Report of the Literature Review Committee*

22nd Annual Review of the Literature on Fats, Oils, and Detergents. II.

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Nutrition and Biochemistry

REVIEWS. The review communications pertinent to this division were on: mechanism of intestinal absorption of fat (Frazer—*Nature 175,* 491; Frazer *et al.—Intern. Colloquim. Biochem. Problem. Lipiden 1953,* 137), fat as a required nutrient of the diet (Deuel—*Federation Proc. 14,* 639), fats in animal feeds (Becker—*Fette u. Seifen 57,* 161; Jacquot—*Rev. franc. corps gras 2,* 143), digestion and absorption (Reiser—*Clin. Chem. 1,* 93; Harris—*J. Clin. Investigation 34,* 685), lipides (Tuba—*Proc. Can. Cancer Res. Conf. Honey Harbor Ont. 1954,* 1, 138), the fatty acid cycle (Lynen—*Angew. Chem. 67,* 463), biosynthesis of fats from carbohydrates (Popjak & Hunter—*Congr. intern. biochim. Resumés Commun., Paris 1952,* 167), the liver in fat metabolism (Gurin—*Trans. 12th Conf. Liver Injury. J. Macy Foundation 1953,* 67), fatty infiltration of the liver and action of lipotropic substance (Stary & Arat—*Forum Medicum 1,* 22), oxidation and synthesis of fatty acids in soluble enzyme systems of animal tissues (Green—*Biol. Revs. Cambridge Phil. Soc. 29,* 330; *Clin. Chem. 1,* 53), unsaturated fat acids and liver necrosis (Martin—*Compt. rend. soc. biol. 148,* 1130), enzymes in the oxidation of fatty acids (Massart—*Intern. Colloquim. Biochem. Problem. Lipiden 1953,* 232), physiological properties of the saponifiable fraction of oils of fish and whales (Creach—*Oleagineux 10,* 161), ethyl oleate in the preparation of injectable solutions (Gialdi & Ponci—*Monit. farm. y terap. Madrid 61,* 185), evaluation of fat-soluble vitamins (Almquist—*Federation Proc. 14,* 650), biological value of various fats (Buogo—*Ann. sanita Pubbl. 14,* 1231), simple obesity (Berryman—*J. Am. Dietet. Assoc. 31,* 347), overheated fats in the formation of harmful substances (Shtenberg & Naumova—*Voprosy Pitaniya 13,* No. 2, 41), effects of various lipides in experimental hypolipotropic diets (Hartroft—*Federation Proc. 14,* 655), companion sterols of cholesterol of various tissues (Fieser—*Congr. intern. biochim. Resumés comm. 2e congr., Paris, 1952,* 127), deranged cholesterol metabolism and human atherosclerosis (Friedman *et al.—J. Gerontol. 10,* 60), biosynthesis of cholesterol (Cornforth—*Revs. Pure Appl. Chem. 4,* 275), lipoproteins (Mehl—*Clin. Chemist 6,* 52), and plasmalogen in lipide metabolism and in physiological and pathological conditions (Voit & Seckfort—*Deut. med. Wachschr. 80,* 241).

FAT NUTRITION. In resumés on the role of fats in nutrition, Deuel (*Food Res. 20,* 81; *Federation Proc. 14,* 639) has pointed out their importance to growth, pregnancy, lactation, nitrogen sparing, work capacity, survival, prevention of x-irradiation injury, prevention of capillary permeability, regulating cholesterol deposition, metabolism, and enzyme patterns. These aspects place fats among essential rather than optional components of the diet. The various concepts mentioned by Deuel are the subject of many current investigations in fat nutrition and biochemistry.

Rats fed fat-free diets after weaning were compared with controls with respect to growth, visible lesions, oxygen consumption; autopsy findings in brain, adrenals, liver, and kidneys. This comprehensive work on fat-deficiency has indicated that the effects are apparent in growth and body organs long before appearance of the usual skin lesion criterion (Panos & Finerty—*J. Nutr. 54,* 315).

Other investigations were on producing fatty acid deficiency in animals, the critical acids involved, and the mechanism of the process. Experiments have been carried out by Holman & Peifer (*Ann. Rept. Hormel Inst. 1954–55,* 37) which showed the production of essential fatty deficiency was accelerated by addition of cholesterol in the diet, that diabetes accelerated depletion; and that in castrated rats the usual roughened hair condition did not develop. Some of the findings were interpreted to indicate that the essential fatty acids are involved in the transport of cholesterol. Deuel *et al.* (*J. Nutr. 55,* 337) reported that essential fat-depleted rats had increased cholesterol content in the liver and a decreased cholesterol content in the plasma; but that presence of hydrogenated coconut oil in the diet brought the levels to normal. The results were attributed to the greater availability of shorter chain acids for esterification of glycerol. In this work the presence of hydrogenated coconut oil in an essential fatty acid deficiency producing diet resulted in accelerated production of the deficiency. Other work by Deuel and co-workers (*J. Nutr. 55,* 647; *57,* 297) on essential fatty acid deficiency has confirmed that these acids protect animals against x-irradiation; and showed that linolenate was less effective than linoleate in supplying the requirements in pregnancy and lactation, but together they were synergistic. Biological tests have shown that double bonds at 6,7- and 9,10-positions in the acids were necessary for biological activity (Thomasson & de Iongh—*Fette u. Seifen 57,* 390). In another investigation it was shown that both of the double bonds of linoleic acid must be cis to possess the activity (Privett *et al.—Arch. Biochem. & Biophys. 57,* 156). However, the cis-9, trans-12-acid plus normal linolenate induces better growth of animals than linolenate alone. In this work it was observed that all rats receiving linolenate had relatively high pentaenoic and hexaenoic acids content. In work on dietary fat and unsaturated fatty acids with infants, essential fat deficiency was appraised on

TABLE OF CONTENTS

* LITERATURE REVIEW COMMITTEE
E. W. BLANK
J. B. BROWN
E. A. GASTROCK
M. M. PISKUR (Chairman)

basis of decreases in serum di- and tetraenoic acid and increase in trienoic acid (Hanson *et al.—Fed. Proc. 14,* 436). In this work better unit gain in weight in relation to caloric intake was obtained on a diet supplying 0.05% of the calories as linoleic acid than on an evaporated milk mixture very low in linoleic acid. A new hypothesis on the mechanism of essential fatty acid activity indicated that the main site of action is the phosphate esterification system in the liver, coupled with the oxidation of reduced cytochrome c (Tulpule & Williams—*J. Biol. Chem. 217,* 229). In this work vitamin B_6 was found necessary for the proper utilization of linoleate in maintaining the activity of certain enzymes affected by essential fat deficiency.

A new biological test for essential fatty acid activity was based on growth response from samples when fed to essential-fatty acid-depleted male rats (Thomasson—*Intern. Colloquim. Biochem. Problem. Lipiden 1953,* 212). In this work data on 27 common edible fats and oils were recorded. Commercial margarines of Germany contained 3–14% of essential fatty acids (Kaufmann—*Fette u. Seifen 57,* 405). Investigations on effect of processing have indicated that refining and baking did not affect linolenic content of fats, whereas roasting may cause very small losses (Franzke—*Ibid.* 482). The losses of essential fatty acids through oxidative deterioration in fats of meat during storage were insignificant even when cuts were stored until unacceptable because of rancidity (Privett *et al.—Food Tech. 9,* 347; *Proc. 7th Res. Conf. Am. Meat Inst. 1955, 65*).

Another normal constituent of natural fats, squalene, was found to be necessary for maintaining successful lactation in albino rats (El Ridi *et al.—Hoppe-Seyler's Z. physiol. Chem. 299,* 283).

Guinea pigs grew better on diets containing fat than on diets devoid of fat even when essential fatty acids were supplied (Reid—*Federation Proc. 14,* 448). In this work hydrogenated lard (containing no essential fatty acid) induced less growth than corn oil, but was better than no fat at all.

During periods of commercial overproduction of fats they may be economically fed to farm livestock. Addition to poultry feeds induced better efficiency of feed utilization (Runnels—*Poultry Sci. 34,* 140; Carver *et al.—Ibid.* 544; Slinger *et al.—Ibid.* 789; Biely *et al.—Ibid. 33,* 1130); chicks preferred fat-supplemented diets (Lewis *et al.—Ibid. 34,* 1165); when stabilized, low-grade fatty acid-containing fats could be fed without harm (Siedler *et al.—Ibid.* 411); and these low grade fats did not adversely affect the storage quality of the poultry carcasses (Darrow & Essary—*Ibid.* 427), nor the flavor the eggs produced (Carver *et al.—Ibid. 131*). However, increasing the fat content of chick diets increased the requirements of the birds for folic acid (March & Biely—*Ibid.* 39) and vitamin B_{12} (Fox *et al.—Federation Proc. 14,* 433). Fish oil addition greater than 2% to broiler rations caused fishy flavor in the dressed birds, but much of this can be eliminated if non-fish oil rations are fed the last few weeks of life (Driggers—*Flour & Feed 56,* No. 3, 9). Addition of tallow to drylot hog rations increased feed efficiency and produced carcasses containing harder fats (Baird—*J. Animal Sci. 14,* 1192). In investigations on hardening fat and firming cuts from peanut-fed pigs with rations containing 15% tallow, the amount of hardening was related to the gain on the hardening ration (Alsmeyer *et al.—Ibid.* 1226). In lamb tests tallow was more digestible than corn oil or hydrogenated fat (Hale & King—*Ibid.* 1205). Low grade tallow additions to dairy calf starter decreased the apparent digestibility of crude protein and nitrogen free extract of the ration (Johnson *et al.—Ibid.* 1211). Fat additions to mixed feeds delayed spontaneous heating during storage at high moisture levels (Richardson & Halick—*Ibid.* 1221).

A high-fat, low-carbohydrate diet was recommended for weight reduction because it provided a higher satiety value than an isocaloric high-carbohydrate diet (Werner—*New Engl. J. Med. 252,* 661). Blood changes following isocaloric breakfasts high in carbohydrates, proteins, and fats, respectively, were recorded to appraise their satiety value and as basic data for planning diets of normal and overweight persons (Clayton & Randall—*J. Am. Dietetic Assoc. 31,* 876).

Substitution of carbohydrate for fat in infant diets diminished output of thiamine in the urine (Holt & Snyderman—*J. Nutr. 56,* 495). In this work the decrease in the thiamine required with the higher fat diets was measured. In thiamine-deficient guinea pig diets, increasing the percentage of fat at the expense of protein or carbohydrates delayed the development of avitaminosis (Aptekar—*Voprosy Pitaniya 13,* No. 2, 25).

The biological value of 20 oils and fats was observed with regard to growth, food intake and longevity of rats (Thomasson—*J. Nutr. 56,* 455; *57,* 17; Thomasson & Boldingh—*Ibid. 56,* 469). Growth from diets containing olive oil, cottonseed oil, winter butter, and beef fat did not differ significantly from that of summer butter. A weight increase inhibition on high fat diets was said to be significant for therapy in obesity. At 73% of the calories as rapeseed oil, mortality of test animals was high; but at 50% of the calories as rapeseed oil the rats lived longer than animals on comparable diets with other common fats. In this work palm oil had a high value of efficiency for reasons not known. In tests on optimum ratio of saturated to mono-unsaturated fatty acids in rat diets, best growth was made on mixtures in which the fatty acid ratio was close to that of normal rat depot fat (Hopkins *et al.—Can. J. Biochem. & Physiol. 33,* 1047). A synthetic triglyceride prepared from oleic acid 60, palmitic acid 30.9, stearic 7.4, and linoleic acid 2.6%, fed at 5–25% levels was well utilized by rats as indicated by weight gain, food intake, and nitrogen and water balances (Meng & Youmans—*J. Nutr. 55,* 527).

Measured on the basis of food nitrogen utilization in humans, sunflower oil showed better nutritional value than beef fat (Pikkat & Kurtsin—*Voprosy Pitaniya 12,* No. 6, 34). In nitrogen utilization studies during caloric restriction the level of fat did not affect the nitrogen balance (Calloway & Spector—*J. Nutr. 56,* 533). A better growth response obtained on a lard containing diet as compared to hydrogenated peanut oil was attributed in part to presence of essential fatty acid in the former (Aaes-Jorgensen *et al.—Brit. J. Nutr. 9,* 42). In this work growth of rats was significantly lower with 28% hydrogenated peanut oil than on fat-free casein diet; but presence of raw skim milk in the high oil diets increased growth rate to the level of those on fat-free diets. Enzymes degraded fat of bodied milk, *in vitro,* better than the fat of commercial infant milks (Ewerbeck & Jaeger—*Z. Kinderheilk. 75,* 496). Heating milks did not influence the fat retention by infants (Söderhjelm—*Acta Paediat. 40,* Suppl. 83; *41,* 207) nor was fat retention from milk improved by addition of emulsifier, choline, or aureomycin (*Ibid.* 316).

Results of several investigations have indicated that the fats we eat should be judiciously selected and handled. Fats that have polymerized or oxidized by heating or aeration or have become rancid during storage may be toxic (Kaunitz *et al.—J. Nutr. 55,* 577; *Federation Proc. 14,* 408; Frahm *et al.—Forschungsber. 5,* 443; Groot & Obbink—*Voeding 14,* 284; Kaneda *et al.—J. Biochem. Japan, 42,* 561). Among the work on this subject, that of Kaunitz and co-workers has demonstrated that the first one per cent distillate and the polymerized still residue were the most toxic fractions and that toxic symptoms did not occur when fresh fat was administered with the toxic fats. They described the toxicity as was evident from comprehensive pathological and histological observations. In *in vitro* tests rancid fats clearly retarded the action of pancreatic lipase (Herisset—*Compt. rend. 239,* 1438). The toxicity of oxidized oils was explained on the basis of antagonism or destruction of vitamin E (Hove—*Am. J. Clin. Nutr. 3, 328*). In poultry this antagonism to vitamin E resulted in development of encephalomalacia which was easily produced in chicks by feeding fish oils but does not tend to develop from scrap animal fats (Singsen *et al.—Poultry Sci. 34,* 1075). Use of antioxidants in the critical fats or injection of Vitamin E into the chicks inhibited the development of the encephalomalacia (Bunnell *et al.—Ibid.* 1068). Feeding of rancid olive oil to goats did not alter the acidity of the milk produced (Biondo—*Atti. soc. ital. sci. vet. 7,* 254).

Among normal fatty alcohols those of 8-14 carbon atoms produced toxic symptoms, the C_{16} alcohol was slightly toxic, and octadecyl alcohol was innocuous because of poor absorption (Miyazaki—*J. Agr. Soc. Japan 29,* 501).

Rats maintained with restriction of water lost more on high fat or high protein diets than with high carbohydrate diets (Schreiber & Elvehjem—*J. Nutr. 57,* 133). This indicated that fats or proteins contribute less metabolic water than carbohydrate. However, when fat was progressively substituted for carbohydrate, protein was used more efficiently and they grew better. This work was intended to demonstrate that growth studies should not be based simply on percent protein. Among female rats being treated with sulfathalidine mortality of young produced was very high when the fat in the ration was corn oil and it was nil with butter fat (Liener & Viswanatha—*Federation Proc. 14,* 441). Among rats receiving diets containing 1–10% fat those receiving the least fat could swim longer at water temperature of 20°, but at 37° there was no difference (Ershoff—*J. Nutr. 53,* 439). Feeding

diets exceedingly high in fats reduced the life span of rats (Silberberg & Silberberg—*Can. J. Biochem. & Physiol. 33,* 167). Alternate feeding of very high fat diets and fasting rendered dogs potentially hypertensive (Wilhemj—*Am. J. Dig. Dis. 22,* 219). Increases of fat in the diet, particularly the unsaturated fatty material, reduced mineral-oil toxicity in rats (Greenberg & Ershoff—*Exptl. Med. Surg. 13,* 143), it enhances toxicity to sodium fluoride (Miller & Phillips—*J. Nutr. 56,* 447), accelerates hepatoma development in rats of strains so predisposed (Jardetzky—*Proc. Soc. Exptl. Biol. Med. 90,* 648; Cabello—*Bol. soc. biol. Santiago Chile 9,* 63), and when unsaturated acids were applied with carcinogenic hydrocarbons to rats, tumor production was accelerated and increased in incidence (De Angelis *et al.—Acta Vitaminol. 8,* 161). In a communication on relation of superheating fats to development of cancer the subject was reviewed with much emphasis on formation of epoxides in the fats and analytical methods for determination of epoxides were discussed (Seelkopf—*Fette u. Seifen 57,* 111).

Clinical experiences gained from 1466 infusions of 10–15% fat emulsion in parenteral nutrition of patients have indicated that cottonseed oil and triolein were the most satisfactory fats and soybean phospholipide was the most suitable emulsifier (Waddell *et al.—J. Lab. Clin. Med. 45,* 697; Geyer *et al.—J. Am. Oil Chemists' Soc. 32,* 528). This group (Geyer *et al.—Ibid.* 365) also described high pressure homogenization equipment for preparing the emulsions. A fat suspension for intravenous use containing no emulsifier was prepared from a warm solution of the fat in alcohol and water by evaporation of the alcohol while agitating (Payne *et al.—Proc. Soc. Exptl. Biol. Med. 89,* 122). Toxic reactions due to stabilizer were thus obviated. Surface tension data were developed for oils that may be used in parenteral nutrition because these data are pertinent to the thermogenic response which sometimes develops (Singleton & Benerito—*J. Am. Oil Chemists' Soc. 32,* 23). Infusions of emulsions of cottonseed oil and of olive oil were studied in normal subjects with regard to the febrile response, optical density, total fatty acid, free fatty acid, lysozyme of the serum, and for clearing of the emulsion *in vitro* by postheparin plasma (Moeller *et al.—J. Lab. & Clin. Med. 46,* 450). There were differences between the two emulsions and between individuals. In other works data were recorded on the clearing of neutral fat emulsion by postheparin plasma as affected by the dose of heparin, pH, and temperature (Meng *et al.—Am. J. Physiol. 179,* 314), and on the effect of heparin on the distribution of intravenously administered C^{14} labeled soybean oil emulsion to rats (Becker *et al.—J. Lab. Clin. Med. 45,* 786). The heparin caused a marked increase of fixation of the fat in the muscle. A fat emulsion patented for intravenous alimentation contained fat synthesized from coconut type fatty acid having 12–18 carbon atoms (Barsky—*U. S. 2,728,706*).

INTESTINAL ABSORPTION OF FATS AND OILS. The results of several investigations have demonstrated that much fecal fat can originate from bacterial growth in the intestines. This has been demonstrated in one study on rats and humans (Holasek—*Hoppe Seylers' Z. Physiol. Chem. 298,* 219) and in another, *in vitro* on feces and *in vivo* on pigs (Chipault—*Ann. Rpt. Hormel Inst. 1954–55,* 27) where fecal fat developments were suppressed with antibiotics. In the latter study the fecal fats contained a higher ratio of linoleic and arachidonic acids and less saturated acids during antibiotic feeding. Observations on fats in the rumen have indicated that dietary fats were resynthesized to a more saturated composition (Shorland *et al.—Nature 175,* 1129) and that the rumen bacterial fats do not contain linoleic and linolenic acids (Garton & Oxford—*J. Sci. Food Agr. 6,* 142). Such reports and the note that some endogenous fats were always excreted in the feces (Kadykov & Shastin—*Voprosy Pitaniya 14,* No. 4, 14) have reaffirmed that absorption of a fat cannot be accurately based on the relationship of that ingested to that excreted. To circumvent such difficulties Blomstrand (*Acta Med. Scand. 152,* 129) measured absorption with unsaturated and saturated acids labeled with C^{14}. The labeled acids were 99.4% absorbed by normal subjects and somewhat less by patients with sprue. Data from this investigation also support the concept that the amount and character of fecal lipids are not influenced by alterations in food fats. Data with deuterium tracer technique have shown variations in the absorption of different fats and fatty acids (Favarger—*Congr. intern. biochim. 2e congr. 1952,* 154). Sacrificing the animals during digestion and analyzing fatty acids in three sections of the intestines showed that saturated acids were absorbed further along the intestines than unsaturated acids. In this work 10–20% of the labeled acids fed as glycerides were recovered from the intestines as phospholipides. Another study on digestion of fats based on analyses in sections of the digestive tract confirmed the greater ease of absorption of unsaturated versus hydrogenated fats (Herting *et al.—J. Nutr. 57,* 369). In this work the absorption of acetylated glycerides also depended largely on the fatty acid composition.

Rats fed low protein diets until they lose 20% of their weight absorb less fat than controls on a normal diet (Peretti & Liguori—*Arch. sci. Biol. Italy, 38,* 481).

Certain investigations yielded information pertinent to the mechanism of absorption of fats. The solubilities of some normal saturated fatty acids in aqueous sodium glycocholate solution were determined and the data were discussed in relation to mobility of the acids through the intestinal wall (Verkade & Meerburg—*Rec. trav. chim. 74,* 263). The solubilization of lipophilic substances in bile acid salts was shown to be based on the existence of micelles (Eckwall—*Intern. Colloquim. Biochem. Problem. Lipiden 1953,* 103). The presence of bile salts during lipolysis of olive oil lowered initial interfacial tension but did not affect the progress of lipolysis (Bayless *et al.—Congr. intern. biochim. 2e congr., Paris 1952,* 151). In such lipolysis with pancreatic lipase only one fatty acid was liberated from a glyceride, but in the presence of increasing concentration of calcium two and also the last fat acid may be released (Desnuelle & Constantin—*Ibid.* 153). Cationic detergents under definite conditions increased hydrolysis by lipase but the effect was not additive to that of bile salts (Wills—*Biochem. J. 60,* 529). Hydroxamic acids were formed when potassium salts of fatty acids were incubated with pancreatic extracts and adenosinetriphosphate (Ivadi & Pontremoli—*Boll. soc. ital. biol. sper. 31,* 172). Desnuelle & Constantin (*Intern. Colloquim. Biochem. Problem. Lipiden 1953,* 174), Borgström (*Ibid.* 182), and Mattson and Beck (*J. Biol. Chem. 214,* 115) have shown that during lipolysis with pancreatic lipase the stepwise reaction first forms 1,2-diglycerides, then 2-monodiglycerides by hydrolyzing the acids from the two primary-position hydroxyl groups. Some 1-monoglyceride which develops subsequently was attributed to isomerization of the 2-monoglyceride. Bergström's *in vitro* work showed that four times as much 2-monoglyceride formed than 1-monoglyceride and in *in vivo* tests by Harris *et al.* (*J. Clin. Invest. 34,* 685) one-half to two-thirds of the monoglycerides were the 2-compound. The appearance of palmitic acid-C^{14} fed in olive oil to rats randomized between 1,3- and 2-positions among the glycerides in the lymph of the thoracic duct exemplified the same mechanism (Borgström—*J. Biol. Chem. 214,* 671). Another investigation on relation of lymph fat to dietary fat was interpreted to indicate that short-chain fatty acids such as those in butter and coconut oil were completely hydrolyzed and do not appear in the lymph, whereas fats such as olive and sunflower oils seemed to appear in the chyle unchanged (Fernandes *et al.—J. Clin. Invest. 34,* 1026; *Intern. Colloquim. Biochem. Problem. Lipiden 1953,* 201). The route of absorption and transport via lymph of stearic, palmitic, oleic and linoleic acids, administered as acid or glycerides, as traced through C^{14} technique were the same (Borgström *et al.—Biochem. J. 58,* 600; Blomstrand—*Acta Physiol. Scand. 32,* 99; Borgström *et al.—Ibid.* 94). In this series of investigations administered C^{14}-cetyl alcohol was partly oxidized to palmitic acid and as such was incorporated into the lymphatic triglycerides (Blomstrand & Rumpf—*Ibid.* 374). An observation that olive oil and oleic acid were absorbed through the same pathways was discussed with respect to being incompatible with the partition hypothesis of Frazer (Simmonds—*Australian J. Exptl. Biol. Med. Sci. 33,* 25).

