik district, of a Chitpavan Brahman family. When his father was minister at Kolhapur he attended the Anglovernacular school in that town, and joined the Elphinstone Institute in Bombay at the age of fourteen. He was one of the first graduates of the Bombay University, taking the B.A. in 1862 and the LL.B. in 1866. Having entered government service he became presidency magistrate and then fourth judge of the small cause court at Bombay in 1871, first-class sub-judge at Poona in 1873, and judge of the Poona small cause court in 1884, after which, as special judge under the Deccan Agriculturists' Relief Act from 1887, he came into close contact with the difficulties of the agrarian classes. In 1886 he was a member of the finance committee appointed to report on the expenditure, both imperial and provincial, with a view to retrenchment. This service won him the decoration of C.I.E. He became a member of the legislative council of Bombay in 1885, and occupied that position until raised to the high court in 1893. Being an energetic social reformer, he directed his efforts against infant marriages, the shaving of widows, the heavy cost of marriages and other social functions, and the caste restrictions on travelling abroad. He strenuously advocated widow remarriage and female education. He was the founder of the social conference movement, which he supported till his death. In the political sphere he founded the Poona Sarvajanik Sabha, through which he frequently helped the government with sound advice. He was also one of the originators of the Indian National Congress.

In Bombay University, where he held the offices of syndic and dean in arts, he displayed much organizing power and great intimacy with the needs of the student class. Himself a thorough Mahratti scholar, he encouraged the translation of standard English works, and tried, with some success, to introduce vernacular languages into the university curriculum. He joined with his friends, Dr. Atmaram Pandurang, Bal Mangesh Wagle and Vaman Abaji Modak, in founding a new sect in Bombay known as the "Parthana Samaj." This community resembles, in all essential points, the Brahma Samaj of Bengal. He died on Jan. 16, 1901.

See G. A. Mankar, Justice M. G. Ranade (Bombay, 1902).

RANAVALO (RANAVALONA) **III.** (1864–1917), the last queen of Madagascar. She succeeded to the throne of Madagascar after the death of Queen Ranavalo II., on July 14, 1883. Although nominally queen, she took no share in the government, which her prime minister, Rainilaiarivony, had controlled since 1864. After placing her on the throne, he married her before the close of the year. For the events which resulted in the establishment of a strict French protectorate see MADAGASCAR, History. General Gallieni abolished the sovereignty by proclamation in Feb. 1897, and exiled Ranavalo to Réunion. In March 1899 she was removed to Algiers. She died May 23, 1917.

RANC, ARTHUR (1831–1908), French politician and writer, was born at Poitiers on Dec. 20, 1831, and studied law. His anti-imperialist activities led to his deportation to Algeria in 1855, but he returned to Paris at the amnesty of 1859. He sat in the Commune, and in 1873 was returned to the National Assembly, where he sat on the extreme left. A threatened prosecution for his share in the Commune obliged him to escape to Belgium, where he remained until the amnesty of 1879, continuing his collaboration on La *République française*. He succeeded Clémenceau as editor of the Aurore. In 1903 he became senator for Corsica, and died on Aug. 10, 1908.

In addition to his political writings, Arthur Ranc published political novels of the Second Empire, *Sous l'empire* (1872) and Le roman d'une *conspiration* (1868).

RANCÉ, ARMAND JEAN LE BOUTHILLIER DE (1626–1700), founder of the Trappist Cistercians. He was ordained in 1651, and embarked on the ambitious and worldly career of a court abbé in the days of Louis XIV. But after a few years he underwent a complete change of life, and in 1662 he retired to his abbey of La Trappe, of which he became regular abbot in 1664 and introduced an austere reform. (See TRAPPISTS.) The best known episode of his subsequent life was the "Contestation" with Mabillon on the lawfulness of monks devoting themselves to study, which De Rancé denied. He resigned his abbacy in 1695, owing to declining health, and died in 1700.

The best of the early lives is that of P. le Nain, his sub-prior (1715); see also M. Serrant, *L'Abbé* de Ranct et Bossuet (1903).

RANCHI, a town and district of British India, in the Chota Nagpur division of Bihar and Orissa. The town, which is situated about 2,100 ft. above sea-level, is the headquarters not only of the division and the district, but also of the provincial Government during the hot weather months. Pop. (1931), 50,517. The town contains a cantonment, a radium institute, and two mental hospitals, one for European patients from the whole of northern India, the other, which can accommodate 1,378 patients, for Indians of Bengal as well as Bihar and Orissa.

THE DISTRICT OF RANCHI, formerly called Lohardaga, after the town which was its headquarters, has an area of 7,102 sq.m. and a population (1931) of 1,567,149. It consists of two tablelands, of which the higher rises to about 2,000 feet. The whole area is broken by hills and undulations, which are terraced for rice. The steep slopes are covered with forest, where wild animals still abound. The principal rivers are the Subarnarekha and the North and South Koel. Rice is the staple crop. Tea cultivation has been introduced, but there are only 21 gardens, with an output (1921) of 172,000 pounds. The only industry on a large scale is the manufacture of shellac. Myrobalans are also exported. Deposits of bauxite have been found and await exploitation. Ranchi is connected with Purubia and the main system of the Bengal-Nagpur railway by a narrow gauge railway, which has been extended through the district to Lohardaga. The most numerous and characteristic races are the aboriginal Mundas and Oraono. Nearly 200,000 persons returned themselves as Christians at the census of 1921.

RAND, a Dutch word, in use in South Africa, meaning rim, edge, ridge of hills; specifically, it is an abbreviated form of Witwatersrand, an elevated ridge in south Transvaal, forming the water-parting between the Vaal river and the Olifants river. The Rand is famous for its auriferous reefs (see GOLD), and the word is often used as a synonym for the extensive gold mining industry of this area, or for Johannesburg (*q.v.*), the city which the industry created.

RANDALL, JAMES RYDER (1839–1908), American journalist and poet, born at Baltimore, Md., Jan. 1, 1839. His academic education was received at Georgetown College, after which he travelled in South America and then became professor of English literature at Poydras College at Pointe-Coupée, La., where he was when the Civil War broke out. The attack made by citizens of Baltimore upon Massachusetts and Pennsylvania troops as they passed through the city was the occasion of his writing "Maryland! My Maryland!" first published in the New Orleans Delta. The poem was widely copied and a few days later came to the attention of Baltimore people. There it was first sung by Miss Hetty Cary to the classic melody of "Lauriger Horatius." Words and music were happily united and from that time forth the song was heard in all the homes and camps of the South and in time became a national favourite. After the war Randall became the editor of the Georgia *Constitutionalist*. He was later Washington correspondent for a number of Southern papers. He died at Augusta, Ga., Jan. 15, 1908.

See The Poems of James Ryder *Randall* (1910), with introduction.

RANDALL, SAMUEL JACKSON (1828–1890), American politician, was born in Philadelphia, Pa., on Oct. 10, 1828. He was educated in the public schools and in the University academy, Philadelphia. In 1858–59 he was a Democratic member of the State senate. During the Civil War he served in the Union army, rising to the rank of captain and playing an important part in the Gettysburg campaign. From 1863 until his death he was a Democratic representative in Congress. During the session of 1874–75 he first gained a national reputation by the masterful manner in which he prevented the Republican majority from passing the Force Bill or Federal Election Law. Under his leadership discipline and party harmony were established among the Democrats for the first time after the Civil War. He was speaker of the House from Dec. 1876 to March 1881, during a period marked by rancorous debates concerning the disputed Hayes-Tilden presidential election. He was noted for his work as chairman of the committee on appropriations and as a member of the committee on banking currency and retrenchment. He was a leader of the Protectionist wing of the party. He died in Washington, D.C., on April 13, 1890.

RANDAZZO, a town of Sicily, in the province of Catania, at the north foot of Mount Etna, 43 mi. N.W. of Catania by rail, and 26 mi. direct. Pop. (1936) 12,558 (town); 13,684 (commune). Remains of architecture of the 13th and 14th centuries include three Norman churches and some interesting palaces. The former contain some fine sculptures and goldsmith's work, while the Museo Vagliasindi has interesting objects from a Greek necropolis in the neighbourhood. It is the nearest town to the summit of Etna (9 m.).

RANDEGGER, ALBERTO (1832–1911), Italian musical composer and conductor, was born in Trieste April 13, 1832. He settled in London in 1854. He became professor of singing at the Royal Academy of Music in 1868 and at the Royal College of Music in 1896. He was conductor of the Carl Rosa Company from 1879 to 1885 and conducted the Norwich Festivals 1881–1905. Randegger, who died in London on Dec 18, 1911, assisted the popular revival of opera in England. His works include *Bianca Capello* (1854), and other operas, also *Primer on Singing*.

RANDERS, a town of Denmark, capital of the *amt* (county) of its name in Jutland, on the Gudenaa at the point where it begins to widen into Randers Fjord, an inlet of the Cattegat. Pop. (1940) 32,928. Randers is best known in history as the scene of the assassination of Count Gerhard by Niels Ebbesin in 1340. Though a place of considerable antiquity—being mentioned in 1086 as the meeting-place of insurgents against Knud, the saint—Randers has few remains of old buildings and bears the stamp of a compact, modern manufacturing town that owes its importance to its distilleries, manufactories of gloves, railway carriages, etc. St. Marten's church dates from the 14th century. The high school is housed in a mediaeval monastery. The town is 15 m. from the open Cattegat and the harbour is 15 ft. deep.

RANDOLPH, EDMUND [JENNINGS] (1753–1813), American statesman, was born on Aug. 10, 1753, at Tazewell Hall, Williamshurg, Va., the family seat of his grandfather, Sir John Randolph (1693–1737), and his father, John Randolph (1727–84), who (like his uncle Peyton Randolph) were king's attorneys for Virginia. Edmund graduated at the College of William and Mary, and studied law with his father, who felt bound by his oath to the king and went to England in 1775. In Aug.–Oct. 1775 Edmund was aide-de-camp to Gen. Washington. In 1776 he was a member of the Virginia convention, and was on its .committee to draft a constitution. In the same year he became the first attorney general of the State (serving until 1786). He served in the Continental Congress in 1779 and again in 1780–82. He had a large private practice, including much legal business for Gen. Washington. In 1786 he was a delegate to the "Annapolis convention," and in 1787–88 was governor of Virginia. He was a delegate to the constitutional convention of 1787, and on May 29 presented the "Virginia plan" (sometimes called the "Randolph plan"). In the convention Randolph advocated a strongly centralized Government, the prohibition of the importation of slaves, and a plural executive, suggesting that there should be three executives from different parts of the country, and refused to sign the Constitution because too much power over commerce was granted to a mere majority in Congress, and because no provision was made for a second convention to act after the present instrument had been referred to the States. In Oct. 1787 he published an attack on the Constitution; but in the Virginia convention he urged its ratification, arguing that it was too late to attempt to amend it without endangering the Union, and thinking that Virginia's assent would be that of the necessary ninth State. In 1788 he refused re-election as governor, and entered the house of delegates to work on the revision and codification of the State laws (published in 1794).

Service in Cabinet.—In Sept. 1789 he was appointed by President Washington first attorney general of the United States. He worked for a revision of Ellsworth's judiciary act of 1789, and especially to relieve justices of the supreme court of the duties of circuit judges, and advocated a Federal code; in 1791 he considered Hamilton's scheme for a national bank unconstitutional; and in 1792–93, in the case *Chisolm* v. *Georgia* before the supreme court, argued that a State might be sued by a citizen of another State.

On Jan. 2, 1794 he succeeded Thomas Jefferson as secretary of State. In 1795 he wrote 13 letters (signed "Germanicus") defending the president in his attack on the American Jacobin or democratic societies. He was the only cabinet member who opposed the ratification of the Jay treaty. Before it was ratified the delicate task of keeping up friendly diplomatic relations with France fell to him. Home despatches of the French minister, Joseph Fauchet, intercepted by a British man-of-war and sent to the British minister to the United States, accused Randolph of asking for money from France to influence the administration against Great Britain. Although this charge was demonstrably false, Randolph when confronted with it immediately resigned, and subsequently secured a retraction from Fauchet; he published *A Vindication of Mr. Randolph's Resignation* (1795) and *Political Truth, or Animadversions on the Past and Present State of Public Affairs* (1796). He died at Carter hall, Millwood, Clarke county, Va, on Sept. 12, 1813.

See M. D. Conway, in his *Omitted Chapters of History disclosed in the Life and Papers of Edmund Randolph* (1888; 2nd ed., 1889).

RANDOLPH, JOHN, of Roanoke (1773–1833), American statesman and orator, was born at Cawsons, Va., on June 2, 1773. Through his father, John Randolph, and his mother, Frances Bland, he was related to the Randolphs of Turkey Island and the Blands of Westover, two of the most conspicuous families of colonial Virginia; and, through an ancestress, Jane Bolling, he was a descendant of the Indian princess, Pocahontas. He received his collegiate education at Princeton, Columbia and William and Mary colleges. In 1799, he was elected to the House of Representatives, after an historic debate with Patrick Henry. In the House, his rise was so rapid that, after the election, in 1801, of Jefferson to the presidency, he was made chairman of the House committee on ways and means, and became the leader of the House Republicans. Soon, however, he drifted away from Jefferson, and lost both chairmanship and leadership. Afterwards he was, for many years, a mere free-lance; but, in 1820, his resolute resistance to the Missouri Compromise made him again a truly powerful figure in the House. After his first election in 1799, he was re-elected to the House, every two years, until 1829 except in 1813, when his opposition to the War of 1812 resulted in his defeat by John W. Eppes, and in 1817, when he declined to be a candidate. After re-election to the House in 1825, he was elected to the U.S. Senate; but he was defeated for re-election by John Tyler In 1807, he was the foreman of the grand jury which indicted Aaron Burr for treason; and he was a prominent member of the famous Virginia Constitutional Convention of 1829–30. In 1830, he was sent by Andrew Jackson on a special mission to Russia. In the succeeding year, he returned, and later denounced, in a series of speeches, the nullification proclamation of Andrew Jackson. He died at Philadelphia on May 24, 1833. Randolph was a passionate partisan of State sovereignty; and, therefore, opposed to a national bank, protection, and Federal internal improvements and interference with slavery; but he disliked slavery, and freed his slaves by his will. He filled with admirable efficiency the chairmanship of the House committee on ways and means. Jefferson said that his "popular eloquence gave him such advantages as to place him unrivalled as the leader of the House."

At the time of the Missouri Compromise, his influence was so great that Henry Clay afterwards declared in a speech: "His acts came near shaking this Union to the centre, and desolating this fair land." After his return to the House in 1827, it was again so great that the failure of John Quincy Adams to be re-elected to the presidency was largely due to it. "Wit and genius *all* allowed him," Thomas H. Benton tells us. "He has probably," declared Horace Binney, "spoken to more listeners than any other man of his day; having been unrivalled in the power of riveting the attention by the force and pungency of his language, the facility and beauty of his enunciation, and the point and emphasis of his most striking manner." Some of Randolph's speeches in Congress are found in every anthology of American eloquence. One of the most brilliant and disinterested, though by no means one of the most useful, of American public men; a captivating talker; a delightful letter-writer; a ripe scholar; a devotee of the horse, the dog and the gun; the scion of old and distinguished family stocks; the lonely occupant, when at Roanoke, of two rude dwellings, in the heart of a primaeval forest, and yet the possessor of a vast landed estate, a numerous retinue of slaves, a splendid stud of thoroughbreds, and a choice library; marked by startling peculiarities of voice, face and form which, once heard or seen, were never forgotten; always eccentric and sick, sometimes actually demented; a party to two duels and many quarrels; dauntlessly intrepid; intensely malignant at times, and yet susceptible also to the tenderest impulses of love and pity, it is not surprising that John Randolph of Roanoke should occupy, in American history, a place that is likely forever to remain unique.

See Lemuel Sawyer, *Biography of Randolph* (1844); Hugh A. Garland, *Life of Randolph* (1850); Henry Adams, *John Randolph* (1882); William Cabell Bruce, *John Randolph* (1922); G. W. Johnston, *Randolph of Roanoke* (1929). (W. C. BE.)

RANDOLPH, PEYTON (1721–1775), American politician, was born at Tazewell Hall, Williamsburg, Virginia, in 1721, a son of Sir John Randolph (1693–1737), the king's attorney for Virginia. He graduated at the College of William and Mary, studied law at the Inner Temple, London, and in 1748 was appointed the king's attorney for Virginia. Randolph wrote the address of remonstrance to the king on behalf of the burgesses against the suggested stamp duties in 1764. His policy was conservative and moderate, and in May, 1765, he opposed Patrick Henry's radical "Stamp Act Resolutions." In 1766 he resigned as king's attorney and was succeeded by his brother John (1727–84). In 1769 he acted as moderator of the privately convened assembly which entered into the non-importation agreement, and in May, 1773, he became chairman of the first Virginia intercolonial committee of correspondence. He presided over the provincial convention of Aug., 1774; was a member of the first Continental Congress, of which he was president from Sept. 5 to Oct. 22, 1774, and was re-elected to Congress in March, 1775. Randolph died of apoplexy in Philadelphia on Oct. 22, 1775. He was provincial grand master of the Masons of Virginia, and was an intimate friend of Washington.

RANDOLPH, THOMAS (1523–1590), English diplomatist, son of Avery Randolph, a Kentish gentleman, was educated at Christ Church, Oxford, and in 1549 became principal of Pembroke College, Oxford, then known as Broadgates Hall. During the reign of Mary, Randolph, who was a zealous Protestant, sought refuge in Paris, where he cultivated the society of scholars. Returning to England after the accession of Elizabeth, he was employed as a confidential diplomatic agent of the English queen in Scotland. Randolph's despatches from Scotland between 1560 and 1585 supply important materials for the history of the political intrigues of that period. In 1568 he undertook a mission to Russia which resulted in the concession by Ivan the Terrible of certain privileges to English merchants; and in 1570 he returned to Scotland. After carrying through certain diplomatic business in France in 1573 and 1576, Randolph returned in January 1581 to Scotland, where the earl of Morton, the regent, had been arrested a few days previously. Randolph, acting on Elizabeth's instructions, intrigued with Angus and the Douglases in favour of a plot to seize the person of the young King James, and to save Morton by laying violent hands on the earl of Lennox. Douglas of Whittingham made revelations which imperilled Randolph, who withdrew to Berwick before the execution of Morton in June 1581. In 1585, when he next visited Scotland, he helped to arrange a treaty between England and Scotland. For the next four years he was chancellor of the exchequer in England, and he died in London in June 1590.

See *Calendar of State Papers relating to Scotland* (1509–1603), 2 vols., ed. M J. Thorpe.

RANDOLPH, THOMAS (1605–1635), English poet and dramatist, was born near Daventry in Northamptonshire, and was baptized on June 15, 1605, Ben Jonson adopted him as one of his "sons." He addressed three poems to Jonson, one on the occasion of his formal "adoption," another on the failure of *The New Inn*, and the third an eclogue, describing his own studies at Cambridge. He was buried in Blatherwick church on March 17, 1634–35.

Randolph's earliest printed work is *Aristippus, Or, The Joviall Philosopher. Presented in a private shew, To which is added, The Conceited Pedlar* (1630). It is a gay interlude burlesquing a lecture in philosophy, the whole piece being an argument to support the claims of sack against small beer. His other authenticated works are: *The Jealous Lovers* (1632); *The Muse's Looking-Glass*; and *Amyntas, or The Impossible Dowry*, a pastoral printed in 1638; and some Latin and English poems. *Hey for Honesty, down with Knavery*, a comedy, is doubtfully assigned to him.

His works were edited by W. C. Hazlitt in 1875

RANDOLPH, a town of Norfolk county, Massachusetts, U.S.A., 16 mi. S. of Boston, on state highway 28, 5 mi. N. of Brockton. Pop. 1930, 6,553; 1940, by the federal census, 7,634. The town was set off from Braintree and incorporated in 1793.

RANDOM, an adjective originally meaning impetuous, hasty, hence done without purpose or aim, haphazard. The term "random work" is used, in architecture, by the rag-stone masons, for stones fitted together at random without any attempt at laying them in courses. (*See* MASONRY.)

RANELAGH, formerly a resort by the Thames in Chelsea, London, England. About 1690 the land lying east of Chelsea Hospital, and bordering the river about the point where Chelsea Bridge now stands, was acquired by Richard, Viscount Ranelagh, later earl of Ranelagh. He built a mansion and laid out gardens, which, in 1742, were thrown open as a proprietary place of entertainment. A building called the Rotunda was erected for concerts, and the gardens became a resort of fashionable society. By the close of the 18th century Ranelagh was ceasing to attract the public, and in 1803 the Rotunda was closed. The buildings were removed, and the grounds passed to Chelsea Hospital.

RANGABÉ, ALEXANDROS-RIZOS (1810–1892), Greek poet, archaeologist and statesman, born at Constantinople in 1810, was the son of Jean-Rizos Rangabé, a celebrated poet and scholar. In 1829, Alexandros entered the ranks of the Bavarian army, but after the establishment of the Greek republic, he returned to his native country, where he became successively minister of education (1833) and director of the royal printing press (1841). In 1844 he became professor of archaeology at the University of Athens, and for the next 12 years, in company with Dr. Bursian, he investigated the ruins of the temple of Juno, near Argos, bringing to light many statues and bas-reliefs, and discovering the entire formation of the building. He died at Athens on Jan. 28, 1892.

Rangabé advocated a revival of the ancient Greek language, and wrote poetry and dramas in Greek, including *Phrosyne*, *The Vigil*, and *The Thirty Tyrants*. He also wrote various archaeological works in French, notably *Antiquités helléniques* (1842–55) and *Antiquités troyennes* (1874).

RANGE: *see* STOVES.

RANGE-FINDERS are used to enable the fire of guns and rifles to be directed with maximum effect. They are indispensable to warships (*see* GUNNERY: *Naval*), coast forts and anti-aircraft guns. Artillery in the field generally relies on accurate maps when such are available, but in open and unmapped country a range-finder is very useful. Infantry require a small and light instrument. In ships weight is unimportant, there are limits to size, while ranges may be 20 miles or more. Coast fort ranges are similar to those of ships, but practically unlimited space is available.

The instruments which have been designed to meet these varied conditions may be divided into three types: (*a*) the self-contained or monostatic. also called short-base or one-man; (*b*) the long horizontal base system, consisting of two azimuth (horizontal angle measuring) instruments and a plotter; and (*c*) the depression range-finder, a single instrument depending for base on its height above the sea.

In each type the base is the base of a triangle, of which the apex is the target. Adjustment of one or both of the angles at the base solves the triangle and usually sets the indicator of the range scale. In type (a) one base angle is a right angle and, since an exceedingly delicate means of adjusting the other is possible, the base may be small. In type (b) adjustment is necessarily coarse, hence a very long base is required, but there are great advantages. In type (c) one angle is again a right angle, while the depression angle can be adjusted with an accuracy intermediate between the other two types. Ships and field army artillery and infantry use only monostatic range-finders, while coast forts may have all three types. Anti-aircraft guns use height-finders which will be described later. (K. F. D.)

(a) MONOSTATIC RANGE-FINDERS

Short-base or monostatic range-finders are those which are entirely self-contained, the instrument itself constituting the base. From a scientific point of view they are perhaps the most interesting of the three types and have been brought very near to human limits of perfection. This is largely due to the work of the British inventors, Messrs. Barr and Stroud, from 1888 onwards. Range-finders vary in length from about 2-ft. to the 100-ft. coast defence range-finders.

In the earliest engagements of the World War the largest in use in the British navy had a base length of only 9 ft., but range-finders up to 30-ft. base and more had been made by Messrs. Barr & Stroud and were in use before the war. One of 15-ft. base was in the Russian navy from 1908. The 9-ft. range-finders were called upon to measure ranges up to 20,000 yards (11 or 12 miles) though originally designed to meet the requirements when the maximum range contemplated was very much less. Modern naval range-finders meeting increased range requirements vary from $4\frac{1}{2}$ ft. to 40-ft. bases.

Many forms of monostatic range-finders have been constructed, commencing with Magellan, an optician, in 1775. The next in importance was Adie, 1860. In 1888, Professors Barr and Stroud produced the first of the long series of range-finding instruments that bear their name.[1]

Two types only are in general use, the "coincidence" and the "stereoscopic." The best known as those of Barr and Stroud, Zeiss and Goerz. The two types are distinguished chiefly by the mode of presentation of the images of the target to the eyes of the observer. As usually constructed the range-finder consists externally of a tube carrying internally at each end a reflector in the form of an "optical square." This is either a "pentagonal" prism or a pair of mirrors inclined to each other at an angle of 45°. The advantage of this type of reflector over a single mirror is that an incident ray is always reflected (within narrow limits) through a constant angle; in this case 90°. The optical distance between the end reflectors constitutes the base length. The end reflectors receive rays of light from the target and reflect them towards the centre of the base, where "eyepiece prisms" are placed to direct them outwards through a single eyepiece, in the coincidence type, or through two separate eyepieces, in the stereoscopic type. Between the end reflectors and the eyepiece prisms are placed object glasses which, with the eyepiece or eyepieces constitute the range-finder telescopes. In addition, there is an optical device to enable the range to be ascertained and provision is made for effecting adjustments.

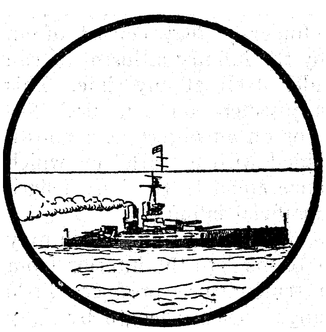

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FIG. 1

In the coincidence type two partial views of the target are seen by one eye in juxtaposition, one above and the other below a fine "separating line," as in fig. 1. The process of "taking a range" consists of operating a device that brings the two partial images into alignment; the range scale then indicates the range.

In a stereoscopic range-finder the two images are presented separately to the two eyes of the range-taker so that the target is seen as in a stereoscope. In the field of view of each eye-piece there is a mark, the two marks being also seen stereoscopically as one. The range is taken by operating an optical device which alters the apparent distance of either the target or the mark until the target and the mark appear to be at the same distance, when the range may be read from the range scale.

Coincidence Range-finders.—As the base is so very small compared with the ranges to be measured, great refinement is essential in the means adopted. If partial images of an object such as a mast are presented to the eye above and below a fine separating line, a want of alignment due to 12 seconds of angle may be detected under ordinary conditions by the unaided eye. In a laboratory this might be reduced to 3 seconds. In this type of observation "the resolving power," as usually defined with regard to telescopic observations, does not apply, nor does the physiological limit of acuity of vision, stated to be 60 seconds.

If the telescopic magnification be 24, a parallax angle of $\frac{1}{2}$ second between the entering beams is detectable. Fig. 2.

If B be the base length and R the range, both in yards, and θ be the apex angle in radians, then, for the small angle concerned

$$\theta = \frac{B}{R} \quad \ldots \quad (1) \quad \text{and} \quad d\theta = -\frac{B}{R^2}\,dR \quad \ldots \quad (2)$$

If then $d\theta$ be taken as $\frac{1}{2}$ second,

$$dR = -\frac{R^2}{400{,}000\,B} \quad \text{approximately} \quad \ldots \quad (3$$

Formula (3) enables us to find the minimum error that is just detectable under good conditions at any range R, with a coincidence range-finder of base B and magnification 24.

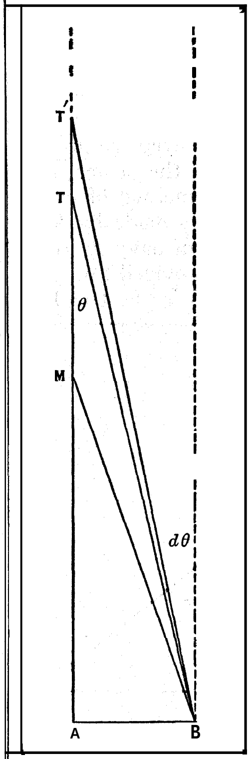

FIG. 2

Equation (3) shows that ranges may be determined within 100 yards with a 9-ft. base up to those of 11,000 yards range, with 15-ft. base up to 14,000 yards and with 30-ft. base up to 20,000 yards and with 100-ft. base up to 36,000 yards.

For the 9-ft. range-finder, if 3,000 yards is the shortest range to be measured, then the largest apex angle is $\frac{3}{3{,}000}$ radian, about 3 minutes of $\frac{1}{20}$, which comprises the whole of the scale corresponding with ranges from 3,000 yards to infinity. At 20,000 yards the apex angle is $\frac{3}{20{,}000}$ radian, about 30 seconds or $\frac{1}{120}$. The difference in angle between 20,000 yards and 20,500 yards is $\frac{3}{4}$ second or the angle subtended by a halfpenny at 43 miles. This will indicate the accuracy of the optical devices to be used.

The optical devices used for effecting coincidence are usually the translational deflecting prism system invented by Barr and Stroud in 1888 or the rotating pair of prisms used by Barr and Stroud in some early types, but chiefly adopted by the continental makers. Other devices have been used, but only these two have survived. Fig. 3 shows the essential parts of a coincidence range-finder.

The eyepiece prisms are shown as crossed mirrors for simplicity. Assuming that the left-hand ray enters the left window at right angles to the base and is directed by the optical system so as to appear in the centre of the field of view, the right-hand ray will enter the right-hand window at an angle depending on the range and the base length. After passing through the object glass the convergent beam of rays is bent through a constant angle by the thin deflecting prism. By sliding the prism longitudinally the

[1]See Proceedings of Institute of Mechanical Engineers, January 1896 and the Dictionary of Applied *Physics*, vol. iv.

image formed by this beam may be so displaced that the eye will see the upper and lower images in alignment. The range may then be read from the range scale, which is rigidly attached to and moves with the prism. Equation (1) shows that the scale is a reciprocal one. The scale may be read through a second eyepiece, or through a special window, or may even be made visible in the main eyepiece at one side of the field of view. It may be

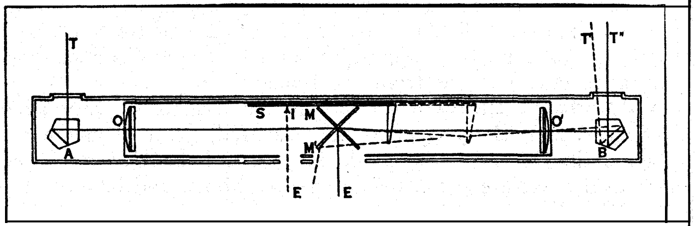

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FIG. 3

noted that there can be no backlash in this arrangement.

The translational prism must be placed in the convergent rays of the telescopic system. The rotating prisms may be placed outside it in the parallel beam. The rotating prisms are mounted in two rings, geared together so as to rotate in opposite directions.

If these prisms have their thin edges vertical and similarly directed, they produce a maximum deviation in the horizontal plane in one sense, and when each is rotated 180° they produce a maximum deviation in the other sense, in neither case producing any deviation in the vertical plane. If they are of equal angle of deviation they produce no deviation in any direction when each is rotated go° from the original position, and it will be evident that as the prisms are rotated equally and in (opposite directions from their original positions they produce a variable deviation in the horizontal plane, while they produce no deviation in the vertical plane. The rotations of such a pair of prisms in a range-finder comprising object glasses and eyepiece prisms, as illustrated in figure 3, therefore provides a means of measuring the angle θ, and a scale of ranges may be associated with the mechanism producing the equal and opposite rotations of the prisms. With suitable modifications such a pair of prisms may be inserted between one of the objectives and the eyepiece prisms, or one of the prisms may be inserted in each of the beams, say, before they enter the end reflectors. This latter method of working was adopted in the first 15-foot range-finders made by Barr and Stroud for the Russian navy and the Italian navy in 1908.

Adjustments. — Two main adjustments are provided for. The *halving* adjustment is to ensure that the images in the two half

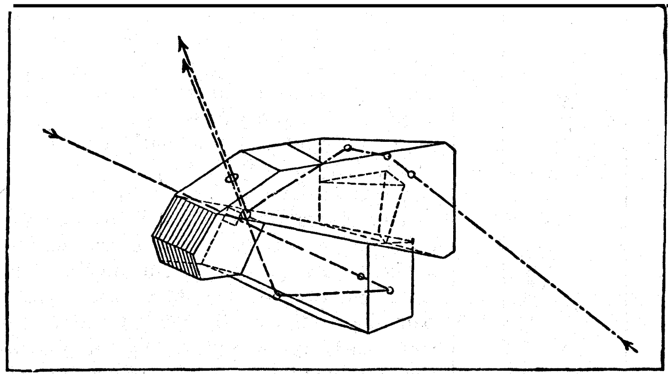

FIG. 4

fields are neither duplicated nor that any part is missing at the separating line. This may be effected by suitably swinging about a horizontal axis a parallel plate of glass placed between one object glass and the eyepiece prism. The *infinity* adjustment is provided to permit of any small index error being removed. For this purpose the images of an infinitely distant object such as the moon or a star are set in coincidence and the scale is then set independently to read infinity. During ordinary range-taking the scale and prism are moved together.

Eyepiece prisms or "centre-prism-combinations" of many different varieties have been produced so as to present various effects in the field of view. (*See* Barr and Stroud's *Patent Specifications* from 1888 onwards.) For instance, both partial images may be erect, as shown in fig. 3, or the lower image may be erect and the upper image inverted. The latter type is often used in field range-finders. Again one side of the range-finder may produce nearly the whole field of view, while the other side is made to produce a narrow strip across the centre. Again, in this narrow strip, the view may be inverted. One type of eyepiece prisms from a German range-finder is shown in fig. 4. It gives an inverted strip field and shows the range scale at the side of the field of view. In all coincidence range-finders the fineness of the dividing line is important.

Stereoscopic Range-finders. — Externally these resemble the coincidence type very closely. The complicated eyepiece prism system is, however, replaced by two fairly simple prisms, each with, its own eyepiece. The adjustments provided are also, in general, similar: but an additional adjustment is required to ensure that the stereoscopic marks are in register with each other. The optical devices for producing stereoscopic movement may be similar to those in the coincidence type. For example, the Levallois stereoscopic height-finder, an instrument of French make, makes use of one fixed and also of one translational prism.