A tracing of ingested triglycerides through the glycerol radical has revealed that intestinal mucosa- and lymph-phospholipides arise from resynthesized triglycerides as precursors (Reiser & Dieckert—*Proc. Soc. Exptl. Biol. Med. 87,* 622).

Absorption of administered glycerides was studied with regard to total amount and composition of the lipides in the lymph. Administration of one gram of olive oil per kilogram body weight to normal subjects increased blood lipides 22% within 2–4 hours, and restoration to starting value began at six hours and was complete after eight hours (Berti—*Giorn. biochem. 1,* 50). This increase was due to both glycerides and phosphatides. After a one milliliter olive oil test meal the rate of flow of lymph as well as the concentration of lymph phospholipides and glycerides rose sharply and returned to fasting levels in about 20 hours (Tasker—*Can. J. Biochem. & Physiol. 33,* 361). In this work about 66% of the fat meal was recovered in the lymph and administration of choline had no effect on the factors studied. In another investigation on the interrelations of plasma and lymph lipide fractions during fat absorption, the data were discussed as evidence that phospholipides were synthesized in the intestines and that any in-

crease in cholesterol was a passive association following fat during absorption (Morris—*Australian J. Exptl. Biol. Med. Sci. 32,* 763). When rats were deprived of fat the phospholipides of the serum contained the major portion of the trienoic acids, and the cholesterol esters contained equal amounts of di- and trienoic acids with small amounts of tetraenoic acids (Weise *et al.—Fed. Proc. 14,* 453). When the dogs received 30% of their calories as fat, 3.9% being linoleic acid, the greatest percentage of the tetraenoic acid appeared in the phospholipides whereas the major portion of the dienoic acid was found in the cholesterol esters. Tests were recorded which indicate that dietary unsaturated fatty acids passed through placenta into fetus and also were transferred to milk (Söderhjelm—*Acta. Soc. Med. Upsaliensis 58,* 239).

INTERMEDIATE METABOLISM. Much fundamental data on behavior of lipides in the liver have been recorded. This information could be interpreted on the basis of transport, synthesis, oxidation, utilization of body reserves and other metabolic processes. In reviewing these data as briefly as possible, little or no interpretation will be included.

After birth the liver lipide concentration of young rats increases from 15% to a maximum of 40% after 40 hours (Hedin & Schultze—*J. Nutr. 56,* 129). The inclusion of vitamin B_{12} and to lesser extent of choline and methionine in the maternal rations decreased this rise of liver lipides but did not prevent it. Similar analyses on human newborns who have died confirmed the findings on animals; here, the maximum liver lipides were attained in 3-4 days and the increase disappeared by the 10th day (Reitano—*Riv. pediat. siciliana 9,* 431). A fatty liver disease observed in children of Ceylon was attributed to low protein and high carbohydrate intake (Jayasekera *et al.—Ceylon J. Med. School, Sect. D, 8,* No. 1, 1).

The fatty acid composition of glycerides and phosphatides of the liver have been determined (Clement *et al.—Compt. rend. 240,* 1827). Both types contained practically no trienoic acid; the dominant unsaturated acid of glycerides was monoenoic; acids containing five and six double bonds were present in phosphatides but not in glyceride; arachidonic acid was present to a greater extent in phosphatides; and dienoic acids were present to the same extent in both types of lipides. The liver fat of swine fed a vitamin E deficient diet contained less than normal concentrations of linoleic and pentaenoic acids (Hove & Seibold—*J. Nutr. 56,* 173). Liver and liver fat regeneration in rats after partial hepatectomy was favored by administration of vitamin E (Pacilli—*Ospedale maggiore 41,* 324) or heparin (Baratta—*Giorn. biochem. 2,* 101). Partial hepatectomy was fatal to rats kept for 15 days before surgery on a high-fat, low-protein diet (Belli *et al.—Arch. sci. med. 99,* 149).

Fatty infiltration of liver was observed in laboratory animals when commercial dried egg albumin alone or mixed with casein was fed as the major component (Cahn—*Australian J. Exptl. Biol. Med. Sci. 32,* 819), and on administration of orotic acid (Standerfer & Handler—*Proc. Soc. Exptl. Biol. Med. 90,* 270), certain hydrazino compounds (Yard & McKennis—*J. Pharmacol. Exptl. Therap. 114,* 391), vitamin K (Ciancimino—*Boll. soc. ital. biol. sper. 30,* 912), biotin (Lino —*Congr. intern. biochim. 2e congr., 1952,* 163), methyl thiouracil (Rowinski—*Giorn. biochim. 2,* 135), and adrenocorticotropic hormone (Benda *et al.—Verhandl. deut. Ges. inn. Med. 59,* 218). In tests with antibiotics, aureomycin was antilipotropic and streptomycin was slightly lipotropic (Djourabtschi & Hartmann—*Hoppe Seylers' Z. physiol. Chem. 298,* 193). Testosterone, 5-androstene-3B, 17B-diol, methyltesterone, and hypophyseal growth hormone inhibited ethionine fatty liver (Faber & Segaloff—*J. Biol. Chem. 216,* 471). Fat deposition in the liver caused by injection of adrenocorticotropic hormone and by partial hepatectomy was inhibited by administration of bile acids (Monzen—*Hiroshima J. Med. Sci. 3,* 137). A reduction of liver damage from choline-deficient diets by administration of corticone was believed to be due to increased glycogen deposition induced by the hormone (Kupperman *et al.— Metabolism, Clin. & Exptl. 4,* 50). Administration of glucose had no influence on the accumulation of fat in livers produced by administration of arsenite or phosphorous (Val'des—*Arkh. Patol. 13,* No. 5, 46). Fabre *et al.*—(*Ann. pharm. franc. 12,* 698) cautioned aquatic poultry raisers regarding the dangerous chronic effects that may develop in commercially inducing fatty livers in these fowl with arsenic or phosphorous compounds. They recommend a diet of fat and corn for the purpose.

Elvehjem and co-workers (*J. Biol. Chem. 214,* 677; *J. Nutr. 53,* 469; *54,* 155; *56,* 187; *Proc. Soc. Exptl. Biol. Med. 87,* 544) demonstrated that dietary supplements of equivalent amounts of various amino acids vary in effectiveness and in time of response to lowering liver fat of rats fed a low protein diet containing choline and methionine. Threonine was particularly different from the other lipotropic agents studied for: its response was slow; it was only effective when lysine was also present; the histological effect of its deficiency could be differentiated from that of choline; and it increased oxidation and decarboxylation in the liver when included in a casein ration containing added methionine and tryptophan with or without choline. In other investigations (Shils—*et al.—J. Nutr. 56,* 95; *Proc. Soc. Exptl. Biol. Med. 87,* 629), it was observed that threonine, choline, and vitamin B_{12} do not prevent the portal type fatty livers which develop in rats subsisting on proteins from corn meal, rice, or cassava. DL-tryptophan and L-lysine were effective; but, with methionine present, amounts sufficient to prevent fatty livers inhibited growth. Liver fat was reduced and negative nitrogen balances were decreased in protein depleted rats fed extra threonine when the carbohydrate of the diet was corn, rice or wheat starch, or corn dextrin as compared with liver fat levels of animals on sucrose-containing diets (Womack & Marshall—*J. Nutr. 57,* 193). The differences in lipotropic activity of proteins in regard to different responses, histological effects, etc. observed by Lucas & Ridout (*Can. J. Biochem. Physiol. 33,* 25) were discussed in relation to synthesis of enzymes and lipoproteins, and protein metabolism.

A standardized biological test, with mice as the animals, has been developed for evaluating the activity of lipocaic, the lipotropic material derived from pancreas (Leites & Yakusheva —*Problemy Endokrinol. i. Gormoneterap. 1,* No. 3, 85). An investigation into the mechanism of action of this material has suggested that it concerns the phospholipide exchange and oxidation of fatty acids in the liver (Leites—*Ibid.* No. 1, 71). Another lipotropic substance, inositol, was said to act through improvement of phospholipide synthesis and by stimulating protein catabolism to provide methionine (Hartmann & Gerth— *Naunyn-Schmiedebergs Arch. Exptl. Pathol. Pharmakol. 224,* 322).

Fatty livers and lipotropic substances were also studied *in vitro.* Contrary to *in vivo* experiments fatty livers showed a lower activity for synthesis of fatty acids than normal livers (Bernhart—*Helv. Chim. Acta 38,* 982). Reduced synthesis of fats was also observed in the livers from adrenalectomized rats (Perry & Bowen—*Am. J. Physiol. 180,* 21). A reduced capacity of livers from protein or choline deficient rats to oxidize fatty acids *in vitro* could be obviated by administration of choline to the live animals (Artom—*J. Biol. Chem. 213,* 681) or adding choline-containing phospholipides to the liver (Rodbell & Hanahan—*Ibid. 214,* 595). The reduced power of livers of choline-deficient rats to oxidize fat was less marked when trilaurin had been fed to the animals as the sole fat (Levy— *Congr. intern. biochim. 2e congr. 1952,* 162).

When cholesterol is fed with a fatty-liver producing diet, the amount of cholesterol esters in the liver may increase 200-fold in amount, but they never actually account for more than a small proportion of the total deposited lipides (Ridout *et al.* —*Biochem. J. 58,* 297, 301). Choline, betaine, and vitamin B_{12} were less efficient for removing cholesterol from such livers than they were for the glycerides.

Various phases of biological fat synthesis were studied. Injection of C^{14}-labeled acetate into laboratory animals followed by analysis of the body lipides has indicated that each tissue seems to synthesize fat acids to replace depleted reserves (Favarger & Gerlach—*Helv. Physiol. et Pharmacol. Acta 12,* C70), that synthesis in the muscle goes through three maximums at respectively, 10-40 minutes, 4-6 hours and 12 hours after meals (Ruyssen & Anciaux—*Intern. Colloquim. Biochem. Problem. Lipiden 1953,* 299), and that no compounds intermediate between acetate and higher fatty acids are detectable (Croes & Ruyssen—*Congr. intern. biochim. 2e congr. 1952,* 152). In *in vitro* tests acetate-C^{14} was incorporated into the fatty acids, squalene, sterols, and probably the wax alcohols of scalp skin (Nicolaides *et al.—J. Am. Chem. Soc. 77,* 1535). The observation that the predominant fatty constituent of pasture forage is linolenic acid but in ruminant depot fat and in rumen fat this acid is only a minor constituent has suggested that the rumen contents act as a powerful hydrogenation medium (Shorland *et al.—Nature 175,* 1129). The observation that liver mitochondria and microsomes do not saturate fatty acid and that whole liver is weaker than the cytoplasm in this respect indicated that the desaturation enzyme system of the liver is dispersed in the cytoplasm (Jacob & LeBreton —*Congr. intern. biochim. 2e congr. 1952,* 159). A new green and yellow flavoprotein prepared from pig liver catalyzed the dehydrogenation of fatty acyl derivatives of coenzyme A (Crane & Beinrt—*J. Am. Chem. Soc. 76,* 4491). A newly pro-

posed fatty acid cycle contained thioesters of pantetheine as a participant (Stern—*J. Am. Chem. Soc. 77*, 5194).

Work on the synthesis of milk fat has suggested that the fatty acids are built up from two carbon units and the conversion of glucose to fat involves breakdown to acetate and reconstruction of fatty acids (Popjak—*Intern. Colloquim. Biochem. Problem. Lipiden 1953*, 262). Other work in this series elaborates some of the enzymes and mechanisms involved (Popjak & Tietz—*Biochem. J. 60*, 147, 155). In tests on metabolism of acetate, propionate, butyrate, and β-hydroxybutyrate in the cow udder, the acetoacetate was formed from the last two and this acetate was metabolized to fatty acid like the administered acetate (Peeters *et al.*—*Intern. Colloquim. Biochem. Problem. Lipiden 1953*, 293). In this work the metabolism of the compounds was not influenced by cortisone or insulin. However, such compounds do affect conversion of glucose to fat in the mammary gland (McNaught *et al.*—*Biochem. J. 60*, 102). The sources and pathways of milk-fat synthesis in ruminants was reviewed by Nikitin & Kaplan (*Uspekhi Sovremenoi Biol. 38*, 319).

The body and liver fats of fish increase in unsaturation and decrease in average chain length during spawning, possibly because the longer chained acids are selectively used as energy sources (Zama & Igarashi—*Bull. Japan Soc. Sci. Fisheries 19*, 1087, 1092). Morawa (*Urania, Germany, 18*, 295) has discussed the variation of fat content and metabolism with spawning time of herring, sprat, and cod. In the development of the chick embryo phospholipides decreased between the 10th and 18th day of incubation, sterols rose sharply after the 15th day with a correlating decrease in glycerides, and low-density lipoproteins were characterized by a predominance of triglycerides (Schjeide—*J. Biol. Chem. 214*, 315). Analyses of the lipides of *Musca vicina* during development showed that the lipides increased in the egg and in the third-stage larva but dropped after pupation until the housefly emerged (Levinson & Silverman—*Biochem. J. 54*, 294). The housefly required sterols as the sole essential lipide. In similar work with ascaris eggs, during embryonation and postembryonic survival, the glycerides decreased to 25% of the initial amount present (Fairbairn—*Can. J. Biochem. & Physiol. 33*, 122). Analysis of the egg membrane lipide in this work indicated that it was nearly all unsaponifiable (Fairbairn & Passey—*Ibid.* 130).

The fat content of muscles of swine raised at low altitudes was less than that of those reared on hills or mountains (D'Agostino-Barbaro—*Arch. sci. biol., Italy, 35*, 583). Among mice raised at 4°, 24° and 35°, the former ate more and had less fat, and the latter ate less than the controls (24°) but deposited the same amount of fat (Young & Cook—*Am. J. Physiol. 181*, 72). During fasts in which 18% of the weight of rats was lost there was no loss in muscle fat alhtough unsaturation increased (Pasargiklian & Marazzi—*Arch. sci. biol., Italy, 34*, 41). Developing anemia in rabbits by bleeding or with administration of acetylphenyl-hydrazine reduced the percentage as well as the absolute quantities of linoleic and linolenic acid in the bone marrow (Evans *et al.*—*Am. J. Physiol. 181*, 504, 509). The conclusions were that marrow fat is a storage depot for body energy and the transport system shows a preference for linoleic and linolenic acids. Subcutaneous injection of the detergent, Triton WR-1339, diluted in saline solution into chickens caused lipemia, and repeated injections reduced tibial muscle fat and abdominal depot fat (March & Biely—*Poultry Sci. 34*, 293). Vitamin B_{12} and folic acid additions to chick heart fibroblasts culture medium retarded fat accumulation by the cells although it stimulated growth (Grunbaum *et al.*—*Proc. Soc. Exptl. Biol. Med. 88*, 459). Analyses of rats showed that water represents 72% of the fat-free body mass, completely independent of the magnitude of the fat depots (Babineau & Page—*Can. J. Biochem. & Physiol. 33*, 970).

Grossman & Sloane (*Am. J. Clin. Nutr. 3*, 403) determined some relationships between weight, fat and caloric intake. The loss of body weight during a period of calorie restriction correlated with initial body weight but not with initial fatness.

A survey of the normal acid values of serums showed 7.4–17.5 meq. per liter triglycerides in men and 6.2–12.0 meq. per liter in women (Seckfort & Andres—*Deut. Z. Verdauungs- w. Stoffwechselkrankh. 15*, 49). In absence of pancreas or when certain endocrine functions are impaired, the addition of pancreatic juice into the intestines caused hyperlipemia and high insulin requirement (Dragstedt *et al.*—*Am. J. Physiol. 179*, 439). Administration of pancreatic lipocaic factor to adrenalectomized rats produced hypolipemia (Briskas *et al.*—*J. Physiol., Paris 46*, 269). In administration of insulin the first response was a decrease of blood fat, followed by action on blood sugar, and only in large doses does amino nitrogen fall (Appel & Hansen—*Hoppe-Seylers' Z. physiol. Chem. 297*, 49). The finding that pancreatectomy does not affect oxygen consumption and administration of pancreas extracts produces more ketone bodies has suggested that lipocaic does not influence oxidation of lipides but stimulates making of glucose from ketone bodies (Pittoni & Rossi—*Arch. sci. biol., Italy, 7*, (169). In rats kept on high fat diet, cortisone and hydrocortisone stimulated ketogenesis and neoglucogenesis (Naets & Wittek—*Acta Endocrinol. 19*, 349). Hepatectomy increased lipemia which was clearable by heparin or protamine, suggesting that these are involved in removal and mobilization of lipides (Spitzer—*Am. J. Physiol. 181*, 83). A production of an increase of free fatty acid in serum by heparin was interpreted to indicate that lipolysis with free fatty acid formation plays a role in fat metabolism and transport (Grossman *et al.*—*Proc. Soc. Exptl. Biol. Med. 90*, 106). In other data, heparin was shown to diminish turbidity of lymph, and decrease glycerides, and increase free fatty acids of this fluid (Young & Freeman—*Ibid. 463*). The behavior of natural clearing factor towards various inhibitors has indicated that it might be a new type enzyme which possesses some characteristics of esterase and lipase without being either of them (Overbeek & van der Vies—*Biochem. J. 60*, 665). In a study of lactescence serums, neutral glyceride seemed to be the only lipide associated with the phenomenon and it seemed to be due to presence of fat in concentration above that which was soluble (Albrink *et al.*—*J. Clin. Invest. 34*, 147).

The observation that sodium fluoride inhibits uptake of esters but not free fatty acids by adipose tissue has suggested that transport of acids into the cells involved an enzyme reaction acting on ester linkages (Stern & Shapiro—*Metabolism, Clin. and Exptl. 3*, 539).

A fatty acid oxidation sparing action by carbohydrate was attributed to restricting fat breakdown (Lossow & Chaikoff—*Arch. Biochem. & Biophys. 57*, 23). In this work, administered C^{14}-palmitate was converted in a greater degree to C_{16} and C_{18} fatty acids in carbohydrate fed rats than in fasted rats. Washed liver particles from fat-adapted rats when compared to carbohydrate fed controls showed a defect in octanate oxidizing capacity which may be related to less than optimal concentration of Krebs cycle intermediates in these livers (Tepperman & Tepperman—*Am. J. Physiol. 180*, 511). A stimulatory effect of α-hydroxy acids on fatty acid oxidation in liver preparation was explained on the basis that adenosinetriphosphate is generated by phosphorylation coupled with oxidation of the α-hydroxy acid and the adenosinetriphosphate stimulates the first step of fatty acid oxidation (Emmelot *et al.*—*Enzymologia 17*, 9, 13). Four flavoproteins were said to participate in the dehydrogenation of fatty acyl coenzyme A in pig liver (Crane *et al.*—*Biochim. et Biophys. Acta. 17*, 292). The inhibition of acetoacetate synthesis by various fatty and other organic acids in extracts which are capable of forming acyl coenzyme A from fatty acids was investigated (Avigan *et al.*—*Biochem. J. 60*, 329). The results were consistent with the hypothesis that the various reactions of acetyl-CoA are specifically inhibited by acyl-CoA compounds and that these inhibitory effects influence the kinetics of fatty acid oxidation to acetoacetate and carbon dioxide. Livers from vitamin B_{12}-deficient rats contained subnormal amounts of cytochrome oxidase but the other oxidase systems were not affected (O'Dell *et al.*—*J. Biol. Chem. 217*, 625). Ultraviolet light irradiated methyl linolenate or ascorbic acid inhibited several of the enzymes that are involved in fat oxidation (Ottolenghi *et al.*—*Arch. Biochem. & Biophys. 56*, 157). In presence of liver slices or cysteine the uptake of oxygen by ascorbic acid was greatly retarded while formation of carbon dioxide from palmitic acid was almost normal (Geyer *et al.*—*Ibid.* 549). In the oxidation of fats in the tail skin of a rat, adrenocortotropic hormone, adrenaline, or exposure to cold had an effect similar to that of adrenal sterols (O'Conner—*Am. J. Physiol. 181*, 89).

PHOSPHOLIPIDES. Analyses of brain tissue of animals have indicated that 50% of the phospholipides and most of the cholesterol are in combination with brain tissue protein (Nedzvetskii & Ratnitskaya—*Biokhimiya 19*, 677). The inositol content of cerebrospinal fluid is three times that of serum (Herken & Maibauer—*Klm. Wochschr. 32*, 1113). The data from this work were interpreted to indicate that brain tissue was involved in inositol metabolism.

In work on lecithin metabolism in the liver it was observed that: lecithin and lysolecithin in the presence of coenzyme A stimulated oxygen uptake of liver mitochondria; phosphorylcholine was incorporated as an intact unit into lecithin; and phosphorylcholine had no influence on palmitic oxidation or inclusion into lecithin (Rodbell & Hanahan—*J. Biol. Chem.*

214, 595, 607). These results were discussed with regard to possible routes of synthesis of lecithin in the liver. An enzyme, glycerokinase, from rat liver, which catalyzes the phosphorylation of glycerol to form L-α-glycerophosphate was concentrated 170 fold and its properties were established (Bublitz & Kennedy—*Ibid. 211*, 951). Experimental data were presented which demonstrate that lecithin, cephalin, sphingomyelin, and cerebroside are either oxidized by rat liver enzymes or act to stimulate respiration in these systems (Marinetti & Stotz—*Ibid. 217*, 745).

A study of phosphorous metabolism in regenerating prostate has shown that, as in regenerating liver, mitotic activity is associated with maximum phosphorus uptake in the phospholipides (Levin *et al.—Arch. Biochem. & Biophys. 56*, 59). Cortisone administration increased phospholipides in plasma and liver but did not affect aortic lipid fractions; whereas epinephrine increased incorporation of phosphorus in the aorta (Dury & DiLuzio—*Am. J. Physiol. 82*, 45).

Phospholipides are synthesized by the lactating gland and are also taken up there from the plasma and degraded (Garton—*Biochem. J. 61*, 402). Lecithin, cephalin, total lipide choline and free cholesterol decreased in residual yolk during incubation of an egg; at the same time there was a gradual increase of these in the embryo (Tsuji *et al.—Arch. Biochem. & Biophys. 56*, 290).

An analytical investigation on inositol phospholipide from soybean oil dealt primarily with establishing the structure (Okuhara & Nakayama—*J. Biol. Chem. 215*, 295). Pure phosphatidyl ethanolamine was prepared from soybean phosphatides (Scholfield & Dutton—*Ibid. 214*, 633).

CHOLESTEROL. Two surveys on adult women have shown that their serum cholesterol levels increase to a maximum at about the 6–7 decade of life and then decline (Swanson *et al.—J. Gerontol 10*, 41; Garcia—*J. Nutr. 55*, 601). In one of these it was also observed that absorption of fat increases with age. Urban Central Americans, who generally eat a low fat vegetable diet, have lower serum cholesterol levels than the urban citizens or North Americans and are usually leaner even though their caloric intake is 10% above National Research Council recommendations (Mann *et al.—Am. J. Med. 19*, 25). This lower cholesterol level was believed to be due to a high energy turnover.

The reports on absorption of cholesterol as influenced by diet are not completely in agreement. Such work by Ivy and his co-workers (*Proc. Soc. Expt. Biol. Med. 89*, 422; *Am. J. Physiol. 171*, 302; *179*, 646; *181*, 439; *183*, 86) have indicated that: increasing amounts, 50–192 mg. per rat, increased cholesterol absorption until 90 mg. per day was being absorbed, additional dietary cholesterol did not increase absorption; presence of oleic acid but not corn oil or triolein facilitate absorption and increased serum cholesterol levels; dihydrocholesterol and soybean sterols were also absorbed when fed with oleic acid; and mineral oil increased excretion of cholesterol. Mineral oil probably increased the excretion possibly through solvation and partly by laxation. Keys *et al.* (*Clin. Chem. 1*, 34) recorded that absorption and serum levels of cholesterol were increased by increased amounts of fats in the diet. Swell *et al.* (*Am. J. Physiol. 180*, 124) reported that the higher the unsaturation of dietary fat the greater was its capacity of inducing higher serum cholesterol, and that free fatty acids were more effective than glycerides. The fat was said to work by stimulating bile flow and provide the fatty acid necessary for cholesterol esterification. In a test on young men, a diet of which 57% of the calories came from fat as provided by pemmican did not increase serum cholesterol or vary the serum lipoprotein fraction (Mann—*Am. J. Clin. Nutr. 3*, 230). However, other workers reported that a switch from animal fats to vegetable fats reduced serum cholesterol, phospholipide, and lipides in general (Kinsell—*Modern Nutr. 7*, No. 9, 6; Kinsell & Michaels—*Federation Proc. 14*, 661) or that diets high in vegetable fat reduced the serum lipides (Beveridge *et al.—J. Nutr. 56*, 311). Shapiro & Freedman (*Am. J. Physiol. 181*, 441) suggest that the effect was from the essential fatty acids. Several groups of investigators (Best *et al.—Am. J. Med. 19*, 61; Willinson *et al.—Metabolism 4*, 320; Schaefer *et al.—Federation Proc. 14*, 449; Chaikoff & co-workers—*Proc. Soc. Exptl. Biol. Med. 87*, 541; *Arch. Biochem & Biophys. 58*, 373) recorded data showing that vegetable sterols or dihydrocholesterol blocked absorption of cholesterol or inhibited hypercholesterolemia. Ivy and his co-workers (*Am. J. Physiol. 183*, 79) have shown that these sterols are absorbed and have suggested that their blocking of cholesterol absorption was due to competition for the total capacity of the sterol absorptive mechanism.

Cook *et al.* (*Biochem. J. 61*, 657, 671, 676; *Congr. intern. biochem. 2e congr. 1952*, 122, 123) reported that rats on high olive oil diets with or without cholesterol excrete lipides containing 80–90% steam volatile (C_2–C_6) fatty acids which seem to balance with losses of cholesterol. In this work the pure cholesterol fed with olive oil did not increase plasma cholesterol, whereas cholesterol in eggs caused a transient increase.

The behavior of cholesterol was studied with regard to pancreatic secretions and lipotropic substances. Pancreatic esterase enzymes were most active in hydrolysis of short chain acids from cholesterol esters and most active in its esterification with long-chain acids. The cholesterol esters of shorter chain acids were more readily absorbed possibly because of this difference (Swell *et al.—J. Biol. Chem. 212*, 141; *Am. J. Physiol. 180*, 129; *181*, 193; *Arch. Biochem. & Biophys. 59*, 393). Removal of pancreatic juice from the intestines was said to inhibit capacity of the intestines to esterify cholesterol and also its absorption in one report (Hermandez *et al.—Am. J. Physiol. 181*, 523) and was said to have little effect upon subsequent cholesterol absorption in another (Byers & Friedman—*Am. J. Physiol. 182*, 69). Administration of DL-ethionine to dogs resulted in prompt reduction of serum fatty acids, phospholipides, cholesterol, and high density proteins (Feinberg *et al.—Science 120*, 317). Other experiments with several lipotropic substances have failed to support a view that lipotropic materials reduce the concentration of bound cholesterol in the serum (Ridout *et al.—Biochem. J. 58*, 306; Wilkinson—*J. Am. Geriat. Soc. 3*, 381).

Hypercholesterolemia was induced in laboratory animals by injection of carbon tetrachloride (Saka *et al.—Bull. fac. med. Istanbul. 18*, 192), feeding of potassium iodide (Homer—*Proc. Soc. Exptl. Biol. Med. 88*, 354), and injection of the surface active agent Tween 80 (Morris & Courtice—*Quart. J. Exptl. Physiol. 40*, 149); it was depressed by injections of sodium salts of malonate and arsenite (Mookerjea & Sadhu—*Arch. Biochem. & Biophys. 58*, 232); and inhibited by insulin in provoked cholesterolemia (Agid—*J. Physiol., Paris 46*, 223). Treatment of young rats with testosterone propionate on alternate days caused a rise in total cholesterol in the testes (Kar & Roy—*Acta. Endocrinol. 18*, 267). Vitamin A deficiency had no effect on cholesterol levels of the plasma and liver of the rat (Green *et al.—Biochem. J. 61*, 447). Rats maintained on extra-cholesterol diet were resistant to carcinogenic doses of *p*-dimethylaminoazobenzene (Clement *et al.—Arch. sci. physiol. 8*, 259). An observation that the cholesterol content of muscle of young is high has suggested that it has some metabolic or structural function in the muscle rather than being a depot (Del Vecchio *et al.—Proc. Soc. Exptl. Biol. & Med. 90*, 449).

Several investigations pertained to the role of liver in cholesterol metabolism. Studies on plasma and liver cholesterol relationships have indicated that the hepatic reticuloendothelial system is not involved in synthesis or disposition of endogenously derived cholesterol but only in the disposition of dietary derived cholesterol (Friedman *et al.—Circulation 10*, 491). The turnover of injected cholesterol-1-C^{14} in normal rats was about 60 hours; with exclusion of liver from circulation the turnover of total cholesterol from plasma ceased abruptly (Hotta & Chaikoff—*Arch. Biochem. & Biophys. 56*, 28). Removal of liver from dogs prevented almost completely the appearance of C^{14}-cholesterol in the plasma after injection of C^{14}-acetate (Eckes *et al.—J. Lab. Clin. Med. 46*, 359). The hepatectomized dogs metabolized C^{14}-acetate at the same rate as controls, and it was used in the synthesis of cholesterol in the intestines, kidney, lung, and skin. Techniques using injected C^{14}-acetate were also used in the study of cholesterol metabolism of patients (Gould *et al.—Ibid.* 372).

Livers of high-fat diet adapted rats synthesized cholesterol at an accelerated rate although glycogenesis and fat synthesis was depressed (Whitney *et al.—Am. J. Physiol. 181*, 446). Liver homogenates from starved and vitamin A deficient rats were unable to synthesize cholesterol and even when added to normal rat livers they inhibited the synthesis; thus indicating that an inhibitor factor may be involved (Migicovsky—*Can. J. Biochem. & Biophys. 33*, 135; Migicovsky & Wood—*Ibid.* 858). *In vitro* synthesis of both fat and cholesterol required divalent ion, particularly calcium; bicarbonate media favored fatty acid synthesis; whereas high potassium ion media containing phosphate favored cholesterogenesis (Lyon *et al.—J. Biol. Chem. 217*, 757).

A study of biosynthesis of C^{14}-cholesterol and of the radioactive companion substances in time experiments and in different tissues of rats, guinea pigs, and fish injected with C^{14}-acetate has been recorded (Schwenk *et al.—Arch. Biochem.*

& Biophys. 58, 37). Minced aortas synthesize cholesterol at rates ranging from 1 to 69% of that of liver (Eisley & Pritham—*Science 122,* 121). In this work it was shown that aorta was able to synthesize cholesterol without added acetate. Sclerotic aorta tissue produced in rabbits by high cholesterol diets converted C^{14}-acetate to fatty acids, non-saponifiable lipides and carbon dioxide to the same extent as normal arterial tissue; but the cholesterol feeding reduced hepatic lipogenesis as well as hepatic cholesterogenesis (Feller & Huff—*Am. J. Physiol. 182,* 237).

Degradation of cholesterol biosynthesized from C^{14}-acetate has indicated that 19 of the 27 carbon atoms were derived from either the methyl or carboxyl carbon of acetate (Block —*Intern. Colloquim. Biochem. Problem. Lipiden 1953,* 281). In this work it was also demonstrated that acetate enters into the endogenous synthesis of squalene and that the latter was a precursor for cholesterol. Other work has shown that various branch chain acids are utilized in the biosynthesis of cholesterol and squalene (Block *et al.—J. Am. Chem. Soc. 76,* 3859; *J. Biol. Chem. 211,* 687; Rabinowitz *et al.—Federation Proc. 14,* 760). Yeast grown in media containing C^{14}-acetate contained sterols and squalene which when fed to rats were converted into cholesterol (Schwenk *et al.—Arch. Biochem. & Biophys. 55,* 274). The application of squalene to the skins of young mice increased the concentration of both D^7-cholestenol and cholesterol in the epidermis (Kandutsch & Baumann—*Ibid. 56,* 356).

The conversion of cholesterol to pregnenolone in bovine adrenal homogenates was interpreted to supply the missing link in the sequence of the reactions: cholesterol → pregnenolone → progesterone → 17-hydroxyprogesterone → 17-hydroxydeoxycorticosterone → hydroxycorticosterone (Saba *et al.—J. Am. Chem. Soc. 76,* 3862). However, the conversion of cholesterol to progesterone was also doubted (Saba & Hechter—*Federation Proc. 14,* 775; Lynn *et al. Ibid.* 783). The rates of incorporation of acetate and cholesterol into cortical steroids by hog adrenal preparations were recorded (Bligh *et al.—Arch. Biochem. & Biophys. 58,* 249). Cholesta-3,5-dien-7-one is formed in arteriosclerotic aorta and other tissues in small amounts on excessive cholesterol feeding (Kantiengar & Morton—*Biochem. J. 60,* 28, 30, 31, 34). The compound formed is also metabolized. Cholestenone injected into the intact rat is not metabolized (Fish & Hickey—*J. Biol. Chem. 213,* 325).

New tests have indicated that the chief pathway of catabolism of cholesterol involves its oxidation to bile acids, and it is as bile acids that cholesterol is eliminated both in the bile and feces (Siperstein & Chaikoff—*Federation Proc. 14,* 767). Thyroid hormone stimulated degradation of cholesterol and in particular its conversion to acidic products (Weiss & Marx —*J. Biol. Chem. 213,* 349). Aqueous extracts of beef adrenals, ovary, testis and liver degrade the side chain of cholesterol to give up to 5% yield of isocaproic acid (Lynn *et al.—J. Am. Chem. Soc. 76,* 4048).

LIPIDES UNDER DISEASED STATES. In the course of the history of clinical study of coronary artery diseases and hypertension clinical laboratory criteria involved determination of degree of hyperlipemia and/or cholesterolemia, and amount abnormal lipoproteins as measured by fractionation with an ultracentrifuge. During the past year the most common technique was measurement of the β-lipolipoprotein content by paper electrophoresis. Several investigators have described and demonstrated such techniques (Boyd—*Biochem. J. 58,* 680; Trautman—*Arch. Biochem. & Biophys. 53,* 85; Gottfried *et al.—J. Lab. Clin. Med. 44,* 651; Vargues—*Compt. rend. 240,* 1583; Halasz & Krehl—*Yale J. Biol. Med. 27,* 119; Voigt & Schrader—*Klin. Wochschr. 33,* 465; Bansi *et al.—Ibid.* 101; Fasoli—*Boll. soc. ital. biol. sper. 28,* 603; Lorenzini *Plasma, Milano, 2,* No. 4, 9 pp.; Martiis & Ricci—*Boll. soc. ital. biol. sper. 30,* 1343; Rebeyrotte—*Bull. soc. chim. biol. 36,* 1617; Reinis—*Casopis Lekaru Ceskych. 93,* 497). In the demonstration of the method in normal, arteriosclerosis diseased states, and in induced hypercholesterolemia it was shown that the β-lipoproteins increase correlate to increases in serum total lipides and cholesterol esters. Other less used methods of studying liproprotein fractions were based on differences in solubilities of their metal salts (Russ & Raymunt—*Circulation Res. 3,* 194), differences in extractabilities with solvents (Scanu & Schiano—*Riv. ist. sieroterap. ital. 29,* 276, 457), and paper chromatography (Kaufmann & Schmidt—*Fette u. Seifen 57,* 666). Atherosclerotic subjects as compared to normal individuals also have higher levels of fatty acids in their blood and lower levels of di- and tetraenoic acids (Hammond & Lundberg—*Arch. Biochem. & Biophys. 57,* 517). Administration of β-lipoproteins to animals induced the formation of antibodies (Grant & Berger—*Proc. Soc. Exptl. Biol. Med. 86,* 779; Korngold & Lipari—*Science 121,* 170). This observation has suggested that the β-lipoproteins may also be detected by a serological test (Morrison *et al.—Am. J. Dig. Dis. 22,* 234).

Various analytical surveys were made of serum lipides and were correlated with age, sex and particularly diseased states. The cholesterol and cholesterol/phospholipide ratio of Yemen Jews and Arabs of Israel were low compared to European Jewish immigrants (Brunner *et al.—Harefuah 48,* 1). These data were discussed with regard to the rarity of atherogenesis and mycocardial infarction in the Yemen Jews and Arabs. South African Bantu natives who subsist on a low-fat diet have significantly lower serum cholesterol concentrations after the age of 40 and lower atherosclerosis and coronary heart diseases than Bantu who consume an European diet, Americans, or Danes (Walker & Arvidsson—*J. Clin. Invest. 33,* 1356). The amount of cholesterol and the cholesterol/phospholipide ratio in the serums were recorded in normal individuals as compared to individuals with arteriosclerotic diseases (Vulterini *et al.—Il. Policlinico. Sez. Prat. 58,* 1565; Labecki—*J. Clin. Nutr. 3,* 132), and with hypertension, some pneumo pathies, carcinoma, posthepatic syndromes, cholangitis, and infectious polyarthritis (Maresova *et al.—Vnitrni Lekarstvi 1,* 209). These diseases cause deviations from normal on those measurements. Much pre- and postmortem total and free cholesterol data for normal and diseased states have been measured to serve as fundamental clinical information (Merkel—*Frankfurt Z. Path. 64,* 312).

Many data on various fractions of lipoproteins in the serum of humans as determined with the ultracentrifuge were recorded and discussed in relation to age, sex, and diseased states (Gofman *et al.—Am. J. Med. 17,* 514; *J. Gerontol. 9,* 395, 404; Eiber *et al.—Bull. N. Y. Acad. Med. 30,* 719; *J. Am. Geriat. Soc. 3,* 367; Ackerman *et al.—Proc. Soc. Exptl. Biol. Med. 88,* 447). Such data for human serum were also compared with that of the dog, rat, rabbit, and chicken (Hillyard *et al.—J. Biol. Chem.* 214, 79). A β_1-lipoprotein found in the chylomicron layer of ultracentrifuge serums was so laden with lipides that it had lost its characteristic density (Hunter—*Proc. Soc. Exptl. Biol. Med. 88,* 538).

Lipoprotein fractionations made by electrophoresis were reported on human serums (Spain *et al.—Am. J. Med. Sci. 229,* 294; Pope—*Ibid.* 34; Adlersberg *et al.—Clin. Chem. 1,* 18) and on serums of several animal species (Bossak *et al.—Proc. Soc. Exptl. Biol. Med. 87,* 637; Morris & Coutrice—*Quart. J. Exptl. Physiol. 40,* 127, 138). The so-called β-lipoproteins, which are characterized as inducing turbidity, and in electrophoresis studies as having a low mobility, were related to lipemia and cholesterolemia, and were considered denatured proteins (Gottfried *et al.—Clin. Chem. 1,* 253). When such serum proteins from rabbits were injected into normal rabbits, the protein regenerations in the heart, liver, and kidney cortex were disturbed (Kritsman *et al.—Biokhimiya 19,* 557).

The relation of nutrition to atherosclerosis has been the subject of various comments. Kummerow (*J. Dairy Sci. 18,* 1403) remarked that since either an inadequate diet or unbalanced hormone therapy has always been necessary to induce experimental atherosclerosis, a balanced diet should best serve in its prevention. Such a diet would contain cholesterol from animal fats because milk, eggs, and meat serve as the best sources of essential nutrients in balanced diets. The hypothesis which suggests that atherosclerosis arises from malnutrition has been questioned by van Handel (*Am. J. Dig. Dis. 22,* 206). Low fat diets in such coronary artery disease were said to prolong life (Morrison—*J. Am. Med. Assoc. 159,* 1425) and reduce symptoms (Kuo & Joyner—*Ibid. 158,* 1008). Langdon (*Am. J. Clin. Nutr. 3,* 84) has suggested that there was a possibility that atherosclerosis could be prevented if it were feasible to lower the plasma cholesterol level to values now regarded as subnormal.

In research work pertaining to atherosclerosis the effect of various factors on inducing the disease itself, or merely inducing associated phenomena such as lipemia, cholesterolemia, abnormal lipoproteins, etc. were studied. Severe caloric restriction enhanced cholesterol absorption and induced atherosclerosis in rabbits (Golden *et al.—Proc. Soc. Exptl. Biol. Med. 87,* 105). Cholesterol was less atherogenic when administered to rabbits in fatty oil than without oil (Kritchevsky *et al.—Arch. Biochem. & Biophys. 59,* 526). The suitability of using high-fat protein diets to obtain a reduction of cholesterol in atherosclerosis was questioned because of lack of palatability (Kinsell & Michaels—*Am. J. Clin. Nutr., 3,* 247). The hypercholesterolemia response of cholesterol feeding was inhibited by feeding high levels of essential fatty acids and supplementation with methionine (Shapiro & Freedman—*Am. J. Physiol. 181,* 441). The observation that essential fatty deficiency in

the diabetic animal and essential fatty acid deficiency intensified by dietary cholesterol in the non-diabetic animal were similar has suggested that atherosclerosis is an expression of deficiency or faulty metabolism of essential fatty acids (Peifer & Holman—*Arch. Biochem. & Biophys. 57,* 520). The hypercholesteremia of elderly atherosclerotic and extremely obese individuals was not affected by weight reduction unless dietary fat was severely restricted (Pomeranze *et al.—Circulation 10,* 742). Treating rabbits with excessive vitamin D increased cholesterol content of the blood and caused deposits of calcium to appear in the aorta (Gaglio—*Atti. soc. ital. cardiol. 15° Congr. 1954,* 284). In other experiments it was shown that vitamin A increased serum cholesterol and neutral fat levels and that vitamin D increased serum cholesterol (Depisch—*Wien. Z. inn. Med. 34,* 89). Administration of cholic acid with cholesterol to rats caused marked hyperlipemia but no atherosclerotic changes occurred in 50-day tests (Mendoza *et al.—Rec. clin. espan. 56,* 159). Tests on rabbits, in which cholesterol, lathosterol, 7-dehydrocholesterol, and cholestanol, respectively, were administered with olive oil have shown that all these were active agents in the production of atheroma (Cook *et al.—Arch. Biochem. & Biophys. 52,* 439). Dihydrocholesterol produced as severe an arteriosclerosis in birds as did cholesterol (Nichols et *al.—Proc. Soc. Exptl. Biol. Med. 89,* 609). Feeding of cream to rabbits increased neutral fat, phospholipides and cholesterol blood levels but did not produce abnormal deposition of cholesterol and wasting as seen on administration of cholesterol (Hirsch & Nailer—*Arch. Pathol. 59,* 419). Heat stress favored aortic atherosclerotic plaque formation in rabbits (Soderman & Logue—*J. Lab. Clin. Med. 46,* 954). The effect of cholesterol feeding on the distensibility and resistance to collapse of rabbit aortas has been measured (Nichol—*Can. J. Biochem. & Physiol. 33,* 507).