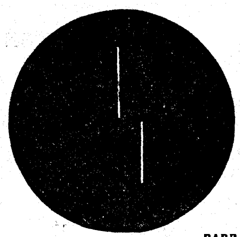

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FIG. 5

There does not seem to be much difference between the accuracy of the two types when used by experts in each. The chief disadvantages of the stereoscopic range-finder in service use are that fewer men can be found with a sufficiently acute stereoscopic sense and that this stereoscopic sense is liable to occasional large errors and to complete derangement if the operator be subjected to fatigue or mental strain. For these reasons they have always been regarded with suspicion in the British service.

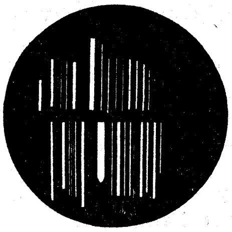

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FIG. 6

Other adjuncts to monostatic range-finders are *astigmatisers* and *internal adjusters.* Astigmatisers as used in coincidence range-finders are thin cylindrical lenses which may be inserted in the telescopic systems at will. Their effect is to draw the images into vertical streaks.

They are useful for taking the range of ill-defined objects, very small objects and of lights. Fig. 5 shows the effect on a star and fig. 6 the effect on a group of lights.

Internal adjusters, of which there are several types, are provided in some of the larger range-finders. They consist of an arrangement of optical parts whereby the infinity adjustment can be carried out within the range-finder itself at any time. This method cannot, however, replace adjustment on a natural "infinity," such as a star or the moon, or on an object at a known range. Small range-finders are provided with a "lath" on which are two marks separated by a distance equal to the base length of the range-finder, constituting an artificial infinity.

General Construction. — The main body is a tube, which may be double with an air space in order to insulate the interior from heat. A general expansion due to temperature produces little effect. A change of 50° F may change the base length by $\frac{1}{30}\%$ and can be detected by a go-foot range-finder only at ranges below 3,000 yards. Differential expansion due to the use of different materials in the various parts is taken into account in the design of the details. As the end reflectors are optical squares a very slight bend of the main tube will produce little or no effect on the range adjustment due to angular movement of the reflectors.

The object glasses, halving and coincidence adjusters, astigmatisers, eyepiece prisms and translational prism are carried in an "inner frame" "geometrically" supported within the main tube, which carries the eyepieces, end reflectors and, when used, rotational prisms. The main tube may be carried on a mounting designed to facilitate the use of the range-finder.

Uses.—In the field small range-finders up to one metre base length are in use. They are handled by one man and are carried either by the man or on a horse or in a vehicle. In the case of the instruments used in ships and forts, which are much larger and are mounted on pedestals or in turrets, although one man is sufficient to "take the range," he is assisted by others in directing the instrument and reading the scale. In battleships and cruisers a range-finder is usually carried in each gun turret, where it is subject to severe shocks.

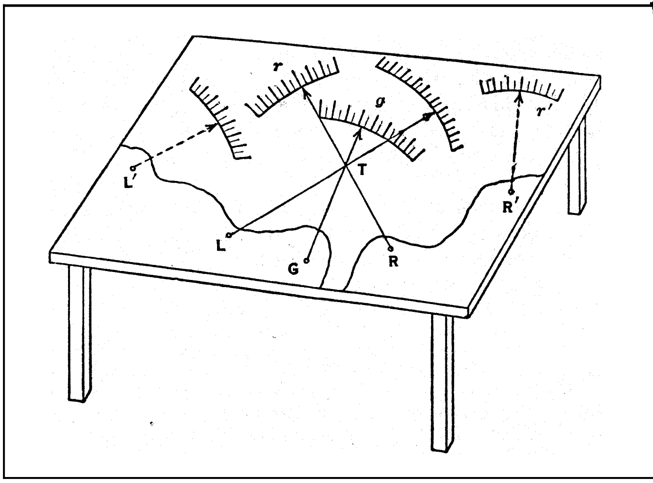


FIG. 7.—PLOTTING TABLE FOR LONG BASE RANGE-FINDING SYSTEM

For descriptions of the various details see publications mentioned in the bibliography. (X.)

(b) THE LONG HORIZONTAL BASE SYSTEM

While details of the long horizontal base range-finding system are usually secret, the principle may be indicated. Fig. 7 shows a simple plotting table or plotter, covered with a chart. R and L represent two azimuth observing instruments at distant posts. The observers lay their telescopes on the target and telephone the angles to the plotter. Arms RT and LT, provided with suitable arcs *r* and I, are set to these angles. Then their intersection T is the position of the target. If G is a gun position, a graduated arm GT with arc *g* will give the range and bearing of the target from the gun G. If the target moves, T will trace its course on the chart, the speed can be ascertained,

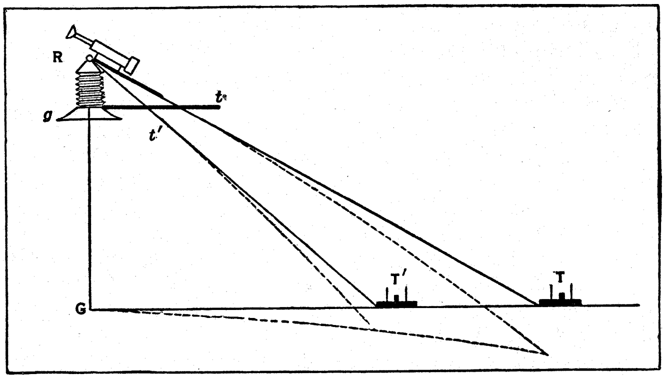


FIG. 8.— PRINCIPLE OF DEPRESSION RANGE-FINDER

and data can be sent to the gun continuously. Thus the gun can be fired at a target which may be invisible from the gun position. Other observing stations such as R′ and L′ may be used alternatively to either R or L, if either or both of these cannot see the target or if the apex angle RTL becomes less than about 10°. Thus the system is very flexible. Disadvantages are the necessary communications and the difficulty of ensuring that both observers are on the same target if several targets are close together; but great accuracy is possible. A simplification is to mount a telescope on one of the arms and use the plotter as an azimuth observing instrument.

The triangle RTL has been solved electrically by employing the logarithmic sine formula (*e.g.,* Pollak, J. E., Br. Pat. 218548). The azimuth instruments actuate rheostats to give the apex angle. Other rheostats then solve the logarithmic sine formula to give the range LT or RT. The plotting board system in various forms is in universal use.

(c) DEPRESSION RANGE-FINDER

In fig. 8 TT' are targets on the sea GT'T. Rgt represents the range-finder on a cliff *g*G The bar gt't is levelled and represents the sea. The height screw Rg represents the height RG and can also allow for tide, while the arm Rt is pivoted at R and carries a

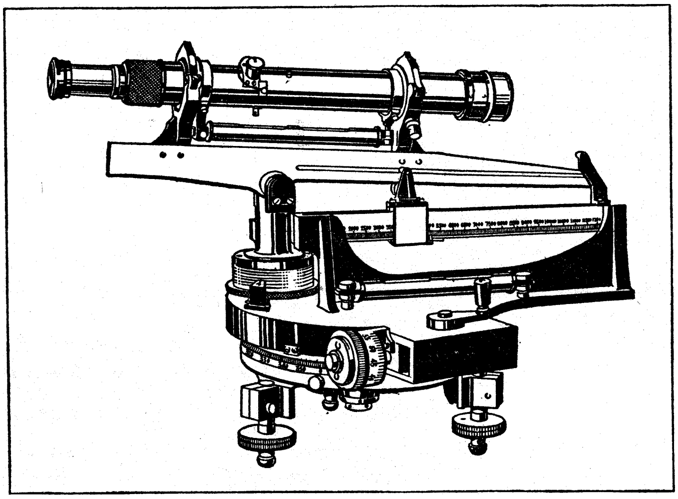


FIG. 9.— DEPRESSION RANGE-FINDER

telescope which can be directed at the water-line of a target by moving a slider along *gt*. The triangles RGT′T and R*gt′t* are then similar and so the bar *gt′t* may be graduated in ranges. curvature of the earth and atmospheric refraction, indicated by dotted lines, may be compensated for by suitably curving the telescope arm R*t*. The pivot R may be displaced laterally from *g* to represent the distance of the range-finder from the gun. The triangle RGT of fig. 8 (*q.v.*) is then reproduced, and the range indicated will be that from the gun. If a chart is placed under the bar *gt′t,* the position of T can be plotted and the instrument becomes a depression position finder. The useful limits of depression instruments are 4,000 to 5,000 yards for every 100 ft. of height above the sea, the accuracy of the "lay" being 10–15 seconds of arc.

The type *(b)* and *(c)* instruments used in the British service, together with their electrical operating devices, and certain field range-finders now replaced by type (*a*) were invented by Col

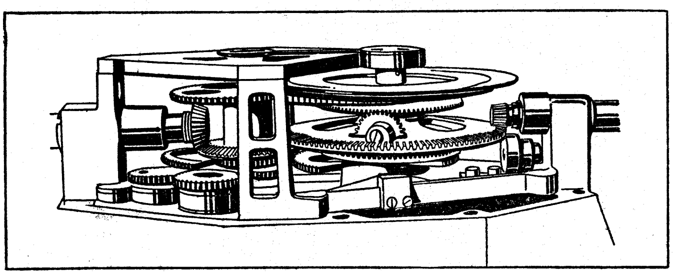


FIG. 10.— HEIGHT CONVERSION GEAR OF BARR & STROUD RANGE-FINDER

H. S. S. Watkin between 1886 and 1899. This was a stupendous achievement at a time when no good range-finder existed.

Height-finders.— The factor which is liable to least alteration in the flight of an aeroplane is its height. Anti-aircraft guns therefore base their calculations on height and angle of sight (elevation) instead of range, and so require height-finders. These are of the types (a) and *(b)*, *q.v.*

Monostatic Height-finders are actually range-finders with the addition of computing gear, based on some form of the equation, height = range × sin. angle of sight (or elevation). The Barr and Stroud is a coincidence range-finder with a beautiful logarithmic toothed cam gear. The French Lavallois is stereoscopic with a triangular link gear. Both these gears are so arranged that adjustment is only lost when the height alters, the necessary movement of the translational prism for range being effected automatically by that part of the computing gear which is controlled by the elevation movement of the main tube. This principle is essential for all height-finders.

In an optical solution, Rottenburg and Willans (Br. Pat. 125164, 1916) split the Barr and Stroud prism into two halves, rotating them in opposite directions through the angle of sight. The translational movement was then a measure of height, not range.

Long Base Height-finders. — These depend on the Bennett-Pleydell or "roof" principle. In fig. 11, T is an aerial object. LA*ar* and RA*ar* are two planes (Bennett planes) capable of being rocked about horizontal axes Ll and Rr (Bennett axes) at the ends of a measured base LR, at right angles to it and parallel to each other. The planes can be rocked about their axes so that their intersection A*a* (the ridge of the "roof") passes through it. If LAR is a vertical plane cutting the roof, then the perpendicular AP is the height of the ridge and therefore of T, wherever T may be along the ridge. If the base LR is b, then the height $h = \dfrac{b}{\cot L + \cot R}$. The angles ART and ALT are known as "sweep" angles. In practice the instruments at L and R have telescopes mounted on universal

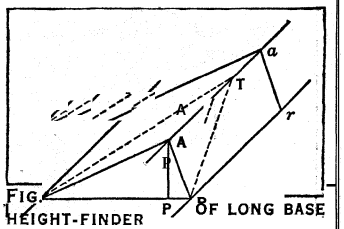


FIG. 11. — HEIGHT-FINDER ... OF LONG BASE

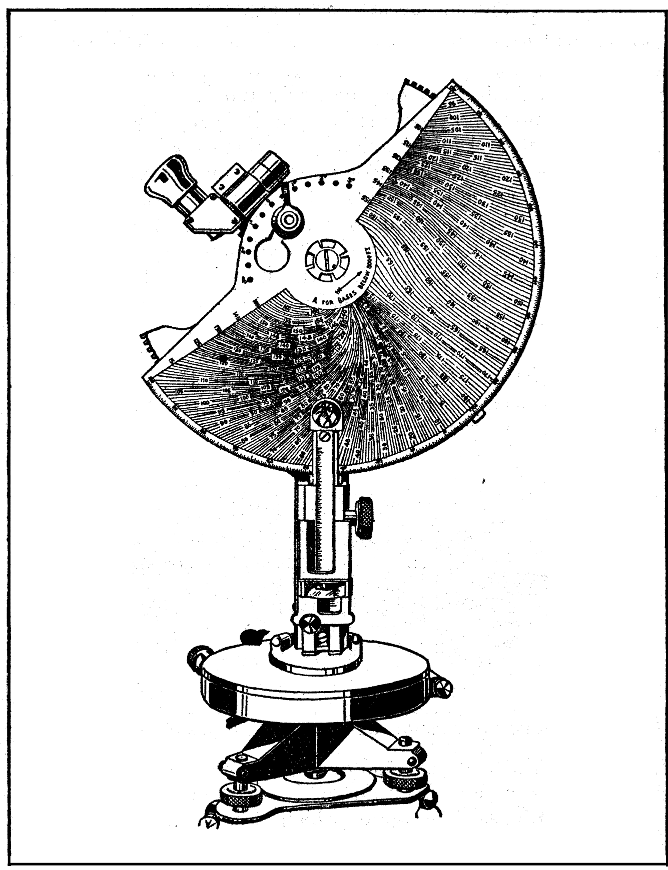


FIG. 12. — LONG BASE HEIGHT-FINDER INSTRUMENT

joints, of which the main (Bennett) axes are horizontal and set at right angles to LR. Movement about these registers the Bennett angles, while movement about the sweep axes allows the telescopes to be swept along the ridge without affecting the Bennett angles,

The formula can be solved in various ways to give the height. The latest British instruments are a copy of the French Puteaux, Modèle 1917. A semicircular plate, covered with curves of Bennett angles is attached to the telescope so as to swing with it about the Bennett axis. A vertically sliding pointer, engraved with a scale of heights, is carried on the body of the instrument and can be moved up or down to touch any curve on the plate. When L and R have laid their telescopes on the target, L telephones his Bennett angle to R, who then moves the pointer to that curve and reads the height opposite the indicator of the height scale. Further if L telephones his angles continuously, R will find that his disc brings the corresponding curves to the height pointer as L calls them through; if not, the height has altered. Cf. constant height constant coincidence of monostatic type.

The disadvantages of this system are similar to those of type (b) range-finders (*q.v.*). Hence, though this type has its uses, the monostatic is more generally relied on; as it is quicker in operation, speed being essential, and there is no confusion of targets.

Bibliography.—F. J. Cheshire, "Rangefinder, Short-base," *Dictionary of Applied Physics*, Vol. IV.; Alex. Gleichen, *Theory oj Modern Optical Instruments*, Eng. trans.: by H. H. Emsley B.Sc. and W. Swaine B.Sc. 1st Edition (H.M. Stationery Office, 1918). Publications of Messrs. Barr and Stroud, Zciss, Goerz, Hahn, *Soc. Anon. d'Optique et d'Instruments d'Haute Précision;* British and Foreign Pat. Specifications; Military handbooks of Range-finders (H M. Stationery Office). (K. F. D)

RANGER, a city of Eastland county, Texas, U.S.A., 100 m. W. by S. of Fort Worth, at an altitude of 1,429 ft.; on federal highway 80, and served by the Texas and Pacific and the Wichita Falls and Southern railways. Pop. 6,208 in 1930; in 1940, 4,553 (95% native white) by the federal census. Oil was discovered on Oct. 21, 1917, and within a few weeks the town of 500 inhabitants was transformed into a camp of 30,000 living in tents and shacks, half of this number becoming permanent residents when the first boom was over. It is the field headquarters of several large refining companies and manufacturers of casinghead gasoline, shipping over 5,000,000 gal. in a month. The city is surrounded by a rich farming and poultry-raising region, and has the largest rock-crusher in the state. Ranger was the site of an old fort which was headquarters of the Texas Rangers. It was chartered as a city in 1919.

RANGOON, the capital of Burma, situated on the left bank of the Hlaing or Rangoon river, 21 m. from the sea, in 16° 47' N. and 96° 13' E. In 1880 the city was detached from the main district, called Hanthawaddy, and formed into a separate district, with an area of 19 sq.m. This has since been continually increased; the census area of Rangoon town district in 1931 was 77 sq.m. with a population of 400,000. Since Aug. 1, 1926, the district has formed part of the Pegu division. Rangoon, from being a comparatively insignificant place, rose in less' than half a century to be the third seaport in British India, being surpassed only by Calcutta and Bombay in the volume of its trade. During the busy season of rice-export, which lasts from the end of December to the middle of May, the pool forming the port of Rangoon presents almost as crowded a scene as the Hugli at Calcutta. Rangoon has the double advantage of being situated near the sea and in easy communication with a great river navigable for 900 m. behind it. It is, in addition, the centre of the Burmese railway system. In the broad and deep river is concentrated the whole of the rich trade of the delta of the Irrawaddy. Great part of the river frontage is occupied with rice-mills, teak wharves and similar buildings. The need for wharfage accommodation has resulted in recent years in the majority of the mills being removed to the opposite or Dalla shore of the Rangoon river, or along the banks of the Pegu river east of Rangoon. The rice exported from Rangoon in the years 1922–3 to 1926–7 averaged nearly 2,000,000 tons.

Architecture and History. — The city is dominated by the great golden pile of the Shwe Dagôn pagoda, the centre of Burmese religious life. Rising to a height of 368 ft., this magnificent building is loftier than St. Paul's cathedral in London, and its size is greatly enhanced by the fact that it stands on an eminence that is itself 168 ft. above the level of the city. It is covered with pure gold from base to summit, and once in every generation this gold is renewed by public subscription. The pagoda is a solid stupa of brick, in the form of a cone, raised over a relic chamber; and the place of worship is the surrounding platform with a perimeter of nearly 1,400 ft.

Though traditionally a site of great sanctity, Rangoon owes its first importance to its rebuilding in 1753 by Alompra, the founder of the Burmese monarchy, who gave it the name of Yan *Kon,* "the end of the war." The present Burmese designation of the town is Yandoon. An English factory was opened here about 1790. On the outbreak of the first Burmese War, in 1824, the city was taken by the British, but subsequently restored. It was captured a second time in 1852, and passed with the province of Pegu into the hands of the British. It was destroyed by fire in 1850, and serious conflagrations occurred again in 1853 and 1855.

Administration and Improvements. — Until 1874, when the existing municipality was constituted, the administration was in the hands of the local government, which devoted itself to raising the centre of the town above the river level, providing land fit for building purposes from the original swamp, which was flooded at spring-tides, and making roads, bridges, culverts and surface drains. In 1892 was introduced the sewage system, and now Rangoon has an excellent drainage system. The water supply, drawn at first from the Victoria lake, 5 m. distant, is now mainly from a large reservoir lake 17 m. distant. The city proper of Rangoon with the Kernmendine suburb is laid out on the block system, each block being 800 by 860 ft., intersected with regular streets. The city is now well lit with electric light, and has an extensive electric tramway system, recently supplemented by motor bus services. Rangoon has many fine public buildings including the Secretariat, the Law Courts, Post Office and General Hospital.

There are two large maidans, or commons, which are used as military parade grounds and for sport, the larger being used as a golf links. There are spacious and well kept zoological gardens, botanical gardens and an extremely pretty and well-kept garden in the cantonments under the pagoda. Beyond these lie the Royal Lake and Dalhousie park, with 160 acres of water and well-laid out and well-timbered park land, indeed, quite the finest in the East. There are two cathedrals, Church of England and Roman Catholic, a Presbyterian church, and churches of most denominations with services in English, Burmese and the principal Indian languages. Buddhists, Hindus, Mussulmans, Parsees, Armenians and Jews all own lands and pagodas, temples, mosques, churches and synagogues.

The chief educational institution is the University of Rangoon, constituted in 1920 and embracing two colleges. One, University college, was formerly known as Rangoon college and was affiliated to Calcutta university. The other, Judson college, is run in connection with the American Baptist Mission organization. The university has recently (1928) been moved to magnificent new buildings overlooking the Victoria or Great lakes. In 1926–27 there were 1,068 regular students in University college and 315 in Judson college. There are also numerous secondary and high schools in Rangoon.

Rangoon can now boast most of the amenities of a western city, including several excellent hotels, a number of cinemas, the largest of which are used for stage plays by travelling companies, fine shops and a number of clubs notably the Gymkhana, Pegu, Golf and Boat clubs. The European residences are mainly on the outskirts of the city to the north-west in what is still called the cantonments. The military lines have, however, recently been moved, in the main, to new cantonments at Mingalodon, 12 m. to the north of Rangoon. At Mingalodon is one of the finest 18 hole golf courses in the East. The development of Rangoon is now in the hands of the Rangoon Development Trust which administers the Rangoon Government Estate on behalf of the Government. The Trust develops the land, and then hands over the completed roads, etc., for maintenance by the Rangoon corporation. A magnificent race course at Kyaikasan was completed in 1926.

The affairs of the port are administered by the Rangoon port commissioners, and Rangoon handles about 85 or 86 per cent of the total trade of the province. Rangoon town is the business centre of Burma, but the rice-milling (at Dalla), ore-refining (at Syriam) and teak working, which form the staple industries, are carried on outside the town proper. The chief exports of Rangoon, with quantities in tons in 1926–27 are rice (1,734,565), bran and pollard (196,152), mineral oils (666,426), timber (215,577), oil cake (71,115), pulse (55,430), lead (51,859), zinc ore (46,452), wax, candles, cotton, oilseed and tobacco. The leading imports are noted under Burma. The port is visited yearly by about 1,650 vessels (1,450 steamers), with a total gross tonnage of between 6,000,000 and 7,000,000 tons.

Most of the labour in the port and the town is immigrant Indian labour; much of the skilled labour, especially in the building trades, is supplied by Chinese. The traders and clerical communities are also mainly Indians. Rangoon is by no means a Burmese city, and out of a population of 341,962 in 1921 there were only 112,000 Burmese, compared with 125,000 Hindus, 62,000 Muslims, 25,000 Christians (mainly Europeans and half-castes, officially styled Anglo-Indians) and 12,000 Chinese.

See references under Burma *see* also *Administration Report of the Commissioners for the Port of Rangoon* (annual), *Report of the Rangoon Development Trust* (annual) and *Report on the Municipal Administration of the City of Rangoon* (annual).

RANGPUR, a town and district of British India, in the Rajshahi division of Bengal. The town is situated on the little river Ghaghat. Pop. (1931) 20,749. It is a long straggling town, with a railway station at one end and the public offices 3 m. away at the other.

The DISTRICT OF RANGPUR, with an area of 3,496 sq m. and a population (1931) of 2,594,785, is one vast plain. The greater part of it, particularly towards the east, is inundated during the rains, and the remainder is traversed by a network of streams. The river system is constituted by the Brahmaputra and its tributaries, chief of which are the Tista, Dharla, Sankosh and Dudhkumar. About three-fourths of the district is under continuous cultivation. The staple crops are rice, oil-seeds, jute and tobacco. The east district is well served by railways. Saidpur (pop. 16,519), with the workshops of the metre-gauge system of the E. Bengal State railway, is an important railway town.

RANJIT SINGH, MAHARAJA (1780–1839), native Indian ruler, was born on Nov. 2, 1780, the son of Sirdar Mahan Singh, whom he succeeded in 1792 as head of the Sukarchakia branch of the Sikh confederacy. By birth he was only one of many Sikh barons and owed his rapid rise entirely to force of character and will. At the age of 20 he obtained from Zaman Shah, the king of Afghanistan, a grant of Lahore, which he seized by force of arms in 1799. Subsequently he attacked and annexed Amritsar in 1802, thus becoming master of the two Sikh capitals. When Jaswant Rao Holkar took refuge in the Punjab in 1805, Ranjit Singh made a treaty with the British, excluding Holkar from his territory. Shortly afterwards acute difficulties arose between him and the British as to the Cis-Sutlej portion of the Punjab. It was Ranjit Singh's ambition to weld the whole of the Punjab into a single Sikh empire, while the British claimed the territory south of the Sutlej by right of conquest from the Mahrattas. The difference proceeded almost to the point of war; but at the last moment Ranjit Singh yielded. In 1808 Charles Metcalfe was sent to settle this question with Ranjit Singh, and a treaty was concluded at Amritsar on April 15, 1809.

The Maharajah organized a powerful force, which was trained by French and Italian officers such as Generals Ventura, Allard and Avitabile, and thus forged the formidable fighting instrument of the Khalsa army, which afterwards gave the British their hardest battles in India in the two Sikh wars. In 1810 he captured Multan after many assaults and a long siege, and in 1820 had consolidated the whole of the Punjab between the Sutlej and the Indus under his dominion. In 1823 the city and province of Peshawar became tributary to him, In 1833 when Shah Shuja, flying from Afghanistan, sought refuge at his court, he took from him the Koh-i-noor diamond, which subsequently came into the possession of the British crown. Though he disapproved of Lord Auckland's policy of substituting Shah Shuja for Dost Mohamed, he loyally supported the British in their advance on Afghanistan. He was known as "The Lion of the Punjab." Ranjit Singh died of paralysis on June 27, 1839. *(See* also PUNJAB: *History.)*

See Sir Lepel Griffin, *Ranjit Singh* (Rulers of India Series), 1892; General Sir John Gordon, *The Sikhs,* 1904; and S. S. Thorburn, *The Punjab in Peace and War,* 1904.

RANJITSLNHJI, KUMAR SHRI (1872–1933), maharajah of Nawanagar, was born at Sarodar in Kathiawar, India, on Sept. 10, 1872. By race a Rajput, he was educated first at Rajkumar college, Rajkot, and afterwards at Trinity college, Cambridge. He did not get his "blue" until his last year, 1893, but thereafter leaped at once into the highest place in English cricket. From 1895–1904 he played for Sussex, and was captain from 1899–1903. He also played occasionally afterwards, his last appearance being in 1920. He went to Australia with Stoddart's team in 1897–98, and took a team to America in 1899. He made in all 14 scores of over 200, and in 1900, his greatest year, made over 3,000 runs for an average of 87, and over 200 five times. His greatest feat was at Hove against Middlesex. On the last day of the match, on a bad wicket, he made 202, when Vine (17) was the only other man on the side to get into double figures.

On his cousin's death in 1907 he succeeded as chief of the State of Nawanagar, and has proved an enlightened ruler. He provided troops for the Allies in the World War, and himself served at the front. He represented the Indian States at the League of Nations Assembly in 1920, and became vice-chancellor of the Indian Chamber of Princes. He died April 2, 1933.

He wrote *The Jubilee Book of Cricket* (1897); *With. Stoddart's Team in Australia* (1898); *How to Play Cricket* (1906).

See P. C. Standing, *Ranjitsinhji, Prince of Cricket* (1903); Beldam and Fry, *Great Batsmen* (1905); *Scores and Biographies,* vol. xv. (1925).

RANKE, LEOPOLD VON (1795–1886), German historian, was born on Dec. 20 or 21, 1795, at Wiehe, in Thuringia. He studied classics and theology at Halle and Berlin. In 1818 he began to teach history in a school at Frankfort-on-the-Oder, thereby entering the service of the Prussian Government.

With the scholar's dislike of textbooks. he rapidly acquired a thorough knowledge of the ancient historians, quickly passed on to mediaeval times, and determined to make a study of universal history. At Frankfort he wrote his first work, *Geschichte der romanischen und germanischen Völker 1494–1514* (1824), which included a critical dissertation on the historians of this period *(Zur Kritik neuerer Geschichtschreiber),* exposing the untrustworthiness of much traditional history. This dissertation was as important for modern history as the critical work of Niebuhr had been in ancient history. A copy of the book was sent to the Prussian minister of education, K. A. Kamptz, and Ranke was appointed supernumerary professor in the University of Berlin, and began his 50 years' connection with the university. His *Fürsten und Völker von Südeuropa im* 16 *und* 17 *Jahrhundert* (1827) was based on the study of ms. records in the Berlin library. In later editions the book was called *Die Osmanen und die spanische Monarchie.* The Prussian Government now provided him with means to prosecute his researches abroad. He visited Vienna, where the friendship of Gentz and the protection of Metternich opened to him the Venetian archives, of which many were preserved in that city—then a virgin field. He wrote a short book on *Die serbische Revolution* (1829), afterwards expanded into *Serbien und die Türkei im* 19 *Jahrhundert* (1879), from material supplied to him by Wuk Stephanovich, a Serbian who had himself been witness of the scenes he related. He spent three Years (1828–31) in Italy. The recommendations of Metternich opened to him almost every library except the Vatican.

For a time Ranke was editor of a periodical in which Friedrich Perthes sought to defend the Prussian Government against the democratic press. He failed; men desired not the scientific treatment of politics, but satire and invective. He earned the hatred and suspicion of the liberals and did not satisfy the Prussian conservatives, and after four years the *Historisch-Politische Zeitschrift* came to an end. Two-thirds of the matter had been contributed by the editor, and the two stout volumes in which the numbers were collected contained the best political thought which had for long appeared in Germany. For Ranke the failure was not to be regretted; the rest of his life was to be wholly devoted to history proper. *Die römischen Päpste, ihre Kirche und ihr Staat im* 16 *und* 17 *Jahrhundert* (3 vols., 1834–36, and many other editions), in form, as in matter, the greatest of his works, contains the results of his studies in Italy. The English translation by Mrs. Austin was the occasion of one of Macaulay's most brilliant essays. Before it was completed Ranke had already begun the researches for the second of his masterpieces, his *Deutsche Geschichte im Zeitalter der Reformation* (1839–47), a necessary pendant to his book on the popes. In 1837 he became full Professor at Berlin; in 1841 Frederick William IV. appointed him Prussian historiographer. In this capacity he wrote the *Neun Bücher preussischer Geschichte* (1847–48), a work which makes severe demands on the attention of the reader—he is the "Dryasdust" of Carlyle's Frederick; but in it he laid the foundation for the modern appreciation of the founders of the Prussian State. The nine books were subsequently expanded to 12 (Leipzig, 1874). His *Französische Geschichte, vornehmlich im 16 und 17 Jahrhundert* (Stuttgart, 1852–61) was followed by his *Englische Geschichte, vornehmlich im* 16 *und* 17 *Jahrhundert* (1859–68). This, the longest of his works, lacked something of the freshness of his earlier books; he was over 70 when it was completed, and he was never quite at home in dealing with the foundations of English public life. In his 81st year he began to write the *Weltgeschichte* (9 vols., Leipzig, 1883–88). Drawing on the knowledge accumulated during 60 years, he had brought it down to the end of the 15th century before his death in Berlin on May 23, 1886.

Ranke's other writings include *Zur deutschen Geschichte vom Religionsfrieden bis zum 30-jährigen Kriege* (Leipzig, 1868); *Geschichte Wallensteins* (Leipzig, 1869; 5th ed., 1896); *Abhandlungen und Versuche* (Leipzig, 1877; a new collection of these writings was edited by A. Dove and T. Wiedemann, 1888); *Aus dem Briefwechsel Friedrich Wilhelms IV. mit Bunsen* (Leipzig, 1873); *Die deutschen Mächte und der Fürstenbund. Deutsche Geschichte 1780–90* (1871–72); *Historisch-biographische Studien* (Leipzig, 1878); *Ursprung und Beginn der Revolutionskriege 1791–92* (Leipzig, 1875); and *Zur Geschichte von Oesterreich und Preussen zwischen den Friedensschlüssen zu Aachen und Hubertusberg* (Leipzig, 1875). He also wrote biographies of Frederick the Great and Frederick William IV. for the *Allgemeine Deutsche Biographie.*

Ranke married, at Windermere, in 1843, Miss Clara Graves, daughter of an Irish barrister. She died in 1870, leaving two sons and one daughter.

At the time of his death Ranke was generally regarded as the first of modern historians. His reputation was due, in part, to his success as a teacher. In his more private classes, where he dealt with the technical work of a historian, he trained generations of scholars. No one since Heyne has had so great an influence on German academical life, and for a whole generation the Berlin school had no rival. Ranke's example and training has made it impossible for any one to attempt to write modern history except on the "narratives of eye-witnesses and the most genuine immediate documents" preserved in the archives. He was determined never to allow himself to be misled, in his search for truth, by those theories and prejudices by which nearly every other historian was influenced—Hegelianism, Liberalism, Romanticism, religious and patriotic prejudice.

Many of Ranke's works have been translated into English. Among these are *Civil Wars and Monarchy in France,* by M. A. Garvey (1852); *History of England, principally in the 17th Century* (1875); *History of the Latin and Teutonic Nations,* 1494–1514, by P. A. Ashworth (1887) and again by S. R. Dennis (1909); *History of the Reformation in Germany,* by S. Austin (1845–47); *History of Servia and the Servian Revolution,* by Mrs. A. Kerr (1847); *Ferdinand I. and Maximilian II. of Austria; State of Germany after the Reformation,* by Lady Duff Gordon (1853); *Memoirs of the House of Brandenburg and History of Prussia during the 17th and 18th Centuries,* by Sir Alexander and Lady Duff Gordon (1849); and *History of the Popes during the 16th and 17th Centuries,* by S. Austin (1840; new eds., 1841 and 1847), by W. K. Kelly (1843), and by E. Foster (1847–

53). A collected edition of Ranke's works in 54 volumes was issued at Leipzig (1868–90), but this does not contain the *Weltgeschichte.*

For details of Ranke's life and work *see* his own *Zur eigenen Lebensgeschichte*, edited by A. Dove (Leipzig, 1890); and the article by Dove in the *Allgemeine deutsche Biographie*. *See* also Guglia, *Leopold von Rankes Leben und Werke* (Leipzig, 1893); M. Ritter, *Leopold von Kanke* (Stuttgart, 1895); H. F. Helmolt, L. *Rankes Leben und Wirken* (Leipzig, 1921) and H. Oncken, *Aus Rankes Frühzeit* (Gotha, 1922).

RANKIN, a borough of Allegheny county, Pennsylvania, U.S.A., on the Monongahela river, 9 mi. S.E. of the centre of Pittsburgh, adjoining Braddock and North Braddock (*qq.v.*). It is served by the Baltimore and Ohio, the Pittsburgh and Lake Erie, the Pennsylvania and the Union railways. Pop. (1920) 7,301 (36% foreign-born white and 12% Negroes); in 1940, 7,470. Rankin, Braddock and North Braddock form one community.