Experimental results concerning the prophylaxis of atherosclerosis and associated blood abnormality were published. One series of tests on rabbits and humans has shown that ascorbic acid, thyroxin and testerone propionate lower blood cholesterol; whereas vitamin D and phenamine caused increases (Myasnikov—*Klin. Med. U.S.S.R. 32,* No. 6, 9). Oral administration of nicotinic acid decreased serum cholesterol particularly in hypercholesterolemia (Altschul *et al.—Arch. Biochem. & Biophys. 54,* 558). The results with lipotropic substances were not wholly in agreement. Diaz (*Anales fac. farm. y bioquim. y bioquim. Univ. nacl., Lima, 4,* 299) reported obtaining a reduction of the cholesterol levels in rabbit serums with lipocaic. Labecki *et al.* (*Am. J. Clin. Nutr. 3,* 141) reduced cholesterol levels in a group of patients with myocardial infarction with a mixture of choline, methionine and inositol; this mixture had no effect in a normal group. Data by Jackson *et al.* (*Ann. Internal. Med. 42,* 583) indicated that choline and inositol had no effect on plasma cholesterol and phospholipide levels, or on the symptoms of angina pectoris. Work by Ravera & Bonzano (*Inform. med. Genoa 5,* 303) on rabbits fed cholesterol has indicated that choline was effective in inhibiting aortic lesions only when fed with the cholesterol. Wilgram *et al.* (*Proc. Soc. Biol. Med. 89,* 476) also noticed that the effect of choline depends on the procedure used. They found that choline in the diet may intensify certain cardiovascular lesions even at low cholesterol levels, whereas other types of cardiovascular lesions may result from a choline deficiency.

A study of synthesis of phospholipides has indicated that those of the aorta were practically all synthesized by the tissue rather than being deposited from the plasma (Shore *et al.—Am. J. Physiol. 181,* 527). Rabbits maintained on atherogenic diet had a marked increase in the capacity of incorporating radioactive phosphate into the phospholipides of the aorta, plasma, and liver (Zilversmit *et al.—Proc. Exptl. Biol. Med. 89,* 48). When adenosinetriphosphate was administered to rabbits with cholesterol there occurred increases in serum total lipides, phosphatides, and cholesterol, but no atheromatous lesions developed (Gambassi & Maggi—*Boll. soc. ital. biol. sper. 28,* 1493). Administration of adrenaline caused significant changes in lipide fractions of the serum and liver but did not alter the concentrations in the aorta (Dury—*Proc. Soc. Exptl. Biol. Med. 89,* 508). Pilgeram (*Federation Proc. 14,* 723) and Pilgeram & Greenberg (*Science 120,* 760) related the susceptibility of various species of animal to atherosclerosis to their inability to convert phosphatidyl ethanolamine to phosphatidyl choline.

When cholesterol-fed rabbits were returned to a normal diet, the total cholesterol content of the aorta did not seem to decrease over a six-month period (McMillan *et al.—Arch. Pathol. 59,* 285).

Estrogen suppressed atherogenesis in cholesterol fed roosters (Stamler *et al.—Circulation 10,* 251). Other studies with chickens have indicated that estrogens may be significant in the relative immunity of premenopausal woman to atherosclerosis (Stamler—*Proc. Inst. Med. Chicago 20,* 17). Cholesterol feeding produced less marked atherogenesis in ovariectomized female rabbits than intact controls (Mininni *et al.—Circulation Res. 3,* 191). Estrogen prophylaxis of experimental cholesterol-induced coronary atherogenesis in cockerels was unimpaired by hyperadrenalism and the steroid diabetes produced by certain hormones (Stamler—*Circulation 10,* 247). One study has indicated that administration of adrenal hormones with cholesterol to rabbits reduced development of atherosclerosis (Wang *et al.—Endocrinology 56,* 628) but another study indicated increasing aortic lesions with increasing amounts of adrenaline (Dury & Moss—*J. Gerontol. 9,* 287). Israel (*Am. J. Digest Dis. 22,* 161) recommended use of thyroid hormone in coronary disease and illustrated its harmlessness. Prolonged treatment with testerone propionate inhibited the hypercholesterolemia and the atherosclerosis brought about in rabbits, by feeding cholesterol (Fabbrini & Vallerini—*Rass. fisopatol. clin. e. terap., Pisa, 25,* 457).

The abnormal lipoprotein associated with atherosclerosis and in some cases atherosclerosis itself were suppressed by heparin in many investigations (Rossi—*Folia Cardiol. 12, Suppl. 1954,* 286; Rizzi *et al.—Ibid.* 288, 293; Pescador *et al.—Rev. clin. espan. 56,* 15; Reinis & Hrabane—*Casopis Lekaru Ceskych. 94,* 195; Inderbitzen—*Schweiz. med. Wochschr. 85,* 675; Gibert-Queralto—*Med. espan. 32,* 58; Lindgren *et al.—J. Phys. Chem. 59,* 930; Cairns & Constantinides—*Can. J. Biochem. & Physiol. 33,* 530; David *et al.—Circulation Res. 3,* 374). In some of these studies the effect of estrogen, adrenaline, testosterone, pituitary extracts, andenosine-triphosphate on this action of heparin were recorded. The action of heparin in clearing abnormal lipoproteins was attributed to giving rise to factors effecting hydrolysis of triglycerides with liberation of fatty acids (Gordon *et al.—J. Clin. Invest. 34,* 477). *In vitro* tests have shown that oleic acid clears the lipoproteins that migrate slowly in paper electrophoresis (Laurell—*Scand. J. Clin. & Lab. Invest. 7,* 28). A heparin-like clearing action on β-lipoprotein was also demonstrated with lipoprotein lipase (Korn—*J. Biol. Chem. 215,* 1; Brown *et al.—Clin. Chem. 1,* 83).

Hypertension and cholesterol levels of cholesterol fed animals were reduced with thiocyanates (Litvak & Sosnina—*Terap. Arkh. 26,* No. 3, 30) and ultraviolet irradiation (Altschul—*Geriatrics 10,* 208). Some improvement in atherosclerotic and vascular diseased patients was obtained by intravenously injecting the chelating agent disodium ethylenediamine-tetraacetate to dissolve the vascular calcium deposits (Clarke *et al.—Am. J. Med. Sci. 229,* 142).

Ultracentrifuge analyses of serum lipoproteins in nephrotic syndrome rats revealed a greatly increased concentration of lower density fractions (Lewis & Heymann—*Proc. Soc. Exptl. Biol. Med. 86,* 766). In nephrotic syndrome patients the amount of cholesterol bound to globulin was higher (Vulterini *et al.—Riv. ist. sieroterap. ital. 28,* 42). Less hyperlipemia occurred in nephrotoxic renal disease when bile was absent or after partial hepatectomy (Heymann & Hackel—*Metabolism. Clin. & Exptl. 4,* 258). Nephrotic and control rats exhibited the same fecal excretion of cholesterol as well as total lipides; hence, nephrotic hypercholesterolemia and hyperlipemia could not be ascribed to diminished intestinal excretion of these substances (Byers—*Am. J. Physiol. 182,* 73). Studies on metabolism of fats with labeled acetate technique have indicated that nephrotic hyperlipemia resulted from mobilization from depots (Marsh & Drabkin—*J. Biol. Chem. 212,* 623). Administration of heparin had no effect on the hyperlipemia of nephrotic patients (Nikkilä & Gräsbeck—*Acta. Med. Scand. 150,* 39).

In a survey on provoked hyperlipemia in diseases, highest values were obtained in atherosclerotic patients, high increases were evident in diabetics with arthritis and obesity patients having vascular impairments; whereas diabetics and obesity patients devoid of vascular complications showed little response to provoked hyperlipemia as do normal controls (Camlin *et al. Presse med. 62,* 1124). The appearance of β-proteins in the serum in biliary cirrhosis, obstructive jaundice, and acute hepatitis has been related to loss of the liver synthesis capacity (Eder *et al.—J. Clin. Invest. 34,* 1147).

The abnormal lipoproteins in diabetic patients have been measured in ultracentrifugal studies (Hanig & Lauffer—*Diabetes 1,* 447; Barach & Lowry—*Ibid.* 441; Keiding *et al.—Ibid.* 434). The deviation from normal was greatest where the cardiovascular system also showed some involvement. Administration of heparin produced a reduction in these abnormal serum lipoproteins (Engleberg *et al.—Ibid.* 425). Therapeutic control of diabetes reduced the hyperlipemia of diabetic pa-

tients (Kaeding—*Deut. Z. Verdauungs- u. Stoffwechselkrankh. 15,* 18; Kolb *et al.—Metabolism, Clin. & Exptl. 4,* 310). High vegetable fat diets in diabetics induced normal plasma cholesterol levels (Kinsell *et al.—Geriatrics 10,* 67) and accelerated removal of glucose from the blood (Sergeeva—*Arkh. Patol. 17,* No. 3, 59). In alloxan diabetes dietary fat afforded protection against the diabetogenic and toxic action of the drug (Nieman—*Am. J. Physiol. 181,* 183). Adding a fat to diets reduced the development of the ketonuria that occurs in diabetes (Perkoff & Rosecan—*Metabolism, Clin. & Exptl. 4,* 214). Prolactin reduced serum lipide abnormalities in experimental diabetes (Fasoli *et al.—Proc. Soc. Exptl. Biol. Med. 88,* 477); whereas anterior pituitary growth hormone intensified the hypercholesterolemia and glycosuria in diabetes induced in dogs by removing the pancreas (*Ibid. 87,* 167). The lipides in the urine of two diabetic patients with chyluria contained ketalphosphatides (Allegretti & Fister — *Deut. Z. Verdauungs- u. Stoffwechselkrankh. 14,* 209).

Studies of serum lipides in relation to carcinoma and tumors have shown that women with advanced carinoma of the breast have about 66% as much plasma α-lipoprotein as found in normal women (Barclay *et al.—Cancer 8,* 253). Many cancer patients showed high cholesterol content of the serum which was related to the amount of cholesterol in the tumor (Lachapele—*Bull. assoc. franc. etude cancer 41,* 75). Inoculation of "Walker tumor 256" in rats decreased the total body neutral fat content whereas the phospholipides and cholesterol increased (McEwen—*Proc. Can. Cancer Res. Conf. 1954,* 1, 141). 6-β-Hydroperoxy-4-cholesten-3-one, an oxidation product of cholesterol, was found to be carcinogenic (Feiser *et al.—J. Am. Chem. Soc. 77,* 3928). Sarcomas were induced in mice by repeated injections of purified cholesterol (Hieger & Orr—*Brit. J. Cancer 8,* 274).

Other surveys of blood in patients have shown that serum cholesterol contents were abnormal in epilepsy (Franchini—*Neurone 2,* 177) and rheumatic diseases (Isemein & Lallemand —*Rev. Rhum. 20,* 685). The serum lipoprotein fractions deviate from normal in the plasma of patients with skin diseases (Lever—*Hautarzt 4,* 426), myelomatosis (Lewis & Page—*Am. J. Med. 17,* 670), and experimental xanthomatosis (Lorenzini —*Giorn. Biochem. 1,* 203). The essential fatty acid content of blood was not abnormal in pigs with parakeratosis (Hvidsten *et al.—Proc. Soc. Exptl. Biol. Med. 89,* 454). The unsaturated fatty acid content of the blood was subnormal in a minor portion of patients with allergic rhinopathies (Clerici—*Arch. ital. otol. rinol. e laringol Suppl. 13,* 158). The blood lipides of patients with follicular and radicular cysts were within the normal range (Amorati—*Riv. ital. stomatol. 8,* 246). The blood cholesterol levels of patients with pyorrhea were within the range of normal controls (Armenio & Chicco—*Boll. soc. ital. biol. sper. 28,* 1804). In infectious mononucleosis there was a reduction in high density lipoprotein fraction (Rubin—*Am. J. Med. 17,* 521). Total blood lipides and glycerides were exceedingly high in the kidney diseases, idiopathic glomerulonephrosis and mixed glomerulonephrosis (Corsini—*Rass. fisiopatol. clin. e terap. 26,* 675). In hemorrhagic lipemia there was an increased mobilization of lipides, a block in the metabolism of lipoproteins, and a decreased capacity of albumin to accept and transport fatty acids (Spitzer & Spitzer—*J. Lab. & Clin. Med. 46,* 461). In pantothenate deficiency hypercholesterolemia occurs when fat is present in the diet but not with fat-free diet (Swell *et al.—J. Nutr. 57,* 121). In epileptic humans administration of adrenaline produced a higher cholesterolemia than in normal subjects (Dury & Treadwell—*J. Clin. Endocrinol. & Metabolism 15,* 818). Serum cholesterol, lipides and lipoproteins were high in hypothyroidism and were decreased with treatment with thyroxine (Gräsbeck & Lamberg *Acta Endocrinology 19,* 82). Treatment of rats with carbon tetrachloride raised serum fatty acid:albumin ratio from 1:1 to 1.3:1 (Shelden & Westphal—*Proc. Soc. Exptl. Biol. Med. 89,* 159). There were no clear signs of abnormal blood lipides in children with mild liver insufficiency (Nordio — *Minerva pediat. 6,* 763). *Klebsiella pneumoniae* and *Pasteurella psnedotuberculosis* in the presence of high blood lipide levels produced a pneumonitis in rabbits characterized by deposition of large quantities of cholesterol and fat in the inflammatory areas (Waddell *et al.—Am. J. Pathol. 30,* 757).

X-irradiation of the whole body of fasted rats reduced the capacity of the spleen to synthesize phospholipides (Cornatzer *et al.—Radiation Res. 1,* 546).

In Cooley's disease patients 52–87% of the dietary fat was absorbed (Romeo—*Riv. pediat. siciliana 8,* 237). The observation that children with fibrocystic disease did not digest iodized fat whereas normal children did, has been used as basis for a diagnostic test (Silverman & Shirkey—*Pediatrics 15,* 143). Fat absorption was affected in the African children's disease, Kwashiorkor (Holeman's & Lambrecht's—*J. Nutr. 56,* 477).

In a study of obese-hyperglycemic mice, goldthioglucose obese mice, rats with hypothalamic lesions, and their respective controls by determining composition of the fats, study of C^{14}-labeled acetate incorporation during synthesis, and study of fatty-acid turnover, the results supported the hypothesis that different types of obesity were characterized by different patterns of fat metabolism (Bates *et al.—Am. J. Physiol. 180,* 301, 304, 309; *181,* 187). During weight reduction by elderly men the total serum lipides decreased, whereas in younger men they increased (Moore *et al.—Am. J. Clin. Nutr. 181,* 397).

LIPIDES IN MICROBIOLOGY AND PLANTS. A reciprocal replacement of carbon dioxide and oleic acids was found to exist in the nutrition of the minute Streptococci and Lactobacillus (Deibel & Niven — *J. Bact. 70,* 134). *Norardia opaca* used C_{12}–C_{18} *n*-hydrocarbons, hexadecyl and octadecyl alcohols, vegetable oils, sodium cholate, Tween 80, and cholesterol as sources of carbon for growth (Webley—*J. Gen. Microbiol. 11,* 420). This microorganism oxidizes side chains on phenyl compounds to shorten the side chain. The observation was interpreted to support β-oxidation as a mechanism in the breakdown of fatty acids (*Ibid. 13,* 361). A scheme that has been suggested for the metabolism of Tween 80 by tubercle bacteria includes splitting into oleate and the polyoxyethylene derivative of sorbitol, and degradation of the latter intermediate through sorbitol, triose phosphate and the tricarboxylic acid cycle (Minami & Yamane—*Symposia on Enzyme Chem., Japan, 10,* 93). Sodium ricinoleate in media interfered with cell division in *Escherichia coli* causing the organism to develop as long filaments (Whiteside-Carlson *et al.—Proc. Soc. Exptl. Biol. Med. 89,* 382). Lipides, synthetic esters, and oleic acid markedly increased the production of fungichromin by a strain of *Streptomyce cellulosae,* when used together with glucose in a peptone basal medium (McCarthy *et al.—Antibiotics Ann. 2,* 719).

A new stable olive oil emulsion was prepared for the determination of lipase activity and was used to demonstrate the presence of antilipase in serum (Tauber—*Proc. Soc. Exptl. Biol. Med. 90,* 375). A fat splitting enzyme derived from castor beans split sunflower oil to yield very light-colored acids (Szamel—*Yrbk. Inst. Agr. Chem., Budapest, Hung. 1952 III—1954 VIII,* 49). The activity of the lipase systems used in the manufacture of Italian cheese was characterized as affected by temperature, pH, and substrate concentrations (Harper & Gould—*J. Dairy Sci. 38,* 87). The capacity of lipases of many dairy products microorganisms to release volatile acids from butterfat was measured (Wilcox *et al.—Ibid.* 775). The alleged presence of a lecithinase in dried eggs was reinvestigated, but its presence was not confirmed (Lea & Wilson—*J. Sci. Food Agr. 6,* 153).

Penicillium roqueforti was reported to be capable of oxidizing certain fatty acids, but fatty acids longer than 10 carbons were oxidized slowly if at all (Girolami & Knight—*Appld. Microbiol. 3,* 264). An assay for lipoxidase in animal tissues has been developed which eliminates the interference of heme compounds (Boyd & Adams—*Can. J. Biochem. & Physiol. 33,* 191). Its application was demonstrated on beef and pork adipose tissue, cured unsmoked bacon, liver, kidney, spleen, heart, brain and lung. Carboxyl-labeled fatty acids have been oxidized into labeled carbon dioxide using oxygen and ascorbic acid in the absence of enzymes (Geyer *et al.—Arch. Biochem. & Biophys. 56,* 549).

Certain polysaccharide-lipide complexes isolated from cultures of *Serratia marcescens* and *Escherichia coli* caused regression of sarcomas in Swiss mice but the high levels necessary were lethal to 30% of the mice (Creech *et al.—Cancer Res. 14,* 817, 824). Aminoacridine salts of unsaturated fatty acids were more inhibiting *in vitro* on *Mycobacterium tuberculosis* than the ethyl esters of comparable fatty acids (Mascitelli-Coriandoli—*Riv. patol. app. respir. 9,* 130). In a study of tissue lipides in relation to the natural resistance of rabbits to human-type tubercle bacilli, the water-soluble and phospholipide fraction supported growth; whereas the acetone extract or fatty acids were inhibitory (Patnode—*Am. Rev. Tuberc. 69,* 710). Branched chain fatty acids inhibited virulent strains of human *Mycobacterium tuberculosis* (Weitzel—*Hoppe-Seylers' Z. physiol. Chem. 288,* 174, 189, 200). With methyl as the side chain greatest inhibition occurred with this at the fifth carbon. Certain mitochondrial enzymes were inhibited by fatty acids oxidized by ultraviolet light (Ottolenghi—*Arch. Biochem. & Biophysics 56,* 157). A lipide fraction of the liver abolished the inhibition of the growth of *Saccharomyces cerevisiae* by phenol, sodium arsenate, and dinitrophenol (Barnebei & Brighenti—*Ricerca Sci. 24,* 1841).

A review of the available data on formation of fatty acids in oil-bearing seeds has indicated that the saturated and unsaturated acids were produced by independent mechanisms (Hilditch—*Oleagineux 10,* 83). Higher saturated acids were said to be synthesized by condensation of elementary C_2 groups from hexoses.

In a series of studies of fat metabolism in peanuts the conditions for incorporation of labeled phosphorus into peanut mitochrondial phospholipides were elaborated (Mazelis & Stumpf—*Plant Physiol. 30,* 237) and soluble fatty acid oxidases were prepared from peanut microsomes and characterized (Humphreys *et al.—J. Biol. Chem. 213,* 941; Castelfranco *et al.—Ibid. 214,* 567).

Characteristics and Composition

GENERAL AND COMPREHENSIVE. Most communications dealing principally with analytical methods, composition, and properties of fatty materials are briefly reviewed in this section. Some such information was placed in other sections because it was more pertinent to the text of these other divisions; as for example, tests for spoilage are under deterioration and soap analytical methods are reviewed in the detergent section.

Many analytical committee reports were published which contain collaborative results on testing methods, discussions on modification, and official actions on the modifications suggested. The texts of these reports were: the methods of analysis of the Japanese oil chemists' (Tsuchiya *et al.—J. Oil Chemists' Soc., Japan, 3,* 42, 178, 235, 298), refining and bleaching tests methods (Smith *et al.—J. Am. Oil Chemists' Soc. 32,* 428), moisture, flash point, and drying oil analysis (Mehlenbacher *et al.—Ibid.* 429), seed and meal analyses (Hopper—*Ibid.* 430), color evaluation (Stillman *et al.—Ibid.* 503, 704), spectroscopic oil analysis (O'Connor—*Ibid.* 452), determination of crude fat in feeds (Hoffman—*J. Assoc. Off. Agr. Chemists' 38,* 225), and recommendation for analytical methods for dairy products (Horwitz—*Ibid.* 306).

The published lectures, reviews, and general discussions were on: the glyceride structure of natural fats (Kartha—*J. Sci. Ind. Res., India, 13A,* 273, 471), fatty acids of uncommon structures (Goldovskii—*Zhur. Priklad. Khim. 21,* 534), the colors and flavors of fats and oils (Obata—*J. Oil Chemists' Soc., Japan 4,* 115), micro methods in the chemistry of fats (Gorbach—*Olli minerali grassi e saponi, colori e vernici 31,* 121), spectrophotometric methods for analysis of unsaturated fatty acids (Bernaerts — *Medelel. Vlaam. Chem. Ver. 16,* 159; Herb—*J. Am. Oil Chemists' Soc. 32,* 153; Narayan & Kulkarni—*J. Indian Chem. Soc. Ind. & News Ed. 17,* 79), separation and identification of components of lipides (Schlenk —*Ann. Rpt. Hormel Inst. 1954–55,* 50), separation of triglycerides by counter-current distribution (Taber—*Univ. Microfilms, Ann Arbor, Mich.,* No. 11609), chromatography in the lipide field (Holman—*Ann. Rpt. Hormel Inst. 1954–55,* 33), variation of the constants of Canadian milk fat (Riel—*J. Assoc. Off. Agr. Chem. 38,* 494), the chemistry of oleic acid (Maruta —*J. Japan Chem. 8,* 582), and fat content of herring, sprat, and mackerel according to season (Bramsnaes *et al.—Medd. Fiskeriministeriets, Forsogslab. 1954,* 15 pp.).

A note on raising false flax, *Camelina stavia,* as an oil crop recommended cultivation of the winter crop because it yields three times more seed and oil than the summer crop (Gildshtein —*Masloboino—Zhirovaya Prom. 20,* No. 3, 1).

ANALYSIS OF FAT SOURCES. Two communications pertained to moisture in oil material. Maskey *et al. (J. Am. Oil Chemists' Soc. 32,* 344) described the theoretical considerations involved in designing a meter for continuously recording moisture of seeds during processing. A study of the relationship of moisture and humidity to spoilage of palm kernels has shown that kernels containing 8.9% moisture become moldy in six days at 92% relative humidity (Somade—*J. Sci. Food Agr. 6,* 425).

A new oil determination method involving milling seed samples with steel balls and sand together with petroleum ether in shaking tubes was designed with the aims of inhibiting oil loss and reducing handling to minimum (Troëng—*J. Am. Oil Chemists' Soc. 32, 124; Fette u. Seifen 57,* 411). The Soxhlet extraction apparatus was slightly modified in structure for warmer analytical extraction of difficultly soluble fatty substance (Merzlikina—*Biokhimiya 20,* 47). The incorporation of a stopcock in the siphon loop of the Soxhlet tube was said to permit economy of solvent, adjustment of siphoning and other advantages (Schwarz—*Z. Lebensm.-Untersuch. u. -Forsch. 99,* 464).

Several means of simplification and improving rapidity of oil determination were investigated. A simplification of yield and iodine value determinations for seeds involved determining oil yield and iodine value on separate aliquots of one extract of a sample (Kartha *et al.—Indian J. Agr. Sci. 25,* pt. 1, 79). A new rapid method for cacao cake was based on titrating acetone extracts of samples with water-acetone solutions up to the point of turbidity and calculation from prepared reference tables (Philipp—*Rev. brasil quim. 37,* 104; *Univ. Bahia escola politec. No. 12,* 13 pp.). With development of proper reference tables, the method can be applied to other materials. The rapid method based on the index of refraction of specific extracts has been improved for the analysis of cacao products by introducing a constant in the calculations (Kleinert —*Rev. intern. chocolat. 10,* 302). A refractometric method was adapted to the determination of oil in fish products (Dreosti & van der Merwe—*Fishing Ind. Res. Inst. Progr. Rept. No. 18*). The butyrometric techniques of the dairy industry were applied for the determination of fat in meat products (Salwin *et al.—J. Agr. Food Chem. 3,* 588; Buss & Raschke—*Arch. Lebensm.-Hyg. 6,* 148). Such a method was found least satisfactory in a comparison with three conventional procedures (Windham—*J. Assoc. Off. Agr. Chem. 38,* 210). Analytical results showed that ether and chlorinated hydrocarbons extracted more lipides from leather than petroleum ether (Weber —*Das Leder 6,* 127). Dichloromethane was the best extractant among several chlorinated hydrocarbons studied. In extracting material containing lecithin, such as egg yolks, with chloroform, the sample should be dried with sand and ethanol (Stas & Rohof—*Olien, Vetten en Zeep 38,* 171). Drying without the ethanol addition did not permit complete extraction of the lipides.

A modified Babcock fat determination method for milk employed a quaternary ammonium compound to release the fat (Lee—*Australian J. Dairy Technol. 9,* 151). The results were about 0.07% lower than by the conventional Babcock method. Another similar test has been modified to give results agreeing closely with the Babcock resutls (Sager *et al.—J. Assoc. Off. Agr. Chemists' 38,* 931). A new modified Gerber test applicable to milk, cream, and skim milk made use of a reagent containing amyl alcohol, methanol, caustic, salt, and a nonionic detergent in water for release of fat from the emulsion (Houston— *J. Soc. Dairy Technol. 8,* 47). A piston syringe has been designed for accurately measuring viscous milk products into Gerber or Babcock bottles (Brus & van der Berg — Neth. *Milk Dairy J. 9,* 42). The British standard Gerber method for milks containing 3, 4, 5, and 6% fat gave results which were 0.01, 0.05, 0.08, and 0.12% higher, respectively, than gravimetric results from the British standard Rose-Gottlieb method (Crocker *et al.— J. Dairy Res. 22,* 336). Another investigation on the same subject has demonstrated that comparable results are obtained by the two methods when digestion is at 65° and 69% sulfuric acid was used in the Gerber method (Kiermeier and Pirner — *Z. Lebensm.-Untersuch. u. -Forsch 100,* 135). A Mojonnier tube with a detachable lower portion was applied to cheese samples by a method in which the sample was digested under a reflux with hydrochloric acid in the lower unit before the usual extraction with fat solvent.

An analytical scheme for the lipides of blood involved extraction with organic solvents according to the Bloor method and the use of aliquots for the determination: of total lipides by oxidation technique, phospholipides by selective extraction with chloroform from acetone-magnesium chloride solution, and steroids by reaction with digitonin (Monasterio—*Giorn. biochem. 1,* 15). Data from this scheme of analysis were recorded along with those of three other schemes for the same purpose (Guarini—*Med. sper. 25,* 7). A procedure for direct determination of the various lipides in brain was modified for application of blood serum (Sperry & Brand—*J. Biol. Chem. 213,* 69). Total glycerides were determined in blood by extraction, saponification, and determination of the released glycerol by the periodic acid oxidation method (Stewart—*Can. J. Biochem. & Physiol. 32,* 679). A similar method was based on colorimetric determination of the methylglyoxal formed by the oxidation of the glycerol (Weigel—*Fette u. Seifen 57,* 486). The Feigl spot test for esters of carboxylic acids was accurate for estimating 0.2–3 micromoles of esters in lipide extracts (Hack —*Arch. Biochem. & Biophys. 58,* 19). In a method of extraction of blood lipide with methylal-methanol, the lipide is fractionated by adding a little water and petroleum ether to yield a layer containing steroides and glycerides and a lower phase containing phosphoaminolipides (Delsal—*Bull. soc. chim. biol. 36,* 1329). A modified hydroxamic acid method was applied for the estimation of esterified fatty acids in small amounts of serum (Nailor *et al.—Arch. Biochem. & Biophys. 54,* 201).

GRADING AND VITAMIN TESTS. Spectroscopic measurements have been devised which give results that are comparable to

those obtained in the colorimetric grading of the National Soybean Processors Association for the green oils derived from frost damaged soybeans (MacMillan & Melvin—*J. Am. Oil Chemists' Soc. 32,* 85).

In a review of various tests for evaluation of lards imported into Germany, odor developed on heating to the smoke point, reduction capacity, neutral red reaction, aniline point, and aniline color were recommended as helpful (Wurziger & Lindemann— *Fette u. Seifen 56,* 786, 920).

A summary of papers read at a meeting of the British Society of Public Analysts and the Fat and Oil group of the Society of Chemical Industry contained descriptions of the standard vitamin A units and information on the effect of synthetic trans-acetate of the vitamin, correction procedures, use of various absorbents for recovery, and spectroscopic data (*Anon.—Nature 175,* 111). When commercial defatted bone meal was used as the absorbent with the British spectroscopic method the results on pure vitamin A were close to 100% compared to 106% by the official method (Lord & Bradley—*Analyst 80,* 429). An alumina adsorbent prepared by heating at 600–50° for six hours permitted best reproducibility with the American procedure (Morgareidge—*J. Assoc. Off. Agr. Chemists 38,* 688). A multiple regression study of the Carr-Price reaction for vitamin A in the presence of carotene has confirmed that pure solutions of carotene contribute to the absorbency in a linear additive manner and has checked the corrections of Dann & Evelyn (Rousseau *et al.—J. Dairy Sci. 38,* 902). The good solubility of vitamin A in glycerol and acetone and insolubility of carotene in these solvents have been suggested as means for their separation (Giral—*Mem. congr. cient. mex., Univ. Mex. 2,* 212). This report contained solubility data and described the colors produced by the Carr-Price reagent with vitamin A in many organic solvents. A method for the determination of vitamin A and carotene in butter was based on the Carr-Price reaction of the former and colorimetric determination of the latter (Sasaki—*Intern. Dairy Congr. 13th 4,* 645). A seven-year study of the vitamin A potency of Oregon State butters shows the usual seasonal variations but no significant differences among years (Weswig & Haag—*Proc. Western Div. Am. Dairy Sci. Assoc. 35,* 423). In a similar survey in Japan, lower results as compared with American butters were attributed to the low carotene content of the dairy feeds in Japan (*Nakanishi—Tohoku J. Agr. Res. 4,* 15). The interference from sesame oil in the determination of the vitamin in Indian hydrogenated oils was eliminated by washing the solution of unsaponifiable, successively, with dilute hydrochloric acid and 1% sodium carbonate and filtering through sodium sulfate (Roy—*Sci. & Culture, India, 20,* 201.)

Morton & Bro-Rasmussen (*Analyst 80,* 410) in comments on determination of vitamin A in cod-liver oils related that the activity was contributed by three active substances and in fish oils about 10% was from vitamin A_2. In analysis of cod-liver oils, partition chromatograms using paraffin oil as a stationary phase and various aliphatic alcohols as the mobile phase have been used to separate the vitamin A from the substance interfering with its spectrophotometric assay (Dunckley & MacFarlane—*J. Sci. Food Agr. 6,* 559). Work on whale-liver oil has shown that 12.1% of the numerical value of the I. U. of vitamin A as determined spectrophotometrically was due to kitol (Tawara & Fukazawa—*Bull. Japan Soc. Sci. Fisheries 15,* 707, 710). Separation of the vitamin A from kitol was accomplished by extraction of the former with 90% methanol from an ether solution of the unsaponifiable. The vitamin A distribution in the different parts of the liver of *Squalus suckleyi* has been recorded (Yamamura—*Ibid.* 611, 635). Records of the Carr-Price reaction and the ultra violet absorption spectra of the visceral and liver oils of 17 species of fish of Japanese waters have indicated that many contain large amounts of vitamin A (Tsuchiya & Kaneko — *Repts. Gov. Chem. Ind. Res. Inst. Tokyo 49,* 273).

A biological four-week test based on storage of vitamin A in the liver of chicks was designed for determining the availability and stability of the vitamin in mixed feed (Harms *et al.—Poultry Sci. 34,* 1125).

A new procedure for estimating vitamins A and D in their mixtures was based on determining conjugation with *p*-benzoquinone as the reagent (Lora-Tomayo—*Fette u. Seifen 56,* 790; Lora-Tomayo & Inigo—*Ibid.* 913). Vitamin D_2 and D_3 were found to react with an iodine-ethylene dichloride reagent to produce a strong yellow color with maximum absorption at 450 mμ, which was highly specific for these vitamins (Lyness & Quackenbush—*Anal. Chem. 27,* 1978).

The interference of peroxides in the estimation of tocopherol in peanut oil was eliminated by adsorption of the sample on activated alumina and elution of peroxide free glycerides and tocopherol with petroleum ether (Gupta *et al.—J. Indian Chem. Soc. Ind. & News Ed. 16,* 175; *17,* 171). The green oil derived from grape seeds contained 2–2.3 grams of tocopherols per kilogram (Blanc & Silvestre—*Bull. soc. pharm. Marseille Dec. 1952,* 27, 31). The content of tocopherols was a good indication of stability against deterioration. A method for estimation of individual tocopherol was based on chromatography on zinc carbonate impregnated paper or the latter plus partition separation on paraffin coated paper (Green *et al.—J. Sci. Food Agr. 6,* 274).

CHEMICAL CHARACTERISTICS. A comparison of the Hanus, Kaufmann and Wijs methods for determination of the iodine value of fats and oils by Stähli (*Mitt. Lebensm. Hyg. 46,* 121) resulted in a preference of the latter when seven grams per liter excess iodine was used. A reduction of the reaction time necessary by addition of mercuric acetate was also suggested. A comparison of methods by Bolley (*J. Am. Oil Chemists' Soc. 32,* 235) also favored the Wijs method, but speeding it up with catalyst reduced its accuracy. In another comparison of methods, the Hanus chemical method was more accurate than the refractometric procedure (Blaim & Kaszlej—*Roczniki Nauk Rolniczych Ser. A68,* 678). A Rosenmund-Kuhnhenn procedure using catalyst to accelerate the reaction has been standardized to give suitable values in much less time than is required for the Hanus procedure (Doadrio & Marzol—*Anales real soc. epan. fis. y quim., Madrid, 50B,* 981). By using large amounts of potassium iodide to keep the iodine in solution and dispersing the fat sample into a water solution with emulsifiers the iodine value determination may be run in aqueous solution (Kuchment—*Aptechnoe Delo 2,* No. 6, 35). A procedure for determining iodine value with the use of hypochlorous acid was adjusted to give results comparable with the more conventional methods (Mukherjee—*J. Am. Oil Chemists' Soc. 32,* 351; Chowdhury & Mukherjee—*Ibid.* 484). The method of Becker for determining bromine value of oils was slightly modified and used for analyzing many semi-drying, drying, and bodied oils (Stock & Goergens—*Deut. Farben-Z. 8,* 426).

A study of the factors that affect the Polenske value determination has shown: that the size of pumice or quartz did not affect volatile soluble acid estimation; the volatile insoluble acid increased with diminishing granule size becoming constant at 0.7 mm. size of granules; and the amount of granules should be at least one gram for consistent results (Mengoli—*Boll. lab. chim. provinciali 5,* 41). The arithmetical mean value of the Reichert-Meissl values of butters produced in Kansas was 29.19 and the range was 27.4–31.35 (Rutz *et al.—J. Dairy Sci. 38,* 387). A survey of Egyptian cow and buffalo butterfat values indicated that the Reichert-Meissl values for both species declined gradually from beginning to end of lactation period, whereas, the iodine value increased (El-Katib —*Indian J. Dairy Sci. 7,* 101). The butyric acid value of Polish butters was quite constant within the range of 19–21 (Laskowski—*Roczniki Panstwowego Zakladu Hig. 5,* 391).

The hydroxyl, acid and Woburn iodine values were not affected by presence of peroxides in an oil sample whereas carbonyl values were excessively high (Milewsky & Wentzel—*Fette u. Seifen 57,* 702). In this work empirical corrections were designed for the carbonyl values and the effect of peroxides on determination of epoxides, lactones, and ester oxygen; and elemental analysis were also discussed with respect to the presence of peroxides.

PHYSICAL PROPERTIES. The phase behavior of binary mixtures of the triglycerides of lauric, palmitic, stearic, and oleic acids and 2-oleyldistearin as observed by melting point, x-ray diffraction and dilatometry has been recorded graphically and in tables (Lutton—*J. Am. Oil Chemists' Soc. 32,* 49). These indicate that solid solutions were absent with most of the binary mixture of pure glycerides but definitely occurred with binary systems of mixed triglycerides and with the tripalmitin-tristearin system. Similar measurements were made on binary mixtures of trans-6-through 12-octadecenoic acid and their dihydroxystearic acids. These showed that mixtures with unsaturation or with an hydroxyl group beginning at even or odd carbons had a narrow melting range whereas mixtures of even with odd members had a broad melting range. Comparable degrees of differences were also recognized in the x-ray diffraction patterns (Swern *et al.—Ibid.* 539). The odd-odd or even-even acid systems formed one phase systems; mixtures of odd-even formed 2-phase systems and gave diffraction patterns in which those of the pure components were superimposed. X-ray diffraction patterns of 2 aminoacyl-1, 3 difatty acid glycerides exhibited an α- and either a β- or β′-form with one compound showing sub α- in addition to the α- and β-forms (Huber *et al.—J. Phys. Chem. 59,* 604). The x-ray diffraction patterns of the acetamides of lauric, myristic, palmitic and

stearic acids exhibited long spacings that correspond in length to two molecules of the acid and two molecules of the acetamide (O'Connor *et al.—J. Am. Chem. Soc. 77,* 892). The infrared spectrum of these compounds resembled those of the constituent molecules. The spacings of crystal-form-B of stearic acids were recorded and the cell was found to contain four molecules (Sydow—*Acta Cryst. 8,* 557). Butter, lard and butteroil samples which had been rapidly cooled, on observation through an optical microscope with crossed nichols showed needles, square crystals, radial needle-spheres, pseudo squares, and gelatinous globules which may or may not contain needles (Mohr & Mohr—*Molkerei- u. Kaserei-Ztg. 5,* 1507). The melting point of some of these structures from the different products differed.

Data on the dependence of specific heats on temperature has been recorded for 27 different fats (Riedel—*Fette u. Seifen 57,* 771). The accumulated heat contents and heats of transition of 1-monostearin, 1-aceto-3-stearin, and 1,2-diaceto-stearin were recorded in graphic and tabular form over the temperature range —73 to 100° and equations were developed for calculating the values (Ward *et al.—J. Phys. Chem. 59,* 4).

In a comparison of methods for determining the melting point of fats, the Fincke procedure gave the most reliable result but was unsatisfactory for soft fats; results from the Association of Official Agricultural Chemists' and the Whymper method were too low (Kleinert—*Rev. intern. chocolat 7,* 711). The coefficient of expansion and melting dilation were measured on the methyl esters of palmitic, stearic, arachidic, behenic, and oleic acids (Craig—*J. Am. Oil Chemists' Soc. 32,* 459). The index of refraction, density, viscosity at four different temperatures and boiling point at 100 mm. of mercury pressure were measured for the naturally occurring C_8 to C_{16} saturated acid ethyl esters and the ethanoate esters of the alcohols obtained through reduction of the respective acids (Shigley *et al.—Ibid.* 213). The actual values obtained for the ethanoate esters were slightly higher than those obtained for the corresponding ethyl esters. The kinematic viscosities of mixtures of olive oil with butanol, isoamyl, alcohol, cyclohexane, toluene, xylene and cyclohexanol at different solvent concentrations and temperatures were measured (Klantschnigg —*Olearia 8,* 203; *9,* 105). The application of the Walther equation as modified by the American Society for Testing Materials for these viscosity-temperature relationships gave satisfactory results.

An apparatus was designed for determining solubilities and used to measure the solubility of fatty acids, fatty alcohols, fatty acid methyl esters, and triglycerides in several common organic solvents (Privett—*Ann. Rpt. Hormel Inst. 1954–55,* 54). Measurements of solubility of water in fats showed that solubility decreases with increasing molecular weight of the fat, increases with higher free fatty acid content, and was independent of the unsaturation (Loncin—*Fette u. Seifen 57,* 413). The vapor pressure of the dissolved water was directly proportional to the moisture content up to the saturation point.

Polyphase refractometry; that is, characterization of mixed liquid and solid fat by refractive index of the liquid phase without separation of the solid phases, has been demonstrated for measuring the solid/liquid relation of a plastic fat and for the characterization of butter and cacao butter (Kaufmann *et al.—Fette u. Seifen 56,* 990; *57,* 21, 114, 247). The polarographs of the most common natural unsaturated fatty acids, soybean oil, and tung oil were determined in a 3:1 methanol: benzene mixture in the presence of tetramethylammonium bromide as electrolyte (Asahara & Hirai—*J. Chem. Soc. Japan, Ind. Sect. 57,* 392).

The resistance to evaporation of water of monolayers of the four saturated fatty acids, C_{17}–C_{20}, was measured as a function of surface pressure, chain length, monolayer phase, subphase composition and surface temperature, and relationships among the data were discussed (Archer & LaMer—*J. Phys. Chem. 59,* 200). A theory was proposed for the source of the energy barrier, and calculation of its magnitude from heats of vaporization agreed well with the experimental results. It has been shown by means of force-area curves that the sudden drop in area per molecule of stearic acid spread on the surface of water at various pH values was probably the result of impurities in water rather than an indication of ionization of the fatty acid (Sanders and Spink—*Nature 175,* 644). The Gibbs equation was verified by calculating the force-area curve of lauric acid monolayers and comparing with experimental results (Minassian-Saraga—*J. chim. phys. 52,* 99).

Neither serum globulin, ovalbumin, arginine, nor pepsin removed built up films of stearic acid on glass under conditions that were effective with serum albumin (Sher & Sobotka—*J. Colloid Sci. 10,* 125). Fatty acid anions and dyes inhibited the removal of the acid with serum albumin; but covering the stearic acid with cholesterol had no effect. The observations were discussed with respect to formation of water-soluble complexes.

An apparatus for thermal capillary analysis based on rise of material on filter paper strips in an oven was designed and used for measurement on fatty materials (Lauer — *Fette u. Seifen 57,* 789).

The dispersion and size of fat globules in milk, milk powders and cream have been observed after absorption of the fluorescent dye phosphine from aqueous solution. The globules under blue light fluoresce as a bright yellow-green coloration against a black background (King—*J. Dairy Res. 22,* 205).

DETECTION OF ADULTERATION. In an elaboration of spectrophotometric methods of detecting adulteration, it was shown that soybean oil is evident in corn oil on the basis of linolenic content and that butterfat contains arachidonic and pantaenoic acids and therefore can be distinguished from margarine fats which do not contain these (Firestone—*J. Assoc. Off. Agr. Chemists' 38,* 657). The measurement of the extinction, $E^{1\%}_{1cm.}$ of the alkali-isomerized fatty acids was superior to determination of the polybromide value for detection of beef, mutton or pork fat in chicken fat in investigating adulteration of chicken meat; or detecting the adulteration of egg fat with beef fat (Franzke —*Z. Lebensm.-Untersuch. u. -Forsch. 102,* 81). The adulteration of cocoa butter, chocolate and chocolate coatings was detected on the basis of the refractive index or extinction of the fatty acids in a specific acetone-fractionated portion (Purr—*Fette u. Seifen 56,* 823; *57,* 120, 173). The refraction of the polyphase mixture of liquid and solid fat has been determined for mixtures of cacao butter, lard, and butter, respectively, with several other fats and oils in a demonstration of the technique for detecting adulteration (Kaufmann & Thieme—*Fette u. Seifen 57,* 114, 247, 726). Vegetable oil was detected in animal fats on the basis of the phytosterol acetate test (Hadorn & Jungkunz—*Mitt. Lebensm. Hyg. 45,* 389). Zinc is a common catalyst for reesterification of split oils and its detection was recommended as a criterion for such oils (Romani & Valentinis—*Boll. lab. chim. provinciali 5,* 7).