RANKINE, WILLIAM JOHN MACQUORN (1820–1872), Scottish engineer and physicist, was born at Edinburgh on July 5, 1820, and completed his education in its university. He was trained as an engineer under Sir J. B. Macneill, working chiefly on surveys, harbours and railroads, and was appointed in 1855 to the chair of civil engineering in Glasgow. Rankine was the earliest of the three founders of the modern science of thermodynamics (*q.v.*) on the bases laid by Sadi Carnot and J. P. Joule respectively, and the author of the first formal treatise on the subject; 150 scientific papers are credited to him in the Royal Society's Catalogue. The more important of these were collected and reprinted in Rankine's Scientific Papers (1881), which contains a memoir of the author by Prof. P. G. Tait. Rankine died at Glasgow on Dec. 24, 1872.

See also his *Civil Engineering, The Steam-Engine and other Prime Movers, Machinery and Millwork,* and *Applied Mechanics.*

RANNOCH, district of north-west Perthshire, Scotland, partly extending into Argyllshire. It measures 32 m. E. and W. and from 10 to 12 m. N. and S. and is surrounded by the districts of Badenoch, Atholl, Breadalbane, Lorne and Lochaber. Dugald Buchanan (1716–68), the Gaelic poet, was schoolmaster of the village, and a granite obelisk has been erected to his memory.

RANSOM, the price for which a captive in war redeemed his life or his freedom, a town secured immunity from sack and a ship was repurchased from her captors. The customs of feudal warfare recognized that captives of knightly rank had the right of buying their liberty from their captors. It was the duty of a feudal tenant to contribute towards his lord's ransom, and a king would often show his appreciation of a knight's services by redeeming him from captivity. The practice introduced a commercial element into mediaeval warfare, which became very prominent in the Hundred Years War between England and France and in the internal wars of Italy in the 15th century. In the former war, the ransom paid by John, king of France, and David II., king of Scotland. sensibly relieved the finances of Edward III.'s administration and at an earlier date the ransom paid by Richard I. to the emperor led to the introduction of new financial devices which are important in the history of English taxation.

RANTERS, an antinomian and spiritualistic English sect in the time of the Commonwealth, who may be described as the dregs of the Seeker movement. Their central idea was pantheistic.

See Rufus M. Jones, *Studies in Mystical Religion,* 1909, ch. xix.

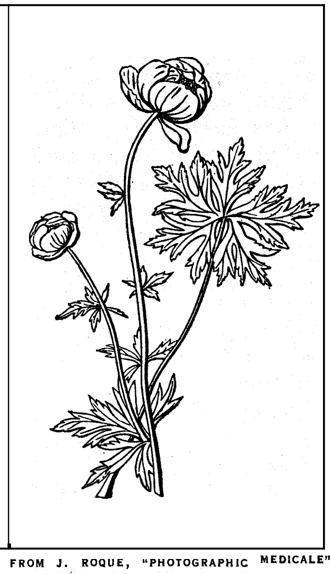
RANUNCULACEAE, a family of Dicotyledons belonging to the series Ranales, and containing 40 genera with about 700 species, which are distributed through temperate and cold regions but occur more especially in the northern hemisphere.

It is generally regarded as a genetic family which gave rise to the higher Dicotyledons, as well as the Monocotyledons. It contains many well known forms, such as buttercup, larkspur, anemone, columbine, clematis, marsh marigold, peony, etc. It is well represented in Britain, where 12 genera are native. In North America there are about 25 genera. The plants are mostly herbs, rarely shrubby, as in Clematis, which climbs by means of the leaf-stalks, with alternate leaves, opposite in Clematis, generally without stipules. The flowers, which show considerable variation in the number and development of parts, are characterized by free hypogynous sepals and petals, numerous free stamens, usually many free one-celled carpels and small seeds containing a minute straight embryo embedded in a copious endosperm. The parts of the flower are generally arranged spirally on a convex receptacle. The fruit is one-seeded, an achene or a many-seeded follicle, rarely, as in *Actaea,* a berry.

The family falls into several well-defined tribes which are distinguished by characters of the flower and fruit.

Tribe I. Paeonieae, peony group, are mostly herbs with deeply cut leaves and large solitary showy flowers in which the parts are spirally arranged, the sepals, generally five in number, passing gradually into the large coloured petals. There are 2–5 free carpels which bear a double row of ovules along the ventral suture. There are no honey-leaves (nectaries) but honey is secreted by a ring-like swelling round the base of the carpels, which become fleshy in the fruit and dehisce along the ventral suture. There are only three genera, the largest of which, *Paeonia,* occurs in Europe, temperate Asia and western North America. P. *officinalis* is the common peony. *P. suffruticosa* is the so-called tree peony, native of China.

Tribe *II.* Helleboreae are almost exclusively north temperate or subarctic. The plants are herbs, either annual, *e.g.,* Nigella (love-in-a-mist), or perennial hy means of a rhizome, as in *Aconitum* or *Eranthis* (winter aconite). The leaves are simple, as in *Caltha,* but more often palmately divided as in hellebore, aconite and larkspur. The flowers are solitary (Eranthis) or in cymes or racemes, and are generally regular as in Caltha (king-cup, marsh marigold), *Trollius* (globe-flower), *Helleborus* (hellebore), Aquilegia (columbine); sometimes markedly irregular as in *Aconitum* (aconite) and *Delphinium* (larkspur). The carpels, generally three to five in number, form in the fruit a many-seeded follicle, except in Actaea (baneberry), where the single carpel develops to form a many-seeded berry, and in *Nigella,* where the five carpels unite to form a five-chambered ovary. There is considerable variety in the form of the floral envelopes and the arrangement of the parts. The outer series, or sepals, generally five in number, is generally white or bright-coloured. Thus in *Caltha* and *Trollius* the sepals form a brilliant golden-yellow cup or globe, and in *Eranthis* a pale yellow star which contrasts with the green involucre of bracts immediately below it; in *Nigella* they are blue or yellow, and also coloured in *Aquilegia.* In Helleborus the greenish sepals persist till the fruit is ripe. *Aconitum* and *Delphinium* differ in the irregular development of the sepals, the posterior sepal being distinguished from the remaining four by its helmet-shape (*Aconitum*) or spur-shape (*Delphinium*). In Caltha there are no petals, but in the other genera there are honey-secreting and storing structures varying in number and in form in the different genera. In *Trollius* they are long and narrow with a honey-secreting pit at the base, in Nigella and Helleborus they form short-stalked pitchers, in *Aquilegia,* they are large and coloured with a showy petal-like upper portion and a long basal spur in the tip of which is the nectary. In Delphinium they are also spurred, and in *Aconitum* form a spur-like sac on a long stalk. The parts of the flower are generally arranged in a spiral (acyclic), but are sometimes hemicyclic, the perianth forming a whorl as in winter aconite; rarely is the flower cyclic, as in Aquilegia, in which case the parts throughout are arranged in alternating whorls. In *Caltha,* where there are no petals, honey is secreted by two shallow depressions situated on the side of each carpel.



FROM J. ROQUE, "PHOTOGRAPHIC MEDICALE" (B. GORMAN & CO)

GLOBE FLOWER (TROLLIUS EUROPAEUS)

Tribe *III. Anemoneae,* are chiefly north temperate, arctic and alpine plants, but also pass beyond the tropics to the southern hemisphere. They differ from the two preceding tribes in the numerous carpels, each with only one ovule, forming a fruit of numerous achenes. They are annual or perennial herbs, erect as in *Anemone, Thalictrurn* (meadow-rue) and many buttercups, or creeping as in *Ranunculus repens*; the section *Batrachium* of the genius *Ranunculus* (*q.v.*) contains aquatic plants with submerged or floating stems and leaves. The flowers are solitary, as in *Anemone pulsatilla* (Pasque flower), or cymose as in species of *Ranunculus,* or in racemes or panicles as in *Thalictrum.* The parts are spirally arranged throughout as in *Myosurus* (mouse-tail), where the very numerous carpels are borne on a much elongated receptacle, *Adonis* (pheasant's eye), or the perianth is whorled as in *Anemone* and *Ranunculus.* In *Anemone* and *Thalictrum* there is only one series of perianth leaves, which are petaloid and attractive in *Anemone* where honey is secreted by modified stamens, as in *A. Pulsatilla,* or, as in A. *nemorosa* (wood anemone), there is no honey and the flower is visited by insects for the sake of the pollen; in *Thalictrum* the perianth is greenish or slightly coloured, and the flower is wind-pollinated (*T. minus)* or visited for its pollen. In *Ranunculus* and *Adonis* a calyx of green protective sepals is succeeded by a corolla of showy petals; in *Ranunculus* there is a basal honey-secreting gland which is absent in *Adonis.* In *Anemone* the achenes bear the persistent naked or bearded style which aids in dissemination; the same purpose is served by the prickles on the achenes of *Ranunculus arvensis. Clematis* (*q.v.*), is characterized by its shrubby, often climbing habit, opposite leaves and the valvate, not imbricate as in the other tribes, aestivation of the sepals. The usually four sepals are whorled and petaloid, the numerous stamens and carpels are spirally arranged; the flowers are visited by insects for the sake of the abundant pollen. The fruit consists of numerous achenes which are generally prolonged into the long feathery style, whence the popular name of the British species, old man's beard *(Clematis vitalba).*

Special articles will be found on the more important genera of Ranunculaceae, *e.g.,* ACONITE, ADONIS, ANEMONE, BANEBERRY, CLEMATIS, COLUMBINE, HELLEBORE, RANUNCULUS. For further details *see* Enpler and *K.* Prantl, *Die natürlichen Pflanzenfamilien* (Leipzig, 1887–1908); **A. B.** Rendle, *Classification* of *Flowering Plants* (Cambridge. 1925).

RANUNCULUS, familiarly known as "buttercup," or crowfoot, a characteristic genus of the botanical family Ranunculaceae. The Latin name, which means a little frog or tadpole (dim. of *rana,* frog), was also given to a medicinal plant, which has been identified by some with the crowfoot. The members of the genus *Ranunculus* are more or less acrid herbs, sometimes with fleshy root-fibres, or with the base of the stem dilated into a kind of tuber *(R. bulbosus).* They have tufted or alternate leaves, dilated into a sheath at the base, and very generally, but not universally, deeply divided above. The flowers are solitary, or in loose cymes, and are remarkable for the number and separation (freedom from union) of their parts. Thus there are five sepals, as many petals, and numerous spirally arranged stamens and carpels. The petals have a little pit or honey-gland at the base, which is interesting as foreshadowing the more fully developed tubular corollas of the nearly allied genera *Aconitum* and *Helleborus.* The fruit is a head of "achenes"—dry, one-seeded fruits.

The genus contains a large number of species (about 300) and occurs in most temperate countries in the northern and southern hemispheres, extending into arctic and antarctic regions, and appearing on the higher mountains in the tropics. About 15 species are found in Great Britain. *R. acris, R. repens, R. bulbosus,* are the common buttercups. *R. arvensis,* which is found in cornfields, has smaller pale yellow flowers and the achenes covered with stout spines. *R. lingua,* and *R. flammula,* the spearwort, grow in marshes ditches and wet places. R. *ficaria* is the pilewort or lesser celandine, an early spring flower in pastures and waste places, characterized by having heart-shaped entire leaves and clusters of club-shaped roots. The section *Batrachium* comprises the water-buttercups, denizens of pools and streams, which vary greatly in the character of the foliage according as it is submerged, floating or aerial, and when submerged varying in accordance with the depth and strength of the current.

Inclusive of the water-buttercups, some 70 native species of *Ranunculus* occur in North America, widely distributed throughout the continent. Representative species are R. *septentrionalis, R. abortivus* and *R. recurvatus,* of the eastern States, and *R. californicus,* of the Pacific coast.

The ranunculus of the florist is a cultivated form of *R. asiaticus,* a native of the Levant, remarkable for the range of colour of the flowers (yellow to purplish black) and for the regularity with which the stamens and pistils are replaced by petals forming double flowers.

RAOUL DE CAMBRAI, the name of a French *chanson* de *geste.* The existing romance is a 13th-century recension of a poem by a trouvère of Laon called Bertholais, who professed to have witnessed the events he described. Raoul de Cambrai, the posthumous son of Raoul Taillefer, count of Cambrai, by his wife Alais, sister of King Louis (d'Outre-Mer), demanded the fief of Vermandois, which was the natural inheritance of the four sons of Herbert, lord of Vermandois. On King Louis's refusal, he proceeded to war. Bernier, a grandson of Count Herbert, eventually slew the terrible Raoul in single fight, but in his turn was slain, after an apparent reconciliation, and the blood-feud descended to his sons. The date of these events is exactly ascertainable. Flodoard (*Annales, Anno* 943) states that Count Herbert died in that year, and was buried by his sons at St. Quentin; that when they learnt that Raoul, son of Raoul de Gouy, was about to invade their father's territory, they attacked him and put him to death.

See Li *Romans de Raoul de Cambrai et de Bernier,* ed. *E.* le Glay (1840); "Raoul de Cambrai," ed. P. Meyer and *A.* Longnon (*Soc. des anc. textes fr.,* **1882**); **J.** M. Ludlow, *Popular Epics of the Middle* **Ages (1865)**; **G.** Grober, *Grundriss d. roman. Phil.* (ii. *pp.* **567** *seq.).*

RAOULT, FRANÇOIS MARIE (1830–1901), French chemist, was born at Fournes (Nord), on May 10, 1830. In 1862 he became professor of chemistry in Sens lycée, where he prepared the thesis on electromotive force which gained him his doctor's degree at Paris in the following year. In 1867 he was put in charge of the chemistry classes at Grenoble, and three years later he succeeded to the chair of chemistry, which he held until his death on April 1, 1901. His name is best known in connection with the work on solutions (*q.v.*). His first paper on the depression of the freezing-points of liquids by the presence of substances dissolved in them was published in 1878, Another conclusion was that the diminution in the vapour-pressure of a solvent, caused by dissolving a substance in it, is proportional to the molecular weight of the substance dissolved—at least when the solution is dilute. These two generalizations not only afforded a new method of determining the molecular weights of substances, but were also used by J. H. van't Hoff, S. Arrhenius, and others, in working out the theory of solutions.

RAPALLO, a seaport and winter resort of Liguria, Italy, in the province of Genoa. Pop. (1936) 6,766, town; 13,947, commune. It occupies a beautiful and well-sheltered situation on' the east side of the Gulf of Rapallo, 18½ m. E. by S. from Genoa by rail. The bridge, known as "Hannibal's Bridge," is mediaeval. To the south lies the small seaport of Portofino (the Roman *Portus Delphini*) under the south-east extremity of the promontory of Portofino (2,010 ft.) crowned by the remains of a castle. On the way from S. Margherita to Portofino is the suppressed monastery of Cervara, in which Francis I. of France was confined after the battle of Pavia on his way to Madrid. At all these places are beautiful villas. On the S. side of the promontory is the small village of S. Fruttuoso, with the tombs of some of the Doria family of Genoa (1275–1305).

RAPALLO, TREATY OF (April 16 1922). During the Conference of Genoa *(see* GENOA, CONFERENCE OF), at which it was designed to consider the economic relations of the participating Powers with Russia, the Russian delegates showed no great desire to resume relations with the Allied and Associated Powers, but to the consternation of the latter signed an agreement with Germany, after secret negotiations. The treaty was initialled on April 16 1922 by M. Chicherin and M. Rathenau. Germany and Russia renounced reciprocally all claims to war indemnities of any sort, including payment for the maintenance of prisoners of war.

Germany renounced any compensation for losses incurred by German subjects in consequence of Russian socialisation of private property "provided that the Soviet Government does not satisfy similar claims of other States." Diplomatic and consular relations were resumed, the principle of the most favoured nation was to be mutually applied, with a Russian reservation in favour of States formerly belonging to the Russian empire. Economic relations were to be regulated "with mutual feelings of goodwill." The treaty was made public immediately on signature. On Nov. 5, 1922, the treaty was extended to the Ukraine, White Russia, the Transcaucasian republics and the Far Eastern republic.

RAPE, a territorial division of the county of Sussex, formerly used for various administrative purposes. There are now six of these divisions: Hastings, Pevensey, Lewes, Bramber, Arundel and Chichestcr.

See the Victoria County History, *Sussex,* vol. i.; *New* English Dictionary; and M. A. Lower, *History of Sussex* (Lewes, 1870).

RAPE, in botany. Several forms of plants included in the genus Brassica are known as rape and cultivated instead of a turnip crop or as a "catch crop" for food for sheep or for their oil-yielding seeds. The nomenclature and relationship of these forms of Brassica are not clear as crosses are frequent. B. *Rapa* is grown in Great Britain as a green crop while B. *Napus* var. *oleifera* known as colza rape or coleseed is grown on the continent of Europe for oil. Its seeds contain from 30 to 45% of oil

For further details see W. W. Robbins, Botany of Crop Plants (Philadelphia, 1924); R. Percival, *Agricultural* Botany (1926).

RAPE, in law, the crime of having carnal knowledge of a woman by a man, not her husband, forcibly and unlawfully, against her will. A felony at common law, it was reduced in England to a misdemeanour in 1275, but in 1285 was again declared a felony, with benefit of clergy. This was the state of the law until 1575, when the punishment was made more severe. Formerly a capital offence, by the Offences against the Person Act 1861, it is punishable by penal servitude for life.

The law of England regards as immaterial whether the woman is chaste or unchaste, married or single, provided the offence has been committed forcibly and without her consent. The offence is complete if consent is extorted by means of threats of death or immediate bodily harm, by fraud or by false pretences or representation. (Criminal Law Amendment Act 1885.)

In the United States the elements of the crime under statute are similar to those at common law. The age when effective consent can be given by the female has commonly been set by the various States between 14 and 18 years. Want of age on the part of the male is not a defence, as at common law, but simply presumptive evidence of lack of physical capacity. Many States require the testimony of the female to be corroborated by other evidence as well as requiring the prosecution to be initiated within a year or less after the commission of the offense. The punishment is imprisonment though a few southern States prescribe death as the penalty.

RAPE OIL, an important fatty oil, known also as "sweet oil," either expressed or extracted from the crushed seeds of cultivated varieties of the cruciferous genus Brassica, the parent form of the whole apparently being the wild navew, B. *campestris.* Under the general name "rape oil" is included the produce of several plants having distinct and fairly constant characters, and one of these oils—colza (*q.v.*)—is a very well-known commercial variety. In Germany, where the production of rape oil centres. two principal oil-seeds—rape and Riibsen—are recognized. (See RAPE.)

The oil yielded by these seeds is, in physical and chemical properties, practically the same, the range of fluctuations not being greater than would be found in the oil of any specific seed under similar varying conditions of production; the winter varieties of all the seeds are more productive than the summer varieties. Newly pressed rape oil has a dark sherry colour with, at first, scarcely any perceptible smell; but after resting a short time the oil deposits an abundant mucilaginous slime, and by taking up oxygen it acquires a peculiar disagreeable odour and an acrid taste. Refined by the ordinary processes (see OILS), the oil assumes a clear golden yellow colour. In specific gravity it ranges between 0·9112 and 0·9117 (raw), and from 0·9127 to 0·9136 (refined); the solidifying point is from $-4°$ to $-6°$ Centigrade.

The principal uses of rape oil are for lubrication and lighting; but since the introduction of mineral oils for both these purposes the importance of rape has considerably decreased. It is but little employed in soap-making, as it saponifies with difficulty and yields only an indifferent product. In Germany it is very considerably used as a salad oil under the name of *Schmalzöl,* being for that purpose freed from its biting taste by being mixed with starch, heated till the starch is carbonized, and filtered after the oil has cooled. The offensive taste of rape oil may also be removed by treatment with a small proportion of sweet spirits of nitre (nitrous ether). In the East Indies rape oil and its equivalents, known under various names, are the most important of oils for native use. They are largely consumed as food instead of ghi under the name of "metah" or sweet oil, but for all other purposes the same substance is known as "kurwah" or bitter oil. Most natives prefer it for the preparation of their curries, and other hot dishes. Rape oil is the subject of extensive adulteration, principally with the cheaper hemp oil, rosin oil and mineral oils. These sophistications can be most conveniently detected, first by taste and next by saponification, rosin oil and mineral oil remaining unsaponified, hemp oil giving a greenish soap, while rape oil yields a soap with a yellow tinge. Rape oil and the other cruciferous oils are characterized by the presence of the unsaturated fatty acid erucic acid, $C_{21}H_{41}COOH$, the identification of which affords a means of detecting rape oil in admixture with other oils. Lead plaster (*Emplastrum* lithargyri) boiled in rape oil dissolves, and, sulphide of lead being formed, the oil becomes brown or black. Other lead compounds give the same black coloration from the formation of sulphide.

RAPHAEL, in the Apocryphal Book of Tobit, the name of the angel who in human disguise and under the name of Azarias ("Yahweh helps") accompanied Tobias in his adventurous journey and conquered the demon Asmodaeus (see TOBIT). He is said to be "one of the seven holy angels [archangels] which present the prayers of the saints and go in before the glory of the Holy One" (Tob. xii. 15). In the Book of Enoch (ch. xx.) Raphael is "the angel of the spirits of men," and it is his business to "heal the earth which the angels have defiled." His name means "God heals."

RAPHAEL SANZIO (1483–1520), the great Italian painter, was the son of Giovanni Sanzio or Santi, a painter in the ducal city of Urbino. The house of Giovanni Santi, where Raphael was born (April 6, 1483) still exists at Urbino in the Contrada del Monte, and is now the property of the municipality. For many years both before and after the birth of Raphael (April 6, 1483) Urbino was one of the chief centres in Italy of intellectual and artistic activity, thanks to its highly cultured rulers, Duke Federigo II. of Montefeltro and his son Guidobaldo, who succeeded him in 1482. Giovanni Santi was a welcome guest at this miniature but splendid court, and the rich treasures which the palace contained, familiar to Raphael from his earliest years, helped to form and foster his early love for art. Raphael's boyish admiration of the oil-paintings of Jan Van Eyck and Justus of Ghent may have had something to do with the miniature-like care and delicacy with which some of his earliest works, such as the "Apollo and Marsyas," were executed.

Though Raphael lost his father at the age of eleven, he certainly owed to him a great part of his early training. The altarpiece painted by Giovanni for the church of Gradara, and a fresco, now preserved in the Santi house at Urbino, are clearly prototypes of some of Raphael's most graceful paintings of the Madonna and Child. On the death of his father in 1494 Raphael was left in the care of his stepmother (his mother, Magia Ciarla, died in 1491) and of his uncle, a priest called Bartolomeo.

First or Perugian **Period.**—Vasari's statement that Raphael was sent to Perugia during his father's lifetime is certainly a mistake. He probably did not enter Perugino's studio till the end of 1499. Of the thirty drawings contained in the so called Sketch Book of Raphael in the Venice Academy but two can be ascribed to the master. (See G. Morelli, Italian Masters in German Gal*leries,* 1882.)

Before long Raphael appears to have shared in the execution of paintings by his master; and his touch may perhaps be traced in some of Perugino's panels which were executed about 1502; examples are the Resurrection of Christ in the Vatican and the Diotalevi Madonna in the Berlin Museum.

About 1500 Raphael began to execute independent works. The portrait of Tangino in the Borghese Gallery, Rome, was probably painted about 1500. Four pictures for churches at Citti di Castello appear to have been painted in the years 1502–04. The first is a gild-banner painted on one side with the Trinity, and below, kneeling figures of S. Sebastian and S. Rocco; on the reverse is a Creation of Eve, very like Perugino in style, but possessing more grace and breadth of treatment. These are still in the church of S. Triniti. Also for Città di Castello were the coronation of S. Niccolo Tolentino, now destroyed, though studies fcr it exist at Oxford and Lille (Gaz. d. B. Arts, 1878, i. p. 48), and the Crucifixion, now in the National Gallery (Mond collection), painted for the church of S. Domenico and signed RAPHAEL VRBINAS P. It is a panel 8 ft. 6 in. high by 5 ft. 5 in. wide, and contains noble figures of the Virgin, St. John, St. Jerome and St. Mary Magdalene. The fourth painting executed for this town, for the church of S. Francesco, is the exquisitely beautiful and highly finished Sposalizio, now in the Brera at Milan, signed and dated RAPHAEL VRBINAS MDIIII. This is closely copied both in composition and detail from Perugino's painting of the same subject now at Caen, but is far superior to it in sweetness of expression and grace of attitude. The Temple of Jerusalem, a domed octagon with outer ambulatory in Perugino's picture, is reproduced with slight alterations by Raphael, and the attitudes and grouping of the figures are almost exactly the same in both. The Connestabile Madonna (sold to the tsar of Russia in 1871) is one of Raphael's finest works, painted during his Perugian period; it is a round panel. The motive, the Virgin reading a book of hours, is a favourite one with him, as it was with his father Giovanni.

Second or Florentine Period, 1504–1508.—In the first half of 1504 Raphael visited Urbino, where he painted two small panels for Duke Guidobaldo, the St. George and the St. Michael of the Louvre. His first visit to Florence was made towards the end of 1504, when he presented himself with a warm letter of recommendation from his patroness Joanna della Rovere to the gonfaloniere Pier Soderini. At the time of his arrival in Florence artistic Italy was excited over the cartoons of the battle of Anghiari and the war with Pisa, to which Leonardo da Vinci and Michelangelo were then devoting their energies. With astonishing rapidity Raphael shook off the mannerisms of Perugino and put one great artist in painting or sculpture after another under contribution for some special power of drawing, beauty of colour, or grace of composition in which each happened to excel. The Carmine frescoes of Masaccio and Masolino taught this eager student long-remembered lessons of methods of dramatic expression. (See his cartoon of St. Paul preaching at Athens [Victoria and Albert Museum].) Among his contemporaries it was especially Signorelli and Michelangelo who taught him the necessity of a thorough knowledge of the human form. From da Vinci he learnt subtleties of modelling and soft beauty of expression (see the portrait of Maddalena Doni in the Pitti), from Fra Bartolommeo nobility of composition and skilful treatment of drapery in dignified folds. (See the Madonna del Baldacchino in the Pitti.) The friendship between Raphael and the last of these was very close. The architect Baccio d'Agnolo was another of his friends, at whose house the young painter enjoyed social intercourse with the chief artists of Florence, and probably learnt from him much that was afterwards useful in his practice as an architect.

The transition in Raphael's style from his first or Perugian to his second or Florentine manner is shown in the large picture of the Coronation of the Virgin painted for Maddalena degli Oddi, now in the Vatican, one of the most beautiful that he ever produced, and especially remarkable for its strong religious sentiment—in this respect a great contrast to the paintings of his last or Roman manner which hang near it. The exquisite grace of the angel musicians shows signs of his short visit to Florence, while the formality of the composition and certain details, such as the fluttering ribands of the angels, recall peculiarities of Perugino and of Pinturicchio, with whose fine picture of the same subject hung close by it is interesting to compare it. The predella of this masterpiece of Raphael is also in the Vatican; some of its small paintings, especially that of the Annunciation to the Virgin, display his careful study of the rules of perspective. Preparatory sketches for this picture exist at Lille and elsewhere. The Lille study is drawn from two youths in the ordinary dress of the time; and it is interesting to compare it with his later studies from the nude, many of which are for figures which in the future picture were to be draped. It was at Florence, as Vasari says, that Raphael began serious life studies, not only from nude models but also by making careful anatomical drawings from dissected corpses and from skeletons.

His first visit to Florence lasted only a few months; in 1505 he was again in Perugia painting his first fresco, the Trinity and Saints, for the Camaldoli monks of San Severo, now a mere wreck from injury and restorations. The date MDV and the signature were added later, probably in 1521. Pgrt of this work was left incomplete by the painter, and the fresco was finished in 1521 (after his death) by his old master Perugino. It was probably earlier than this that Raphael visited Siena and assisted Pinturicchio with sketches for his Piccolomini frescoes. He probably had no hand in the actual execution of the paintings. The Madonna of S. Antonio (Metropolitan Museum of Art, New York) was also finished in 1505, but was probably begun before the Florentine visit. A record of his visit to Siena exists in a sketch of the antique marble group of the Three Graces, then in the cathedral library, from which, not long afterwards, he painted the small panel of the same subject now at Chantilly.

In 1506 Raphael was again in Urbino, where he painted for the duke another picture of St. George, which was borne to England as a present to Henry VII. by Guidobaldo's ambassador, the accomplished Baldassare Castiglione (*q.v.*), a friend of Raphael, whose noble portrait of him is in the Louvre. At the court of Duke Guidobaldo the painter's ideas appear to have been led into a more secular direction, and to this stay in Urbino probably belong the Chantilly Graces and the miniature "Knight's Dream of Duty and Pleasure" in the National Gallery (London), which also possesses its cartoon in brown ink, pricked for transference.

Towards the end of 1506 Raphael returned to Florence, and there (before 1508) produced a large number of his finest works, carefully finished, and for the most part wholly the work of his own hand. The following is a list of some of his chief paintings of this period: the "Madonna del Gran Duca" (Pitti); "Madonna del Giardino," 1506 (Vienna); "Holy Family with the Lamb," 1506 or 1507 (Madrid); the "Ansidei Madonna," 1506 or 1507 (National Gallery); the Borghese "Entombment," 1507; The Panshanger "Madonna" (now in America), 1508; "La bella Giardiniera," 1508 (Louvre); the "Eszterhazy Madonna," probably the same year, as well as the "Madonna del Cardellino" (Uffizi), the "Tempi Madonna" (Munich), the "Colonna Madonna" (Berlin), the "Bridgewater Madonna" (Bridgewater House), and the "Orleans Madonna" (Chantilly). The "Ansidei Madonna" was bought in 1884 for the National Gallery from the duke of Marlborough. It was painted for the Ansidei family of Perugia as an altar-piece in the church of S. Fiorenzo, and is a work of the highest beauty in colour, well preserved. The Virgin with veiled head is seated on a throne, supporting the Infant with one hand and holding a book in the other. Below stands S. Niccolo Tolentino, for whose altar it was painted; he holds a book and a crozier, and is clad in jewelled mitre and green cope, under which appear the alb and cassock. On the other side is the Baptist, in red mantle and camel's-hair tunic, holding a crystal cross. The rich jewellery in this picture is painted with Flemish-like minuteness. A favourite method of grouping his Holy Families is that seen in the "Madonna del

Cardellino" and the "Bella Giardiniera," in which the main lines form a pyramid. This arrangement is also used in the "Madonna del Giardino" and in the larger group, including St. Joseph and St. Elizabeth, known as the "Canigiani Holy Family," now at Munich. The "Entombment of Christ," now in the Galleria Borghese in Rome, was painted during a visit to Perugia in 1507 for Lady Atalanta Baglioni, in memory of the death of her brave and handsome but treacherous son Grifonetto, who was killed in 1500 by his enemies the Oddi party. (See Symonds, Sketches *in* Italy, the chapter on Perugia, mainly taken from the contemporary chronicle of Matarazzo.) The many studies and preliminary sketches for this important picture which exist in various collections show that it cost Raphael an unusual amount of thought and labour in its composition. It is, however, much injured by repainting. The "Madonna del Baldacchino," owing much to Fra Bartolommeo, is also unsatisfactory in execution; being left unfinished by Raphael, it was completed by Ridolfo Ghirlandajo. It was painted for the Dei family as an altar-piece for their chapel in S. Spirito, Florence. The "St. Catherine" of the National Gallery was probably painted in 1507; its cartoon, pricked for transference, is in the Louvre. To the Florentine period belong some of his finest portraits, and it is especially in these that da Vinci's influence appears. The portraits of Angelo Doni and his wife Maddalena (Pitti) are vivid and carefully executed paintings, and the unknown lady with hard features (now in the Uffizi) is a masterpiece of noble realism and conscientious finish. A fine but much-restored portrait of Raphael by himself, painted at Florence, exists in the Uffizi; it represents him at a very early age, and was probably painted during the early part of his stay in Florence.

Third or Roman Period, 1508–1520.—In 1508 Raphael was painting several important pictures in Florence; in September of that year we find him settled in Rome, from a letter addressed in the warmest terms of affectionate admiration to Francia, to whom he sent a sketch for his "Adoration of the Shepherds," and promised to send his own portrait in return for that whish Francia had given him. Raphael was invited to Rome by his fellow-citizen Bramante, who was then occupied in the erection of the new church of St. Peter, the foundation-stone of which had been laid by Julius II. on the 18th of April 1506. At this time the love of the popes for art had already attracted to Rome Michelangelo, Signorelli, Perugino, Pinturicchio, Lorenzo Lotto, Peruzzi, Sodoma and many others, and it was among this brilliant assembly that Raphael, almost at once, took a leading position. Thanks to Bramante's friendly intervention, Julius II. (Della Rovere) soon became Raphael's most zealous patron and friend, as did also the rich bankers Agostino Chigi and Bindo Altoviti, of whom a portrait, by Giulio Romano, is now in Munich.

A series of rooms in the Vatican, over the Appartamenti Borgia, were already decorated with frescoes by Bonfigli, Perugino, Piero della Francesca, Andrea del Castagno, Signorelli and Sodoma; but so rapidly had the taste of the time changed that Julius II. decided to re-cover the walls with paintings in the more developed style of Raphael. It was not without regret that Raphael saw the destruction of this noble series of frescoes. One vault, that of the Stanza dell' Incendio, painted by his master Perugino, he saved from obliteration; it still exists, well preserved, a most skilful piece of decorative work; and he also set his pupils to copy a number of portrait-heads in the frescoes of Piero della Francesca before they were destroyed.

The Stanza della Segnatura (papal signature room) was painted in 1509–11. The first painting executed by Raphael in this room was the so-called Disputa, finished in 1509. In its religious sentiment it far excels any of the later stanze paintings, retaining much of the sacred character of earlier Florentine and Umbrian art. As a scheme of decoration it appears to have been suggested by some of the early apsidal mosaics. Gold is largely used, while the later purely pictorial frescoes have little or none. The subject is the hierarchy of the church on earth and its glory in heaven.