The acetyl value, index of refraction, hydroxy acid content, and Jaffe reaction of synthetic olive oils that have been reconstituted from free fatty acids were recorded as fundamental data for their detection in pure olive oils (Truddaiu—*Ibid.* 58). Other methods of detection of adulteration of olive oils were based on the fluorescence of the samples (Arpino *et al. —Olii minerali, grassi, saponi, colori e vernici 32,* 149; Provvedi—*Ibid. 31,* 139), on fluorescence of rings and bands formed on chromatographs on alumina (Petronici—*Chimica e ind., Milan, 37,* 273), and on determination of squalene (Fabris & Vitagliano—*Ricerca sci. 24,* 2062; Keskin—*Rev. fac. sci. univ. Istanbul 19C,* 214).

The methods for detection of adulteration of butter were based on the refractive index of fractions segregated by specific urea-complex technique (Schipe — *J. Assoc. Off. Agr. Chemists' 38,* 156), on determination of the butyric acid value (Akiya & Hazama—*Rept. Food Res. Inst., Tokyo 5,* 81), and on the observations of the fat in a 55:45 mixture of ethanol: isopropylanol (Keeney—*Proc. Ann. Conv. Intern. Assoc. Ice Cream Mfrs. 49,* 46). Methods of specifically detecting vegetable oils in butterfat were based on determination of tocopherol (Anglin *et al.—J. Dairy Sci. 38,* 333, 1089) and on the melting point of the sterol acetates (Cannon—*J. Assoc. Off. Agr. Chemists' 38,* 338). The methods of detection of hydrogenated dolphin oils in butters were dependent on the detection of isovaleric acid chromatographically (Parrozzani & Mancinelli—*Boll. lab. chim. provinciali 5,* 43; D'Arrigo—*Olii minerali, grassi, saponi, colori, vernici 32,* 2). The determination of the Reichert-Meissl and Polenske values were reviewed with regard to their use for detecting foreign fats in dairy products (Fine—*J. Assoc. Agr. Chemists' 38,* 319).

The use of the erucic acid value has been demonstrated for determining the purity of rape and mustard oils (Pathak & Aggarwal—*J. Sci. Ind. Res., India, 13B,* 720). The Bellier test was recommended for the detection of peanut oil in olive, sesame, nigerseed and safflower oils (Kane—*Oils & Oilseeds J., India, 7,* No. 9, 8). Reaction of picric acid with tung oil in organic solvent yields a bright yellow complex which may serve as a qualitative test for tung oil (Goguadze & Pkheidze—*Zhur. Anal. Khim. 9,* 308).

COMPOSITION. A new method for estimating solids content is based on adding a weighed amount of oil-soluble dye to a known amount of fat, separation of the oil phase by ultracentrifuge, and determination of the concentration of the dye in the separated portion by absorbance measurements (Zobel

et al.—J. Am. Oil Chemists' Soc. 32, 706). The calculation is based on the dye being distributed throughout the oil phase only. The methods for estimating solid fatty acids in fatty acid mixtures were based on, respectively, solubility of the lead soaps (Pilc—*Ceskoslov. kozarstvi 2,* 107), and crystallization from dichloroethane (Loury & Frelat—*Rev. franc. corps gras 1,* 557). The amount of higher saturated fatty acids in blood was determined by extraction of the fat, conversion to the free fatty acids, oxidative fission of the unsaturated and separation of the higher saturated fatty acids chromatographically (Pikaar—*Rec. trav. chim. 74,* 627). In applying potassium permanganate oxidation to oleic and elaidic acid esters the former were oxidized at a greater rate than the latter (Bulatskii—*Zhur. Obshchei Khim. 24,* 1835).

A direct procedure for the determination of the dihydroxystearic acid in hydrogenated castor oil was based on oxidation with an excess of a standard solution of periodic acid and calculation from a measure of the unreacted periodate (Kamath *et al.—Current Sci., India 23,* 262).

Urea complex precipitation followed by determination of the characteristics of the fraction obtained was used for estimating the composition of mustard oil (Mehta *et al.— J. Indian Chem. Soc., Ind. & News Ed. 18,* 1). In application of urea adduct fraction to each series of mono- and diglycerides of C_8–C_{18} saturated acids, the molecular relationship of urea to the glyceride of the precipitate was a linear function of the number of the carbon atoms of the adduct (Mareno *et al.— Anales real. soc. espan. fis. y quim., Madrid, 50B,* 625; *Fette u. Seifen 57,* 652). On the basis of composition and density measurements the diglyceride adducts had a different crystal structure than those of other fatty compounds.

The infrared spectra of castor oil (Narayan & Kulkarni—*J. Indian Chem. Soc. Ind. & News Ed. 17,* 87) and of the mono-, di-, and triglycerides of the even C_{14}–C_{18} acids and mixed "acetoglycerides" (O'Connor *et al.—J. Am. Oil Chemists' Soc.* 32, 88) have been recorded for use as fundamental data for design of analytical methods. In an elaboration of the use of ultraviolet spectrophotometry in analysis of fats the coefficients of absorption of various structures in fatty acids and information on determination of vitamin A and β-carotene were presented (Popov *et al.—Vestnik Leningrad. Univ. 1950,* No. 3, 87).

Many variations of chromatographic technique for the analysis of fatty materials were demonstrated. Absorption and elution techniques with refractometric control were described for separation of paraffin oxidation products, determination of acids, separation of *n*-esters, oxyesters, and alcohols (Spengler & Hauf—*Fette u. Seifen 57,* 474). The separation and determination of the C_6–C_{22} saturated acids using powdered rubber adsorption columns have been described (Boldingh—*Intern. Colloquim Biochem. Problem. Lipiden 1953,* 64). Such columns were applied to the analysis of biological fats with a procedure which included removal of unsaturated acids by oxidation (van de Kamer *et al.—Biochem. J. 61,* 180) and to bacterial lipides with a procedure which involved hydroxylation of the unsaturated fatty acids (Hoffmann *et al.—J. Biol. Chem. 217,* 49).

Powdered "Polyene" columns permitted better separation of saturated acids than kieselguhr columns (Green *et al.—Chemistry & Industry 1955,* 591).

Static adsorption isotherms on charcoal, with 95% ethanol as solvent have been determined for a series of saturated, unsaturated, and branch-acids and discussed with respect to potential use for estimation of separability by chromatography (Cason & Gillies—*J. Org. Chem. 20,* 419). A study of adsorption of linseed oil on carbon blacks has shown that they have a minimum bulk volume when they are just saturated with oil (Watanabe—*Tanso 3,* 42).

The separation of oleic and isoöleic acids from hydrogenated oils was accomplished with alumina as the adsorbent and 1:1 benzene:petroleum ether mixture as the solvent (Bowma—*J. Sci. Ind. Res., India, 13B,* 718). Similar technique was used to separate the unsaponifiable fraction of corn oil into hydrocarbon, wax, carotenoid pigment, and β-sitosterol (DeCastro & Jannke—*J. Am. Pharm. Assoc. 44,* 281) and in the analysis of mixtures of unsaturated acids for the separation of vicinal pairs of brominated substituents (Howton—*Science 121,* 704). Egg lecithins separated on alumina columns possessed low fatty acid/phosphorous ratio, but on rechromatographing on silicia they separated into lecithin of correct acid/phosphorous ratio and lysolecithin (Lea *et al.—Biochem. J. 60,* 353). This report also showed that several glycerophospholipides, both natural and synthetic, can be separated on silica-impregnated paper. Silicic acid columns capable of quantitatively separating all the unsaturated fatty acids from C_2 to C_{14} have been developed (Zbinovsky—*Anal. Chem. 27,* 764). Olive oil has been segregated into fractions of widely different characteristics on different sections of a silicic acid column (Tous & Vioque—*Grasas y aceite 5,* 115).

The paper chromatographic techniques of Kaufmann and his co-workers (*Fette u. Seifen 57,* 231, 473, 666) have been described and fundamental measurements made for application to higher unsaturated acids, even *n*-alcohols from C_{10} to C_{18}, mixtures of oleyl alcohol, cholesterol and fatty acids, and for the analyses of blood lipides. Experimental data using paraffn and latex coated paper, various solvents and indicators such as bromothymol blue, lead sulfide and acetates of copper, mercury, and silver were recorded from investigations in which a reverse-phase chromatographic technique was developed for separation of saturated higher acids (Ashley & Westphal—*Arch. Biochem. & Biophys. 56,* 1; *Federation Proc. 14,* 175). In an elaboration of indicators for the paper chromatography of lipides: α-dextrin was used successfully on chromatographs of fatty alcohols, acids, methyl or ethyl esters and monoglycerides; diglycerides and triglycerides did not respond to this indicator; iodine vapors were useful for a variety of lipide components; and lead acetate was applicable to the chromatography of monoglycerides (Mangold *et al.— J. Am. Chem. Soc. 77,* 6070). In demonstrations of paper chromatograph technique, saturated fatty acids were separated using potassium alum impregnated paper, a mixture of carbon tetrachloride, methanol and ammonium hydroxide as the developer, and Rhodamine B as the indicator (Holasek & Winsauer—*Monatsh. 85,* 796) and use of paraffin oil treated paper, acetic acid as the ascending solvent, and silver salt as the indicator (Spiteri —*Bull. soc. chim. biol. 33,* 1355). In similar technique ammonical silver nitrate solution was used to trace the glycerol formed by splitting of fat (Bergner & Sperlich—*Deut. Apoth.-Ztg. 93,* 676).

Separation of unsaturated fatty acid esters was accomplished by chromatographing them as their mercuric acetate addition compounds (Inouye *et al.—J. Am. Oil Chemists' Soc. 32,* 132) and as hydroxy or halogen derivatives (Kobrle & Zahradnik—*Chem. Listy 48,* 1703). Permanganate oxidation of unsaturated acids was used in some paper chromatographic techniques for the analysis of fats (Crombie *et al.—Biochem. J. 59,* 309; Lakshminarayana & Rebello — *J. Sci. Ind. Res., India, 14B,* 189). Column partition chromatography of fatty acids on cellulose powder as their hydroxamic derivatives has been demonstrated (Davenport—*Chemistry & Industry 1955,* 705). Two communications on paper chromatography of fatty acids were discussions of common techniques (Savary—*Bull. soc. chim. biol. 36,* 927; Perilä—*Acta Chem. Scand. 9,* 864).

A study of the electrophoretic movement of fatty acids on filter paper has indicated that this technique cannot separate acids below C_{10} because they move at the same rate and that the C_{18} acids cannot be separated because of strong absorption on the paper, but the technique permits determination of impurities in oleic acid (Barnett & Smith—*J. Sci. Food Agr. 6,* 53; *Nature 174,* 659).

Gas-liquid partition chromatography of volatile fatty acids was modified to permit determination of lower fatty acids up to C_{12} in one column (van de Kamer *et al.—Biochem. J. 61,* 174). Displacement chromatography in conjunction with ultra violet and infrared spectra was shown to be effective for the separation of cis, trans diene and triene isomers (Abu-Nasr & Holman—*J. Am. Oil Chemists' Soc. 32,* 414).

A scheme for determining the component acids of oils containing epoxy and/or hydroxy acids involved converting the epoxy acids to hydroxy acid, separating these by partition to 80% methanol from petroleum ether, and applying crystallization technique with determination of characteristics on all fractions (Bharucha & Gunstone—*J. Sci. Food Agr. 6,* 373). The Kaufmann procedure based on calculating composition from iodine and thiocyanate values was demonstrated to be satisfactory for the analysis of lard (Drozdov & Materanskaya — *Trudy Moskov. Technol. Inst. Myasnoi i Molochnoi Prom. 1954,* No. 2, 33). A micromolecular distillation method was devised for the quantitative analysis of mono-, di-, and triglyceride composition of commercial emulsifiers (Privett—*Ann. Rpt. Hormel Inst. 1954–55,* 17). The accuracy of a crystallization procedure for estimation of glyceride types in natural fats was questioned (Vander Wal—*J. Am. Oil Chemists' Soc. 32,* 240), and also supported (Hilditch—*Ibid.* 241).

Characteristics and analytical data that permitted convenient tabulation are so presented in tables appended to this section of the review. The analysis of some oils pertained only to specific constituents and are reviewed in the paragraphs that follow. Some analyses which were not included in the charts pertained to analysis of safflower seeds of India (Rao &

Swaminathan—*Indian Soap J. 19,* 71), identification of the fatty acids in the seeds of *Digitalis lanta* (Maslov—Molodstov —*Zhur. Priklad. Khim. 28,* 334), chemical nature of the fatty acids of group C Streptococcus species (Hofmann & Tausig—*J. Biol. Chem. 213,* 415), the fatty acids from lanolin (Liu—*Essays & Papers, Memory of President Ssu-Nien 1952,* 199), composition of lipides of the fat gland of ducks (Weitzel & Lennert — *Hoppe-Seyler's Z. Physiol. Chem. 288,* 251), and occurrence of trilaurin in the seeds of *Tetradenia glauca* (Tsuchiya & Tanaka—*J. Chem. Soc. Pure Chem. Sect. 75,* 1090). The fixed oil of Delphiniuim staphivagria was not present as glycerides but esters of aminocyclic polyhydroxy compounds (Nath—*J. Sci. Ind. Res., India, 13B,* 776). The properties of lard were considerably altered by interesterification treatment whereas those of tallow were unchanged (Luddy *et al.—J. Am. Oil Chemists' Soc. 32,* 522). The treatment changes the distribution of the acids among glyceride to random, whereas in tallow such distribution must be natural. The higher fresh-water plants such as duckweed and thyme contain no saturated fatty acids in their oils, and linoleic acid was the most unsaturated of the fatty acids (Chechenkin—*Biokhimiya 20,* 249).

Acids of C_{20} and longer with as many as six double bonds were isolated from bovine testis (McElroy *et al.—J. Am. Oil Chemists' Soc. 32,* 286; *Congr. intern. biochim., 2e Congr., 1952,* 164), from brain glycerophosphatides (Klenk & Bongard—*Ibid.* 160), and from liver phospholipides (Klenk & Dreike—*Hoppe-Seyler's Z. physiol. Chem. 300,* 113). All these fatty acids and comparable acids of salt-water fish oils were said to contain the divinyl-methane group and the first double bond was said to be at the same position as that in oleic, linoleic, and linolenic acids (Klenk—*Inetrn. Colloquim. Biochem. Problem. Lipiden 1953,* 33). However, one analysis of the C_{20} fatty acid with four double bonds of swine liver suggested that the double bonds were at the 4, 8, 12, and 16 carbon (Shimooka & Toyama—*J. Am. Oil Chemists' Soc. 4,* 27; *Mem. Fac. Eng. Nagoya Univ. 6,* 48). Highly unsaturated fatty acids of length greater than C_{18} were isolated from fish oils and their structures were studied (Toyama & Shimooka—*Ibid. 5,* 319, 323, 330; *6,* 42; Swain—*Fisheries Res. Board Can. Progr. Pacific Stas. No. 99,* 6). An examination of the depot fats of ruminants showed the presence of 3.5–11.2% of trans-acids (Hartman & Shorland—*Biochem. J. 61,* 603).

Hansen, Shorland and their co-workers (*Biochem. J. 58,* 358; *59,* 350; *61,* 141, 453, 547, 702; *Chemistry & Industry 1954,* 1229; *1955,* 92) have isolated branched chain acids from butterfat, ox fat, mutton fat and shark liver oil.

Hydroxymyristic acid was detected in the lipides of typhoid bacteria (Cmelik—*Hoppe-Seyler's Z. physiol. Chem. 299,* 277). Santalbic acid, the chief component acid of *Santalum album* seed oil, was shown to be trans-octadec-11-en-9-ynoic acid and thus is identical with ximenynic acid (Grigar *et al.—J. Chem. Soc. 1955,* 1069; Gunstone & Russell—*Ibid.* 3782). *Veronia anthelmintica* and *Strophanthus hispidus,* respectively, contain 12,13-epoxyoctadec-9-enoic acid and 9-hydroxyoctadec-12-enoic acid (Bharucha & Gunstone—*J. Sci. Food Agr. 6,* 373). The various structures assigned to ricinoleic acid were historically reviewed (Gunstone—*Chemistry & Industry 1955,* 250). 2,4-Dodecadienoic acid was isolated from the seed oil of *Sebestiana lingustrina* (Holman & Hanks—*J. Am. Oil Chemists' Soc. 32,* 356). Guptas' & Aggarwals' (*J. Am. Oil Chemists' Soc. 32,* 501; *J. Sci. Ind. Res., India, 13B,* 449, 889) and Ahlers' & Gunstones' (*Chemistry & Industry 1954,* 1291) infrared studies have shown the structure of α-kamlolenic acid to be cis-9, trans-11, trans-13, and the β-acid as trans-9, trans-11, trans-13. Mikusch (*Deut. Farben-Z. 8,* 166) also determined the structure of kamlolenic acid. The glycerides of Japan wax contain a C_{42} dibasic acid (Toyama & Hirai—*Res. Rept. Nagoya Ind. Sci. Res. Inst. No. 7,* 46). A method has been devised for the colorimetric determination of the α-glycerol ethers of the unsaponifiable fraction of fats and was applied to the study of development of such compounds in the starfish (Karnovsky & Brumm—*J. Biol. Chem. 216,* 689).

A review and an examination of the chromatograms of the unsaponifiable material of palm oil have indicated the presence of phytoene, phytofluene, ζ-carotene and tetrahyrolycopene (Argoud—*Oleagineux 9,* 717, 789). Rapeseed oils produced by solvent extraction contain 1.7–2.5 times more unsapnifiable materials than oils obtained by pressure extraction (Andre & Maille—*Compt. rend. 239,* 1240). The lipides of dog adrenals contain sterol esters, 29.4, free sterols, 0.6 phosphatides, 11.8, hydrocarbons and waxes, 1.8% (Schulze—*Pflügers Arch. ges. Physiol. 258,* 226). Several sterols were isolated from various fish lipides and their characteristics were reported (Toyama & Tanaka—*Bull. Chem. Soc. Japan, 26,* 497; *27,* 39, 264).

The new procedures for determining cholesterol in blood serum based on the Liebermann-Burchard reaction featured rapid extraction with acetic anhydride, acetic acid, and *p*-toluenesulfonic acid mixture (Goudou *et al.—Ann. biol. clin., Paris 13,* 285), segregation from similar fluids by elution chromatograph (Janda—*Casopis Lekaru Ceskych 91,* 21), use of spectrophotometry (Guy *et al.—Ann. biol. clin. 13,* 43) and fluorescence of the color reaction (Albers & Lowry—*Anal. Chem. 27,* 1829). A nephelometric method was modified to give results agreeing with more standard procedures (Stenger — *Klin. Wochschr. 33,* 534). Polarography was used to examine the C_{21}-ketosteroids related to cholesterol (Robertson—*Biochem. J.* 61, 696). The ease of oxidation of cholesterol and the structure of the oxidation products formed were investigated and recorded (Smith—*J. Am. Chem. Soc. 76,* 3232). A steroid related to cholesterol with an absorption maximum at 270 mμ was isolated from animal fats (Festenstein *et al.—Biochem. J. 59,* 558; Cain & Morton—*Ibid. 60,* 274).

The lipides of tubercule bacteria contained the laevo rotatory alcohol, phthicerol (Lewis & Polgar—*J. Chem. Soc. 1955,* 3971). The visceral oil of the fish *Laemonena morosuc* contained 31–34% unsaponifiable of which the main component is 11-docosen-1-ol (Komori & Agawa—*J. Am. Oil Chemists' Soc. 32,* 525), and unsaturated alcohols with 2, 3 and more double bonds (Ueno *et al.—J. Japan Oil Chemists' Soc. 4,* 26). Human hair lipides have been analyzed for sterols, hydrocarbons, alcohols, etc. (*Liu — J. Chinese Chem. Soc., Taiwan, Ser. II, I,* 71; Nicolaides & Rothman—*J. Invest. Dermatol. 19,* 389). The squalene content of fresh and rancid olives was compared with that of many other commercial oils (Mihelic & Momirovic—*Fram. Glasnik 11,* 191).

Virulent strains of *Mycobacterium tuberculosis* contain 30–40% more lipides, particularly phosphatides, than nonvirulent ones (Pokorny—*Rozhledy tuberk. 15,* 119). The new methods for determination of inositol in phosphatides featured chromatographic separation (Böhm & Richarz — *Hoppe-Seylers' Z. physiol. Chem. 298,* 110) and colorimetric determination based on oxidation with bromine and development of a blue color in the oxidized products with phosphomolybdotungstic acid (Balatre & Traisnel—*Bull. soc. pharm. Lille 1955,* No. 1, 28). Based on ester groups, beef heart lecithin is 61% phosphatidal choline (Rapport & Alonzo—*J. Biol. Chem. 217,* 199). The phosphatides of the seed oil of *Panicum crus-galli* consisted of lecithin 23% and cephalin 76% (Obara & Kitamura—*J. Agr. Chem. Soc. Japan 29,* 37). Acetic, octanoic, propionic, hexanoic, butyric, iso-valeric, and valeric acids were identified in decreasing amounts in muscle phospholipides (Hawke—*Nature 176,* 882). These represented only 0.17% of the weight of the total fatty acids present. A photometric micromethod to determine the carboxylic acid groupings in phospholipides was based on hydroxylaminolysis followed by measurement of the liberated hydroxamic acid (Rapport & Alonzo—*J. Biol. Chem. 217,* 193).

The steam distilled odorous material from rapeseed oil contained crotonylsenevol 94–91% and angelylsenevol 1–3% (Andre & Delaveau—*Oleagineux 9,* 773). The sesamin, sesamolin, and sesamol content of sesame oil as affected by strain, location grown, aging, and frost damage has been measured (Beroza & Kinman—*J. Am. Oil Chemists' Soc. 32,* 348). The structure of sesamolin was discussed with regard to its stereochemical relationship to sesamin, asarinin, and pinoresinol (Beroza—*J. Am. Chem. Soc. 77,* 3332). Treatment of the alcohol extract of karanja oil precipitates pongamol and karanjin is extractable from the mother liquor (Jatkar & Mattoo—*Indian Chem. Soc. Ind. & News Ed. 17,* 39). Natsudaidai seed oil resembled that of other citrus seed and was also bitter, probably due to limonin (Nomura—*Yamaguchi J. Sci. 1,* 37).