The painting on the vault of this room is the next in date, and shows further transition towards the "Roman manner." In his treatment of the whole Raphael has been partly guided by the painting of Perugino's vault in the next room (the Stanza dell' Incendio). The pictures are kept subordinate to the lines of the vault. A great part of the ground is gilt, marked with mosaic-like squares, a common practice with decorative painters. The principal medallions in each cell of this quadripartite vault are very graceful female figures, representing Theology, Science, Justice and Poetry. Smaller subjects are arranged in the intermediate spaces, and each has some special meaning in reference to the medallion it adjoins; some of these are painted in warm monochrome to suggest bas-reliefs. The fine painting of the "Flaying of Marsyas" is interesting as showing Raphael's study of antique sculpture: the figure of Marsyas is a copy of a Roman statue. The very beautiful little picture of the "Temptation of Eve" recalls Albert Dürer's treatment of that subject, though only vaguely. Much mutual admiration existed between Raphael and Dürer: in 1515 Raphael sent the German artist a most masterly life study of two nude male figures (now at Vienna); on it is written in Albert Dürer's beautiful hand the date and a record of its being a gift from Raphael. It is executed in red chalk, and was a study for two figures in the "Battle of Ostia."

On the wall opposite the Disputa is the so-called School of Athens. The subject of this noble fresco, in contrast to that opposite, is "Earthly Knowledge," represented by an assembly of the great philosophers, poets and men of science of ancient Greece. The central figures are Plato and Aristotle, while below and on each side are groups arranged with the most consummate skill, including the whole "filosofica famiglia" of Dante (Infer. iv. 133–144), and a number of other leaders of thought, selected in a way that shows no slight acquaintance with the history of philosophy and science among the ancient Greeks. Many interesting portraits are introduced—Bramante as the aged Archimedes, stooping over a geometrical diagram; a beautiful fair-haired youth on the left is Francesco Maria della Rovere, duke of Urbino; and on the extreme right figures of Raphael himself and Sodoma are introduced. The stately building in which these groups are arranged is taken with modifications from Bramante's first design for St. Peter's.

Over one window is a group of poets and musicians on Mount Parnassus, round a central figure of Apollo; it contains many heads of great beauty and fine portraits of Dante and Petrarch. Over the opposite window are graceful figures of the three chief Virtues, and at one side Gregory IX. (a portrait of Julius II.) presenting his volume of decretals to a jurist; on the other Justinian presents his code to Trebonianus.

The next room, the Stanza d'Eliodoro, was painted in 1511–14. The room is so called from the fresco representing the expulsion of Heliodorus from the Temple (2 Macc. iii.), which is an allusion to the struggles between Louis XII. of France and Julius II. Its chief motive is the glorification of the pontificate, with insistence on the temporal power. The main incident of this picture is the angel visitant on the horse. The group of women and children on the left is very beautiful, and the figures of Julius II. and his attendants are nobly designed. This picture was completed in 1512. Over one window is shown the scene of the Miracle at Bolsena of 1264, when the real presence was proved to a doubting priest by the appearance of blood-stains on the Corporal. (See Orvieto.) Julius II. is introduced kneeling before the altar; and the lower spaces on each side of the windows are filled with two groups, that on the left with women, that on the right with officers of the papal guard. The last group is one of the most masterly of all throughout the stanze: each face is a marvel of expression and power, and of technical skill. The next fresco in date is that of the Repulse of Attila from the walls of Rome by Leo I., miraculously aided by the apparitions of St. Peter and St. Paul; it contains another allusion to the papal quarrels with France. It was begun in the lifetime of Julius II., but was only half finished at the time of his death in 1513; thus it happens that the portrait of his successor, the Medici pope Leo X., appears twice over, first as a cardinal riding behind the pope, painted before the death of Julius II., and again in the character of S. Leo, instead of the portrait of Julius which Raphael was about to paint. A pen sketch in the Louvre by Raphael shows Julius II. in the place afterwards occupied by Leo X. In 1514 he painted the "Deliverance of St. Peter from Prison," with a further political allusion. It is skilfully arranged to fit the awkward space round the window, and is remarkable for an attempt to combine and contrast the three different qualities of light coming from the room, the glory round the angel, and the torches of the sentinels.

For the so-called Stanza dell' Incendio Raphael designed and partly painted the "Incendio del Borgo," a fire in the Borgo or Leonine City, which was miraculously stopped by Leo IV. appearing and making the sign of the cross at a window in the Vatican. On the background is shown the façade of the old basilica of St. Peter, not yet destroyed when this fresco was painted. One group on the left, in the foreground, is remarkable for its vigour and powerful drawing; the motive is taken from the burning of Troy; a fine nude figure of Aeneas issues from the burning houses bearing on his back the old Anchises and leading the boy Ascanius by the hand. Many studies for this picture exist. This is the last of the stanze frescoes on which Raphael himself worked. Others in this room designed by him and painted by Giulio Romano and other pupils were the "Battle of Ostia," and the "Oath of Leo III. before Charlemagne." The enormous fresco of the "Defeat of Maxentuis by Constantine," in the Saladi Constantino, was painted by Giulio Romano, soon after Raphael's death, from a sketch by the latter.

The paintings in the stanze were only a small part of Raphael's work between 1509 and 1513. To this period belong the Madonna of Foligno (Vatican), painted in 1511 for Sigismondo Conti. Of about the same date are the gem-like Garvagh Madonna (National Gallery, once in the possession of the Aldobrandini family), the Diademed Virgin of the Louvre, and the Madonna del Pesce at Madrid. The last was executed in 1513 for S. Domenico in Naples. In addition to other easel pictures a number of his finest portraits belong to this period—that of Julius II. the original of which is lost (copies in the Uffizi and National Gallery, London); the Tommaso Inghirami in the Gardner Collection, Boston; the Baldassare Castiglione of the Louvre; and the portrait of a cardinal in the Prado, Madrid.

When Giovanni de' Medici became pope as Leo X., a period of splendour and magnificence succeeded the sterner rule of Julius II. Agostino Chigi, the Sienese financier, was the chief of those whose lavish expenditure contributed to enrich Rome with works of art. For him Raphael painted, in 1513–14, the very beautiful fresco of the Triumph of Galatea in his new palace by the Tiber, the Villa Farnesina, and also made a large series of magnificent designs from Apuleius's romance of Cupid and Psyche, which were carried out by a number of his pupils.[1] For the same patron he painted (also in 1513) his celebrated Sibyls in S. Maria della Pace—figures of exquisite grace, arranged with perfect skill over an arch in the nave. It is not without reason that Vasari gives these the highest position among his fresco-paintings. Agostino Chigi also employed Raphael to build for him a private chapel in S. Maria del Popolo, and to make a series of cartoons to be executed in mosaic on the inner dome. The central medallion has a figure of God among clouds and angel boys, surrounded by eight planets, each with its pagan deity and directing angel in accordance with Dante's scheme in the Paradiso. The execution of these brilliant mosaics was carried out in 1516 by the Venetian Luigi della Pace. Probably in the early years of Leo X.'s reign were painted the Madonna della Sedia (Pitti), the S. Cecilia at Bologna (not completed till 1516), the miniature Vision of Ezekiel (Pitti) and two important pictures at Madrid. The latest of these, known as Lo Spasimo, from the church at Palermo, for which it was painted, represents Christ bearing His Cross. The Madonna called Della Perla, "the pearl" of the Spanish royal collection, was originally painted for Bishop Louis of Canossa; it was sold by Cromwell with the greater part of Charles I.'s collection at Hampton Court. The portrait of Leo X. with Cardinals de' Rossi and de' Medici, in the Pitti, is one of his finest portrait-pictures. Little is known about the Madonna di S. Sisto, the glory of the Dresden Gallery; no studies or sketches for it exist,

One of Raphael's latest works is the large "St. Michael and the Devil," in the Louvre, signed "Raphael Urbinas pingebat. MDXVIII."

The tapestry cartoons, seven of which are in the Victoria and Albert Museum, were painted by pupils from Raphael's designs. They are part of a set of ten, with scenes from the Acts of the Apostles, intended, when copied in tapestry, to adorn the lower part of the walls of the Sistine chapel. The tapestries themselves, worked at Brussels, are now, after many vicissitudes, hung in a gallery in the Vatican; the set is complete, thus preserving the design of the three lost cartoons ("The Martyrdom of St. Stephen," "St. Paul's Conversion" and "St. Paul in Prison"). The existing seven, after being cut up into strips for use on the looms, were bought by Rubens for Charles I. The tapestry copies are executed with wonderful skill. The designs are reversed, and the colours far more brilliant than those of the cartoons, much gold and silver being introduced. The rich framework designed by Raphael's pupils, probably by Penni and Giovanni da Udine, exists in the tapestries and adds greatly to their decorative effect. The cartoons were executed in 1515 and 1516, and the finished tapestries were first exhibited in their place in the Sistine chapel on Dec. 26, 1519.

The **"Transfiguration."**—In 1519 Cardinal Giuliano de' Medici (afterwards Clement VII.), as bishop of Narbonne, ordered two altar-pieces for his cathedral—the one by Raphael, the other by Raphael's Venetian rival Sebastiano del Piombo. That by the latter painter is the Resurrection of Lazarus, now in the National Gallery. Several studies for Raphael's picture exist, showing that he at first intended to paint a Resurrection of Christ as a pendant to Sebastiano's subject, but soon altered his scheme into the Transfiguration. The eight or nine existing studies are scattered through the Oxford, Lille, Windsor and some private collections. A great part of the lower group was unfinished at the time of the painter's sudden death in 1520, and the heavy colouring of Giulio Romano is visible in it. On the death of Raphael the picture became too precious to send out of Rome, and Cardinal de' Medici contented himself with sending the Resurrection of Lazarus to Narbonne The Transfiguration was bequeathed by him to the monks of S. Pietro in Montorio, in whose church it remained till it was stolen by Napoleon I. It now hangs in the Vatican Gallery.

Architectural Work.—Bramante, before his death in March 1514, requested that Raphael should be made his successor as chief architect of St. Peter's. To this important post he was appointed by Leo X., Aug. 1, 1514. The progress of St. Peter's was, however, too slow for him to leave much mark on its design. Another work of Bramante's, completed by Raphael, was the graceful Cortile di S. Damaso in the Vatican, including the loggie, which were decorated with stucco-reliefs and paintings of sacred subjects by his pupils under his own supervision, but only very partially from his designs. The Palazzo dell' Aquila, built for Giovanni Battista Branconio, and destroyed in the 17th century during the extension of St. Peter's, was one of Raphael's chief works as an architect. He also designed the little cross church, domed at the intersection like a miniature St. Peter's, called S. Eligio degli Orefici, which still exists near the Tiber, almost opposite the Farnesina gardens. According to M. Geymiiller, *Raffaello come Architetto* (Milan, 1883), the Villa Farnesina of Agostino Chigi, usually attributed to Peruzzi, was, as well as its palace-like stables, designed by Raphael; but internal evidence makes this very difficult to believe. It has too much of the delicate and refined character of the 15th century for Raphael. whose taste seems to have been strongly inclined to the more developed classic style, of which Palladio afterwards became the chief exponent. Villa Madama, on the slopes of Monte Mario above Rome, was designed by Raphael, though its actual carrying out, and the unrivalled stucco-reliefs, are due to Giulio Romano and Giovanni da Udine, as mentioned in Vasari's life of the latter.[2] The original design for this villa made by Raphael himself has been discovered by Sf. Geymüller. Another architectural work was the little Chigi chapel

[1]Chiefly by Giulio Romano. Gianfrancesco Penni and Giovanni da Udine; much injury has been done to these frescoes by repainting.

[2]*See* Gruner, *Fresco Decorations, etc.* (London, 1854), pls. 6–12, and Kaffaelle Santi, *Ornati della Villa Madama, etc* {Rome, 1875).

in S. Maria del Popolo, built in 1516. At the time of his death, Raphael was preparing to build himself a handsome palace near the church of S. Eligio; the deed for the purchase of its site was signed by him only a few days before his last short illness. Though not completed till 1530, the Palazzo Pandolfini at Florence was also designed by him.

Sculpture. — That Vasari is right in attributing to him the model for the beautiful statue of Jonah which is in the Chigi chapel is borne witness to by two important documents, though there is no evidence to show that he ever worked in marble. One of these is a letter written to Michelangelo to warn him that Raphael had been invading his province as a sculptor by modelling a boy, which had been executed in marble by a pupil, and was a work of much beauty. Again, after his death his friend Baldassare Castiglione, in a letter dated the 8th of May 1523, asks his steward in Rome "if Giulio Romano still possesses a certain boy in marble by Raphael and what his lowest price for it would be." The statue of Jonah was executed in marble by Lorenzetto, a Florentine; and it remained in his studio for many years after Raphael's death. The Victoria and Albert Museum possesses a small clay sketch for this beautiful group, slightly different from the marble; it is probably the original design by the master's own hand. The whole feeling of the group — a beautiful youth seated on a sea-monster — is classical, and the motive is probably taken from some antique statue representing Arion or Taras on a dolphin.

A large number of Raphael's designs were engraved by his pupils Marcantonio Raimondi and Agostino Veneziano. These valuable engravings are from Raphael's sketches, not from his finished pictures, and in some cases they show alterations made in the execution of the picture. Raimondi's engraving of the S. Cecilia of Bologna in design is very inferior to that of the actual painting. Several of Raphael's most important compositions are known to us only by these early engravings, *e.g.,* the Massacre of the Innocents (engraved by Raimondi), which is one of his finest works. Another magnificent design is the Judgment of Paris, containing a large number of figures; the nude figure of Minerva is a work of especial force and beauty. A standing figure of Lucretia about to stab herself is also one of his most lovely figures. Many of Raphael's studies for Marcantonio's engravings still exist.

Archaeology. — Raphael's report to Leo X. in 1518 is an eloquent plea for the preservation of ancient buildings. In 1515 he had been appointed by Leo X. inspector of all excavations in Rome and within 10 miles round. His study of the antique is clearly shown in many of his frescoes, and especially in the graceful stucco reliefs and painted grotteschi, in the Vatican loggia, the Villa Madama and elsewhere.

Raphael's Fame. — Among all the painters of the world, none has been so universally popular as Raphael, or has so steadily maintained his pre-eminent reputation throughout the many changes in taste which have taken place in the last three and a half centuries. In the seventeen or eighteen years which composed his short working life he passed through stages of development for which a century would not have seemed too long, while other painters lived through the same changeful time with but little alteration in their manner of work. Perugino, who outlived his wonderful pupil, completed in 1521 Raphael's San Severo fresco in a style differing but little from his paintings executed in the previous century.

In versatility of power Raphael remains almost without a rival; whether painting an altar-piece for a church, a large historical fresco, a portrait or decorative scenes from classical mythology, he seems to excel equally in each; and the widely different methods of painting in tempera, oil or fresco are employed by him with apparently equal facility. His range of scale is no less remarkable, varying from a miniature, finished like an illuminated ms., to colossal figures in fresco dashed in with breadth and vigour.

His personal beauty, charm of manner and kindliness of heart endeared him to all who knew him. He was as an equal to the princes of the church, the distinguished scholars and the world-famed men who formed the courts of Julius II. and Leo X. In accordance with the spirit of the age he lived with considerable display and luxury. His pupils formed round him a sort of royal retinue, numbering about fifty youths, each talented in some branch of the arts. Giulio Romano and Gianfrancesco Penni, his two favourite pupils, lived with him in the Palazzo di Bramante, a house (now destroyed) near St. Peter's, where he resided during the greater part of his life in Rome.

Raphael died on Good Friday, April 6,1520, at the age of thirty-seven, after an attack of fever which lasted only ten days. His body was laid out in state in his studio, by the side of the unfinished Transfiguration, and all Rome flocked to the place for a last sight of the "divino pittore." His drawings and mss. he left to Giulio Romano and Gianfrancesco Penni, his newly bought land to Cardinal Bibbiena, the uncle of the lady to whom he had been betrothed. He desired to be buried in the Pantheon. His body is laid beside an altar, which he endowed with an annual chantry, and on the wall over it is a plain slab, with an inscription written by his friend Cardinal Bembo. See PAINTING.

BIBLIOGRAPHY.—Vasari, *Vite* (ed. Milanesi, 1878–85); Duppa, *Life of Raphael* (London, 1816); Rehberg, *Rafael Sanzio aus Urbino* (Munich, 1824); Quatremère de Quincy, *Vita ed Opere di Raffaello,* trans. by Longhena (Milan, 1829) (a work marred by many inaccuracies); Gruyer, *Raphaël et l'antiquité* (Paris, 1864), *Les vierges de Raphaël* (Paris, 1878) and *Raphael, peintre* de *portraits* (Paris, 1880); Grimm, *Das Leben Raphaels von Urbino* (Berlin, 1872); Anton Springer, *Raffael und Michelangelo* (Leipzig, 1878); Clément, *Michelange et Raphaël* (5th ed.) (Paris, 1881); Eug. Miintz, *Raphael, sa vie, son oeuvre,* etc. (Paris, 1881); Passavant, *Rafael und sein Vater* (Leipzig, 1858) especially for its list, translated by Guasti into Italian (Florence, 1882) and by Lacroix into French (Paris, 1860); Crowe and Cavalcaselle, *Life and Works of Raphael* (London, 1882–85); Eug. Miintz, *Les historiens et les critiques de Raphael* (Paris, 1883); Morelli, *Italian Masters* (in German, 1880; in English, 1882, and subsequently republished); B. Berenson, *Central Italian Painters* (1897); Venturi, *Raffaello* (1920), contains *a* good bibliography; Fisorel, *Raphael's Zeichnungen* (Berlin, 1913–15); A. Rosenberg, *Raffael* (Stuttgart and Leipzig, 1906); J. Klakzko, *Rome and the Renaissance, the Pontificate* of *Julius II.* (Eng. trans. 1926). (J. H. MI.; X.)

RAPID CITY, a city of South Dakota, U.S.A., beautifully situated in the western part of the state, on Rapid river, at the foot of the Black Hills, 3,229 ft. above sea level; the county seat of Pennington county. It is on federal highways 14 and 16, and is served by the Chicago and North Western, the Chicago, Milwaukee, St. Paul and Pacific and the Rapid City, Black Hills and Western railways. Pop. 1940 federal census, 13,844. It is the centre of a wide agricultural and grazing region and of the mining district of the Black Hills, which produces gold, silver, lead, copper, tin, antimony, tungsten and mica. Its manufactures include flour, lumber, meat, brick, stucco, cement, boxes and foundry and machine shop products. The State School of Mines was established here by the Territorial Legislature of Dakota in 1885. Its museum contains, besides minerals, a fine collection of fossils from the Bad Lands, 30 mi. to the southeast. The state game lodge, in the state park near Custer, 30 mi. S.W. of Rapid City, was occupied by President Coolidge as the summer White House in 1927, and the executive offices were housed in Rapid City. The city was founded in 1876 and incorporated in 1878.

RAPIER, the name given to two distinct types of sword. Originally the "rapier" (Fr. *rapière)* was a long two-edged and pointed weapon with a wide cup hilt, used together with the dagger in fencing and duelling chiefly as a thrusting weapon, the cut taking a secondary position. This was the typical duelling sword of the 16th and 17th centuries. In the 18th century the "small-sword" took its place; this was a pointed weapon only, the "cut" having entirely dropped out, and the dagger being discarded. (See FENCING and ***SWORD.)***

RAPPOLTSWEILER: see RIBEAUVILLÉ.

RARE EARTHS, in chemistry, the name given to a group of metallic oxides originally called by this title since they resemble the substances then known as earths (lime, magnesia, etc.). The corresponding elements are unique in that they are all very similar in their chemical properties. The group has been roughly sub-divided into three portions more for convenience than from theoretical considerations. The elements, together with their main characteristics, are given in the sub-groups shown below. The atomic number precedes the name and the atomic weight is given after the symbol. For details *see* separate article on each element.

SUB-GROUP 1

(57) *Lanthanum* (La 138.9). Colourless salts; solutions show no absorption spectrum. White, strongly basic oxide, La_2O_3, which is diamagnetic.

(58) *Cerium* (Ce 140·2). Forms two series of salts, cerous and ceric, derived from the oxides Ce_2O_3 and CeO_2. Cerous salts are colourless and show no absorption spectrum. Ceric salts are yellow or orange-red, and are rapidly hydrolyzed by water. The stable oxide, CeO_2, is insoluble in hydrochloric and nitric acids when pure.

(59) *Praseodymium* (Pr 140·9). Forms leek-green coloured salts whose solutions show a very characteristic and intense absorption spectrum. The stable oxide (Pr_4O_7) is black.

(60) *Neodymium* ((Nd 144·3). Amethyst-coloured salts, the solutions of which give a characteristic and intense absorption spectrum. The oxide, Nd_2O_3, is blue when carefully ignited.

(61) *Illinium* (I1 ?). Solutions said to give an absorption spectrum which is obliterated by the presence of neodymium or samarium. Also called florentium.

(62) *Samarium* (Sa 150·4). Very pale yellowish oxide, Sa_2O_3, giving topaz-yellow salts, showing a characteristic absorption spectrum.

SUB-GROUP 2

(63) *Europium* (Eu 152·0). Pale pink oxide, Eu_2O_3, and pale rose-tinted salts; solutions give weak but characteristic absorption spectrum and brilliant and very strong spark spectrum.

(64) *Gadolinium* (Gd 157·3). White oxide, colourless salts; solutions show absorption spectrum in the ultra-violet only.

(65) *Terbium* (Tb 159.2). Stable oxide, Tb_4O_7, almost black. Salts and solutions almost colourless, giving one absorption band in the blue.

SUB-GROUP 3

(66) *Dysprosium* (Dy 162·5). Oxide, Dy_2O_3, white, forms greenish-yellow salts; solutions characterized by an absorption spectrum. Compounds possess a very high magnetic susceptibility.

(67) *Holmium* (Ho 163.5). Oxide, Ho_2O_3, yellow, giving orange-yellow salts; solutions show characteristic absorption spectrum.

(39) *Yttrium* (Y 89·0). This element is placed here for convenience. Its atomic weight is out of order, and many do not consider it a true member of the series. Oxide, Y_2O_3, white and diamagnetic, gives colourless salts whose solutions give no absorption.

(68) *Erbium* (Er 167.7). Oxide, Er_2O_3, rose, gives rose-coloured salts showing very characteristic absorption spectrum.

(69) *Thulium* (Tm 169·4). Oxide, Tm_2O_3, greenish-white, forms pale bluish-green salts. Solution characterized by both absorption and bright line spectra.

(70) *Ytterbium* (Yb 173·5). Oxide, Yb_2O_3, white, gives colourless salts and solutions showing no absorption spectrum. Spark spectrum, however, is very characteristic. Differs from La_2O_3 and Y_2O_3 since the oxide is a much weaker base and is paramagnetic.

(71) *Lutecium* (Lu 175·0). Oxide, Lu_2O_3, white; almost identical in its properties with the preceding element except that it has a lower magnetic susceptibility and a characteristic spark spectrum.

Of the elements listed above, cerium, lanthanum and neodymium are comparatively common, while europium, terbium and thulium are very rare. While it is true that certain minerals are richer in one sub-group than in others, nevertheless if a sufficient amount of any mineral is examined, the presence of every member of the series can be detected. Monazite, cerite, allanite, etc., are the best sources for the elements of sub-group 1; samarskite and certain varieties of xenotime for sub-group 2; gadolinite, xenotime, euxenite, fergusonite, etc., for sub-group 3. These minerals are found chiefly in Norway, U.S A., Brazil, India and Australia.

In 1794 Gaaolin separated a new earth yttria from a black mineral found at Ytterby in Sweden, and in 1804 Berzelius and Hisinger (Klaproth independently) found another new earth in a mineral from Bastnäs which they named ceria. In 1839 Mosander showed that ceria consisted of ceria and a new oxide—lanthana. A little later the same worker showed that lanthana was composed of lanthana and another oxide didymia. Again, in 1843 Mosander showed that yttria was composed of the oxides, viz., yttria, terbia (rose) and a dark oxide, erbia. Berlin and other chemists in 1860 found only two oxides, viz., yttria and the rose-coloured oxide which they now called erbia.

Delafontain and Marignac independently showed that Mosander's three oxides really existed, and, since the name erbia had been given to terbia, the latter was used to designate erbia. In 1879 de Boisbaudran claimed the discovery of a new element in didymium oxide which he called samarium. Marignac found another element in samarium which he later named gadolinium. In 1885 von Welsbach split didymium into praseodymium and neodymium, and in 1896 Demarcey separated europium from samarium. In 1926 Hopkins announced the discovery of element 61—illinium. In the same year Corke, James and Fogg obtained "61" independently and measured the lines of the X-ray spectrum. These discoveries may be represented graphically as in scheme (I.)

$$\text{(I.)}\qquad \text{Ce}\begin{cases}\text{Ce}\\ \text{La}\begin{cases}\text{La}\\ \text{Di}\begin{cases}\text{Di}\begin{cases}\text{Nd}\begin{cases}\text{Nd}\\ \text{Il}\end{cases}\\ \text{Pr}\end{cases}\\ \text{Sa}\begin{cases}\text{Sa}\begin{cases}\text{Sa}\\ \text{Eu}\end{cases}\\ \text{Gd}\end{cases}\end{cases}\end{cases}\end{cases}$$

In 1878 Marignac divided erbia into erbia and a new oxide ytterbia. In 1878 and 1879 Soret and Cleve separated erbia into three oxides, erbia, holmia and thulia; de Boisbaudran, in 1886, obtained a new oxide, dysprosia, from holmia. In 1906 Urbain claimed the discovery of lutecia in ytterbia. Thus we have scheme (II.).

$$\text{(II.)}\qquad \text{Y}\begin{cases}\text{Y}\\ \text{Er}-\text{Tb}\ \{\ \text{Yb}\begin{cases}\text{Yb}\\ \text{Lu}\end{cases}\\ \text{Tb}-\text{Er}\ \{\ \text{Er}\begin{cases}\text{Er}\\ \text{Ho}\begin{cases}\text{Ho}\\ \text{Dy}\end{cases}\\ \text{Tm}\end{cases}\end{cases}$$

The rare earths possess a valence of three, and with the exception of cerium, do not form salts higher than the type RX_3. A few, like samarium, form a lower chloride RCl_2.

The position of these elements in the periodic system presented a great difficulty, which has been solved by N. Bohr's work. Further, it is clear from Moseley's work on the atomic number (*q.v.*) that all the elements of this series are now accounted for.

For the extraction and separation of the individual members of the group the reader is referred to the following: J. F. Spencer, *The Metals of the Rare Earths* (1911); *J. N.* Friend, *Text-book of Inorganic Chemistry,* vol. iv. (1914, etc.); S. I. Levy, *The Rare Earths* (1915, 1924); J. W. Mellor, *Treatise on Inorganic and Theoretical Chemistry,* vol. v. (1922). (C. J.)

RASCHIG, FRIEDRICH AUGUST (1863–1928), German chemist, was born at Brandenburg on June 8, 1863. He studied at Berlin and Heidelberg, and became assistant in the chemical laboratories at the University of Berlin (1885–87). He became chemist to the Badische Anilin und Soda Fabrik in 1887, and in 1891 started a factory for the manufacture of phenol. He carried out researches on the reactions involved in the lead chamber process of producing sulphuric acid. Raschig discovered a technical method of preparing hydroxylamine, and his researches on chloramine led to his well known process for the manufacture of hydrazine. He was an authority on the distillation of coal tar and the manufacture of synthetic phenol. He died on Feb. 4. 1928.

RASHI (1040–1105), Jewish scholar. RABBI SOLOMON IZHAQI (son of Isaac), usually cited as Rashi from the initials of those words, was born at Troyes in 1040 and died in the same town in 1105. He seems to have passed the decade beginning with 1055 in Worms, where a niche in a wall, where his mother was miraculously saved from death was long shown. Within this, it is said, Rashi was wont to teach. A small edifice on the east of the synagogue is called the "Rashi Chapel," and the "Rashi Chair," raised on three steps in the niche, is one of the objects of the pious admiration of pilgrims. At Worms Rashi worked under Jacob ben Yaqar, and at Mainz under Isaac ben Judah, perhaps combining at the same time the functions of teacher and student.

Rashi was twenty-five years of age when he returned to Troyes, which became a recognized centre of Jewish learning. Here he acted as rabbi and judge; he and his family worked in the vines of Troyes. His learning and character raised him to a position of high respect among the Jewries of Europe, though Spain and the East were long outside the range of his influence. As was said of him soon after his death: "His lips were the seat of wisdom, and thanks to him the Lam, which he examined and interpreted, has come to life again." The latter part of his life was saddened by the massacres in the Rhineland at the time of the first Crusade. Rashi died in Troyes in 1105.

Besides minor works, such as a recension of the Prayer-Book *(Siddur)*, the *Pardes* and *ha-Orah,* Rashi wrote two great commentaries on the whole of the Hebrew Bible and on about thirty treatises of the Talmud. His commentary on the Pentateuch, in particular, has been printed in hundreds of editions; it is still to Jews the most beloved of all commentaries on the Mosaic books. More than a hundred supercommentaries have been written on it. His influence in Christian circles was great, especially because of the use made of the commentary by Nicolaus de Lyra (*q.v.*), who in his turn was one of the main sources of Luther's version. Even more important was his commentary on the Talmud, which became so much the definitive interpretation that Rashi is cited simply as "the Commentator."

BIBLIOGRAPHY.—M. Liber, *Rashi* (1906), published as a memorial of Rashi on the 800th anniversary of his death. Rashi's commentary on the Bible has been iranslated into Latin by Breithaupt (1710–14); and into German (Pentateuch) by Dukes (1833–38) and others. The foundation of recent investigation into Rashi's life is Zunz's *Salomon b. Isaac* (1823), to which I. H. Weiss added much in his (Hebrew) biography (in *Bet Talmud* ii., Nos. 2–10). *See* also Graetz, *History of the Jews* (Engl. trans., vol. iii. ch. ix.). A critical edition of Rashi's Pentateuch commentary was published by A. Berliner (2nd ed., 1905).

RASHTRAKUTA, an Indian dynasty which ruled in the Deccan (*q.v.*) from about A.D. 750 to 973. The Rashtrakuta or Ratta clan are supposed to have held power during the historical blank before the 6th century; but they came to the front in A.D. 750, when Dantidurga overthrew the Chalukya dynasty and made himself ruler of the Deccan. He was succeeded by his uncle Krishna I. (*c.* 760), who completed his conquests, and whose reign is memorable for the execution of the Kailasa, the rock-cut temple at Ellora. His grandson Govinda III. (780–81 j) extended the power of the family from the Vindhya Mountains and Malwa on the north to Kanchi on the south. The next king, Amogavarsha, reigned for sixty-two years. The reign of Krishna III. was remarkable for a war with the Cholas, in which the Chola king was killed on the field of battle in 949. The last of the Rashtrakuta kings was Karka II., who was overthrown by the Chalukyas in 973.

See R. G. Bhandarkar, *Early History of the Deccan* (Bombay, 1884).

RAŠIN, ALOIS (1867–1923), Czechoslovak statesman, was born at Nechanice. While at the university he took an active part in politics, and his abilities as an orator, journalist and organizer brought him into the forefront of the Czech progressive movement. His anti-Austrian activities brought him into conflict with the authorities; he was tried in connection with the "Omladina" affair in 1893 and condemned to two years' imprisonment and the loss of his doctorate. After serving his sentence he gained a prominent position in the Czech Liberal ("Young Czech") party, which he represented both in the provincial diet of Bohemia and in the Austrian Reichsrath. During the anti-Czech persecution in the World War period, Rašin, together with Kramár, was arrested in 1915, charged with treason and condemned to death. The sentence, however, was not carried out, and after the accession of the emperor Karl, Rašin, with other political prisoners, was amnestied. He then took part in the preparations for the revolutionary coup in 1918, which, as a member of the National Committee, he helped to bring about. In the first Czechoslovak Government he became finance minister and rendered inestimable services to his country by freeing the Czechoslovak currency from that of Austria and inaugurating a financial policy which led to the stabilization of the Czechoslovak crown. He described his achievement in a book entitled *Financial Policy of Czechoslovakia During the First Year of its History* (1921, Eng. trans., 1923). In Jan. 1923 he was attacked by a demented youth and died of his injuries six weeks afterwards, on Feb. 16, 1923.

RASK, RASMUS CHRISTIAN (1787–1832), Danish scholar and philologist, was born at Brandekilde, Fiinen, on Nov. 22, 1787. He studied at the university of Copenhagen, and in 1808 was appointed assistant keeper of the university library, and later professor of literary history. In 1811 he published, in Danish, his *Introduction to the Grammar of the Icelandic and other Ancient Northern Languages,* from printed and ms. materials accumulated by his predecessors in the same field of research. The Arna-Magnaean Institution then commissioned him to edit the ms. of the Icelandic *Lexicon* (1814) of Bjorn Haldorson. Rask spent ten years in Iceland, mastering the language and familiarizing himself with the literature, manners and customs of the natives. He was the first president of the Icelandic Literary society, established at Copenhagen early in 1816. In October 1816 Rask left Denmark on a literary expedition, at the cost of the king, to prosecute inquiries into the languages of the East, and collect manuscripts for the university library at Copenhagen. He went first to Sweden, making an excursion into Finland to study the language. Here he published, in Swedish, his *Anglo-Saxon Grammar* in 1817. In his *Essay on the Origin of the Ancient Scandinavian or Icelandic Tongue* (Copenhagen, 1818) he traced the affinity of Icelandic to the other European languages, particularly Latin and Greek. In the same year he brought out the first complete editions of Snorro's *Edda* and Saemund's *Edda.* From Stockholm he went in 1819 to St. Petersburg, and thence through Tartary into Persia, and resided for some time at Tabriz, Teheran, Persepolis and Shiraz. From Persia he went to India and Ceylon. Rask returned to Copenhagen in May 1823, bringing a considerable number of Oriental manuscripts, Persian, Zend, Pali, Sinhalese and others, with which he enriched the collections of the Danish capital. He died at Copenhagen on Nov. 14, 1832.

During the period between his return from the East and his death Rask published in his native language a *Spanish Grammar* (1824), a *Frisic Grammar* (1825), an *Essay on Danish Orthography* (1826), a *Treatise respecting the Ancient Egyptian Chronology* and an *Italian Grammar* (1827), and the *Ancient Jewish Chronology previous to Moses* (1828). Rask's *Anglo-Saxon, Danish* and *Icelandic Grammars* were brought out in English editions by Thorpe, Repp and Dasent respectively.

See his collected essays, *Samlade Afhandlinger* (Copenhagen, 3 vols., 1834–38).

RASLE, SEBASTIEN (1658–1724), French missionary, born at Dôle, studied at Dijon, and for some time taught Greek at Nimes in the seminary of the Jesuit order, of which he was a member. He went out to Canada as a missionary in 1689, and was placed in charge of the station at Norridgewock. He used his great influence with the Indians in the interest of France against England, came into collision with the colonial authorities in New England, and a price was placed on his head. He escaped capture for a long period, but was eventually captured at Fcrt Richmond and was shot. He compiled a dictionary of the Abenaki language.