The activities on gossypol were development of a modified *p*-anisidine method for determination of free and total gossypol (Miller—*J. Am. Oil Chemists' Soc. 32,* 29), a survey of the amount in Indian cottonseed oils (Rao & Murthy—*Food Technol. Res. Inst. Mysore 3,* 311), and a description of its behavior on heating in air, water vapor, and carbon dioxide (Rzhekhin—*Zhur. Priklad. Khim. 28,* 193). The pigments of whale oil start to precipitate at pH 7 and are completely precipitated at pH 3.5 (Mukai—*Bull. Japan. Soc. Sci. Fisheries 19,* 912).

The Pardum method of determining residual petroleum solvent in extracted oil gave better results when the solvent was distilled along with added acetic acid (Purr & Hettich—*Fette u. Seifen 57,* 782).

A rapid method for determination of nickel in hydrogenated oils was based on measuring the amount of color developed by reaction with dimethyglyoxime (Kul'berg *et al.—Maslobo-ino—Zhirovaya Prom. 20,* No. 1, 19). The method was com-

Oil or Fat Source	Common Saturated Acids			Common Unsaturated Acids			Other Fatty Acid Constituents
	C_{14} Myristic	C_{16} Palmitic	C_{18} Stearic	$C_{18}(-2H)$ Oleic	$C_{18}(-4H)$ Linoleic	$C_{18}(-6H)$ Linolenic	
Anamirta cocculus seed[1]		6.1	47.5	43.3	3.1		
Benincasa cerifera seed kernel[2]		10.6	5.8	20.0	1.0	62.4	C_{20} 3.0
Buffalo kidney region[5]							
Male	1.42	36.44	31.52	28.32	2.3		
Female	0.91	32.95	21.83	42.74	0.84		C_{20} 7.3
Cardamon seed[7] *Elettaria cardamomum*		8.4	18.3	62.8	10.5		C_8 and C_{10} 0.3
Cerbera odallam seed[8]		32.0	10.8	38.8	18.4		
Chaksu seed[9] *Cassia absus*	3.7	10.2	2.7	14.0	42.31		C_{20} 0.12, C_{22} 1.2, C_{24} 0.02, ricinoleic 9.8
Chimpanzee body[10]	2.4	29.8	6.8	44.4	7.9		C_{12} 0.4, C_{20} 0.2, $C_{12}(-2H)$ 0.3, $C_{14}(-2H)$ 0.8, $C_{16}(-2H)$ 5.0, $C_{16}(-4H)$ 0.1, $C_{20}(-2H)$ 1.7
Coconut of Indonesia[12]	18.0	8.4	3.7	5.8	1.5		C_6 0.2, C_8 7.7, C_{10} 9.7, C_{12} 45.0
Coconut of Solomon Islands[12]	17.4	8.6	2.0	5.5	2.2		C_6 0.3, C_8 8.1, C_{10} 8.1, C_{12} 46.3, C_{20} 1.5
Coconut of Ceylon[12]	18.9	7.6	2.5	6.3	1.7		C_8 7.3, C_{10} 7.5, C_{12} 47.8, C_{20} 0.4
Crocodile fatty tissue[14] *Gavialus gangeticus*	4.2	25.8	8.7	35.3 (−3.0H)			C_{12} 0.2, $C_{14}(-2H)$ 2.0, $C_{16}(-2H)$ 11.6, $C_{20}(-4.8H)$ 10.0, $C_{22}(-8H)$ 2.0
Fish							
Hilsa ilska body[16]	5.3	23.5	8.9	32.9	1.7	9.7	$C_{14}(-2H)$ 1.3, $C_{16}(-2H)$ 6.8, $C_{20}(-2H)$ 9.0, $C_{20}(-8H)$ 0.5, $C_{22}(-10H)$ 0.5
Leporimus affinis mesenteric[17]	2.6	23.6	7.8	34.1 (−2.6H)			C_{20} 0.6, $C_{14}(-2H)$ 0.6, $C_{16}(-2H)$ 10.5, $C_{16}(-6H)$ 0.2, $C_{20}(-5.6H)$ 14.3, $C_{22}(-8.1H)$ 5.7
Pimelodus albicans mesenteric[18]	3.2	22.7	8.4	50.5 (−2.4H)			$C_{16}(-2H)$ 7.3, $C_{20}(-5.5H)$ 5.9, $C_{22}(-9.7H)$ 1.2, C_{20} 0.6, $C_{14}(-2H)$ 0.4
Pterodoras granulosus mesenteric[19]	2.6	27.8	10.4	40.0			C_{20} 0.94, C_{14} unsatd. 0.6, C_{16} unsatd. 7.8, C_{20} unsatd. 9.7
Shark (*Carcharias melanopterus*) liver[20]	4.4	18.5	9.0	19.9 (−4.0H)			C_{20} 1.8, $C_{14}(-2H)$ 2.8, $C_{16}(-2.1H)$ 12.8, $C_{20}(-8H)$ 19.0, $C_{22}(-9.9H)$ 7.3, $C_{24}(-11H)$ 4.3
Shark (*Galeocerdo tigrinus*) liver[21]	3.0	25.1	13.8	23.6 (−2.6H)			C_{20} 1.3, $C_{14}(-2H)$ 0.4, $C_{16}(-2H)$ 7.8, $C_{20}(-5.6H)$ 15.5, $C_{22}(-10.5H)$ 9.6
Shark (*Galeocerdo tigrinus*) embryo[21]	8.6	25.1	5.1	38.2 (−2.1H)			$C_{14}(-2H)$ 0.2, $C_{16}(-2H)$ 18.0, $C_{20}(-4.4H)$ 3.9
Stromateus cinerus body[16]	4.8	20.6	11.2	33.2	3.6	3.6	$C_{14}(-2H)$ 1.4, $C_{16}(-2H)$ 9.2, C_{20} 0.5, $C_{20}(-2H)$ 7.5, $C_{20}(-8H)$ 5.0
Stromateus niger body[16]	4.4	13.3	7.3	33.2	0.4	1.7	$C_{14}(-2H)$ 2.4, $C_{16}(-2H)$ 18.8, $C_{20}(-2H)$ 4.5, $C_{20}(-8H)$ 6.7, $C_{20}(-10H)$ 3.4, $C_{20}(-2H)$ 3.4
Gourd seed[24] *Lagenaria vulgaris*		17.8		18.2	64.0		
Guinea fowl egg[25]	5.5	20.0	12.4	49.8	6.7		C_{22} (−10H) 5.6
Haloptela integrifolia seed[26]		37.6	10.0	46.7	3.6		C_{20} 2.0
Hydnocarpus wightianus seed[27]				12.4			Palmitic and lower homologues of hydnocorpic 9.6, hydnocorpic 46.4, chaulmoogric 21.5, gorlic 10.
Jatropha glandulifera seed[28]	2.3	14.5	6.0	34.2	43.0		
Linden tree fruit[29]*		6.6		38.4	49.6		
Mold fungus[30] *Aspergillus nidulans*	0.7	20.9	15.9	40.3	17.0	0.2	C_{20-24} 1.4, $C_{16}(-2H)$ 1.2, C_{20} unsatd. 2.4
Olive residue (Sulfured olive oil)[34]	0.7	13.9	1.9	64.0	15.1		C_{20} and higher satd. 0.9, $C_{16}(-2H)$ 1.6, C_{20} and higher unsatd. 2.1
Omphalea queenslandiae seed[35]		12.7	8.1	47.0	31.7	0.5	$C_{16}(-2H)$ 0.02
Palm kernel[36]	18.2	8.5	2.5	15.1	2.1		C_8 2.4, C_{10} 3.7, C_{12} 45.2, C_{20} 1.9
Pinoncillo seed[38] *Garcia nutans*		2.0		10.0	0.8		Eleostearic 85
Poinciana regia seed[40]		0.4	16.6	31.4	51.5		
Prunus communis seed kernel[42]	3.1	0.5	4.4	64.4	19.4		C_{12} 0.6, C_{20} 6.0
Puma body[43]	4.1	24.2	10.5	39.5	8.6	3.6	C_{20} 0.8, $C_{14}(-2H)$ 0.9, $C_{16}(-2H)$ 4.6, $C_{20}(-3.4H)$ 3.2
Pumpkin seed[24]		15.6		21.9	62.3		
Rosa rubiginosa seed[45]	0.4	1.6	1.5	6.6	73.6	16.3	
Rubber (Para) seed[46]		14.6		29.2	40.8	14.3	
Snake body[50]							
Python molurus		16.1	10.1	41.3	7.6	3.0	$C_{16}(-2H)$ 4.8, C_{20} 2.3, $C_{20}(-2H)$ 11.9, $C_{22}(-2H)$ 3.1
Python stinotis	1.6	15.7	13.3	36.8	9.4	3.2	$C_{14}(-2H)$ 0.2, $C_{16}(-2H)$ 5.2, C_{20} 1.0, $C_{20}(-2H)$ 12.8, $C_{20}(-8H)$ 0.8
Squash (Hubbard) seed[24]		30.9		24.7	44.4		
Swietenia macrophylla seed[52]		12.5	16.4	25.3	33.9	11.4	C_{20} 0.6
Tall oil (of Japan)[53]		5.6		56-58	36-38		(Volatile components 15)
Tamarind tree seed[54]		6.2	2.6	38.0	41.3		C_{20} 4.4, C_{22} 6.9
Tiger body[45]	3.0	26.8	10.7	38.0	6.2	6.8	$C_{14}(-2H)$ 0.6, $C_{16}(-2H)$ 5.6, $C_{16}(-4H)$ 0.2, $C_{16}(-6H)$ 0.2, $C_{20}(-4.7H)$ 1.8
Virola surinamesis seed kernel[56]	69.7	3.0	0.9	7.7	5.1		C_{10} 0.7, C_{12} 13.0
Water melon seed[34]		22.7		18.7	58.6		
Whale-liver[57] *Berardins bairdii*	1.3	17.9	14.0	30.1			C_{14} unsatd. 1.3, C_{16} unsatd. 7.4, C_{20} and higher unsatd. 28.1

* Data based on whole oil.

NEWLY RECORDED CHARACTERISTICS OF FATS AND OILS

Oil or Fat Source	% Oil or Fat	Specific Gravity	Index of Refraction	Acid No. or (% Free Fat Acids)	Saponification No.	Iodine No.	Thiocyanogen No.	Acetyl No.	Reichert-Meissl No.	Polenske No.	% Unsaponifiable
Anamirta cocculus seed[1]*	2.6	0.9057^{45}	$1.4522^{49.5}$	39.9	187.5	38.1	35.1	20.3	4.2	0.6	0.68
Ber tree seed[3]											
Zizphus jugba	33.0	0.9117^{25}	1.4631^{30}	2.4	194.5	87.4			0.62	0.88	0.81
Bombax sessile seed kernel[4]	43.6		1.4604^{40}	1.6	196.7	49.89	42.9				0.82
Buffalo kidney region (Indian)[5]											
Male		0.853^{35}	1.4250^{30}	4.0	196.3	30.6					0.30
Female		0.913^{35}	1.4350^{30}	3.6	197.4	35.1					0.31
Calophyllum wightianum seed[6]		0.921^{30}	1.4780^{30}	31.4	190.0	102.1		57.44	3.7	0.2	4.5
Cardamon seed[7]											
Elettaria cardamomum	4.0	0.9376^{25}	1.4710^{25}	32.0	209.0	90.6		8.8	11.1	1.45	5.87
Cerbera odallam seed[8]	62.1	$0.9684^{?3}$	1.4640^{30}	1.7	188.9	65.7		0.0	1.7		0.74
Chaksu seed[9]											
Cassia abusus	2.15	0.9203^{25}	1.4610^{25}	22.1	189.0	117.1		40.0	0.8	0.7	3.8
Citellus citellus body[11]**			1.4620^{25}	3.5	196.5	69.4	65.0	2.5	4.8	1.6	
Couroupita guianensis seed[13]	22.6	0.92^{30}	1.47^{30}	0.6	190.1	148.0		75.6	2.7	0.2	3.8
Fish											
Hexagrammos otakii body[15]			1.4801^{20}	55.0	184.1	153.9					2.2
Katsuwonus vagans liver[15]	3-8	0.9200^{20}	1.5035^{20}	2.14	132.6	239.0					28.6
Mugil cephalus body[15]	1.2	0.9306^{20}	1.4803^{20}	1.50	197.8	159.0					0.7
Ophiocephalus tadianus body[15]		0.9344^{20}	1.4776^{20}	19.5	173.3	116.7					9.9
Spheroids pardalis liver[15]		0.9259^{20}	1.4796^{20}	2.9	180.3	171.9					2.5
Trachurus japanicus body[15]		0.9165^{25}	1.4767^{20}	3.3	192.4	136.7					1.6
Xenogramma carinatum body[22]		0.8703^{20}	1.4617^{20}	2.6	107.4	90.6					46.6
Xenogramma carinatum viscera[22]		0.9195^{20}	1.4740^{20}	13.5	151.3	135.6					24.6
Xenogramma carinatum liver[22]		0.9271^{20}	1.4754^{20}	74.0	177.0	124.0					11.0
Gourd seed[23]											
Cucurbita pepo	33.0	0.9417^{25}	1.4720^{25}	6.8	178.4	119.0		10.6	5.3	2.1	1.3
Grampus orca[15]		0.9135^{20}	1.4701^{20}	1.0	186.5	112.3					7.5
Guinea fowl egg[26]		$0.9388^{25.5}$	$1.4640^{25.5}$	47.7		71.3		50.5	1.8	0.9	3.2
Lupinus termis seed[4]	9.1		1.4686^{40}	1.5	179.3	102.8	77.5				3.5
Mucuna pruriens seed[31]	5.9			22.4	150.1	95.4		110.0	0.6	0.4	10.5
Nagkassar seed[32]											
Mesua ferrea		0.9598^{27}	1.4780^{27}	6.1	208.6	88.4		0.0	4.8	0.5	2.9
Nigerseed [33]											
Guizotia abyssinica	31.3			(1.0)	188.8	120.5	85.4				0.6
Wild peanuts[37]											
Arachis pusilla	50.4		1.4686^{25}			100.4	69.6				
Arachis villosa	55.7		1.4677^{25}			94.7	73.1				
Pistacia lentiscus seed[39]					185.7	85.9		13.4	0.11		
Porpoise[41]											
Middle head					305.1	35.5					
Jaw oil					295.7	38.9					
Head skin		0.9348^{4}		2.1	246.1	80.4					2.97
Rapeseed (Finnish winter)[44]			1.4726^{20}	3.3	173.0	103.0					
Sapindus saponaria germ[47]	35.0	0.922^{15}	1.4662^{20}	0.6	240-5	70-3					1.6
Sesbania aegyptica seed[48]	6.0	0.9320^{15}	1.4768^{15}		185.0	108.0	66.0				1.8
Silkworm pupa[49]				(23.0)	193.0	121.0					2.4
Sterculia foetida seed kernel[51]	53.4	0.9239^{40}	1.4658^{40}	6.5	179.4	74.5		2.5			1.3
Tea seed (of India)[55]											
Thea sasanqua			1.4640^{40}	(1.7)	187.7	88.8					1.8
Whale blubber[15]											
Balaena glacialis		0.9196^{20}	1.4760^{20}	2.6	186.6	132.2					0.5
Whale blubber[57]											
Berardius bairdii		0.8748^{30}	1.4560^{40}	0.3	123.2	87.4					40.1

* Melting point 44–6°. ** Solidification point 3–4°.

pared with the gravimetric method (Lesyuis & Ovcharenko—*Ibid.* No. 3, 26).

The Averell & Norris method for detection of the insecticide, Parathion, was modified for application to olive oils (Romas *et al.*—*Oleagineux 10,* 509).

Detergents

MANUFACTURE. Poor quality raw materials were converted into suitable soaps by various treatments either on the materials themselves or on the finished soaps. Thus, partitioning residues from the distillation of resins with alcohol and benzene yielded an alcohol layer containing acids suitable for soapmaking (Tausent—*Span. 199,035*). Slaughterhouse, sewage and tannery fats were conditioned for soap making by treatment with sulfuric acid at 60° and steam deodorization (Gawenda & Niewandomski—*Glownego Inst. Przemyslu Rolnego i Spozywczego 3,* No. 3, 35). A continuous system for acidulated vegetable oil refining foots was based on heating at 175–195°F. with 4% sulfuric acid (Keith *et al.*—*J. Am. Oil Chemists' Soc. 32,* 517). In tests on improving peanut oil soapstock for conversion to distilled fatty acids better final yields were obtained when hydrolysis was by autoclaving or by a saponification with lye and acidulation than when the raw material was submitted to a preliminary acid refining (Naudet *et al.*—*Rev. franc. corps gras 2,* 222). A comparison of 13 acids and bleaching agents used singly and in combinations has indicated that partial bleaching of the soapstock with chlorine dioxide and finishing the bleaching on the soap with benzoyl peroxide was most economical (Loury—*Ibid.* 150). In bleaching of soapstock with sodium chloride the presence of stannous chloride as an activator gave better results than use of either phosphoric acid or persulfates for the same purpose (Paquot & Paquot—*Ibid.* 217). Black cottonseed soapstock was converted into hard and light colored soap by saponifying with 20% excess of 40–50% lye and heating at 170–250° (Yakubov & Khramushina-Pushkar—*Masloboino-Zhirovaya Prom. 20,* No. 3, 14). In this process palmitic and acetic acids are formed from oleic acid as in the Varentraps' reaction. Two similar processes in which small amounts of cadmium compounds (Stein & Hartmann—*U. S. 2,694,081*) and 20% water (Henkel & Cie—*Brit. 713,257*), respectively, were used as catalyst for the reaction were patented. Heating seal oil for four hours at 525°F. reduced its iodine value to 90 and made it suitable for making firm soap (Dugal & Laframboise—*Fisheries Res. Board Can. Atlantic Coast Sta. No. 59,* 27).

In directions issued for making 60% household soap without settling, the highly acid stock is boiled with enough soda ash to saponify 60% of the acids and the saponification is completed with caustic (Sheiko *et al.*—*Masloboino-Zhirovaya* Prom. 19, No. 8, 20). Manufacture of an anhydrous soap from peanut oil by adding 20 parts of glycerol per 100 parts of oil and the required amount of soda ash and heating for one hour at 250° was patented (Narayana & Leley—*Indian 50,765*). Whole peanuts were converted to a soap by crushing, adding some hydrogenated oil and rosin, and saponifying the mixture (Lorente—*Span. 198,988*). Directions have been issued for making soaps from inedible oils of India such as margosa, karanja, and undi seed oils (Kelkar—*Indian Soap J. 20,* 13). In direction for making soaps from combinations of vegetable oils and synthetic fatty acids, the raw materials are saponified separately and grained, and the resulting soaps are combined (Zalioppo *et al.*—*Masloboino-Zhirovaya Prom. 19,* No. 6, 17). This permits production of a soap with less contamination by glycerol lyes.

Pure potassium oleate soap was prepared as a white powder by saponifying oleic acid in absolute ethanol with potassium hydroxide in absolute alcohol and precipitating the soap with acetone (Kajiji & Desai—*Sci. & Culture, India 20,* 89).

New improvements were patented for continuous soap making processes. Innovations patented by Palmqvist (*U. S. 2,727,915, Swedish 148,850-1*) pertain to mixing some saponified material with the soapstock before adding the saponifying agent, to proportioning and dispersing reactants, and to regulating the amount of electrolyte to be added. Two other patents on continuous processes pertain, respectively, to emulsifying (Lachampt—*U. S. 2,726,937*) and mixing (Turcotecnia Inventrice e Sindacale—*Ital. 480,401*) equipment. A new continuous process comprised homogenizing fat with sodium carbonate solution and passing this through a heated zone under vacuum (Mulet—*Span. 211,080*).

Several reports on soap making pertained to the final steps. Data were recorded in tables and curves showing the effect of salt used in graining on the amount of electrolytes (sodium-hydroxide, -chloride, and -carbonate) in the grained and paste soaps (Manneck—*Seifen-Öle-Fette-Wachse 81,* 429). The information is for use in design of graining operations. Milling of a product comprising 5–30% potash soap and 95–70% soda soap was simplified when the operation was performed at a temperature below the crystalline reversion point of the soap (Marshall—*U. S. 2,724,702*). The process induced a desirable texture. With a new soap mill, the soap is fed to the mill from a long zone underpressure, it is submitted to shearing during milling, and discharged elongated (Marshall—*U. S. 2,723,242*). Granular soap containing alkali silicate was inhibited from agglomeration by treatment with carbon dioxide for a time sufficient to form silica on the surface, but insufficient to make the particles substantially water-insoluble (Packard—*U. S. 2,715,110*). Soap was dried in a continuous system by generating steam in the stream of moist soap to convert the stream into the two phase system of steam and dried soap before discharge (Bassett & Packard—*U. S. 2,710,057*). A patented dryer for the Mazzoni continuous process dried the soap under vacuum (Mazzoni & Mazzoni—*Ital. 478,301*). The effects of irradiation of soap blocks at various distances and temperatures with infrared lamps was determined to serve as fundamental information for design of infrared drying equipment (Ezaki & Ishikawa—*J. Chem. Soc. Japan, Ind. Sect. 57,* 626, 631). Irradiation from nearer than 30 cm. at 40–45° hindered drying because of a molten film which formed on the soap. A new patented soap plodder contained polished heating plates to give the soap a glossy finish (Garvey—*U. S. 2,713,188*).

The new information on processing the glycerol produced in soap making was on purifying it by ion exchangers (Eechelaers—*Belg. 505,125, Belg. 524,300*), and on recovering polyglycerols from glycerol distillation residues by extraction with dioxane (Rowe—*U. S. 2,717,271*).