RASMUSSEN, KNUD JOHAN VICTOR (1879–1933), Danish explorer, was born at Jakobshavn, Greenland, on June 7, 1879. In 1902 he made the first of several expeditions to Greenland and the northern polar regions. Between 1905 and 1924 Rasmussen visited all the extant Eskimo tribes and ascertained that they were originally Red Indian tribes which had wandered east and west from the coast. Rasmussen, whose ancestors in the maternal line were Eskimos, gained a thorough knowledge of arctic peoples and customs and made them the subject of numerous tracts and publications, including *Nye Mennesker* (1905); *Myter og Sagn fra Gronland* (1921) and *Gronland Langs Polhavet* (1919; Eng. trans., *Greenland by the Polar Sea,* 1921).

RASPBERRY, an old and well-known fruit-bearing bush, was known to classic writers and was mentioned by Pliny as a wild fruit called *Idea* from Mt. Ida in Asia Minor on which it grew. Parkinson *(Paradisus,* 1629) speaks of red, white and thornless varieties of raspberries, and its culture began about this time. The raspberries (of the genus *Rubus*) bear juicy red or black (rarely orange, amber or pale yellow) berries which pull off the plant, leaving the receptacle on the stem. This characteristic differentiates the raspberry from the blackberry in which the receptacle picks off the plant.

The raspberry section of *Rubus* probably evolved in eastern Asia, where upward-of zoo species of raspberries are known. In Great Britain and throughout Europe only one species, R. *idaeus*, is known, from which the European cultivated varieties are derived. In the United States and Canada, three species *(R. strigosus,* the red raspberry; *R. occidentalis*, the eastern black raspberry; and *R. leucodermis*, the western black raspberry) are found. American red varieties are derived from *R. strigosus* and hybrids of it with *R. idaeus*. They are much hardier and less prickly than European varieties. Black varieties came from R. *occidentalis*, purple varieties are hybrids of the black and red.

Related edible berries often called raspberries are the two flowering raspberries of the northern woodlands, *Rubus odomtus* and *R. parviflorus;* the Rocky Mountain flowering raspberry, *R. deliciosus;* the salmonberry, *R. spectabilis,* of the Pacific northwest; and the baked-apple berry, R. *chamaemorus,* of the northern bogs, a circumpolar species.

Three other raspberries are grown slightly for their fruit in other parts of the world — the Andes black raspberry, R. *glaucus,* in northern South America, the Southern Asian black raspberry, *R. niveus,* and the wineberry, R. *phoenicolasius*, introduced from northeastern Asia. R. *kuntzeanus* from China has been hybridized with the Cuthbert to give the Van Fleet, and *Rubus biflorus,* also from China, has been hybridized with Latham to give the Dixie, both of these. being varieties adapted to southern U.S.A.

The acreage of red raspberries in Great Britain was reported as 5,401 in 1937. In Scotland the Blairgowrie district is the centre of production; in England, Kent, the eastern counties and Worcestershire are important centres. It is grown in mixed plantings with other fruits, the plants being set 18 in. apart in rows 6 or 7 ft. distant. Lloyd George is the chief variety — having very large berries which are excellent for canning and jam. Red Cross and Pynes Royal are other good varieties.

The acreage of raspberries in the United States was 59,000 in 1939 with a crop value of $7,416,000. Black raspberries are nearly as important as the red. The acreage of purple varieties is small. Important red-raspberry sections are western Maryland, southern New Jersey, the Hudson river valley, western Michigan, near Minneapolis, Minn., the Puyallup valley of Washington, the Willamette valley of Oregon, and the Santa Clara valley of California. The largest acreage of black raspberries is in western Michigan. Smaller sections are in western Maryland, western New York, and the Willamette valley of Oregon. Few plantings in the United States, except in the Hudson river valley, are mixed with other fruits. Good red varieties are Cuthbert and Washington in the Pacific northwest, Ranere in California, Latham for eastern states, except for Sunrise for very early crop in New Jersey and southward, and Taylor and Milton in New York and New England. The Cumberland is the chief black variety. In eastern Canada, Viking and Newman red varieties are widely grown. Sodus and Potomac are desirable purple varieties. Ranere and Indian Summer are red sorts that also bear fruit on the young canes in late summer and fall.

Red raspberries are propagated by suckers which come from the roots of the parent plant. Root cuttings about? in. long are also used for rapid increase of new varieties. Black and purple varieties have arched canes and are propagated by tip layers, the tips of the shoots being buried about 2 in. deep in August and the rooted tips being dug in early spring. Leaf-bud cuttings may be used for the rapid propagation of new black varieties. Red raspberries are usually planted 2½ ft. apart in rows 6 to 9 ft. distant; the black and purple being planted about 4 ft. apart in rows also 6 to 8 ft. distant. Shoots are produced by these plants in spring and summer which bear fruit the following year and then die. These old canes are cut away each year just after the harvest to make room for the new shoots. The new shoots of the black varieties are tipped or cut off at 12 in. to induce branching; those of the purple are cut at 18 to 24 in. These branches are shortened the following winter to about 8 in. for the black and 12 in. for the purple. The canes of the red raspberries are either not pruned or are shortened to 3 to 5½ ft., depending on the variety and vigour. However, surplus suckers should be cut away early in the summer, leaving 7 or 8 of the strongest canes per plant or per 30 in. of row. The stouter the canes of both black and red varieties the more productive they are. Stakes or trellises are commonly used to support the canes of the red raspberry. Two wire trellises with a wire each side of the row about 3 ft. high or with one wire above the other at 30 in. and 54 in. are common types.

Virus diseases, leaf spot, anthracnose, crown gall, wilt and yellow rust are serious diseases, while the red spider mite, crown borer and fruit worms are serious insect pests. (G. M. D.)

RASPE, RUDOLF ERICH (1737–1794), the original author of the *Adventures* of *Baron Munchausen (see* MUNCHAUSEN), was born in Hanover in 1737, and studied at Gottingen and Leipzig. In 1767 he was appointed professor in Cassel, and subsequently librarian. In 1775 he went to Italy to buy curios for the landgrave of Hesse, to whom he was keeper of the gems, and sold the landgrave's valuables for his own profit. On orders being issued for his arrest, he decamped to England. Later he found a patron in Sir John Sinclair of Ulbster, whom he deceived by pretending to discover valuable and workable veins on his estates; but Raspe had "salted" the ground himself, and on the verge of exposure he absconded. He betook himself to Ireland and died at Muckross in 1794. His authorship of *Munchausen* was only revealed in 1824, by the biographer of its translator Burger.

RASPUTIN, GREGORY EFIMOVITCH (1871–1916), Russian monk, was born in 1871 in the village of Pokrovskoe. near Tyumen, in the province of Tobolsk, Siberia. He was the son of a poor peasant whose disorderly behaviour resulted in his being given the name of Rasputin, meaning "debauchee." He received no education, and till the end of his life was unable to write properly. He spent the first part of his life till the age of 33 in his native village; he married in 1895 a well-to-do girl, Olga Chanigoff, and they had two daughters and a son. In 1904 Rasputin resolved to change his mode of living. He left his family and devoted himself to religious exercises, declaring to his people that he was inspired by God. His passionate nature, his great physical strength and the superstitious atmosphere in which he had been brought up, gave an unexpected direction to his religious exaltation. He adopted the views of the sect known under the name of "Khlysty," the leading idea of whose teaching was that salvation could be achieved only by repentance.

"Sin in order that you may obtain forgiveness" — was the practical rule which he drew from this doctrine. "A particle of the Supreme Being is incarnated in me" — he told his hearers. "Only through me you can hope to be saved; and the manner of your salvation is this: you must be united with me in soul and body. The virtue that goes out from me is the source of light, the destruction of sin" (E. J. Dillon, *The Eclipse of Russia).* This extravagant and dangerous teaching, which resulted in practice in the wildest orgies, not only created for Rasputin immense popularity and the reputation of a holy man among his fellow-peasants, but opened before him the doors of some of the most fashionable Russian houses and even those of the Imperial palace. Looking for new experiences Rasputin left his native village, and made long pilgrimages to various holy places, and even went to Mount Athos and Jerusalem. He spent some time in different monasteries and applied himself to the study of holy books, but his lack of elementary education reduced the results of his labours almost to nothing. He only retained by heart some incomprehensible passages, and often used them in his prophecies. He had, however, a strong magnetic power, the influence of which was recognized by his bitterest opponents.

In 1907, during a stay in St. Petersburg (Leningrad), Rasputin was introduced to the archimandrite Feofan, rector of the theological academy and confessor to the empress, who took an interest in the story of his conversion. The archimandrite, with the assistance of the grand duchesses Militza and Anastasia, presented Rasputin at court, and he produced a deep impression on the empress and emperor. The mystic atmosphere which always prevailed at the Russian court and the constant fear for the health of the tsarevich created a favourable background for the appearance of such a man. The eventual improvement in the health of the grand duke Alexis procured for Rasputin a commanding influence over the empress.

For some time Rasputin was satisfied by his social success, and at first he did not interfere in politics. But his activity was felt in church questions. His friendship with the famous monk, Heliodor, and the bishop of Saratov, Hermogen, which resulted in a complete rupture between them and in a series of scandals, had a painful echo in the country. The appointment of Varnava, an illiterate peasant and a friend of Rasputin, to be bishop of Tobolsk in 1911, and the servility with which the Holy Synod followed the wishes of the favourite, provoked a strong opposition among all classes of society. An unsuccessful attempt to kill him, made by a certain Guseva in 1914, incited by the monk Heliodor, only strengthened his influence. No important nomination was made without his approval, and the most unexpected people rose to the highest offices as the result of his influence. Rasputin was t o ignorant to have any opinion on political questions: he was in most cases a mere instrument of the reactionaries. Numberless stories of the debauchery practised at the court, in which the name of Rasputin was coupled not only with some of the court ladies but even with that of the empress herself, became a common topic of conversation in all classes of Russian society. At length a small group of men of the highest social position, which included the grand duke Dimitri Pavlovich, Prince Yussupoff and Purichkevich determined to end the empire of Rasputin. He was invited to a supper at the Yussupoff palace on Dec. 17, 1916, and shot dead, after an attempt at poisoning him with a strong dose of potassium cyanide mixed with wine had not produced the desired effect. The empress had the body transferred to the park of Tsarskoe Selo, where a special chapel was erected, and she went every night to pray on his grave.

See *Letters of the Tsaritsa to the Tsar 1914–16* (1923); and further letters published in *The Manchester Guardian*, Jan. 9 and Feb. 7, 1924; also Prince Yussupoff, *Rasputin: His Malignant Influence* and *his Assassination* (*Eng.* ed. 1927); M. V. Rodzianko, *Reign of Rasputin* (1927); *R.* Fülöp-Miller, *Rasputin, the holy devil* (1928).

RASSAM, HORMUZD (1826–1910), Assyriologist and traveller, was born at Mosul of native Christian parents. His first work was done as assistant to Sir A. H. Layard in his first expedition (1845–47). He then studied at Oxford, and was again sent by the British Museum trustees to accompany Layard in his second expedition (1849–51). Rassam continued the work (1852–54) in Assyria under the direction of the British Museum and Sir Henry Rawlinson at Nimrud and Kuyunjik. In 1866 he was sent by the British government to Abyssinia, where, however, he was imprisoned for two years until freed by the victory of Sir Robert Napier. From 1876 to 1882 he was again in Assyria conducting important investigations, especially at Nineveh, and during the Russo-Turkish War he was sent on a mission of inquiry to report on the condition of the Christian communities of Asia Minor and Armenia. His archaeological work resulted in many important discoveries and the collection of valuable epigraphical evidence.

See *The Times*, Sept. 17, 1910.

RASSKAZOVO (formerly Byelaya Polyana and Arzhenka), the name of two settlements in the Russian S.F.S.R., on the river Arzhenka, a tributary of the Tambov, and on the road and railway between Kirsanov and Tambov, in 52° 42' N., 41° 46' E. Population 25,168. One settlement, formerly called Byelaya Polyana, was noted for its fair in June. Both have cloth factories.

RAS TAFARI MAKONNEN: *see* MAKONNEN, RAS TAFARI.

RASTATT, a town of Germany, in the *Land* of Baden, on the Murg, 15 mi. by rail S.W. of Karlsruhe. Pop. (1939) 17,-503. The old palace of the margraves of Baden, a Renaissance edifice in red sandstone, contains a collection of pictures, antiquities and trophies from the Turkish wars. The chief manufactures are stoves, beer, paper, sugar, furniture and tobacco.

Rastatt has been the scene of two congresses. The first congress culminated in the treaty of Rastatt between France and Austria, signed on March 7, 1714. The second congress, opened in Dec. 1797, was intended to rearrange the map of Germany by providing compensation for those princes whose lands on the left bank of the Rhine had been seized by France but it had no result.

RASTELL (or RASTALL), **JOHN** (*c.* 1475–1536), an English printer and author, belonged to a Coventry family, and was educated for the law. He succeeded his father as coroner at Coventry in 1506. He was also M P. for Dunheved, Cornwall, from 1529 to the time of his death. He began his printing business some time before 1516, for in his preface to the undated *Liber Assisarum* he announced the forthcoming publication of Sir A. Fitzherbert's *Abbreviamentum librorum legum Anglorum,* dated 1516. In that year he undertook an expedition to America, but got no further than Ireland when his sailors left him. Among the works issued from the "sygne of the meremayd at Powlysgate," where he lived and worked from 1520 onwards, are *The XII. Mery Gestys of the Wydow Edyth* (1525), and *A Dyaloge of Syr Thomas More* (1529). The last of his dated publications was *Fabyl's Ghoste* (1533), a poem. In 1530 he wrote, in defence of the Roman doctrine of Purgatory, *A New Boke of Purgatory* (1530), dialogues on the subject between "Comyngs and Almayn a Christen man, and one Gyngemyn a Turke." This was answered by John Frith in *A Disputacion of Purgatorie.* Rastell replied with an *Apology against John Fryth,* also answered by the latter. Rastell had married, at some time before 1504, Elizabeth, sister of Sir Thomas More, with whose Catholic theology and political views he was in sympathy. More had begun the controversy with John Frith, and Rastell joined him in attacking the Protestant writer, who, says Foxe (*Actes and Monuments,* ed. G. Townsend, vol. v. p. 9), did so "overthrow and confound" his adversaries that he converted Rastell to his side. Separated from his Catholic friends, Rastell does not seem to have been fully trusted by the opposite party, for in a letter to Cromwell, written probably in 1536, he says that he had spent his time in upholding the king's cause and opposing the pope, with the result that he had lost both his printing business and his legal practice, and was reduced to poverty. He was imprisoned in 1536, perhaps because he had written against the payment of tithes. He probably died in prison, and his will was proved on July 18, 1536.

Rastell's best-known work is *The Pastyme of People, the Chronycles of dyvers Realmys and most specially of the Realme of England* (1529), a chronicle dealing with English history from the earliest times to the reign of Richard III., ed. T. F. Dibdin (1811). His *Expositiones terminorum legum Angliae* (in French, trans, into English, 1527; reprinted 1629, 1636, 1641, etc., as *Les Termes de la Ley*), and *The Abbreviacion of Statutis* (1519), of which 15 editions appeared before 1625, are the best known of his legal works.

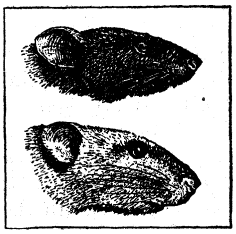
To Rastell is generally attributed the morality play, *A new Interlude and a Mery of the IIII Elements* (*c.* 1519). The fullest details available on John Rastell's life are in A. W. Reed, *Early Tudor Drama* (1926). For the books issued from his press *see* a catalogue by R. Proctor, in *Hand-Lists of English Printers* (Bibliographical Soc., 1896).

RASTELL, WILLIAM (*c.* 1508–1565), English printer and judge, son of the preceding, was born in London about 1508. At the age of 17 he went to the university of Oxford, but did not take a degree, being probably called home to superintend his father's business. The first work which bears his own imprint was *A Dyaloge of Sir Thomas More* (1531), a reprint of the edition published by his father in 1529. He also brought out a few law-books, some interludes ascribed to John Heywood (*q.v.*), an edition of *Fabyan's Cronycle* (1533), and *The Apologye* (1533) and *The Supplycacyon of Soulys* of his uncle Sir Thomas More. He became a student at Lincoln's Inn on Sept. 12, 1532, and gave up the printing business two years later. In 1547 he was appointed reader. On account of his Catholic convictions he left England for Louvain; but upon the accession of Mary he returned, and was made serjeant-at-law and treasurer of Lincoln's Inn in 1555. His patent as judge of the Queen's Bench was granted on Oct. 27,1558. Rastell continued on the bench until 1562, when he retired to Louvain where he died on Aug. 27, 1565.

It is difficult to distinguish between the books written by William and those by his father. The following are believed to be his: *A Colleccion of all the Statutes* (1559), *A Table collected of the Yeares of the Kynges of Englande* (1561), both frequently reprinted with continuations, and *A Colleccion of Entrees, of Declarations, etc.* (1566), also frequently reprinted.

RASTENBURG, a town in the province of East Prussia, Germany, on the Guber, 64 mi. S.E. of Konigsberg by the railway to Lyck. Pop. (1939) 19,494. Its principal manufactures are flour, sugar, oil, beer and machinery.

RAT, probably in its original sense the designation of the British rodent known as the black rat (*Mus rattus*), but also applied to the brown or Norway rat (*M. norvegicus*), and in a wider sense to all the larger representatives of the family Muridae.



ABOVE: BLACK RAT (MUS RATTUS); BELOW: BROWN RAT (MUS NORVEGICUS)

Rats have more rows of scales on the tail (reaching to 210 or more) than mice, in which the number does not exceed 180. For the distinctive characteristics of the family Muridae *see* RODENTIA. Of the two British species the brown or Norway rat (M. *norvegicus*) is distinguished by its large size, brownish grey colour, short tail and ears, stout skull, and the possession of from 10 to 12 teats. It is fierce and cunning, and overcomes all allied species with which it is brought in contact. Its original home would seem to have been some part of Central Asia. Thence it has spread to all parts of the world, driving out the house-haunting species everywhere, as it has in England all but exterminated the black rat. The brown rat migrated westwards from Central Asia early in the 18th century, and is believed to have first reached Great Britain about 1730. Its already evil reputation has been increased of late years by the fact that it is a disseminator of bubonic plague. Black phases are not uncommon. The black rat (M. *rattus*) is distinguishable from the brown rat by its smaller size, longer ears and tail, and glossy black colour. It shares the roving habits of the latter, frequenting ships and by these means reaching various parts of the world. On this account it is common in many places to which the brown species has not yet penetrated, for instance in South America. This long-tailed rat, originally a native of India, would seem to have first penetrated to all parts of the world and to have nearly exterminated the indigenous rats. After this followed the advance of the more powerful brown rat. The black rat first reached Europe in the 13th century. The Isle of Dogs and Yarmouth, in Norfolk, are the chief of the English strongholds of the black rat. Both species agree in their predaceous habits, omnivorous diet and great fecundity. They bear, four or five times in the year, from four to ten blind and naked young, which are in their turn able to breed at an age of about six months; the time of gestation being about twenty days.

See J. G. Millais, "The True Position of *Mus rattus* and its Allies," *Zoologist*, June 1905; M. A. C. Hinton "Rats and Mice; Enemies of Mankind," *Brit. Mus. Pamphlets.*

RATAFIA. A liqueur or cordial flavoured with peach or cherry kernels, bitter almonds, or other fruits; many different varieties are made. The same name is given to a flavouring essence resembling bitter almonds, and also to a light biscuit.

RATCHET AND PAWL is an important mechanical device in a great many machines and appliances, enabling a movement to be effected in one direction, with slip or freedom in the opposite direction. The mechanism is used to lock something so that it cannot slip or reverse, to hold a load as in a winch, or to give a positive feed. Some ratchets are straight, or with a moderate curve, but the majority are circular. The teeth are usually V-shaped, and the pawl is pivoted so that it drops against any tooth and remains without danger of jumping out. Where a continuous movement is desired. the objectionable clicking of the pawl may be checked by a leather facing, or by the use of a ball or roller, or a set of these, to catch in the teeth, with gravity or spring action to ensure engagement. In the case of a silent ratchet, the wheel has no teeth but an eccentrically-pivoted pawl works frictionally against the periphery.

Various drives and brake mechanisms are made safe by ratchet mechanism, the ship's capstan being one of the oldest examples. Screwdrivers and wrenches are operated by ratchet for access in difficult situations, or to help the worker in manipulative power. Braces and metal drills are actuated by ratchet when it is not possible to make the complete revolution of a handle. So also are jack screws for lifting loads rapidly. Ratchet feed, by which an arm holding the pawl is moved over, and the ratchet-wheel and a feed screw are turned, is utilized in many types of machines and is usually automatic in action. The finest example occurs in cylindrical grinding machines, in which by means of an automatic feed the grinding-wheel travels along a shaft or spindle, the ratchet mechanism setting the wheel to cut a very little smaller before each traverse takes place, this process being repeated as often as is necessary to bring the shaft to size.

RATE. In England the term is specially applied to the levying of public money contributions for local purposes, as distinguished from the "taxes" raised for what are treated as general State purposes. By the Rating and Valuation Acts of 1925 and 1928 the English system of rating has been amended and the law partially consolidated as also for Scotland by the Rating Act, 1926, and the Rating (Scotland) Amendment Act, 1928. In the United States the term "rate" does not signify a form of taxation, but is used to indicate the assessment percentage. (*See* further POOR *LAWS*; UNITED KINGDOM: *Local Government*; TAXATION.)

RATEL or **HONEY-BADGER,** the name of certain Indian and African small clumsy-looking creatures of the size and appearance of badgers, representing the genus *Mellivora* in the family Mustelidae (*see* CARNIVORA). Two species of ratel are commonly recognized — the Indian (M. *indica)* and the African (*M. ratel*), which ranges over Africa; but a black ratel from the Ituri forest has been separated as M. *cottoni*. Both the two former are iron-grey on the upper parts and black below, a style of colouration rare among mammals. The body is stout and thickly built; the legs are short and strong, and armed, especially the anterior pair, with long curved claws; the tail is short; and the ears are reduced to rudiments. The Indian ratel is found throughout India, chiefly in hilly districts, but also in the north of India in alluvial plains. It lives usually in pairs, and eats rats, birds, frogs, white ants, and various insects. Like its Cape congener it occasionally partakes of honey and is often destructive to poultry. In confinement the Indian ratel becomes tame and even playful.

THE RATEL (MELLIVORA INDICA), OR HONEY BADGER

RATHENAU, WALTHER (1867–1922), German statesman and industrialist, was born in Berlin on Sept. 29, 1867, the son of Emil Rathenau, the founder of the Allgemeine Elektrizitats-Gesellschaft. After studying philosophy, physics and chemistry at Berlin and Strasbourg he graduated in 1889, and spent a year studying machine structure and chemistry at Munich. He was then engaged as a civil engineer by the Aluminium Industrie A.-G. of Neuhausen, Switzerland.

In 1893 he became a director of the Electrochemische Werke (Limited) at Bitterfeld for the utilization of a process for making chlorine and alkalis by electrolysis. He also built large works at Rheinfelden, in Russian Poland, and in France, and elaborated processes for the production of ferrosilicate, chrome, soda and magnesia. In 1899 Rathenau became a director of the Allgemeine Elektrizitats-Gesellschaft, and built central stations at Manchester, Amsterdam, Buenos Aires and Baku. In 1902 he belonged to the board of directors of about 100 enterprises. During 1907 Rathenau accompanied Dernburg, the Secretary of State of the Imperial Colonial Office, to German East and West Africa, and also visited the British Colonies in Africa. His *Reflexionen* (1908) contain his two final reports on those visits.

Even at the beginning of the World War Rathenau foresaw the threat to the German supply of raw materials involved by the British blockade. In an astoundingly short time, with the acquiescence of the War Minister von Falkenhayn, he established a huge organization for the administration of the war raw materials then at Germany's disposal. This Board of the War Ministry, called the *Kriegsrohstoff-Abteilung,* which he left in splendid working order to his successor on March 31, 1915, alone made it possible for Germany to hold out with raw material.

After his father's death in the summer of 1915 Rathenau was made president of the Allgemeine Elektrizitats-Gesellschaft. He published *Von Kommenden Dingen* (Eng. trans. *In Days to Come),Eine Streitschrift vom Glauben* and *Vom Aktienwesen.* In 1918 his collected works were published. After the War Rathenau endeavoured to found a middle-class Democratic Party which should bridge the gulf between the middle classes and labour caused by the revolution, and in this way to restore national unity. In 1919 he participated in the preliminary preparations in Berlin for the Conference of Versailles. From April 1920 to May 30, 1921 Rathenau was a member of the so-called "Socializing Commission" convoked by the newly founded *Reichswirtschaftsrat* to discuss the question of nationalizing the coal-mines.

He was government expert at the Spa conference of July 1920, and in the spring of 1921 took part in the preliminaries to the London Conference. At the end of May 1921 he was asked by the chancellor Wirth to join the Government. The two leading men of the Cabinet thus formed, Wirth and Rathenau, were united by trust and friendship. The combination of the chancellor's original and impulsive nature, his courage and love of responsibility, was a happy blend with Rathenau's far-sighted and extraordinary capability. Rathenau co-operated in the final conclusion of the Peace Treaty with the United States of America in Aug. 1921. As Minister of Reconstruction he concluded with Loucheur, the French Minister of the Liberated Regions, the Wiesbaden agreement, securing to France the privileged supply of deliveries in kind as reparation payment, which helped to relax the tension between France and Germany. But the disruption of the Upper Silesian coal and iron district, quite contrary to the German reading of the Versailles Treaty and to the result of the plebiscite, provoked Rathenau to resign from the Cabinet by way of protest. He did not withdraw his support from the Cabinet, however, and went, in Nov. and Dec. 1921 to London, to enlist England's interest and understanding, and to secure a British loan for the next reparation instalment. This loan was refused on technical grounds But in England Rathenau came in touch with members of the British Government. Under his influence arose the famous Lloyd George "Chequers scheme," which gave a practical form to the idea of a "United States of Europe" by proposing the reconstruction of Russia through the united economic forces of the other great European Powers, including Germany. The ideas underlying the later Pact of Locarno (1925) were also discussed. In Paris Rathenau found less support. Nevertheless, the project discussed at Chequers led to the conference of Cannes (Jan. 1922), where Rathenau, in an eloquent speech, exposed the impossibility of the London reparation demands and secured an essential diminution of the reparation payment of 1922.

Meanwhile, at the wish of the chancellor, Wirth, Rathenau had re-entered the Cabinet, this time as Minister for Foreign Affairs. The Genoa negctiaticns did not, unfortunately, lead to a united European work of reconstruction. But separate negotiations between British and French representatives took place with Russia to the exclusion of Germany. Rathenau, fearing that German interests would suffer, accepted on April 16, 1922 at Rapallo the Treaty of Peace and Friendship offered by the Russians, cancelling all reciprocal demands which had accrued from the War.

The climax of his endeavour to replace blind hatred by reason was shown in his great speech in Genoa on May 19, 1922, which ended with the cry of Petrarch: *"Pace—Pace—Pace!"* The question of the alleged War guilt of Germany was one that Rathenau had greatly at heart. He furthered the publication of the pre-War documents.

The effects of the inflation of the currency on the impoverished middle classes caused him the greatest anxiety, and he secured many relief measures. Yet he fully realized that German industry, when inflation ceased, would be faced with extraordinary dangers; but that the development of reparation payment in kind and the treaty with Russia would at least ensure some work for industry in the impending hard times of recovery.

Rathenau, however, was not to see the fulfilment of his plans. On his usual morning drive from his house to the Foreign Office on June 24, 1922 he fell a victim to the bullets and hand-grenades of misguided young Germans, who by this deed robbed their country, not only of a great philosopher and industrialist, but of one of their most fervent patriots and of the best Foreign Minister of that time.

In philosophy Rathenau was an idealist. Adopting the evolutionary theories of Leibniz and Darwin, he saw the development of man's purpose in three stages — first, prehistoric man wholly guided by instinct, then historical man led by intellect and conscious purpose, and lastly the man of the future whose fulfilment will be in the kingdom of the soul. "The soul is no weapon," says Rathenau. It thus stands in contrast to the whole spiritual world of instinct and purpose resulting from the struggle of life. In the social world, whilst believing in an aristocracy of the mind, he realized that democracy was necessary to consolidate the crumbling foundations of the society of his day. A capitalist by birth and training, he held without repudiating his creed, that in countries like Germany, carrying the burden of a dense population, "Consumption, like all enormous activities, is not an individual but a communal affair"; "The equalization of property and income is prescribed both by ethics and by economics"; "The extant sources of wealth are: monopolies in the widest sense, speculation and inheritance"; "The restriction of the right of inheritance, in conjunction with the equalization of popular education at a higher level, will throw down the barriers which now separate the economic classes of society, and will put an end to the hereditary enslavement of the lower classes."

Rathenau's collected works (5 vol.) were published in 1925. The following were not included and appeared separately *Die Neue Wirtschaft* (1918); *An Deutschlands Jugend* (1918); *Zeitliches* (1918); *Nach der Flut* (1919); *Der Kaiser* (1919); *Der Neue Staat* (1919) (Eng. trans. *The New Society*); *Krit. der dreifachen Revolution* (1919); *Die neue Gesellschaft* (1919); *Autonome Wirtschaft* (1919); *Was wird werden?* (1920); *Demokr. Entwicklung* (1920); *Albert Kollmann* (1921); *Reden* (1924); *Briefe* (1926); H. Kessler, *Walther Rathenau, sein Leben und sein Werk* (1928, English trans. *Walther Rathenau*, 1929) The *Rathenau Stiftung* (Berlin), founded after his death, collects all bibliographical material. (F. SI.)

RATHENOW, a town in the Prussian province of Brandenburg, Germany, on the Havel, 45 mi. W.N.W. of Berlin. Pop (1939) 33,531. Rathenow was incorporated as a town in 1295. In 1394 it was taken and partly destroyed by the archbishop of Magdeburg. It suffered much from the ravages of the Thirty Years' War. The Protestant church of St. Mary and St. Andrew, originally a basilica, was transformed to the Gothic style in 1517–89.

RATIBOR (Polish *Raciborz*), a town of Germany, in the Prussian province of Silesia, situated on the left bank of the Oder at the point where the river becomes navigable, 97 mi. S.E. of Breslau by rail, on the main line to Oderberg. Pop. (1939) 49,085. Ratibor, which received municipal privileges in 1217, was formerly the capital of an independent duchy, 380 sq.m. in extent, which existed from 1288 to 1532, and afterwards passed successively into the hands of Austria and Prussia. In 1821 a small mediate principality was formed and was conferred upon the landgrave of Hesse-Rotenburg, as compensation for some Hessian territory absorbed by Prussia. In the partition of Upper Silesia between Germany and Poland in 1921 (*see* SILESIA) Ratibor was retained by Germany. The most prominent buildings are the law-courts and the chbteau on the right bank of the Oder.

RATIOCINATION, a term used in logic and psychology for those processes by which the mind proceeds from general to particular truths. The steps involved in ratiocination may perhaps be most clearly seen in the form of reasoning followed in the syllogism. (*See* SYLLOGISM.)

RATIONALISM is that trend of philosophy which intercedes for the rights of "natural reason" and sees in it the source of all truth. Common to all the historical forms of rationalism is the belief in the "autonomy of thought," *i.e.,* the view that thought can discover by its own strength, without support from a supernatural revelation and without appeal to sense perception, a system of "eternal truths," a system presented to thought within its own realm and comprehended by thought as necessary.

In the theoretical field there are certain "innate ideas" which form the basis of all certainty and from which all specific proofs are derivable by logical inference. The same is true also of practical consciousness. Beside the theoretical, especially logical and mathematical, truths, there are ethical truths which can be comprehended with certainty as unconditional obligations or imperatives of action.

Early History. — This fundamental conviction found its clearest expression in the Stoic doctrine of the κοιναὶ ἔννοιαι (notitiae communes), as it is developed in the writings of Cicero. From here it exercised a lasting influence. In modern philosophy this influence first appears within the religious sphere, in which also the terms "rationalism" and "rationalist" seem to have originated, and where they designate the assumption that there cannot be an insurmountable conflict between the "natural" cognition of reason and the "supernatural" truth of revelation.

Thus, in English religious philosophy of the 16th and 17th centuries, for instance, those are called "rationalists" who consider reason the highest authority not only in science but also in matters relating to religion and society. (Cf. Lechler, *Geschichte des englischen Deismus,* p. 61.) Also in the Netherlands it was customary at that period to distinguish between "rational" and "non-rational" theologians. (*Cf.* Bayle, *Dictionnaire historique et critique.*) In the introduction to his *Théodicée,* in the "Discours de la conformité de la foi avec la raison," Leibniz gave an outline of the development and significance of "theological rationalism."

It was especially in England and through Herbert of Cherbury (1581–1648) that religious rationalism received its complete foundation and its clear formulation. In his two works *De veritate* (1624) and *De religione gentilium* (1645), Herbert of Cherbury starts from the assumption that reason possesses in itself the capacity for all truths, including religious and moral ones. Beside reason, there is no other higher authority; for even revelation can claim validity only because its content harmonizes with the principles of rational knowledge. The dogma of original sin, or the corruption of reason through the fall of man, is unconditionally rejected by Herbert. In every healthy and reasonable person there are universal and innate truths, by which our earthly mind, implanted as it were, from heaven, is enabled to participate in the recognition of things of God and of moral good. From the sphere of religion this doctrine passes to the science of law (doctrine of "natural law"); to the theory of the State (doctrine of "raison d'état," of the foundations of international law, etc.), to ethics ("autonomy" of morals). In its totality it represents the new "natural system of the sciences of mind" which, since the Renaissance, unfolds itself steadily and supercedes the mediaeval view of the world, which was theological and hierarchic.

Modern Science.—The strongest support was given to this movement by the new achievements of natural knowledge through the great scientists of the 17th century, Copernicus, Galilei, Kepler and Descartes. The new science rests on the basis of mathematics, and it recognizes as "clear and distinct" only what can be expressed in mathematical form. All such cognitions have this in common: that they go back to certain major premises, to "axioms" and "principles" which can be comprehended by reason as universal and necessary, as a priori propositions. Thus, according to Galilei, Truth is written in the great book of Nature, but only he can read it who can decipher the letters in which it is written. These letters, however, are the terms of mathematics, especially of geometry: the concepts of the straight line, the circle, the sphere, etc. None of these concepts is derived from experience; the mind rather takes them "from itself" in order to apply them to sense-perceptions. In the same way, Kepler considers the ideas of number and magnitude as "innate ideas," not drawn from experience but required for the scientific investigation of nature. (Cf. Cassirer, *Das Erkenntnisproblem,* 3rd ed., I., p. 328 sqq.) Descartes enlarges this view by setting forth a system of universal concepts of reason which are obtained by mental analysis from a contemplation of certain fundamental, logical and mathematical, relationships, and which can be applied to all empirical data. These concepts are valid—as he expounds in Le *monde*—not alone for the actual world but for all possible worlds, so that, in understanding by means of them every effect from its cause, we can obtain a priori knowledge of the universe as a whole. As instances of such fundamental concepts, Descartes cites primarily the concept of *Being,* then also the ideas of *Number* and *Time,* of Space, Figure and Motion (Oeuvres, ed. Adam-Tannery, III., 665).

As a middle term for making the transition from the rational to the empirical, from the "possible" to the "actual," a metaphysical idea is used by Descartes as well as by Kepler. The actual world must correspond to the supreme laws of reason, because it is the work of an infinite mind, because it is a creation of the divine intellect. The applicability of pure mathematics to physics, to the concrete phenomena of nature, seems explainable only on this presupposition. It is valid because nature itself is the product of a "divine mathematics": *cum* Deus *calculat, fit mundus.*

For Leibniz, too, there is a continuous harmony between "truths of reason" and "truths of fact," between the empirical and the rational world. The pure laws of thought as exhibited in logic, arithmetic, geometry and abstract dynamics, apply to all objects in nature, and to all changes taking place therein.

This metaphysical rationalism is further developed by Leibniz so that the eternal truths of reason constitute the essence of the divine mind, and God, therefore, cannot desert them in his activity, in his creation. Creation consists in transition from "essence" to "existence," from the "possible" to the "actual."

Leibniz developed this view of rationalism in two directions. It determines, first of all, the entire structure of his metaphysics; it forms the logical and methodical basis of his *monadology.* The system of "monads," *i.e.,* of perceiving minds, is graded, according to Leibniz, in such a way that each monad resembles the others as regards the content of its perception; for each of them represents and reflects the total universe from a definite angle. Accordingly, the difference between the various minds can consist in nothing other than the form of perception, the greater or lesser degree of clarity. Hence a gradation from the dim and confused mode of perception, such as we must assume, for instance, in plant or animal consciousness, up to the divine cognition which consists in completely distinct and adequate ideas. Human knowledge lies in the middle between the two extremes; it knows "confused" ideas, *e.g.,* those of sense-qualities, as well as "distinct" ideas, *e.g.,* those of logic and mathematics.

However, its specific task consists in referring progressively the former to the latter, in transforming all data into pure objects of thought, all merely factual presentations into notions continuously connected by proof and thus conceived by reason. This task can be accomplished in detail only by presupposing a general system of the possible forms of thought and of the universal laws of connection which those forms obey. Leibniz attempted to satisfy this demand in the grandiose outline of his "general characteristique" in which the primary elements of all cognition were to be set forth in conjunction with the demonstration of a method by which all truths, however complex, could be exhibited as combinations of those primary elements. Through this outline of his "general characteristique," Leibniz became the founder of that "symbolic logic" which reached its complete development only in the nineteenth century through the works of Boole and Schroder, of Peirce and Peano, of Whitehead, Frege and Russell. (Cf. Couturat, La Logique de Leibniz, 1901.)

In the eighteenth century, on the other hand, philosophical rationalism became dominant only in that more limited form which it had received in the system of Christian Wolff (1679–1754). Wolff's doctrine, too, rests entirely on the distinction between contingent "truths of fact" and necessary "truths of reason": he, too. contends that the specific task of cognition, especially the task of philosophical knowledge, consists in transforming all contingent elements into rational ones by understanding them according to the principle of sufficient reason.

Consequently, we cannot claim a philosophic insight into a region of facts unless we succeed in bringing the factual details into a rational order so that each member can be completely understood from the context and from the necessary laws which determine this context. Accordingly, Wolff supplements each form of empirical cognition by a corresponding "rational" form. The propositions, for instance, which in the field of physics result directly from observation and from experiments, must be raised to the rank of genuine cognitions of reason by being deduced from the principles of general ontology and general cosmology. Specifically, Wolff's system is subdivided into Logic as the doctrine of the operations of the understanding in general, into Ontology as the doctrine of Being and its most universal determinations, Cosmology as the doctrine of the world, of the simple substances and their combination, Psychology, Theology, and, finally, universal Teleology, the doctrine of ends in general and of the end of human action in particular.

Kant.—It is against this rationalism of Wolff that the attack of Kant is directed in the Critique of Pure Reason. In the section on the "transcendental dialectic," he demonstrates the fact that, and the reason why, a rational psychology, a rational cosmology, a rational theology, such as Wolff had planned and developed, are impossible. The decisive ground for this impossibility lies, according to Kant, in the fact that mere reason does not suffice for the cognition of absolute Being, of God, Soul and World. Soul, God and World are transcendental "ideas"; but reason becomes involved in insoluble contradictions as soon as it tries to "hypostasize" these ideas; *i.e.,* as soon as it takes them for transcendent objects, for objects beyond all possible experience. All that reason can reach, lies within the boundaries of experience itself; it cannot recognize the nature of things in themselves, its sole task in theoretical cognition consists in "spelling phenomena in order to be able to read them as experiences."

The *metaphysical* rationalism of the dogmatic systems, as it is to be found in Descartes and Spinoza, Leibniz and Wolff, is thus opposed by the new attitude of critical rationalism. The latter, too, retains the fundamental idea of the older rationalism; namely, that reason can recognize completely only that which it can produce according to its own design—"that we know a priori only so much of things as we ourselves put into them." (*Critique of Pure Reason*, 2nd. ed.; p. 18.) But this kind of "construction" is possible only in so far as we deal not with things-in-themselves, independently of all possible experience, but with experience itself and the conditions of its possibility. The understanding is able to recognize a priori and, as it were, to anticipate the *form* of experience in so far as it constitutes this form. It is, itself, "the legislation for nature"—but only in so far as we understand by "nature" not the subsistence and constitution of absolute objects, but the order and regularity of empirical phenomena. Thus rational cognition becomes fruitful only where, instead of dwelling in the world of "noumena," it concerns itself with phenomena. The characteristic of these, however, is that they form a spatio-temporal manifold. All efficacy of the "pure concepts of understanding" is, therefore, necessarily confined to space and time, to the forms of "pure intuition." Only in connection with pure intuition does cognition by understanding or cognition by pure reason receive a real content

This fundamental idea of Kant's critical rationalism is more explicitly developed in his doctrine of the "schematism of the pure concepts of understanding." The categories of thought are merely directions for establishing certain relationships; but these directions need to be referred to sensuousness. Thus, the concept of substance, for instance, does not mean the Being-in-itself as *such* (as conceived by Spinoza), but the persistence of an object *in time*, and it immediately loses all possibility of application when we abstract from the order of time. In general, the "schemata" of the pure concepts of understanding are nothing but "determinations a priori of time according to rules," and these schemata are "the true and only conditions for securing for our concepts of understanding a reference to objects, *i.e.*, significance. The categories are, therefore, only of empirical use, inasmuch as they merely serve to subject phenomena to general rules of synthesis and thus make them fit for coherent correlation in experience." (*Critique of Pure Reason*, 2nd ed., p. 185.) Kantian rationalism, in other words, does not aim at the "existence of things," but at the form of experience itself, at the order and connection of phenomena. (*Cf.* TRANSCENDENTALISM.)

The mistake of Empiricism consists in overlooking the intellectual factor which is indispensable for any cognition of objects; the mistake of Rationalism consists in over-estimating this factor, in isolating it from the sensuous conditions upon which its applicability depends. "Leibniz *intellectualized* the phenomena, just as Locke altogether *sensualized* the concepts of understanding, *i.e.*, regarded them as nothing but empirical or abstracted concepts of reflection." (*Critique of Pure Reason*, 2nd ed., p. 327.) In this form of *critical* rationalism, the original problem from which the *scientific* rationalism of the Renaissance had started, is restated; but it is now solved in a new sense. The scientific rationalism of Kepler and Galilei, too, asserted that "experience is possible only through the representation of a necessary connection between perceptions." (*Critique of Pure Reason*, 2nd ed., p. 218.) But it was able to explain this necessity only by founding it on a metaphysical proposition, namely, the contention that the world itself is the work of an infinite intellect. Kant removes this dependence of rationalism upon a proposition of dogmatic metaphysics: he treats the truth of experience as self-sufficient, although its form and order are based on the general orderliness of the understanding, without which they would be impossible.

BIBLIOGRAPHY.—W. E. H. Lecky, *Hist. of Rationalism in Europe* (1870); J. F. Hurst, *Hist. of Rationalism* (1901); J. MacCabe, *Modern Rationalism* (1909), and *Biographical Dictionary of Modern Rationalists* (1920). (E. CR.)

RATIONALIZATION OF INDUSTRY. This term would appear to have come first into common use in Germany in the post-war years of inflation and economic derangement to denote the type of organization and leadership under which, it was in some quarters contended, German industries must more than ever be arrayed in order to stand firm against threatening dissolution. As post-armistice depression settled upon the great industries of other countries the same idea was thrust to the fore and the term "rationalization" crept into the terminology of industrial re-organization.

World Economic Conference.—In the report of the World Economic Conference of 1927 rationalization is taken to mean "the methods of technique and organization designed to secure the minimum waste of either effort or material." It includes the scientific organization of labour, standardization of both material and products, simplification of processes, and improvements in the system of transport and marketing. The conference considered that one of the principal means of increasing output, improving conditions of labour, and reducing costs of production, was to be found in "rational organization of production and distribution," the judicious and constant application of which was "calculated to secure (1) to the community greater stability and a higher standard in the conditions of life, (2) to the consumer lower prices and goods more carefully adapted to general requirements, (3) to the various classes of producers higher and steadier remuneration to be equitably distributed among them."

If this were all that rationalization implied and entailed nothing would remain but to recognise a new name for a familiar and excellent thing and to continue with redoubled effort the good work that has been going forward for decades past along these salutary lines. But something more revolutionary is involved.

Control of Industry.—Broadly conceived, rationalization is the bringing of the whole of an industry under intelligent direction and administration. It implies a conception of industrial organization and control radically different from that which prevailed in the last century, under which it was regarded as normal that the output, prices, and evolution of an industry should be at the mercy of demand interacting with supply through the machinery of competition between the independent firms of which the industry was comprised. (*See* COMPETITION.) It implies the conception of an industry as an organic body, with each separate establishment a corporate part of the whole, no longer expending energy in internecine conflict, but working together to a common policy and programme laid down by a directorate in whom absolute authority over the industry as a whole has been reposed. Regarded aggressively, it implies an industry presenting a united front to the handlers, carriers and users of its goods. Regarded constructively it implies the organization of an industry as a corporate whole in such manner as to eliminate "friction, waste and slip," to bring the technique and machinery of all establishments to the level of the best; and, most of all, to order the capacity, output, selling activities, and prices of the industry as a whole in accordance with what are deemed to be the present and future needs of the market and the highest interests of the industry itself in the industrial, social and political complex in which it has its being.

Monopoly Aspect.—The bringing together of the disparate units of an industry into such an organization can be effected in three main ways; by the voluntary association of independent firms for policy purposes (*see* ASSOCIATIONS, INDUSTRIAL); by the centralised control of quasi-independent firms under some form of holding company; and by outright amalgamation. Obviously such thorough-going organization and administration as is indicated above cannot be made effective unless the whole, or a predominant part of the whole, industry is ranged under the centralised direction. The organization, in other words, must have a more or less complete monopoly, and one of the major social and political problems that "rationalization" brings in its train is the curbing of the power of monopoly should that power be used to the detriment of consumers and of the public generally.

The conception of "rationalized" industries has much in common with that of industrial guilds, which were the subject of much forceful advocacy during the post-war reconstruction period. The rationalization of industry is also hardly to be distinguished, in many of its promised advantages, from the "nationalization of industries" which has figured for so long on the socialist programme. (*See* SOCIALISM.) But it differs fundamentally from both these on the question of who shall be in control. Rationalization envisages the retention, with no radical change, of the capitalist order. The ultimate control of the industry is vested, not in a democratic electorate of all those engaged in the industry, and not in a Government department, but in the shareholders and other financiers of the combined enterprises. Proposals for associating the workpeople with the internal management and with the fortunes of the separate or combined undertakings by means of works committees, workmen's representatives on the board, and schemes of profit-sharing and co-partnership do not essentially alter this fact; nor does the probability that such organization will find it wise to keep on good terms with the political power shift sensibly the nominal seat of industrial power. From this aspect flows two important considerations; one as to the manner in which the nominal control of the stock-holders and other financiers (including the banks) will find expression in the policy of the central directorate and the type of administrator that will be thrown up; and the other the attitude of the workpeople to the form and policy of the organization.

Attitude of Trade Unions.—From the latter standpoint much interest attaches to the approaches made towards the end of 1927 by Sir Alfred Mond (Lord Melchett) head of the great chemical consolidation, on behalf of a body of employers identified with rationalization aims; to the General Council of the Trades Union Congress, the response of that organization, and the conferences that subsequently took place. The declared view of the Trade Union movement, as expressed in the course of these conferences, is that while rationalization can never prove an alternative to nationalization the movement was prepared to welcome and support such changes in the organization of industry during the period of private ownership as would lead to improvements in the efficiency of industry, and to the raising of the standard of living of the people.

BIBLIOGRAPHY.—Sir Alfred Mond, Industry and Politics (1928); David Houston, Rationalization in the United States (Geneva, 1926); Prof. D. H. MacGregor, "Rationalization of Industry" in the Economic Journal (Dec. 1927). See also the bibliographies to MONOPOLY and TRUSTS. (J. H.)

RATIONING, a term of military origin, indicating the apportionment to each member of a population or of an army of his due share of the available supplies. As usually understood, the process of "rationing" is associated with the distribution of commodities in a time of shortage.

A complete and effective system of rationing involved the control of commodities at every stage from the source of supply to the consumer. Rationing proved to be a twofold problem, positive in the securing and conserving of supplies, negative in the prevention of injustice, waste and fraud. The consumer saw only a small part of a complex and far-reaching organization. The economic order of the operations is: (1) Supply; (2) distribution to localities; (3) distribution to consumers or rationing.

During the World War two distinct rationing plans were evolved, by Germany and Great Britain respettively. Other countries adopted one or other of these schemes, with more or less modification.

The Central European Systems.—In September, 1914, the general commanding in Brandenburg assumed control of all cereals, and, before the end of the year, bread cards had appeared in many German cities. By the early days of 1915, all bread cereals in Germany were under official management. The method adopted to deal with supplies and distribution gives the keynote for all the Central European efforts at rationing. The control of bread was quickly followed by that of practically every article of daily consumption. The German scheme was based on the local control of consumption, and this reposed on a supply in the main nationally controlled. Distribution and control were largely conditioned by the existing machinery of local government, with its regular gradation from the Reich to the Commune.

Taking the control of bread cereals as an example, the system may be thus described: The consumer was provided with a card, with dated and numbered sections, and the appropriate section was cancelled by the retailer or official distributor when the ration allotted by the local authority (Kommunalverband) was purchased. Card sections were only valid as dated and numbered. This was to prevent fraud and sudden fluctuations in demand. Bona *fide* travellers used special cards. Supplies were allotted to *Kommunalverbände* on the basis of the amounts available and the number of "men" to be fed. Manual workers received slightly more than a "man's" ration, and women and children less. The Kommunalverband got its supplies either from local producers, or from the authorities of the Kreis. These again indented on the next highest authority, and, step by step, the requisitions went on till they reached the central authority of all. This was a company formed, partly of business representatives, partly of Government nominees, and capitalized partly by subscription and partly by Government funds. Beyond this central company, which controlled only the supplies of its own particular group of products, was the Imperial Food Bureau, with corresponding ministries in most of the Federal States.

The country's supplies were thus centralized, and the requirements of the various subordinate authorities were met in that degree which the national or local food policy made possible.

The central empires had to rely for their food supplies almost exclusively on home production. They had, therefore, to face the problem of obtaining the articles to be distributed from the actual producers. A special ration was allowed to "self-suppliers" (Selbstversorger), which, although small, was generally greater in amount than that allowed to other people. This was inevitably accompanied by evasion of regulations. If the self-supplier could conceal part of his output he could retain more than his official "ration," and this he usually succeeded in doing. As official rations dwindled, the practice of concealing output increased, and an extensive illicit trade (*Schleich-handel*) came into being. The activities of this trade completely upset the calculations of the German and Austrian food controllers, and by the middle of 1917 the rationing authorities themselves were obliged to have recourse to this efficient and wide-spread organization. The German plan for rationing food was beginning to break down.

The British System.—The British control of foodstuffs began to take shape in 1917. This system, as finally organized, depended principally on the fact that the bulk of supplies was sea-borne. Nearly all articles, therefore, came naturally and easily under public control from the moment they entered the country. Since Britain met her problems after Germany had been compelled to deal with similar difficulties, she had the advantage of the German experience. The British authorities had first of all to find out the real incidence of demand. This was accomplished indirectly by the first measures adopted to deal temporarily with the effects of shortage in the supply of sugar.

In August, 1914 a royal commission on sugar supplies was set up. By the end of 1916 sugar began to be in short supply. Each trader, wholesale or retail, was then given 50% of his 1915 supply, and left to share this among his customers as best he could. In June 1917, the cabinet decided upon a rationing scheme, under which each householder was invited to register with a particular retailer, to whom supplies were issued at a given ration per head of registered customers. In order to work this first sugar rationing scheme, some 1,800 food control committees were appointed by local authorities. Their expenditure was met from national funds, and they were supervised by 15 divisional food commissioners. These commissioners were appointed by a special wartime ministry of food, at the head of which was the food controller.

On Jan. 1, 1918, the rationing of individuals began, and as meantime other food supplies (*e.g.*, tea, margarine, bacon, cheese) had begun to run short, and there was no hope of a national rationing scheme being made effective for some months, local food committees had to arrange for the consumers under their charge as they best could. Several of them, that of Birmingham notably, began to use the powers of requisition granted to them by the ministry of food, and to distribute supplies to retailers, with whom consumers had to be registered. General provision for such schemes was made by an order of the food controller, dated Dec. 22, 1917. The same difficulty arose, however, as had been experienced in Germany many months before; different action by the authorities of adjacent districts led to confusion.

A rationing scheme, covering meat and fats, for London and the home counties, came into force on Feb. 25, 1918. Each individual (about 10,000,000 were involved) received two cards, one with detachable coupons for meat, and one with numbered spaces, to be marked by the retailer, for butter and margarine. Each consumer was registered with one retailer, and each retailer was supplied with the appropriate quantity of rationed articles necessary for his registered customers. A short time before the rationing scheme for London and the home counties was put into force, 500,000 people stood in food queues every Saturday in London. A month afterwards the queues had practically disappeared.

Since local authorities could not wholly ensure or control supply, they could not effectively ration meat. A national scheme for meat rationing was therefore introduced on April 7. The success was as great as that of the London scheme. On July 14, 1918, each member of the public received a single book, with coupons for meat, fats, sugar and lard. After May 3, 1919, coupons were abolished; and when sugar was decontrolled, in November 1920, the period of rationing was over. In Ireland, the only rationing was a control over the distribution of sugar.

The Two Systems Contrasted.—In Germany the essential idea was the administrative independence of the local authority, which, within its limits, was jealously guarded. The whole organization of food supply had to turn upon that which lay within the competence of the local power, namely, the actual distribution of the ration. In Britain, and the countries which followed Britain, the primary thought was the assurance of supply, and its control.

In none of the other Allied countries was food rationing so complete or so successful as in Great Britain. Both in France and Italy the system was conditioned mainly by the allocations of the inter-allied programme committees (see CONTROL) and by the fact that the scheme was administered by local bureaucrats acting to a large extent independently, with the natural result of uncoordinated control and public indifference. Among the neutral countries Holland and Sweden had the most efficient organization, built up on German experience.

United States.—Sugar and wheat flour were closely regulated. Towards the end of 1917 the diversion of ships from the Cuban trade made it necessary to reduce the supplies to confectioners and sweet-makers; and from July 1, 1918, shipments of sugar to retailers were made on the authority of certificates issued by the food administration on the basis of the number of their customers. The restrictions placed on the sale of wheat flour were at first voluntary, but compulsory regulations were issued in January 1918. These were dictated solely by the necessity of maintaining export to the European Allies.

BIBLIOGRAPHY.—*Beiträge zur Kriegswirtschaft* (official, 1916, etc.); *Daily Review of the Foreign Press*, especially the *Food Supplement* (War Office publication, 1917, etc.); F. H. Coller, *An Adventure in State Trading* (1925); W. H. Beveridge, *British Food Control* (1928); A. N. Merritt, *War-Time Control of Distribution of Foods* (1920); H. Hoover, "Food Control, a War Measure," *Banker's Home Mag.*, Vol. xii. (1918); I. L. Pollock, *Food Administration in Iowa* (1923); G. N. McCain, *War Rations for Pennsylvanians* (1920). (A. C. M.)

RATIONING OF NEUTRALS (BLOCKADE). The rationing of neutral countries contiguous to the enemy was a new departure, and certainly one of the most momentous and far-reaching steps taken in connection with the economic section of the World War. It was also one which, not unnaturally, the United States and the other neutral countries saw in a different light from the British Government.

The British Government, in Aug. 1914, proclaimed that it would abide by the Declaration of London, but it soon became clear that, owing to the exceptional conditions in which the war was being conducted, it would be necessary to apply more vigorous methods to prevent the enemy procuring what he most needed through neutral countries. When the restriction of enemy's supplies committee was appointed by Winston Churchill, first lord of the Admiralty, on Aug. 13, 1914, it was allotted the task of watching all means or routes by which supplies of food or raw material might reach Germany or Austria, and of recommending by what methods such supplies might be restricted or stopped.

Conditions were such, however, that it soon became evident that pressure by means of a rationing policy must be brought to bear on various neutrals, who were rapidly becoming storehouses for enemy purposes.

The first suggestion of the application of a rationing policy was due to the Restriction of Enemy Supplies Committee which in April 1915 called attention to the extraordinary supplies of almost every kind of commodity that Germany was obtaining through Swedish intermediaries since the beginning of the war. It proposed that since the German attacks on British and neutral shipping with a view to laying siege to the United Kingdom should be effectively countered in accordance with the reprisals policy formally announced on March 11, 1915, the Swedish imports should be confined to their normal pre-war proportions having regard to any special circumstances or to any imports that country might lack through failure of supplies from Germany.

For the application of such a rationing, two courses appeared possible (1) that of making arrangements and agreements with responsible bodies in neutral countries for the consignment of imported goods under guarantee, for the purpose of ensuring that such supplies should not be re-exported to the enemy, or (2) rationing by force.

Agreements were made, after prolonged negotiations as follows:

The Netherlands Overseas Trust.—By agreement with this body, goods consigned to it were stored in bonded warehouses, and warrants for these goods were held by the banks who guaranteed the N.O.T. contracts. All private buyers having goods consigned to the N.O.T. were required to make a deposit as a guarantee of good faith, and this was liable to seizure by the N.O.T. in case of fraudulent practices being discovered. It was the custom of the N.O.T. to review the position of trade at the beginning of each month, first as regarded trade from the Dutch East Indies, and secondly, as regarded other countries. If the N.O.T. considered that any import was becoming excessive the trade was stopped and merchants compelled to purchase from accumulated stocks. By the Customs Exportation Restriction Act of June, 1915, further provision was made for the prevention of British goods passing through neutral countries to an enemy destination, the export from the United Kingdom of any goods to Holland, except such as were consigned to the N.O.T., being prohibited. By the Order in Council of June 25, 1915, all free list goods had to go to the N.O.T.

The Societé Suisse de Surveillance Economique.—The proposal to create a responsible body for the control of imports into Switzerland met with violent opposition as being derogatory to Swiss honour; nevertheless, after a long delay and tedious negotiations the S.S.S. was established. The basis of the rationing policy was that of allowing Switzerland her normal imports after deducting the exports to enemy countries.

Sweden.—Negotiations between the British Government and the Swedish authorities were protracted and on the whole unsatisfactory; it was found impossible to establish an authoritative control on the lines of the Netherlands Overseas Trust, but cotton was made subject to an agreement by which only a certain quantity was permitted to be exported monthly to Sweden for her home requirements.

Norway.—No actual agreement was made by the British Government with Norway, though that country was restricted in regard to imports. Legislation was, however, introduced early in 1915, into the *storting* with a view to preventing goods imported into Norway (under a guarantee against re-export) from being re-exported either by the person who had given the guarantee or by third parties.

Denmark.—It was recognized from the beginning that the geographical position of Denmark caused an exceptionally difficult and delicate blockade situation. An agreement was, nevertheless, made by the British Government with a well-organized commercial body which was known as the Danish Merchants Guild. Goods were only allowed to proceed to Denmark under the guarantee of this dependable guild, and further, the British custom house had full powers to insist, whenever it was deemed desirable, on the production of guarantees and to refuse to allow exports (even of free goods) except when covered by guarantees.

See WAR TRADE ADVISORY COMMITTEE; BLOCKADE. (L. C. L.)

RATITAE, the name given to the "flatbreasted," flightless birds, in opposition to the Carinatae, which possess a keeled sternum. Ratitae comprise the genera *Struthio* (see OSTRICH), *Rhea* (*q.v.*), Casuarius (see CASSOWARY), *Dromaeus* (see EMU), Apteryx (see KIWI), and the fossils *Dinornis* and Aepyornis. For their characteristics see ORNITHOLOGY.

The names Ratitae and Carinatae are now generally replaced by Palaeognathae and Neognathae respectively.

RATLAM (or RUTLAM), an Indian state in the Malwa agency of Central India. Area, 693 sq.m. The population in 1931 was 107,321. The chief, whose title is Maharaja, is a Rahtor Rajput of the Jodhpur family.

RATNAGIRI, a town and district of British India, in the southern division of Bombay. The town is on the seacoast, 136 m. S. of Bombay. Pop. (1931) 23,906. There is no railway, but there is steamer connection with Bombay.

The DISTRICT OF RATNAGIRI has an area of 3,989 sq. miles. It forms a strip between the western Ghats and the sea, and its general character is rugged; nearly all the fertile land lies on the banks of the streams which intersect the country. Ratnagiri (pop. [1931] 1,302,527) formed part of the dominions of the Peshwa, and was annexed by the British government in 1818 on the overthrow of Baji Rao. It is the home of the influential class of Chitpavan Brahmans.

RATNAPURA (*i.e.*, "The City of Gems"), the chief town in the province of Sabaragamuwa, Ceylon. It is the centre of a long established industry in digging for precious stones—rubies, sapphires, cat's-eyes, etc. There is also much rice and fruit cultivation and planting of tea in the district. Pop. of town was 8,497; of province (1931) 578,368. It is the railhead with connections to Colombo.

RATON (rah-ton'), a city of northeastern New Mexico, U.S.A., on the Raton range, spur of the Rockies; county seat of Colfax county. It is on federal highways 85, 87 and 64; is served by the Santa Fe railway system and by bus lines. Pop. (1920) 5,544 (89% native white), 7,607 by the federal census in 1940. Its altitude is 6.666 ft., just south of the Raton pass, in the midst of forest and mountain scenery. There are many camps for boys and girls and other vacation resorts in the vicinity. Thirty miles S.E. is the extinct volcano El Capulin; 60 m. S.W., the Eagle's Nest Dam (keystone of an irrigation project) at the head of the Cimarron cañon; and 30 mi. farther west, the Indian pueblo and artists' colony at Taos. The city lies in the richest coal-producing area of New Mexico.

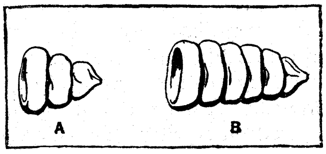
It has a municipal electric power plant and extensive railway shops and is a livestock and jobbing centre. Raton was a stage station on the Santa Fe Trail; was established as a railway station in 1879, and was incorporated in 1891.

RATTAZZI, URBANO (1808–1873), Italian statesman, was born on June 29, 1808, at Alessandria, and from 1838 practised at the bar. In 1848 he was sent to the chamber of deputies in Turin as deputy of his native town. For a short time he held the portfolio of public instruction; afterwards, in the Gioberti cabinet, he became minister of the interior, and on the retirement of Gioberti in 1849 he became practically the head of the Government. The defeat at Novara compelled the resignation of Rattazzi in March 1849. His election as president of the chamber in 1852 was one of the earliest results of the so-called "connubio" with Cavour, *i.e.*, the union of the moderate men of the Right and of the Left. Rattazzi resigned office in 1858, but again entered the cabinet under La Marmora in 1859 as minister of the interior. He again retired in Jan. 1860. He was entrusted with the formation of a new ministry in March 1862, but his policy of repression towards Garibaldi at Aspromonte led to his fall in December. He was again prime minister in 1867, from April to October. He died at Frosinone on June 5, 1873.

See Madame Rattazzi, *Rattazzi et* son *temps* (1881); B, King, History of *Italian Unity* (1899).

RATTLESNAKE, any snake of the genera *Sisturus* and *Crotalus,* American pit-vipers with the tail terminating in a rattle. The "pit" characteristic of this sub-family of the vipers is a deep depression on each side of the snout between eye and nostril.

The rattle is developed as a modification of the single scale which covers the tip of the tail; instead of being a simple, conical sheath, as in ordinary snakes, it has two ring-like constrictions so that it resembles three hollow bulbs, gradually diminishing in size and each one opening into its neighbour; the largest is also open at its free end, where the tail enters. All snakes shed the horny, epidermal covering of their scales periodically, a new one forming beneath the old one before the latter is sloughed; when however, the new covering of the end of the tail is developed in the rattlesnakes, the middle "globe" develops within the largest of the old sheath and, though the rest of the old skin is sloughed, the old tail sheath remains loosely fitting over the new one but prevented from slipping off by its shape. Thus, newly-born rattlesnakes have no rattle but with each succeeding moult a joint is added; the older joints, however, gradually wear away and are lost so that the number of joints on the rattle is not necessarily any criterion of a snake's age.



A.—A SINGLE RATTLE WITH THREE JOINTS. B.—FIVE RATTLES JOINED TOGETHER

The characteristic noise is produced by rapid vibration of the whole tail, when the loosely fitting horny shells produce a shrill noise which may be audible 20 yards away. The majority of the species are dwellers of the plains and open spaces and it has been suggested that the development of the rattle was to give a warning audible at a distance.

The venom of the rattlesnakes is of the same general type as other viperine venoms and all species are large enough to be able to inject sufficient to kill a man. They are, however, not easily provoked and will usually endeavour to escape or, if cornered, to frighten the aggressor by rattling and puffing themselves out as much as possible. In all species the eggs are retained within the body of the mother until the young are ready to emerge.

Sisturus, with only two species and confined to the southern United States and northern Mexico, may be distinguished from *Crotalus* by the presence of large, regularly arranged shields on the top of the head; both species are small, not more than about $2\frac{1}{2}$ ft. long. Crotalus, with small irregular scales on the top of the head, contains about 20 species, most of which occur in North and Central America. The largest and most dangerous species is the diamond back (C. adamanteus) which reaches a length of about 8 ft.; it is confined to the south-eastem United States. Other well known species are the prairie rattler (C. *confluentus*) which occurs all over the Great Plains from Canada to Texas, the timber rattlesnake (C. horridus) of the eastern United States and C. *terrificus* which ranges from Mexico to the Argentine and is the only representative of the genus in South America. The sidewinder (C. cerastes) is a small, desert-dwelling form from south-westem North America and is characterized by the development of a blunt, horn-like process above each eye. (H. W. P.)

RAU, KARL HEINRICH (1792–1870), German political economist, was born on Nov. 29, 1792, at Erlangen, where he studied at the university, of which he subsequently became a professor (1818). In 1822 he was called to the chair of political economy at Heidelberg where the rest of his life was spent in teaching and research. He took some part, however, in public affairs: in 1837 he was nominated a member of the first chamber of the duchy of Baden; in 1845 he became a privy councillor, and in 1851 he was one of the commissioners sent to England on the part of the Zollverein to study the Industrial Exhibition. A result of this mission was his account of the agricultural implements exhibited at London (Die *landwirthschaftlichen Geräthe* der *Londoner Ausstellung,* 1853). He was elected a corresponding member of the French Institute in 1856. He died at Heidelberg on March 18, 1870.

His principal work is the Lehrbuch *der politischen Ökonomie* (1826–37), an encyclopaedia of the economic knowledge of his time, written with a special view to the guidance of practical men. The three volumes are respectively occupied with (1) political economy, properly so called, or the theory of wealth, (2) administrative science (*Volkswirtschaftpolitik*) and (3) finance. The two last he recognizes as admitting of variations in accordance with the special circumstances of different countries, whilst the first is more akin to the exact sciences, and is in many respects capable of being treated, or at least illustrated, mathematically. This threefold division marks his close relation to the older German cameralistic writers. The book has passed through many editions; in that of 1870 by Adolf Wagner it was transformed into a new book.

His most important works are his early prize essay, *Über das Zunftwesen* (1815) ; *Ansichten der Volkswirtschaft* (1821) ; *Malthus und Say* (1821) ; *Grundriss der Kameralwissenschaft* oder *Wirtschaftslehre* (1823) ; *Über die Kameralwissenschaft* (1825) ; *Uber die Landwirtschaft der Rheinpfalz* (1830) ; and *Geschichte des Pfluges* (1845). Rau founded in 1834 the *Archiv der politischen Ökonomie und Polizeiwissenschaft,* in which he wrote a number of articles, afterwards issued in separate form.

RAVAILLAC, FRANÇOIS (1578–1610), the assassin of Henry IV. of France, was born near Angoulême. He began life as a *valet de chambre,* but afterwards became a lawyer and school reacher. He failed to obtain admission either to the recently founded order of Feuillants or to the Society of Jesus. Rumours that the king was intending to make war upon the pope suggested to him the idea of assassination, which he carried out on May 14, 1610.

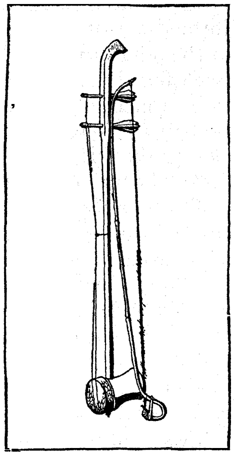
He was executed on May 27, 1610.

See Jules Loiseleur, *Ravaillac et ses complices* (1873) ; E. Lavisse, *Histoire de France,* tome vi. (1905) ; J. J. Tharand, *Tragkdie de Ravaillac* (1913 and 1920).

RAVAISSON-MOLLIEN, JEAN GASPARD FELIX (1813–1900), French philosopher and archaeologist, was born at Namur on Oct. 23, 1813. He attended the lectures of Schelling at Munich and in 1837 published the first volume of his *Essai sur la me'taphysique d' Aristote,* to which in 1846 he added a supplementary volume. He was professor of philosophy at Rennes (1838), inspector-general of public libraries (1840), inspector-general in the department of higher education (1860), and curator of the Department of Antiquities at the Louvre (from 1870). He died in Paris on May 18, 1900. He belonged to the school of Cousin, with whom, however, he was at issue in many important points. The act of consciousness, according to him, is the basis of all knowledge. Ravaisson's chief philosophical works are: "Les Fragments philosophiques de Hamilton" (in the *Revue des Deux Mondes,* Nov. 1840); *Rapport sur le stoicisme* (1851) ; *La Philosophie en France au dix-neuvième siècle* (1868; 3rd ed., 1889) ; *Morale et métaphysique* (1893).

See Renouvier, in *L'Année philosophique* (1868) ; Dawriac, "Ravaisson philosophe et critique" (*La Critique philosophique,* 1885, vol. ii.).

RAVANASTRON, an Indian stringed instrument played with a bow, used by wandering pilgrims. It consists of half a round gourd, over which is fixed a sound-board of skin or parchment, with strings, either one or four in number, above. It is considered by some to have been the first instrument played with a bow.



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THE RAVANASTRON, AN ANCESTOR OF THE VIOLIN

RAVEL, MAURICE (1875–1937), French musical composer, was born at Ciboure, near St. Jean de Luz, Basses-Pyrénées, March 7, 1875. He was the most outstanding figure in modern French music. More than that, he held an assured place in that line of composers beginning with the *clavecinistes* of the 17th century, who had so powerful an influence on French instrumental music. Educated at the Paris Conservatoire, where his master in composition was Gabriel Fauré, Ravel won the second Prix de Rome for composition in 1901. But he was not awarded the Grand Prix de Rome, and the judges were severely criticised for thus refusing to recognise his talent; the resignation of Dubois from the directorship of the Conservatoire was in fact attributed to this cause. When Ravel's piano pieces began to be known, notably *Pavane pour une Infante Ddfunte* and *Jeux d'eau,* played in Paris by Ricardo Vifies in 1902, a comparison was made between him and Debussy, whose *Pelléas et Mélisande* (Opéra-Comique, 1902) was then arousing heated controversy.

It is true that such diverse minds as Fauré, Chabrier, and Erik Satie exercised an influence on Ravel during his formative years, but his personality showed itself from the first. This personality became more clearly defined in his subsequent works, which included the string quartet in F, the three *Schéhérazade* melodies for voice and orchestra or piano (both 1904); the *Histoires Naturelles* (1907); *Introduction and Allegro* (septet for harp, strings, flute and clarinet) and the *Rapsodie Espagnole* for orchestra (1907). For the piano he wrote *Miroirs* and *Sonatine* (1905); *Gaspard de la nuit* (3 pieces) (1909); *Ma Mère l'Oye* (suite of five pieces) (1908); and *Valses nobles et sentimentales* (1911). The last two of these are best known in England as orchestrated by the composer.

However daring Ravel's harmony may appear, he was never experimental. He had an unerring sense of direction and knew where he was going, even if he sometimes seemed to watch himself going there with a smile of amusement. The cynical wit of his one-act opera, *L'heure Espagnole* (Opéra-Comique, 1911) and the conscious pose of the ballet *Daphnis et Chloe'* (choreography by Fokine and produced by Diaghilev, 1912), emphasize in different ways the detached attitude of Ravel towards his art. His later works include a sonata for violin and violoncello, and a trio for piano and strings (1915); *La Valse* for orchestra (1920) and *Tzigane,* for violin and piano (1924). (H. C. C.)

See Roland Manuel, *Maurice Ravel et sou oeuvre* (1914) and *L'oeuvre de Maurice Ravel* (1921); A. Coeuray, *La musique française moderne* (1922); G. Dyson, *The New Music* (1924); C. Gray, *A Survey of Contemporary Music* (1925).

RAVELLO, a village of Campania, Italy, in Salerno province, 3 mi. N N.E. of Amalfi, 1,227 ft. above sea-level. It commands a magnificent view, especially from the Belvedere of Cimbrone. Pop. (1936) 703 (town), 3,237 (commune). The history of Ravello begins in the 9th century. In the 11th it was called Rebellum, because it rebelled against Amalfi; in the 13th, at the height of its prosperity, it had 36,000 inhabitants. The Palazzo Rufolo, begun in the 11th century, has two lofty towers and beautiful Saracenic decoration in the courtyard. The ex-cathedral of S. Pantaleo has a good campanile, fine bronze doors by Barisanus of Trani (1179) and two pulpits in Cosmatesque work. The larger, supported by six columns resting on the backs of lions, was made in 1272 by Nicolaus of Foggia; the bust over the entrance may be a portrait of Sigilgaita Rufolo, or may symbolise the Church. The smaller (c. 1130) has curious representations of Jonah and the whale. The parish church of S. Giovanni in Toro contains a splendid pulpit in Cosmatesque work, supported on four pillars, and the crypt some 14th-century frescoes. S. Maria Immacolata is another Romanesque church.

RAVEN, the largest bird of the order Passeres, and a member of the Corvidae. Quick-sighted, sagacious and bold, the raven preys on the spoils of fishers and hunters, also on weakly animals among flocks and herds. A sentiment of veneration or superstition has often been attached to it. Superstition has been generally succeeded by persecution, which in many districts has led to extirpation.

The raven breeds early in the year, in England resorting to its nest, which is usually an ancient structure, towards the end of January. Therein are laid from five to seven eggs of the common corvine colouration (*see* CROW), and the young are hatched before the end of February. The young have bright crimson throats. In more northern countries the breeding season is naturally delayed, but everywhere this species is almost if not quite the earliest breeder. The raven measures about 26in. in length, and has an expanse of wing exceeding a yard. It is entirely black, the feathers having a purple iridescence. The common raven (*Corvus corax*) inhabits the whole of Europe, northern Asia and northern America. In Africa its place is taken by allied species, one of which (*Corvus umbrinus*) has a brown neck; farther south are species whose plumage is varied with white.

RAVEN-HILL, LEONARD (1867–1942), English artist and illustrator, was born on March 10, 1867. He studied art at the Lambeth school and afterwards in Paris under A. W. Bouguereau and Aimé Morot. He began to exhibit at the Salon in 1887, and at the Royal Academy in 1889. In 1893 he founded, with Arnold Golsworthy, the humorous and artistic monthly The *Butterfly* (1893–94, revived in 1899–1900). He contributed to many illustrated magazines, and was with *Punch* from 1896 until his retirement in 1935. He illustrated Sir Walter Besant's *East* London (1901) and J. H. Harris's Cornish Saints and Sinners. His impressions of his visit to India on the occasion of the tour of the prince and princess of Wales appeared as An Indian Sketch-Book (1903); other published sketch-books include Our Battalion (1902) and The *Promenaders* (1894). He died March 31, 1942.

RAVENNA, a city and archiepiscopal see of Emilia, Italy, capital of the province of Ravenna, in a marshy plain 13 ft. above sea-level, 6 mi. from the sea and 45 mi. by rail E of Bologna. Pop. (1936) 31,251 (town), 81,086 (commune)—a considerable increase, as the population of 1881 was only 34,270 (commune). The town is a centre for agriculture, which has been much favoured by extensive drainage and reclamation works. There is also a sugar factory at Classe. The town is connected with the sea by the Corsini Canal. Ravenna has railway communication with Bologna (via Castel Bolognese), Ferrara and Rimini, and by steam tram with Forlì. Though the external aspect of the town is not striking, no other in the world offers so many and such splendid examples of the ecclesiastical architecture of the centuries from the 5th to the 8th. The style is commonly called Byzantine; but the colonnades and the mosaics are not so much Byzantine as representative of early Christian art generally.

The cathedral of Ravenna, built by S. Crsus in 370–390, which had a nave and four aisles, was destroyed in 1734–44, only the (inaccessible) crypt and the round campanile remaining from the earlier structure; there are fragments of reliefs from a pulpit erected by Archbishop Agnellus (556–569) in the interior. The present cathedral contains several early Christian marble sarcophagi, a silver cross of the 11th century and the throne of the Archbishop Maximian (546–552), adorned with reliefs in ivory.

The period from the transference of the imperial residence to Ravenna to the death of Valentinian III. (404–455) was the first period of great building activity in Ravenna, when the archiepiscopal see of Ravenna attained great importance. It was to it that we owe the erection of the Basilica Petriana at Classe (396–425), which has entirely disappeared, of the churches of S. Giovanni Evangelista (425), of S. Agata (425–432), of the chapel of S. Pier Crisologo (433–449), of the mausoleum of Galla Placidia (440), the church of S. Pier Maggiore (now S. Francesco) (433–458), the baptistery of Neon (449–458), S. Giovanni Battista and S. Croce.

S. Giovanni Evangelista, erected by Galla Placidia in fulfilment of a vow made on her voyage from Constantinople, has been entirely rebuilt, though the columns are ancient. The Gothic portal is fine, and the church contains a mosaic pavement of 1213 with representations of the 4th Crusade and some frescoes by Giotto, painted during a visit to Dante between 1317 and 1320. S. Agata was almost entirely rebuilt in 1476–94. The chapel of S. Pier Crisologo in the archiepiscopal palace preserves its original mosaics; so also does the mausoleum of Galla Placidia (SS. Nazario e Celso), a small structure in the form of a Latin cross with a dome (in which, as in the baptistery of Neon, the old cathedral, etc., the constructional use of amphorae is noteworthy), with a plain brick exterior, and rich mosaics on a dark blue ground.

S. Francesco has been modernized, except for the crypt and campanile (10th century). The baptistery adjacent to the cathedral was either originally part of the Roman baths, converted to a Christian baptistery by the Archbishop Neon (449–452), or a Christian building dating from before A.D. 396. It is an octagon, with a dome; in the interior are two arcades one above the other. The mosaics of the 5th century, in the dome, are the earliest and perhaps the finest at Ravenna.

Of S. Giovanni Battista, also erected in this period, hardly anything remains after the restoration of 1683, and S. Croce has been overtaken by a similar fate. Honorius and Galla Placidia built a palace about A.D. 402, remains of which have been found under S. Croce.

The reign of Theodoric (493–526) marks another era of magnificence. In the eastern part of the city he built for himself a large palace. There still remains fronting the Corso Garibaldi a high wall built of square Roman bricks, with pillars and arched recesses in the upper portion, which goes by the name of Palazzo di Teodorico, but is a guardhouse erected by the exarchs, recent explorations having made it clear that it was an addition to the palace, while mosaic pavements and a court once surrounded by colonnades and really belonging to the latter were found behind S. Apollinare Nuovo and the so-called Palazzo at a lower level and a different orientation. (See Ghirardini in *Monumenti* dei *Lincei*, xxiv. 737–838.) A mosaic in the church of S. Apollinare Nuovo gives some faint idea of the palace. The massive mausoleum of Theodoric stands still perfect outside the walls near the north-east corner of the city. It is circular internally and decagonal externally, in two storeys, built of marble blocks, and surmounted by an enormous monolith, brought from the quarries of Istria and weighing more than 300 tons. It has been converted into a church dedicated to the Virgin.

S. Apollinare Nuovo, the most important basilica in the town, was built by Theodoric to be the largest of Arian churches. The exterior is uninteresting, and the church lost both atrium and apse in the 16th century. The interior has twenty-four columns of marble, with almost uniform capitals. The walls of the nave are adorned with mosaics of the 6th century; the scenes from the New Testament above the windows date from the time of Theodoric.

The campanile (850–878) is circular, and has perhaps the earliest example of the use of disks of coloured majolica as a decoration. This, like the other campanili of Ravenna, is later than the church to which it belongs. Those of the cathedral of S. Apollinare in Classe, S. Maria Maggiore and S. Agata, also circular, probably belong also to the 9th century, while the two square campanili of S. Giovanni Evangelista and S. Francesco probably belong to the 10th century. The other churches erected by Theodoric are: S. Teodoro (or S. Spirito), erected by Theodoric for the Arian bishops, but entirely modified; the baptistery of this church (afterwards the oratory of S. Maria in Cosmedin), formed out of the octagonal hall of a Roman bath, with mosaics of the 6th century; S. Maria Maggiore, founded by the Archbishop Ecclesius (521–534), but almost entirely rebuilt; and S. Vittore, which has suffered a similar fate. To the same period probably belong a few columns of the so-called Basilica of Heracles in the Piazza Vittorio Emanuele, with capitals like those of S. Apollinare in Classe.

The impulse given by Theodoric was continued by his successors, and during the regency of Amalasuntha and the reigns of Theodatus and Vitiges (526–539), S. Vitale and S. Apollinare in Classe were constructed by Julius Argentarius contemporaneously with S. Lorenzo in Milan and the cathedral of Parenzo—also S. Michele in Africisco, little of the original structure of which now exists; the apse mosaic is in the Berlin museum. The former, well restored by Ricci (except for the dome with its baroque frescoes which has not been altered), is a regular octagon, with a vestibule, originally flanked by two towers on the west, a choir added on the east, triangular outside and circular within: it is surrounded within by two galleries interrupted at the presbytery, and supported by eight large pillars, the intervals between which are occupied by open exedrae. The mosaics of the choir (547) are due to Justinian, and, though inferior in style, are remarkable for their splendour of colouring and the gorgeous dresses of the persons represented, and also for their historical interest, especially the scenes representing the emperor and the empress Theodora presenting offerings. The marble screens of the altar are wonderfully finely carved. The marble mosaic pavement (11th century) is very effective. Remains of the original marble wall lining and stucco decoration also exist.

The architecture of S. Vitale, according to Rivoira, was inspired not by Byzantium, where similar churches—S. Sofia and SS. Sergio and Racco—are slightly later in date, but by the churches of Salonica (A.D. 495), while the plan is derived from a Christian baptistery, or from such a building as the so-called temple of Minerva Medica at Rome.

It has been ascertained that a 5th century building already occupied the site.

S. Apollinare in Classe, erected at the same time outside the walls of Classis, and now standing by itself in the lonely marshes, is the largest basilica existing at Ravenna. It has a nave and aisles with a closed vestibule on the west, and a fine round campanile of the 9th (?) century. The exterior brick walls are divided by shallow arches and pilasters, as in other churches of Ravenna. It has twenty-four columns of Carystian (cipollino) marble, with capitals probably of Byzantine work with swelling acanthus leaves; but the rest of the church is due to native architects. The lofty presbytery and the crypt under it belong to the 12th century. The walls of the interior were stripped of their marble panelling by Sigismondo Malatesta in 1449, for the adornment of his church at Rimini. The apse has mosaics of the 6th and 7th centuries. The 18th-century series of portraits of the archbishops of Ravenna is no doubt copied from an earlier original. There are a number of fine carved sarcophagi in the church (5th to 8th century). The building activity of the Gothic kings was continued by Justinian, to whose time we owe the completion of S. Vitale and S. Apollinare in Classe, and some of the mosaics in S. Apollinare Nuovo.

The buildings of a subsequent period are of minor importance, but the basilica of S. Maria in Portofuori near the ancient harbour (1096 sqq.), a basilica with open roof, with frescoes by masters of the Rimini school, may be noticed. The campanile dates from 1173–87. The tomb of Dante, who died at Ravenna in 1321, is close to S. Francesco; it is a square domed structure, with a relief by Pietro Lombardo (1483) representing the poet, and a sarcophagus below, in an urn within which lie the poet's remains. Close by is a small court with early Christian sarcophagi, containing the remains of the Braccioforte family. The important museum near S. Vitale has Roman and Byzantine antiquities, inscriptions, sculptures, jewelry, etc. The library has rare mss. (including the best extant ms. of Aristophanes), and incunabula. The Accademia has pictures by local masters.

In the Piazza Vittorio Emanuele are two granite columns erected by the Venetians in 1483. The cloisters of S. Maria di Porto erected in the town in the 16th century (owing to malaria, as in the case of those of Classe), and of S. Vitale, are pleasing 16th-century structures, The 15th-century castle in the north-east corner of the town erected by the Venetians is a picturesque brick building. The walls, 3 m. long, which still surround the town, were also built by them.

History.—Strabo mentions a tradition that Ravenna was founded by Thessalians, who afterwards called in the Umbrians and left the city to them. About 191 B.C., by the conquest of the Boii, the whole of this region passed definitely under the dominion of Rome. Under Augustus it rose into importance, when it was made the station for the fleet on "the upper sea." Two hundred and fifty ships could ride at anchor in its harbour. At the same time Augustus conducted a branch of the Po (the fossa Augusta) through the city into the sea. It also became important for the export of timber from the Alps. Strabo gives a description which corresponds closely with modern Venice.

On the other hand, good water was proverbially difficult to obtain at Ravenna—dearer than wine, says Martial. Trajan, however, built an aqueduct nearly 20 miles long, which was restored by Theodoric in 503. Of this some traces still exist in the bed of the Ronco above Ravenna. Flies and frogs were also complained of, and Sidonius, writing in the 5th century, complains bitterly of the "feculent gruel" (*cloacalis puls*) which filled the canals of the city, and gave forth fetid odours when stirred by the poles of the bargemen. The port of Ravenna, situated about 3 miles from the city, was named Classis. A long line of houses called Caesarea connected it with Ravenna, and in process of time there was such a continuous series of buildings that the three towns seemed like one. It had large gilds of fabri (smiths and carpenters) and *centonarii* (firemen).

A pre-historic station was found in 1894 at S. Zaccaria near Ravenna, belonging to a Terramare. Of Roman Ravenna nothing remains above ground. It was connected with Ariminum, 33 miles to the south by the coast road, the Via Popilia, which ran on north to Hatria, and joined the road between Patavium and Altinum at Ad Portum.

Early in the 5th century, Honorius, alarmed by the progress of Alaric in the north of Italy, transferred his court hither. From this date (404) to the fall of the Western Empire in 476 Ravenna was the chief residence of the Roman emperors. Here Stilicho was slain; here Honorius and his sister Placidia caressed and quarrelled; here Valentinian III. spent the greater part of his life; here Majorian was proclaimed; here the little Romulus donned his purple robe; here in the pinewood outside the city his uncle Paulus received his decisive defeat from Odoacer. The great pinewood to the east of the city, which is still one of the great glories of Ravenna, must therefore have been in existence in the 5th century. Odoacer made Ravenna his chief residence. Theodoric's siege of Ravenna lasted for three years (489–492); ten days after his entry into the city he slew his rival at a banquet in the palace of the Laurel Grove (March 15, 493). Ravenna was also Theodoric's chief residence (493–526).

In 535 Justinian sent an army to destroy the Gothic monarchy and restore Italy to the empire. The Goths at length, weary of the feebleness of Vitiges, offered to transfer their allegiance to Belisarius on condition of his assuming the diadem of the Western Empire. Belisarius dallied with the proposal until he had obtained an entrance within the walls of the capital, and proclaimed his inviolable fidelity to Justinian (539). Under the rule of Narses and his successors the exarchs, Ravenna was the seat of Byzantine dominion in Italy. In 728 the Lombard king Luitprand took and destroyed the suburb Classis; about 752 the city itself fell into the hands of his successor Aistulf, from whom a few years after it was wrested by Pippin, king of the Franks.

It formed part of the Frankish king's donation to the pope in the middle of the 8th century, though the archbishops, as a fact, retained almost independent power. It was an independent republic, generally taking the Guelph side in the 13th century, subject to rulers of the house of Polentani in the 14th, Venetian in the 1 jth (1441), and papal again in the 16th. St. Romuald and St. Peter Damian were both natives of Ravenna. From this time (1509) down to our own days, except for the interruptions caused by the wars of the French Revolution, Ravenna continued subject to the papal see and was governed by a cardinal legate. In 1849 Garibaldi's wife Anita, who had accompanied him on his retreat from Rome, succumbed to fatigue in the marshes near Ravenna

Charles the Great carried off the brazen statue of Theodoric and the marble columns of his palace to his own palace at Aix-la-Chapelle. Lord Byron resided at Ravenna for eighteen months in 1820–21, attracted by the charms of the Countess Guiccioli.

AUTHORITIES.—The most important authority for the history of Ravenna is Bishop Agnellus, who wrote, about 840, the Liber *Pontificalis* Ecclesiae Ravennatis. The best edition is that by Holder-Egger in the Monumenta Germaniae Historica (1878). See G. T. Rivoira, *Lombardic* Architecture (London, 1910); C. Ricci, Ravenna (Bergamo, 1902), Ravenna (London, 1913); E. Hutton, The Story of Ravenna (London, 1926). To the careful restorations of Ricci the buildings of Ravenna owe much. (T. H.; T. A.)

BATTLE OF 1512

This battle, one of the principal events of the long Italian wars of Charles VIII., Louis XII. and Francis I. of France, is, like Marignano (*q.v.*), interesting in a tactical sense, from the fact that the feudalism of the past and the expert soldiership of the future were strangely mingled. It arose out of the attempt of the Spanish and Italian forces to relieve Ravenna, besieged by Gaston de Foix, duke of Nemours. The most celebrated captains of these wars were present on either side—under Gaston de Foix were Bayard, Yves d'Allègre, La Palisse; and under Cardona the Spanish viceroy of Naples, Pedro Navarro the great engineer, and Pescara, the originator of the Spanish tactical system. After some preliminary manoeuvres the two armies drew up face ta face on the left bank of the Roneo, the Spanish left and the French right resting on this river. The Spaniards were entrenched, with their heavy artillery distributed along the front, but, thanks to Navarro, they had a more mobile artillery in the shape of 200 arquebuses *à* croc mounted in groups upon carts, after the German fashion. The battle opened with a prolonged cannonade from the Spanish lines. For three hours the professional regiments of all sorts in the French lines rivalled one another in enduring the fire unmoved, the forerunners of the military systems of to-day, landsknechts, Picardie and Piedmont, showing the feudal gendarmerie that they too were men of honour. There was no lying down. The captains placed themselves in the front, and in the centre 38 out of 40 of them were struck down. Molart and Empser, drinking each other's health in the midst of the cannonade, were killed by the same shot. Sheltered behind the entrenchments, the Spaniards scarcely suffered, for they were lithe active troops accustomed to lie down and spring up from the ground. But after three hours, Pescara's light horse having meantime been driven in by the superior light horse of the enemy, the artillery-loving duke of Ferrara conceived the brilliant plan of taking his mobile field-guns to the extreme right of the enemy. This he did, and so came in sight of the prone masses of the Spaniards. Disciplined troops as they were, they resisted the temptation to escape Ferrara's fire by breaking out to the front; but the whole Spanish line was enfiladed, and on the left of it the papal troops, who were by no means of the same quality, filled up the ditch in front of their breastworks and charged forward, followed by all the gendarmerie. Once in the plain they were charged by the French gendarmes under Gaston himself, as well as by the landsknechts, and driven back. The advantage of position being thus lost, the Spanish infantry rose and flung itself on the attackers; the landsknechts and the French bands were disordered by the fury of the counterstroke, being unaccustomed to deal with the swift, leaping and crouching attack of swordsmen with bucklers. But La Palisse's reserve wheeled in upon the rear of the Spaniards, and they retreated to the entrenchments as fast as they had advanced. The papal infantry, the gendarmes, and the light horse had already vanished from the field in disorder; but the Spanish regulars were of different mettle, and it was only after a long struggle that the landsknechts and the French bands broke into the trenches. The conflict continued, but at last La Palisse, with all the gendarmerie still in hand, rode completely round the entrenchments and charged the Spaniards' rear again. This was the end, but the remnant of the Spanish infantry retreated in order along the river causeway, keeping the pursuers at bay with their arquebuses. Gaston de Foix, recklessly charging into the midst of them, was killed.

RAVENNA, a city of northeastern Ohio, U.S.A., 33 mi. S.E. of Cleveland; the county seat of Portage county. It is served by the Baltimore and Ohio, the Erie, the Pennsylvania and electric railways. Pop. 1940, 8,538. It has manufactures of structural steel, iron castings, rubber goods and lumber. It is the site of the Ravenna Ordnance plant, employing about 10,000. Ravenna was founded in 1852 and incorporated as a city in 1912.

RAVENNA, EXARCHATE OF, the official name of that part of Italy which remained in the allegiance of the Roman emperors at Constantinople from the closing years of the 6th to the middle of the 8th century. The civil and military head of these possessions, the exarch (*q.v.*), was stationed at Ravenna. The territory round the town, from the southern border of the modern Venetia to the beginning of the Pentapolis at Rimini, was under his direct administration and formed in a limited sense the exarchate. The other provinces were governed by dukes and *magistri militum,* titles which were generally, but not always, borne by the same person. But as all were subject to his authority, they were included in the exarchate of Ravenna, which was therefore another name for the province of Italy. Sicily formed a separate government. Corsica and Sardinia belonged to the exarchate of Africa. The organization of the exarchate is placed by modern investigators under the reign of the emperor Maurice (582–602), when the imperial Government was confronted by the new problems created by the settlement of the Lombards (*q.v.*). At the end of the 6th century it included Istria; the maritime part of Venetia as distinct from the interior which was in the hands of the Lombard kings at Pavia; the exarchate proper, or territory around Ravenna on the eastern side of the Apennines, to which was added Calabria, which at that period meant the south-east and not the south-west of Italy; the Pentapolis, or coast from Rimini to Ancona with the interior as far as the mountains; the duchy of Rome, or belt of territory connecting the Pentapolis with the western coast, the coast of Naples, with Bruttium, the modern Calabria, and Liguria, or the Riviera of Genoa. Piedmont, Lombardy, the mainland of Venetia, Tuscany and the interior of Naples belonged to the Lombards. The superior organization of the imperial Government enabled it to regain lost territory and delay complete ruin. In 590 it recovered much of Venetia. But these revivals were not permanent. In 640 the Ligurian seacoast fell under the power of the Lombards. About a century later the exarchate had been greatly reduced, though the imperial officials endeavoured to conceal the fact by retaining and transferring names when the reality of possession was lost. About 740 it consisted of Istria, Venetia, Ferrara, Ravenna (the exarchate in the limited sense), Pentapolis, Perusia, Rome, the coast of Naples and the south-west of Italy, which was being overrun by the Lombards of the duchy of Beneventum, which with Spoletum held the interior. In Rome the pope was the real master. These fragments of the "province of Italy" were almost all lost either to the Lombards, who finally conquered Ravenna itself about 750, or by the virtual independence of the papacy. Subsequent Frankish intervention (see ITALY) made a revival of the exarchate impossible. It disappeared, and the small remnants of the imperial possessions on the mainland, Naples and Calabria, passed under the authority of the "patricius" of Sicily, and when Sicily was conquered by the Arabs in the 10th century were erected into the themes of Calabria and Langobardia. Istria was attached to Dalmatia.

In its internal history the exarchate was subject to the influences which were everywhere, in central and western Europe at least, leading to the establishment of feudalism. The great imperial officials gradually became landowners, and conversely the great landowners intruded on the imperial administration. The local militias, organized under imperial authority for defence against the Lombards, tended to become independent. These bodies formed the *exercitus romanae* militiae, who were the forerunners of the free armed burghers of the Italian cities of the middle ages.

See C. Diehl, *Études sur l'administration* Byzantine *dans l'exarchat* de Ravenne (568–751) (1888).

RAVENSBURG, a town in the Land of Wiirttemberg, Germany, on the Schussen, 12 mi. N. of Friedrichshafen on the lake of Constance. Pop. (1939) 32,257. Raverisburg was founded in the 11th century by the Guelphs, and in their castle on the Veitsburg, Henry the Lion was born. In 1180 the town passed to the Hohenstaufens, and a century later it became a free town of the empire. It was ceded to Wiirttemberg in 1810. It retains its walls and nine towers, and its 15th century town hall.

RAVENSCROFT, THOMAS (c. 1590–*c.* 1633), English composer and musical editor, received his B. Mus. at Cambridge in 1607, and from 1618–22 was music master at Christ's hospital. He is best known by his The Whole Booke of *Psalmes* (1621), 48 of the harmonizings being his own. His other works, the first three of which show his appreciation of popular and humorous poems, are Pammelia, a collection of 100 rounds and catches (1609); Deuteromelia, a collection of 31 items, including "Three Blind Mice" (1609) ; *Melismata*, a collection of 21 items, chiefly short madrigals (1611); and *A Briefe* Discourse of *the True* (but Neglected) *use* of *Charact'ring* the Degrees, by *their Perfection,* Imperfection and Diminution in *Measurable Musicke,* etc. (1621).

RAVI, a river of India, one of the "Five Rivers" of the Punjab. It rises in the Kulu subdivision of Kangra district, flows through Chamba state, and enters British territory again in Gurdaspur district. Thence it flows through the plains of the Punjab, passing within a mile of Lahore, and finally falls into the Chenab after a course of about 450 m. Its water is utilized for the Upper and Lower Bari Doab canals, with head works at

Madhupur, and the Sidhrai canal. The Upper Bari Doab canal irrigates some 1,177,000 acres, and the Lower Bari Doab canal (opened 1913) about 345,000 acres. The Upper Chenab canal enters the Ravi at Balloki, where the Lower Bari Doab canal has its head works on the opposite bank, thus providing a level crossing of the Ravi. The Sidhrai canal, which starts a few miles above the Chenab junction, is frequently dry in winter, but the Haveli project, including a dam on the Chenab with a canal delivering water into the Ravi above the Sidhrai weir, will ensure a perennial supply when completed.

RAWALPINDI, a town of British India, which gives its name to a district and a division in the Punjab. The town is situated on the north bank of the little river Leh, 1,726 ft. above the sea, 111 m. E. by S. of Peshawar, and 1,443 m. N.W. of Calcutta. Pop. (1931) 119,284. It is chiefly notable as the largest military station in India, and the key to the British system of defence upon the North-West Frontier. It is also the starting-point of the cart-road to the hill-station of Murree and of the route into Kashmir. It is the headquarters of the northern army with a strong force of all arms, and contains an arsenal. Besides the locomotive works of the North-Western railway, there are gas-works, a tent factory, an iron foundry, an oil refinery and a brewery. An annual horse fair is held in April.

The DISTRICT OF RAWALPINDI has an area of 2,023 sq.m. It contains the Murree hills. The district is traversed by the main line of the North-Western railway, crossing the Indus at Attock, and also by a branch towards the Indus at Kushalgarh. The population in 1931 was 634,357.

RÂWANDIS, a Persian sect (from Rāwand, a town near Isfahan). Its origin is unknown, but its members held ultra-Shiah doctrines (*see* ISLAM). They maintained that the spirit that was in Jesus was in 'Alī, then in the imāms one after the other to Ibrahīm ibn Muhammad, and that thus these were divine. They believed in metempsychosis, or the transmigration of souls, and asserted that the Lord who fed them and gave them drink was Manṣūr. In 759 they came to the palace of Manṣūr in Hashimiya and began to hail him as Lord. The Caliph, however, secured their chiefs and threw them into prison.

See E. G. Browne, *Literary History of Persia* (1902, bibl.)

RAWLINS, a city of southern Wyoming, U.S.A., 6,741 ft. above sea level, on federal highways 30 and 87 and the main line of the Union Pacific railroad; the county seat of Carbon county. Population in 1940 was 5,531. It is the most important shipping point for sheep and wool in the state; a division point on the railroad, which maintains extensive shops and roundhouses here; the supply centre for a mining, stock-raising and oil-producing area, extending 100 mi. on either side of the railroad; and the seat of the State penitentiary (established 1907).

RAWLINSON, SIR HENRY CRESWIGME (1810–1895), English soldier and orientalist, was born at Chadlington, Oxfordshire, on April 11, 1810. In 1827 he went to India as cadet under the East India Company; and after six years as a subaltern he was sent to Persia in company with other English officers to reorganize the Shah's troops. He became interested in the hitherto undeciphered cuneiform character. In two years he transcribed as much as he was able of the great cuneiform inscription at Behistun (*q.v.*); but the friction between the Persian court and the British government ended in the departure of the British officers. He became political agent at Kandahar in 1840. Then, at his own desire, he was sent as political agent to Turkish Arabia; thus he was enabled to settle in Baghdad, where he devoted much time to his cuneiform studies. He was now able to make a complete transcript of the Behistun inscription, which he deciphered and interpreted.

During two years' leave in England (1849–51) he prepared a memoir on the Behistun inscription. He disposed of his valuable collection of Babylonian, Sabaean and Sassanian antiquities to the trustees of the British Museum, who made him a grant to enable him to carry on the Assyrian and Babylonian excavations initiated by Layard. In 1851 he returned to Baghdad. In 1855 he resigned his post in the East India Company and he received the K.C.B. and crown directorship of the East India Company. The remaining forty years of his life were mainly spent in London. In 1858 he was appointed a member of the first India Council, but resigned in 1859 on being sent to Persia as envoy extraordinary and minister plenipotentiary. The latter post he held only for a year. Rawlinson rejoined the Council of India in 1868, and continued to serve upon it until his death. He was a strong advocate of the forward policy in Afghanistan. He died in London on March 5, 1895.

His published works include four volumes of cuneiform inscriptions, published under his direction between 1870 and 1884 by the trustees of the British Museum; *The Persian Cuneiform Inscription at Behistun*, 1846–51, and *Outline of the History of Assyria*, 1852, both reprinted from the Asiatic Society's journals; *A Commentary on the Cuneiform Inscriptions of Babylon and Assyria*, 1850; *Notes on the Early History of Babylonia*, 1854; *England and Russia in the East*, 1875. He contributed to the *Encyclopædia Britannica* (9th edition) the articles on Baghdad, the Euphrates and Kurdistan, and several other articles dealing with the East; and assisted in editing a translation of Herodotus by his brother, Canon George Rawlinson (1812–1902).

See G. Rawlinson, *Memoir of Henry Creswicke Rawlinson* (1898).

RAWLINSON, HENRY SEYMOUR RAWLINSON, 1ST BARON (1864–1925), British soldier, was born on Feb. 20, 1864, son of Maj. Gen. Sir H. Rawlinson, Bart. He joined the army in 1884 and a year later became aide-de-camp to Sir F. Roberts in India on whose staff he served intermittently for some years. He took part in the Burma operations in 1886–87 and on the Nile in 1898; he had succeeded to the baronetcy in 1891. He served throughout the South African War (1899–1902). Some months after his return to England he became commandant of the staff college and from 1910 to May 1914 commanded the 3rd Division. Gen. Rawlinson was in charge of the forces sent to assist Antwerp in 1914, and took part in the first battles of Ypres and in the Neuve Chapelle and the Loos offensives. He commanded the IV. Army during the battle of the Somme (1916) achieving important successes. At the end of 1917 he was transferred temporarily to the command of the II. Army during Gen. Plumer's absence in Italy, and in Feb. and March 1918 he acted for some weeks as British representative on the Supreme War Council. Resuming his command of the IV. Army in April, his troops on Aug. 8, in conjunction with the French, attacked the enemy near Amiens and gained a signal victory, which heralded the general advance of the Allies. After the War he was raised to the peerage as Baron Rawlinson of Trent and received a grant of £30,000. In the latter part of 1919 he mas sent to north Russia to conduct the withdrawal of the Allies from Archangel and Murman, and on his return he commanded at Aldershot for a year. At the end of 1920 he went to India as commander-in-chief. He died at Delhi on March 28, 1925.

See Sir F. Maurice, *Life of Genera2 Lord Rawlinson of Trent, from his Journals and Letters* (1928).

RAWMARSH, an urban district in the West Riding of Yorkshire, England, 74 mi. N.E. of Sheffield on the L.M.S. and L.N.E. railways. Pop. (1938) 18,210. Area 4 1 sq.mi. It is 1½ mi. from the river Don, and is almost continuous with Rotherham. Rawmarsh has large iron-works, steel rolling-mills, and potteries.

RAW MATERIALS include objects, classified with respect to their place in trade and industry, rather than with respect to their physical character. An object that may be classed with raw materials at one time may become a finished product at another, or vice versa. Camphor and indigo were formerly classed as raw materials in the chemical industry. Since the invention of the synthetic processes for their manufacture they have come to be classed as finished products. Coal tar, formerly a finished product of the distillation process, has now come to be the raw material for a great variety of chemical manufactures.

An International Pool.—As modern industry developed in many countries after the middle of the 19th century, notably in the United States and Germany, France, Belgium, Italy and Japan, the principal raw materials became, as it were, an international pool, distributed automatically among the consuming nations in proportions determined by what may be described in general terms as relative power of economic attraction; this power being based on a number of factors of fluctuating value, of which the chief are: (1) facilities for assembling materials in large masses; (2) facilities for distributing the manufactured product; (3) cheapness of fuel, or other sources of power, especially hydro-electric; (4) cheapness and above all efficiency of labour; (5) abundant liquid financial resources for carrying raw material stocks and finished products on their way to the consumer.

Old Versus New Countries.— The predominance of England as a market for raw materials in the first three-quarters of the 19th century rested upon a relative superiority in all these factors. Gradually other nations gained upon England in one factor or another; Germany in fuel and labour, especially the highly trained labour of the chemical industries; the United States in fuel, particular kinds of labour, financial power; Italy and Switzerland in hydro-electric power. In general, it may be said that the tendencies of the 50 years before the outbreak of the World War were in the direction of reducing the lead of the older industrial countries and sections in the power to attract raw materials. The disturbances of trade resulting from the war forced many countries to develop independent manufacturing facilities, with the consequence that the claimants upon the international pool of raw materials have become more numerous and more nearly on an even footing. Under the régime of virtual freedom the trade in raw materials underwent an immense development. The demands of industry produced a great expansion in the production of raw materials, and this expansion, often outrunning demand, reacted upon industry and stimulated its development.

Science Gives New Resources.— In rare instances the progress of science and invention has freed industry from its dependence on the raw materials that figure in world trade. Scientific and industrial progress has steadily increased the number of raw materials in trade and the volume consumed.

At the same time technical progress applied to the production of raw materials themselves has greatly extended the range of possible sources. Prior to the introduction of the flotation process in copper extraction, the minimum paying ore was about 3%; less than 1% is profitable now. Electric concentration has made available magnetic iron ores formerly regarded as too lean for working. The progress of plant-breeding is greatly extending the possibility of supplementing the limited natural production of long-staple cotton. The development of effective systems of plantation management has opened the whole tropical belt to the production of rubber, formerly confined to limited areas in the tropical forests. Moreover, chemical science progresses steadily toward a stage in which an increasing number of raw materials may be produced synthetically.

Increased Consumption.— The growth of industry and wealth has further affected the demand for raw materials by raising the standard of consumption. To this influence must be ascribed not only such striking instances as increase in the demand for raw silk, and the finer grades of wool and cotton, but also the growth in the consumption of a long array of articles of common use.

For a study of the distribution of raw material ***see*** the article PHYSICAL RESOURCES.

Marketing.— It is rarely the case that rich sources of raw materials coincide with the industrial equipment and the consuming power requisite to their utilisation. They must, as a rule, seek distant markets, and therefore assume an important place in international trade. This trade is marked by serious fluctuations in both demand and supply. The production of raw materials of mineral origin is subject to shrinkage from the exhaustion of deposits and to expansion due to the discovery of new deposits. Raw materials of vegetable and animal origin are subject to serious fluctuations under seasonal influences. The demand for many of these products is peculiarly responsive to the alternations of prosperity and depression in the centres of industry and population.

Fluctuations of Brice.—Because of the wide fluctuations in the demand and supply of raw materials, rapid price fluctuations are characteristic of the whole field. In the case of raw materials that are relatively imperishable, like the textile fibres, metals and other minerals, the fluctuations are somewhat evened out by the accumulation of stocks in plethoric times, to be gradually released to trade in times of scarcity. This involves a complicated organisation of finance for carrying the stocks and for distributing the risks of price fluctuations. The physical aspects of the problem involve grading and storage — technically complicated processes, but seldom occasioning serious issues of policy. The financial aspects are more difficult, involving as they do the question of speculation.

In general, it may be said that the carrying of raw material stocks is inherently speculative. Where the producer holds the ramr material until he can dispose of it directly to the manufacturer, he carries the risk of price fluctuations himself. Where the manufacturer accumulates large stocks for future use, the risk rests on him. If speculative markets are well developed, much of the risk may be transferred from the producer of raw materials to a specially trained body of men, whose business it is to study all the possible sources of supply and form forecasts as to the future. Where such markets exist the manufacturer who makes a contract for the future delivery of goods, may safeguard himself against fluctuations in raw material prices through buying "futures"; a manufacturer who is producing for the general market may safeguard himself against a fall resulting from falling prices of material by "hedging," or selling futures for an equivalent volume of raw material.

From time to time the belief gains currency that the speculative markets are themselves responsible for price fluctuations in raw materials, and laws are passed for curbing their operations. While there are numerous instances of price manipulation through "corners," the weight of experience seems to indicate that speculative operations which do not conform with underlying conditions of demand and supply are doomed, as a rule, to disaster. It also indicates that price fluctuations are most disastrous in those materials for which there is no organised speculative market.

The Chief Markets.— The principal markets for dealing in raw materials are situated at the financial centres that were originally most closely related to the points of assembly and primary distribution. London has long been the predominant market for an extensive list of raw materials. Alongside of the London market, independent markets are established wherever the business of handling materials becomes important. The various markets are closely interrelated. No very wide difference can long maintain itself in the prices on the London and the New York copper markets, for example. The initiative toward price changes may arise in either market; it will soon be reflected in the other. Chief influence, however, rests with the market which represents the greater aggregation of trained speculative abilities combined with financial power. For this reason a market might retain its dominant position long after the immediate cause of its establishment, the concentration in the vicinity of material stocks for consumption, has disappeared.

International Control.— The World War brought to the attention of the governments and the public the remarkable dependence of modern industrial countries upon the international movement of raw materials. For the tremendous consumption of war the ordinary supplies of many raw materials were inadequate. Accordingly every belligerent nation adopted measures for conserving, rationing, stimulating the production or importation of, or preventing the exportation of, various raw materials. Raw materials occupied the centre of wartime economic policy (see CONTROL). After the close of hostilities there was a flood of projects for the rationing among nations of the available stocks of raw materials, and for the working out of a permanent policy of international control. All these projects fell to the ground because of the inherent difficulties of the problem. The world's trade in raw materials returned for the most part to the system of automatic distribution under the principle of relative economic attractive power.

Decline of Monopolistic Control.— The idea of controlling raw materials in the nationalistic interest persisted after the war, but under a different form and with different objectives. Thr general impoverishment resulting from the war threw into the foreground policies designed to increase the wealth of governments and their nationals. Possession of the sole or principal source of an important raw material appeared to offer an opportunity for price fixing which should draw to the controlling nation an increased share of the world's wealth. The pre-war control of nitrates by the Chilean Government and the German potash monopoly offered precedents for this policy of price control. For a time it was generally feared that a new régime of nationalistic raw material monopolies might be inaugurated, since it was technically feasible for single governments or two governments acting together to control over twenty important raw materials.

This apprehension proved groundless. Most of the attempted controls failed of their object through increased competition (rubber, Chile nitrates) or through threatened shrinkage of demand (potash). While it is true that most governments to-day are more sensitive to over-production and price depression in raw materials than before the war, the faith in the possibilities of important nationalistic gains through monopolistic methods of price control has greatly weakened.

Restriction of Capital.— A more subtle, and at first glance more justifiable, method of extracting a nationalistic gain from the possession of sources of raw materials consists in reserving their exploitation to national capital. This method has never been employed by the United States. Foreign and native capital have been admitted on equal terms to the development of raw material sources. The policy of most countries of Europe even before the war restricted the operations of foreign capitalists and companies in the raw material field. Since the war this policy has been stiffened rather than relaxed.

So far as concerns the raw materials found within the boundaries of the nation proper, no one questions the morals of a policy of restriction, although there remains a very serious question as to its expediency. A mine opened by foreign capital affords the same employment to domestic labour, gives the same stimulus to trade and transportation as a mine opened by native capital. The only difference consists in the fact that the profits must be remitted abroad, ultimately, however, in the form of commodity exports. If a country is sufficiently supplied with native capital to open up all its raw material resources, the problem of foreign capital will not arise. If it does not have adequate capital, its rate of progress may be greatly accelerated by the active participation of foreign capital in the work of development. The fear that the free admission of foreign capital to the actual work of development may produce a permanent tributary relation is groundless. If the interests of national labour and trade are properly safeguarded, the national enrichment following development will in the end make possible the buying out of foreign interests. Much of the financial power which has enabled the United States to change from the rôle of a debtor to a creditor nation is due in the last instance to the work of foreign capital in developing its resources. There can be no doubt that freedom and security for foreign investment in Russia and Siberia would raise the whole level of national prosperity and in the end produce so great an accumulation of Russian capital as to make foreign capital superfluous.

Exploitation of Colonials.—In the case of colonies and dependencies restrictions upon foreign capital are not only inexpedient, but of doubtful morality. It is an accepted principle of contemporary international ethics that colonies should be administered in the interest of their own inhabitants and of the world at large, not' in the particular interest of the imperial nation. The principle of mandate, as elaborated by President Wilson, is ethically applicable to all colonies. To reserve the exploitation of colonial raw materials to the imperial country, or, if the imperial country has inadequate capital, to hold such resources undeveloped, is injurious to the colony and to the world.

It was the prevalence of the conception of the colony as an exclusive field for imperial capital that led to the nineteenth century scramble for colonies and spheres of influence which, as is now universally admitted, was one of the ulterior causes of the World War. The same policy to-day not only holds back the progress of economic recovery from the war, but is generating throughout the world economic friction which seriously impairs the prospect of a peacefui and harmonious world order.

BIBLIOGRAPHY.—C. Gini, *Report on the Problem of Raw Materials and Foodstuffs: with Annexes* (League of Nations, 1922); Inter. Labour Office, *Enquête sur la Production*, 2 vol. (1923); J. M. Keynes and R. B. Lewis, *Stocks of Staple Commodities* (London and Cambridge, Econ. Service. Spec. Memo. Nos. I. and VI., 1923 and 1924).
(B. M. B.)

RAWTENSTALL, municipal borough in the parliamentary borough of Rossendale, Lancashire, England, 18 mi. N. from Manchester by the L.M.S.R. Pop. (1938) 27,070. Area, 14.9 sq.mi. Rawtenstall, which was incorporated in 1891, manufactures cotton and woollen goods and shoes.

RAY (or WRAY, as he wrote his name till 1670), **JOHN** (1628–1705), sometimes called the father of English natural history, was the son of a blacksmith of Black Notley, Essex, where he was born probably on Nov. 29, 1628. Educated at Catherine Hall and Trinity college, Cambridge, Ray became a fellow of Trinity college. He held many college offices.

His first botanical tour was undertaken in 1658, and on being compelled to give up his fellowship (1662), because he could not subscribe to the Act of Uniformity, Ray toured through Europe in 1663 with Francis Willughby (*q.v.*). From this tour Ray and Willughby returned with collections, on which they meant to base complete systematic descriptions of the animal and vegetable kingdoms. Willughby undertook the former part, but, dying in 1672, left only an ornithology and ichthyology, for Ray to edit; while the latter used the botanical collections for the groundwork of his *Methodus plantarum nova* (1682), and his great *Historia generalis plantarum* (3 vols., 1686, 1688, 1704). The plants gathered on his British tours had already been described in his *Catalogus plantarum Angliae* (1670), which work is the basis of all later English floras. He published an account of his foreign travel in 1673, entitled *Observations topographical, moral, and physiological, made on a Journey through part of the Low Countries, Germany, Italy, and France.*

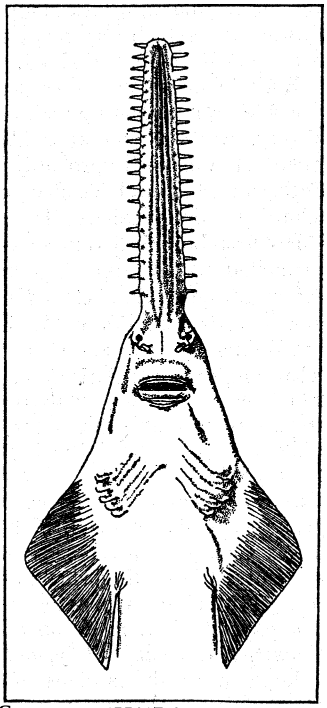
Ray's work shows signs of indebtedness to Joachim Jung of Hamburg and others. In his early work he classified his plants alphabetically but later he used the number of cotyledons as the basis of his classification. Ray also classified according to the fruit but eventually he used the flower for purposes of classification. He distinguished several natural groups such as the grasses, Labiatae, Umbelliferae and Papilionaceae. He was involved in a controversy with Rivinus upon Ray's indefensible separation of ligneous and herbaceous plants. In conjunction with Willughby Ray wrote a paper on his experiments on the motion of sap in trees. In 1667 Ray was elected F.R.S. He died on Jan. 17, 1705. The Ray Society, for the publication of works on natural history, was founded in his honour in 1844.

Ray was also the author of *Catalogus plantarum circa Cantabrigium* (1660, appendices in 1663 and 1685), this was written in conjunction with John Nid; *Catalogus plantarum Angliae* (1670, 1677); *Synopsis stirpium Britannicarum* (1690, etc.); *Stirpium Europaearum extra Britannias nascentium Sylloge* (1694); *Synopsis methodica Animalium Quadrupedum et Serpentini Generis* (1693), *Synopsis methodica Avium et Piscium* (1713) and *Historia Insectorum* (1710).

AUTHORITIES.—*Memorials of Ray* (with the addition of a complete catalogue of his works) edited by Dr. Edwin Lankester (Ray Society, 1846); *Correspondence* (with Willughby, Martin Lister, Dr. Robinson, Petiver, Derham, Sir Hans Sloane and others), edited by Dr. Derham (1718); *Selections*, with additions, edited by Lankester (Ray Society, 1848). For accounts of Ray's system of classification, *see* Cuvier, *Leçons hist. s. Sci. Nat.*, p. 488; Sprengel, *Gesch. d. Botanik*, ii. p. 40; Sachs, *Gesch. d. Botanik*; also Whewell, *Hist. Ind. Sci.*, iii. p. 332 (ed. 1847), and Wood, art. "Classification" in Rees's *Cyclopaedia.*

RAY, the name given to the short-snouted fish of the genus *Raia*, the skates and rays, and in a more general sense used for all the Selachians (*q.v.*) of the order Hypotremi, which are distinguished from sharks by their depressed form, and by the large pectoral fins, produced forwards and attached to the sides of the head above the gill-openings, which are ventral in position. Generally the nostrils and the transverse mouth are placed on the flat under surface of the head. On the upper surface of the head, behind the eyes, are large holes leading to the pharynx; these are termed spiracles, and serve for the intake of water for respiration. Rays are fitted, by their structure, for life at the bottom of the sea; most are viviparous, but the Raiidae have eggs enclosed in oblong horny cases similar to those of dog-fishes.

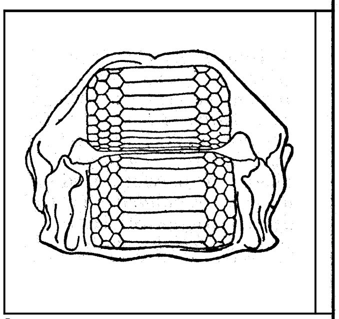
The l'orpedinidae, or electric rays, form an isolated family, distinguished by possessing large paired electric organs, formed of vertical hexagonal columns, placed between the pectoral fins and the head, and capable of giving powerful shocks, either for defensive purposes or to kill prey. The electric rays have a smooth and naked skin; the head and trunk, with the pectoral fins, form a circular disc; the tail is short and stout. About 20 species are known from warm seas, some reaching a weight of 200 lb.; one or two species of Torpedo occur in British waters.



SAW-FISH (PRISTIS PERROTTETI). THE SAW MAY REACH A LENGTH OF SIX FEET AND IS A FORMIDABLE WEAPON

The other rays, without electric organs, generally have a rough skin, often bearing strong spines. The most shark-like are the Rhinobatidae, of which about 20 species are known, from tropical and sub-tropical seas; in most of them the pectoral fins are relatively small, and the trunk passes gradually into the tail. The saw-fishes, or saw-rays (*Pristis*) differ from them in that the snout is produced into a long blade armed with a series of strong teeth on each side; five species are known from warm seas, frequenting sandy shores and estuaries. Some attain a length of 20 feet; such large specimens are dangerous, the saw being a formidable weapon.

In the Raiidae the large pectoral fins extend to the snout, and form a disc distinct from the slender tail. Numerous species of the cosmopolitan genus Raia are known, some living at considerable depths; some species reach a weight of 500 lb. These rays swim by undulating or flapping movements of the pectoral fins; their teeth are small, and blunt in some species, pointed in others; their food consists of molluscs, crustaceans and fishes. One of the largest British species is the common skate (R. *batis*), with long, pointed snout and greyish belly; the commonest ray in British waters is the thornback (R. clavata). Numbers of skates and rays are trawled; the pectoral fins are cut off and used as food.



JAWS OF AN EAGLE-RAY. THE PAVEMENT-LIKE TEETH ARE USED FOR CRUSHING SHELLS

The remaining rays are collectively termed "whip-tailed," the tail being long and slender and bearing a strong barbed spine connected with a poison gland; this spine is capable of inflicting noxious wounds, and is a dangerous weapon when the tail is lashed. All the whip-tailed rays are inhabitants of warm seas, except a few kinds of sting-ray in the rivers of South America. In the sting-rays (Trygon, etc.), as in most of the rays previously described, the teeth are numerous, small and blunt, but in the eagle rays (*Myliobatis*), they are relatively few in number, hexagonal, forming a flat pavement, and in the spotted eagle-rays (Aefobatus) are reduced to a single series of broad flat teeth, used by these large rays to crush the shells of oysters and other molluscs. Largest of all the rays are the devil-fishes, Manta and Mobula, which may measure 20 ft. across the disc. These rays are peculiar in that the anterior ends of the pectoral fins arc free, projecting forwards, when rolled up looking like a pair of horns, but when unrolled meeting below the mouth to form a scoop; a part of these devil fishes have been observed in a shallow bay pursuing the shoals of small fishes and scooping them into their mouths. (See SELACHIANS, SHARK.)

(C. T. R.)

RAYAH, the name given to the non-Muslim subjects of a Mohammedan ruler; all who pay the haraj or poll-tax levied on unbelievers (Arabic *ra'iyah,* peasants). Five classes of rayahs existed under Turkish rule until the system was destroyed by the revolution following the World War. These were: (1) the Greek, or *Roum* milleti; (2) the Armenian, or *Emeni milleti;* (3) the Catholic Armenians—Eremeni gatoliki milleti; (4) the Latin Christians, or *Roum* gatoliki milleti; and (5) the Jews, or *Ichondi* milleti. The name rayah was most commonly used of the peasants, but did not apply only to the agricultural populations. It depended on the status of the non-Muslim subject; this was fixed by religious faith.

RAYLEIGH, JOHN WILLIAM STRUTT, 3RD BARON (1842–1919), English physicist, was born in Essex on Nov. 12, 1842, and educated at Trinity college, Cambridge. He succeeded to his father's title in 1873. From 1879 to 1884 he was Cavendish professor of experimental physics in the University of Cambridge, and from 1887 to 1905, professor of natural philosophy at the Royal Institution of Great Britain. In 1896 he became scientific adviser to Trinity House, and in 1901 chief gas examiner. His early papers were mainly mathematical, including two on electromagnetic phenomena considered in connection with dynamical theory, and one on the stationary thermal conditions of a sphere exposed to radiation from distant sources. His paper on resonance was the first of a series of memoirs which culminated in his standard work, *A* Treatise on *Sound.* Other papers on sound dealt with the vibrations of a gas contained in a rigid spherical envelope, disturbances produced in sound waves by a spherical obstacle, general theorems relating to vibrations, absolute pitch and the resultant of a large number of vibrations of the same pitch and of arbitrary phase. He carried out experiments on the amplitude of the sound wave near the limit of audibility and on the direction of sound. Rayleigh also carried out investigations in optics and experiments in colour vision. He wrote on polarization, the scattering of light by particles, and the colour of the sky. Great experimental skill was shown in his reproductions of gratings by photographic methods. A series of four papers entitled "Investigations in Optics, with special reference to the Spectroscope," were published in the *Philosophical* Magazine in 1879 and 1880. These dealt with the general question of the resolving power of optical instruments. Later he dealt more particularly with the microscope. His contributions to hydrodynamics were important; he dealt with problems connected with the propagation of waves, showing how the wave velocity depends on the period. He applied this to the case of deep sea water waves and showed the part played by waves in earthquakes. Rayleigh's experiments on the instability of water jets led him to work on surface tension. While at the Cavendish laboratory he carried out his determination of the ohm. Rayleigh also worked out a formula for the distribution of energy in black-body radiation which holds for long wave-lengths. His interest in Prout's hypothesis as to atomic weights led him to a series of experiments to determine the densities of gases. While working on nitrogen Rayleigh made observations which led to the discovery of argon. Sir William Ramsay co-operated with him in the latter stages of the work. Lord Rayleigh had an interest in abnormal psychological investigations, and became a member and vice-president of the Society for Psychical Research. He was one of the original members of the Order of Merit, instituted in connection with the coronation of King Edward VII. In 1904 he was awarded a Nobel prize, and at the end of 1905 he became president of the Royal Society, of which he had been elected a fellow in 1873, and had acted as secretary from 1885 to 1896. He remained president till 1908, in which year he succeeded the 8th duke of Devonshire as chancellor of Cambridge university. In 1909 the prime minister, Asquith, set up a committee of aeronautics, of which Rayleigh was president. Rayleigh was the recipient of many academic and other honours. He died at Witham, Essex, on June 30, 1919

Rayleigh's papers are collected in four volumes. An account of his life, by his son, was published in 1924. *See* obituary notice by Sir A. Schuster in *Proceedings of the Royal Society* (vol. 98, 1920–21).

RAYMOND, HENRY JARVPS (1820–1869), American journalist, was born near the village of Lima, Livingston county, (N.Y.), Jan. 24, 1820. He graduated from the University of Vermont in 1840. After teaching, acting as correspondent for various papers, assisting Horace Greeley (*q.v.*) on the *New Yorker* and the *Tribune,* and serving on the *Courier and Enquirer,* Raymond obtained backing for a venture of his own, and the first issue of the New York *Times* appeared Sept. 18, 1851. Of this journal Raymond was editor and chief proprietor until his death. Raymond was a member of the New York Assembly in 1850 and speaker in 1851 and again in 1862. He supported the views of the radical anti-slavery wing of the Whig Party in the North. His nomination over Greeley on the Whig ticket for lieutenant-governor and his election in 1854 led to the dissolution of the famous political "firm" of Seward, Weed and Greeley. He took a prominent part in the formation of the Republican Party, and drafted the famous "Address to the People" adopted by the Republican convention which met in Pittsburgh in Feb. 1856. He was a member of the National House of Representatives in 1865–67. He retired from public life in 1867 and devoted his time to newspaper work until his death in New York city, June 18, 1869. Raymond was an able and polished public speaker; but his great work was in elevating the style and general tone of American journalism. He published several books, including a biography of President Lincoln, which in substance originally appeared as *A History of the Administration of President Lincoln* (1864), and which with additions has been republished under varying titles.

See Augustus Maverick, *Henry J. Raymond and the New York Press for Thirty Years* (1870), which includes in the appendix an autobiographical fragment, various addresses by Raymond, etc., and "Extracts from the Journal of Henry J. Raymond," edited by his son, Henry H. Raymond, in *Scribner's Monthly* (1879–80).

RAYMOND, a city of Pacific county, Washington, U.S.A., on Willapa Harbor, at the mouth of the Willapa river, 15 m. from the ocean and about 30 m. N. of the estuary of the Columbia river. It is on the Roosevelt Pacific highway, and is served by the Chicago, Milwaukee, St. Paul and Pacific and the Northern Pacific railways and by steamship lines. Pop. (1940) 4,045. The traffic of the harbour amounted in 1939 to 352,921 gross tons of vessel cargo, valued at $5,274,680 (largely shipments of lumber) and floated timbers valued at $6,942,806.

RAYMUND, prince of Antioch (1099–1149), was the son of William VI., count of Poitou. On the death of Bohemund II. of Antioch (*q.v.*), the principality devolved upon his daughter, Constance, a child of less than 10 years of age (1130). Fulk, the king of Jerusalem, and, as such, guardian of Antioch, sent envoys to England to offer her hand t~ Raymund, who was then at the court of Henry I. Raymund reached Antioch in 1135. Here he was married to Constance by the patriarch of Antioch, but not until he had done him homage. The marriage excited the indignation of Alice, the mother of Constance, who had been led by the patriarch to think that it was she whom Raymund desired to wed; and the new prince had thus to face the enmity of the princess dowager and her party. In 1137 he had also to face the advent of the eastern emperor, John Comnenus, who had come south partly to recover Cilicia from Leo, the prince of Armenia, but partly, also, to assert his rights over Antioch. Raymund was forced to do homage, and even to promise to cede his principality as soon as he was recompensed by a new fief, which John promised to carve for him in the Mohammedan territory to the east of Antioch. The expedition of 1138, in which Raymund joined with John, and which was to conquer this territory, failed. New disputes arose, and in 1142 John ravaged the neighbourhood of Antioch, but was unable to attain any effective decision. When, however, Raymund demanded from Manuel, who had succeeded John in 1143, the cession of some of the Cilician towns, he found that he had met his match. Manuel forced him to a humiliating visit to Constantinople, during which he renewed his oath of homage and promised to receive a Greek patriarch. In 1149 he fell in battle during an expedition against Nureddin.

For his career see Rey, in the *Revue de l'orient latin,* vol. iv.

(E. B.)

RAYMUND OF TOULOUSE (d. 1105) (called also Raymund of St, Gilles, after a town near Nimes), count of P'rovence, one of the leaders of the first Crusade. According to an Armenian authority, he had lost an eye on a pilgrimage to Jerusalem before the first Crusade; but the statement probably rests on the fact that he was one-eyed, *vir monoculus.* He is also recorded to have fought against the Moors in Spain before 1096; and he was the first of the princes of the West to take the cross after Pope Urban's sermon at Clermont. The oldest and the richest of the crusading princes, the count of Provence started, in October 1096, with a large company, which included his wife, his son, and Adhemar, bishop of Puy, the Papal Legate. His march lay by Ragusa and Scutari to Durazzo, whence he struck eastward, along the route also used by Bohemund, to Constantinople. At the end of April 1097 he was with difficulty induced to take a somewhat negative oath of fealty to Alexius. He was present at Nicaea and Dorylaeum; but he first showed his hand in October 1097, when, as the army neared Antioch, and a rumour was spread that Antioch had been deserted by the Turks. he sent a detachment in advance to occupy the city—an action which presaged his future difficulties with Bohemund (*q.v.*), the would-be prince of Antioch. In the siege of Antioch (which was far from having been deserted) Raymund played his part. When the city was taken by Bohemund (June 1098), the count garrisoned the *palatium Cassiani* (the palace of the emir, Yagi Sian) and the tower over the Bridge Gate. He lay ill during the second siege of Antioch by Kerbogha; but in his camp a great spiritualistic activity culminated in the discovery of the Holy Lance by the Provençals. The miracle stimulated the crusaders to defeat Kerbogha: the Lance itself, discovered by the Provençals and carried henceforward by their count, became a valuable asset in Raymund's favour. A struggle arose between the Provencals and the Normans, partly with regard to the genuineness of the Lance, and partly with regard to the possession of Antioch. Raymund moved southward in the autumn of 1098 to the siege of Marra, leaving a detachment of his troops in Antioch. With Bohemund left in Antioch; with the Holy Lance to give him prestige; and with the wealth which he had at his disposal, the count of Provence began to figure as the leader of the Crusade. But he delayed the advance to Jerusalem to besiege Arca with the intention of founding a principality to check the extension of Bohemund's kingdom. A wave of indignation in the ranks, and the inducements which the emir of Tripoli offered to the other princes, forced Raymund to desist from the siege (May 1098), and to march southwards to Jerusalem. He hampered Godfrey in the campaigns which followed.

Going north in the winter of 1099–1100 Raymund began hostilities against Bohemund, from whom he hoped to wrest Laodicea. From Laodicea he went to Constantinople, where he fraternized with Alexius, the great enemy of Bohemund. Joining in the ill-fated crusade which followed the first, he escaped from the *débâcle,* and returned to Constantinople. In 1102 he went by sea from Constantinople to Antioch, where he was imprisoned by Tancred, regent of Antioch during the captivity of Bohemund, and only dismissed upon promising not to attempt any conquests in the country between Antioch and Acre. He broke his promise, attacking and capturing Tortosa, and beginning to build a castle for the reduction of Tripoli (on the *Mons Peregrinus*). In this policy he was aided by Alexius. In 1105 Raymund died. He was succeeded by his nephew William, who in 1109, with the aid of Baldwin I., captured the town and definitely established the county of Tripoli. William was ousted in the same year by Raymund's eldest son Bertrand; and the county continued in the possession of his house during the 12th century[1].

Raymund of Toulouse represents the Provencal element in the first Crusade, as Bohemund represents the Norman, and Godfrey and Baldwin the Lotharingian. If in temperament he is the least attractive among the princes of the first Crusade, he was yet one of its foremost leaders, and he left his mark upon

[1]For the future history of the county, *see* under RAYMUND OF TRIPOLI and BOHEMUND IV.

history in the foundation of the county of Tripoli.

Raymund of Agiles, a clerk in the Provencal army, gives the history of the first Crusade from his master's point of view. For a modern account of Count Raymund's part in the crusading movement, one may refer to Rohricht's works. *(See* CRUSADES.)

RAYMUND OF TRIPOLI, the most famous of the descendants of Raymund of Toulouse, was a great-grandson of his eldest son Bertrand: his mother was Hodierna, a daughter of Baldwin II., and through her he was closely connected with the kings of Jerusalem. He became count of Tripoli in 1152, on the assassination of his father. In 1164 he was captured by Nureddin, and was only released in 1172 after a captivity of eight years. In 1174 he claimed the regency on behalf of Baldwin IV. (at once a minor and a leper), in virtue of his close relationship, and the claim was acknowledged. After two years the regency seems to have passed to Reginald of Chbtillon; but Raymund, who had married the heiress of the county of Tiberias, continued to figure in the affairs of the kingdom. His great ability procured him enemies; for two years, 1180–1182, Baldwin IV. was induced by evil advisers to exclude him from his territories, But as Saladin grew more threatening, Raymund grew more indispensable; and in 1184 he became regent for Baldwin V., on condition that, if the king died before his majority, his successor should be determined by the great powers of the West. Raymund conducted the regency with skill, securing a truce from Saladin in 1185; but when Baldwin V. died, in 1186, the supporters of Guy de Lusignan (the husband of Baldwin IV.'s sister, Sibylla) had him crowned, in defiance of the stipulation under which Raymund had become regent. Raymund, left in isolation, retired to Tiberias, and negotiated a truce for himself with Saladin. His ambiguous position led contemporaries to accuse him of treasonable correspondence with Saladin; but his loyalty to the Christian cause was nobly shown in 1187, when he reconciled himself to Guy, and aided him in the battle of Hattin, which was engaged, however, in the teeth of his earnest advice. He escaped from the battle wounded, and ultimately retired to Tripoli, where he died (1187). Raymund was as free from venality as any other man of his period and more capable than most of his contemporaries.

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