A polyose compound added to soap as a partial substitute for soap was made by treating cellulose material with nitric

CHART REFERENCES

1. Kasturi & Iyer. *J. Indian Chem. Soc. 31,* 623.
2. Sethi & Aggarwal. *J. Sci. Ind. Res., India 13B,* 853.
3. Rao & Laxmikantam. *Indian Soap J. 19,* 94.
4. Grindley & Akour. *J. Sci. Food Agr. 6,* 461.
5. Dhingra *et al. J. Indian Chem. Soc. Ind. & News Ed. 16,* 172.
6. Nair & Varier. *Bull. Central Res. Inst. Univ. Travancore Ser. A. 3,* 161.
7. Kasturi & Iyer. *J. Indian Inst. Sci. 37A,* 106.
8. Subbaram. *J. Madras. Univ. 22B,* 223.
9. Gupta *et al. Res. Bull. Panjab Univ. No. 48,* 63.
10. Gunstone. *Biochem. J. 59,* 454.
11. Rankov & Popov. *Compt. rend. acad. bulgare sci. 7,* No. 1, 9.
12. Dale & Meara. *J. Sci. Food Agr. 6,* 162.
13. Bai. *Bull. Cent. Res. Inst. Univ. Travancore Ser. A, 3,* 114.
14. Pathak & Pande. *J. Sci. Food Agr. 6,* 48.
15. Toyama & Takai. *J. Oil Chemists' Soc. Japan 3,* 268.
16. Karkhanis & Magar. *J. Am. Oil Chemists' Soc, 32,* 492.
17. Brenner *et al. Anales asoc. quim. Argentina 42,* 192.
18. Brenner *et al. Ibid. 43,* 67.
19. Brenner *et al. Ibid. 42,* 95.
20. Pathak & Pande. *J. Am. Oil Chemists' Soc. 32,* 7.
21. Pathak & Suwal. *Ibid.* 229.
22. Matsumoto *et al. J. Japan Oil Chemists' Soc. 4,* 131.
23. Narayanamurthy *et al. Indian J. Pharm. 16,* 148.
24. Chowdhury *et al. J. Am. Oil Chemists' Soc. 32,* 384.
25. Airan & Kalyanka. *J. Indian Chem. Soc. Ind. & News Ed. 15,* 175.
26. Farooq & Siddiqui. *Fette u. Seifen 57,* 389.
27. Nair & Varier. *Indian Soap J. 19,* 225.
28. Sheth & Desai. *J. Indian Chem. Soc. 31,* 407.
29. Dima *et al. Acad. Rep. Populare Romine Studii Cercetari Chim. 2,* 89.
30. Singh & Walker. *Biochem. J. 61,* 85.
31. Nair & Pillai. *Bull. Cent. Res. Inst. Univ. Travancore Ser. A, 3,* 83.
32. Kasturi *et al. J. Sci. Ind. Res., India, 13A,* 453.
33. Rao & Swaminath. *Indian Soap J. 19,* 135.
34. Fuhrmann. *J. recherches. Centre. Labs. Bellevue* E, 325; *Rev. franc. corps gras* 2, 237.
35. Hatt & Szumer. *J. Sci. Food Agr. 5,* 534.
36. Dale & Meara. *Ibid. 6,* 162.
37. Pickett. *J. Am. Oil Chem. Soc. 32,* 521.
38. Madrazo & Sierra. *Ciencia, Mex., 14,* 208.
39. Cordella. *Chim. e ind., Milan 35,* 912.
40. Murthy & Iyer. *J. Indian Inst. Sci. 36,* 155.
41. Nakamura & Isujino. *J. Agr. Chem. Soc., Japan, 26,* 642.
42. Dhingra & Dhingra. *Indian Soap J. 18,* 187.
43. Gunstone. *Biochem. J. 59,* 455.
44. Kirjakka & Kivisto. *Suomen Kemistilehti 27B,* 65.
45. Cattaneo & Sutton. *Anales asoc. quim. Argentina 42,* No. 2, 108.
46. Tuason & Cruz. *Philippine J. Sci. 82,* 341.
47. Fenandez, F. *Congr. farm. bioquim. peruano y convencion farm norte Actas y Trabajos 1953,* 398.
48. Bhatty & Karimullah. *Pakistan J. Sci. Res. 6,* 70.
49. Hagmann. *Mitt. schweiz. entomol. Ges. 27,* 441.
50. Karkhanis & Magar. *Biochem. J. 60,* 565.
51. Verma *et al. Oils & Oilseed J., India 7,* No. 6, 10.
52. Chowdhury *et al. Sci & Culture, India, 20,* 52.
53. Matsumoto & Hirai. *J. Oil Chemists' Soc., Japan, 3,* 270
54. Tawakley & Bhatnagar. *Indian Soap J. 19,* 113.
55. Chakrabarty & Chakrabarty. *Ibid. 20,* 16.
56. Pinto. *Rev. quim. ind. Rio de Janeiro 23,* 98.
57. Saiki *et al.* Bull. Japan. Soc. Sci. *Fisheries 19,* 611, 614, 619, 809, 1028; *20,* 396, 401.

acid followed by treatment with sulfites or thiosulfates (Nederlandsche Org. Toegepast-Natuurwetenschappelijk, Handel en Verkeer—*Brit. 711,238*). A mixture of water-soluble resins and hydrolyzed albumin was also added to soap products as partial substitutes (Justeau—*Fr. 985,589*). A patented liquid soap contained soap and saponin (Perez *et al.*—*Span. 211,044*).

Various compounds were added to soaps for special purposes. A mixture of soap and unsaponifiable material prepared from wool fat was patented as a superfatting agent for toilet soaps (Kollontay—*Ger. 825,117*). Excess alkali in soap lowers its vapor pressure as well as water absorption (Kawaguchi & Nobori—*J. Chem. Soc. Japan Ind. Sect. 57*, 573). Urea was added to liquid shaving soaps to prevent solidification (Kelber —*Ger. 825,118*). Cream shampoos were protected against microbial attack by addition of N-hydroxymethylphthalimide (Owen *et al.*—*U. S. 2,711,397*). Development of microbial stains on solid soaps during humid weather was inhibited with sodium dithionite or thiosulfate (Hollo & Gorog.—*Agr. Chem. Technol. Univ. Budapest 1952–1954, 181*). Trisphenols were incorporated into toilet soaps to induce antiseptic properties (Beaver *et al.*—*U. S. 2,713,036*). Bleaching and softening qualities of laundry soaps were improved by addition of organic sulfates (Roig & Bonas—*Span. 215,175*). Tensile tests on washed cloths have indicated that perborated soaps for washing cotton fabrics should not contain over 15% sodium perborate (Krässig—*Melliand Textilber 36*, 55). An investigation on stability of perborates in soaps and soap solutions has shown that copper is detrimental; silicates and phosphates are protective at high pHs; and synthetic detergents are also protective (Linder—*Fette u. Seifen 57*, 575; *Riechstoffe, Parfums, Seifen 1955*, No. 8, 13). The new fluorescent whitening agents intended for use in or in connection with detergents were principally derivatives of stilbene (Roberts—*U. S. 2,723,288*, Farbenfabriken Bayer A.-G.—*Brit. 715,239;* J. R. Geigy A.-G.—*Swiss 286,338-41;* Ciba Ltd.—*Swiss 287,194, 298,024;* Hein & Pierce—*J. Am. Chem. Soc. 76*, 2725). Certain triazole derivatives were patented for the same purpose (Lubs & Sartori—*U. S. 2,720,528*). Laboratory experiments and practical tests were used to demonstrate that commercial optical whitening agents were not corrosive to copper laundering equipment (Uhl —*Fette u. Seifen 57*, 793). An increase in the silicate content of heavy-duty household detergent reduced its corrosiveness to zinc and inhibited staining of brass and nickel silver (Getty *et al.*—*ASTM Bull. No. 205*, 50). The tendency of phosphate-containing detergents to tarnish metals was inhibited with aryl biguanides (Tundermann—*U. S. 2,706,179*), with thiocabazones or thiuram sulfides (Sylvester—*U. S. 2,706,180*) and with heterocyclic dithiazine compounds (Krems—*U. S. 2,687,379*).

Various soap formulations were made for specific uses. The new degreasing and metal cleaning mixtures comprised: ammonium soaps of highly unsaturated acids and amyl ester solvent (Martin—*Span. 208,342*), a combination of soap, sodium carbonate, clay, and water (Mattesini—*Ital. 479,207*), a mixture of ammonium soap, silicate and petroleum derived solvent (Prod. Belbainos para Ind. S. A.—*Span. 210,262*), a mixture of mineral oil, chlorinated hydrocarbons, magnesium soap, and lower alcohol (Johansson—*Swed. 150,498*), and a paste made from various inorganic cleaners (Nitsche—*Swed. 149,348*). An emulsified cleaner contained benzene, xylene or trichloroethylene, sodium carbonate, and soap of cocoanut fatty acids (Pogany—*Span. 209,881*). A cleaning and polishing composition contained soap, silica, flour or pumice, glycerol, water, and pine oil (Smith—*Can. 490,156*). A stain-forming or color-providing material was added to an abrasive detergent cleaner so that its dispersion becomes visible and in use it clung to the dirt or other particles that must be removed (Houser—*U. S. 2,708,157*). A foaming or bubble soap solution contained fatty alcohol sulfate, borax, gums, and carbon dioxide producing agent (Ceimertz—*Swed. 149,843*). A foamless laundering detergent was prepared by mixing soap, trisodium phosphate, and polyoxyethylene ester type nonionic detergent (McDonald—*U. S. 2,697,695*).

In investigations on manufacturing synthetic detergents from animal fats, the sodium 9,10-dichloroöctadecyl sulfates (Weil *et al.*—*J. Am. Oil Chemists' Soc. 32*, 148) and the esters of α-sulfonated fatty acids and isethionates (*Ibid. 370*) were prepared and evaluated. The former resembled sodium oleyl sulfate in detergent properties; and the latter were good detergents, were resistant to alkaline or acid hydrolysis, but had poor foaming properties. In similar work, sulfated tallow alcohols were prepared and tested (Osipow *et al.*—*Ind. Eng. Chem. 47*, 492). These were not sufficiently soluble for use as liquid detergents, but were successfully used in combination with other synthetic detergents. For cotton and wool detergency, combinations of equal amounts of unsaturated and saturated tallow alcohol sulfates proved superior to combinations of the products with other detergents.

Data of the effect on refractive index, heat evolution, and strength, reaction time, reaction temperature, etc. of sulfating acid obtained for designing a continuous sulfation of fatty acid process were recorded (Whyte—*J. Am. Oil Chem. Soc. 32*, 313). Best results were obtained on operating at 160°F. for 10 seconds' reaction time using 99% sulfuric acid. The effect of time, concentration of acid, and molar ratio of oleic acid to sulfuric acid were determined for the sulfation of oleic acid in carbon tetrachloride (Mehta *et al.*—*J. Indian Chem. Soc., News Ed., 15*, 111). Maximum sulfation was obtained with 1:3.5 molar ratio of oleic acid to 36 *N* sulfuric acid. Formation of sulfonic acid anhydride, a fault in sulfonation with sulfur trioxide, was prevented by additions of small amounts of water (Gilbert & Veldhuis—*Ind. Eng. Chem. 47*, 2300).

Surface active agents prepared from ricinoleic acid and its ester with sulfamic acid did not foam well, but were superior to many commercial detergents in emulsifying ability (Komori *et al.*—*J. Chem. Soc. Japan Ind. Sect. 57*, 83). Erucic acid was converted to various detergent products by reaction of the chloride with *n*-methyltaurine, and with sarcosine, by conversion to alcohol and then the sulfate, and by reaction with formaldehyde and pyridine; and the utility of the products were discussed (Fulde—*Prace Glownego Inst. Prezem, Rolnego i Spozywczego 3*, No. 3, 13). The lauric, myristic, palmitic and stearic diethanolamides have been prepared from fatty acid chlorides and excess diethanolamine, and their properties were determined (Trowbridge *et al.*—*J. Org. Chem. 20*, 990). Detergent compounds of the polyoxyethylene type which are fluids were converted to solids by adding urea and holding at room temperature (Barker & Ranauto—*J. Am. Oil Chem. Soc. 32*, 249). The solid products may be converted to powders, flakes, bars, or pellets.

The literature communications on making detergents from mineral oil products or hydrocarbons of Fischer-Tropsch synthesis were on synthesis of the intermediate dodecylbenzene (Sharrah & Feighner—*Ind. Eng. Chem. 46*, 248), preparation and properties of dodecylbenzene sulfonate (Baldacci — *Riv. combustibili 8*, 712), alkylphenol esters of polyethylene glycol (Kogan—*Khim Prom. 1954*, 105), sulfonic acids from hydrocarbons of Fischer-Tropsch synthesis (Kowalski & Weghofer—*Prezemysl Chem. 9*, 138; Ravenscroft & Turney—*J. Am. Oil Chemists' Soc. 32*, 418), sulfonated detergents from chlorinated petroleum products (Kunugi & Kudo—*J. Chem. Soc. Japan, Ind. Sect. 57*, 728; *58*, 23), sulfonated naphthalene oil (Kunugi & Arakawa—*Coal Tar, Japan 7*, 16), and products prepared from benzene or toluene, lower and higher alcohols, and sulfuric acid (Fukuzumi *et al.*—*Res. Rept. Nagoya Ind. Sci. Res. Inst. No. 7*, 36).

Other literature on synthetic detergent manufacture are patents on manufacturing techniques and products. For convenience of presentation these are cited below under the name of the assignee or patentee:

Aktieselskabet Grindstedvzaerket
Neutralization of organic sulfonation and sulfation products (*Brit. 727,275*).

Allied Chemical & Dye Corp.
Sulfonation of alkylates (*U. S. 2,704,295, 2,723,990*).

American Cyanamid Co.
Free-flowing dialkyl sulfosuccinate detergents (*U. S. 2,702,818*). Adding epichlorohydrin to a mixture of rosin acid and diethylene triamine which had previously been acetylated (*U. S. 2,708,666*). Condensates of polyalkylene polyamines and tall oil (*U. S. 2,710,856, Brit. 716,128*).

Aug. Luhn & Co.
Refining sodium salts of alkanesulfonic acids (*Ger. 827,065, Cl. 12o*).

Badische Anilin- & Soda-Fabrik
Diphenyl sulfone derivatives (*Ger. 764,384, Cl. 12o*). Polyglycol ether of ketonic C_6–C_{10} fatty acids (*Ger. 767,812, Cl. 12o*). Similar ether of alkyl phenols (*Ger. 767,842, Cl. 12q, Ger. 834,567, Cl. 12o*). Certain quaternary ammonium compounds (*Ger. 767,843, Cl 12q*). Sulfonates of hydrocarbons resulting from carbon monoxide hydrogenation (Ger. *852,689, Cl. 12o*).

Bayerische Stickstoff-Werke A.-G.
Guanidinesulfonic acid (*Ger. 763,865, Cl. 12o*).

Bersworth, F. C.
Alkylene polyamine derivatives (*Brit. 721,196*).

Blumenthal, Armin
Alkylaryl sulfonate bound with estergum and stearic acid (*U. S. 2,714,093*).

Böhme Fettchemie G.m.b.H.
Condensation products of fatty halogen products and hexamethylenetetramine (*Ger. 867,854, 12p*). Preparation of organic sultone compounds and conversion of these to sulfonates (*Ger. 887,341, 901,054, 901,288, 904,894, 907,892, Cl. 12o*). Sulfonated organic hydroxy, sulfide, amines, and hydroxy compounds containing double bonds (*Ger. 902,737, Cl. 12o*).

Bray, U. B.
Purification of petroleum sulfonates (*U. S. 2,689,221*).

British Petroleum Co., Ltd.
Alkyl sulfate from hydroperoxides obtained in oxidation of paraffin (*Brit. 728,433*).

California Research Corp.
Esters of alkylphosphonic acids (*U. S. 2,670,367*). Esters of alkenylphosphonous acids (*U. S. 2,686,803*). Quaternary taurine-type compounds (*U. S. 2,697,116*). N,N-di(alkylbenzyl-N-alkanol glycines (*U. S. 2,697,656*). Non-caking monoalkyl benzene sulfonic acid (*U. S. 2,709,684–7*).

Cassella Farbewerke Mainkur A.-G.
Fatty alcohol esters of sulfophthalic acid (*Ger. 849,106, Cl. 12o*).

Chemische Fabrik R. Baumheier
Sulfonated naphthalenes (*Ger. 762,904, Cl. 12o*).

Chemische Werke Hüls G.m.b.H.
Purification of anion-active detergents (*Ger. 825,258, Cl. 12o*).

Colgate-Palmolive Co.
Neutralizing sulfonated compounds (*U. S. 2,690,446, Ger. 867,393, Cl. 12o*). Continuous sulfonation (*U. S. 2,693,479*). Soap-sulfated monoglyceride combination toilet soap (*U. S. 2,704,279*). Long chain aliphatic ether-amides in detergents (*U. S. 2,704,280*). Substituted urea having a long-chain alkyl radical in detergents (*U. S. 2,708,183*). Apparatus for removing salts from sulfated monoglycerides (*U. S. 2,710,250*). Detergents containing imides (*U. S. 2,717,878*). Sulfonated detergents containing alkyl mononuclear aryl sulfonamide (*U. S. 2,721,847*).

Commercial Solvents Corp.
Reaction of fatty ester with an N-mono-alkylglucamine (*U. S. 2,703,798*).

Dehydag Deutsche Hydrierwerke G.m.b.H.
Disulfimides and their salts (*Ger. 757,603, Cl. 12o*). Sulfonation products of tetralin and its homologs (*Ger. 852,-690, Cl. 12o*). Condensation products of proteins and ether carboxylic acids (*Ger. 861,250, Cl. 12p*).

Dow Chemical Co.
Hydroxy aralkylene ethers of arene sulfonic acids (*U. S. 2,694,087*). Hydroxy derivatives of carboxylated alkylene polyamines (*Brit. 727,483*).

E. I. du Pont de Nemours & Co.
Reaction products of salts of dialkyl dithiocarbamic acids with ammonia or amines (*U. S. 2,692,862*). Long-chain unsaturated diketones (*U. S. 2,671,810*). Mixture of N-dodecylacetamide and other detergents (*U. S. 2,702,278*). Mixtures containing N-alkyl betaines (*U. S. 2,702,279*).

Elektrochem. Fabrik Kempen/Rhein Brandenburg & Weyland G.m.b.H.
Cation-active amides and esters (*Ger. 860,495, 12p*).

Esso Research and Engineering Co.
Sulfonated detergent blends (*U. S. 2,712,530, 2,730,240*).

Farbenfabriken Bayer A.-G.
Polyglycol ethers of monohydroxy derivatives of aromatic compounds (*Ger. 824,949, Cl. 12s*).

Farbwerke Hoechst A.-G. Lucius & Brüning.
Sulfonated nonaromatic hylohydrocarbons (*Ger. 903,814–15, 907,052–4, Cl. 12o*). Sulfonated products from ethers (*Ger. 917,602, Cl. 12o*).

Farmaceulici Italia Soc. Anon.
Salts of alkyl ethers of 2,4-diguanidinophenol (*Brit. 730,-394*).

J. R. Geigy A.-G.
Basic polyglycol ethers (*U. S. 2,717,270*).

General Aniline & Film Corp.
N-Alkylbenzenesulfonyl-N-alkyltaurates (*U. S. 2,694,727*). Mixture of polyalkylene glycol type detergent and vinyl methyl ether-maleic anhydride polymer (*U. S. 2,702,277*). Condensed product of dehydroabietinyl amine with ethylene oxide (*U. S. 2,703,797*).

General Mills, Inc.
N_1 N-dialkylmorpholinium chlorides (*U. S. 2,694,707*). Reacting a β-alanine detergent with an aldehyde (*U. S. 2,-720,536*).

Th. Goldschmidt A.-G.
Fatty amine derivatives (*U. S. 2,684,946*).

Henkel & Cie G.m.b.H.
Sulfonation with sulfonylchloride (*Ger. 765,194–5, 12o*). Sulfonates of alkylated tetrahydronaphthalenes (*Ger. 754,-122, Cl. 12o*). Salts of alkylaromatic sulfonic acids (*Ger. 767,014, 859,545, Cl. 12o*). Arylsulfonic acids (*Ger. 816,855, Cl. 12o*). Sulfocyanoguanidides (*Ger. 824,941, Cl. 12o*).

Imhausen & Co. G.m.b.H.
Hydrocarbon sulfonates (*Ger. 883,895, 921,939, Cl. 12o*).

Imperial Chemical Inds., Ltd.
Esters of aryl phosphoric acids (*Brit. 699,080*). Decolorizing sulfonic acid esters (*Brit. 723,330*).

M. M. Kellogg Co.
Apparatus for sulfonation of petroleum hydrocarbons and refining of products (*U. S. 2,700,052*).

Koppers Co., Inc.
Polyglycol-phenol condensate products (*U. S. 2,709,683*).

Laboratories Espanolas Zeltia, S. A.
Alkylarylene sulfonates (*Span. 202,470*).

Lobitos Oilfields, Ltd.
Alkyl aromatic sulfonates (*Brit. 735,221*).

Margarita Mas & R. de Luzuriaga
Neutralization and refining of sulfated alcohols (*Span. 209,386*).

Märkische Seifen-Industrie
Sulfonates of C_8–C_{10} alcohols and ketones obtained by hydrogenating palm-kernel oil (*Ger. 764,950, Cl. 12o*). Sulfonated secondary alcohols (*Ger. 767,428, Cl. 12o*).

Monsanto Chemical Co.
Polyglycol ethers of 2-butyl-1-octanol (*U. S. 2,671,115–16*). Hydroxyethylated-N-kerylalkenediamines (*U. S. 2,695,314*).

Procter & Gamble Co.
Mixture of builders and anionic synthetic detergents (*U. S. 2,712,529*).

N. V. de Bataafsche Petrol. Maatschappij
Dry mixtures of sulfonated detergents and proteins (*Dutch 76,296*).

Pharmachemisch Lab.
Quaternary ammonium derivatives of 1,2-dihydroxy-3-aminopropane (*Brit. 704,014*).

Philadelphia Quartz Co.
Quaternary ammonium base silicates (*U. S. 2,689,245*).

Purex Corp. Ltd.
Alkylarylsulfonates (*U. S. 2,703,788*).

Rohm & Haas Co.
Hydroxyalkylamines (*U. S. 2,689,263*).

Ruhrchemie A.-G.
Neutralizing sulfonic acids with carbonates (*U. S. 2,688,-035, Brit. 716,521, 727,669, Ger. 853,443, Cl. 12o*). Sulfonated paraffin hydrocarbons (*Ger. 764,597, 765,130, Cl. 12o*). Aldehyde sulfonates (*Ger. 843,851, Cl. 12o*). Sulfonates of alcohols and aromatic compounds (*Ger. 883,896, Cl. 12o*).

Scottish Oils Limited
Sulfonated shale oil fraction (*U. S. 2,708,185*).

Shell Development Co.
Oil-soluble organic sulfonates (*U. S. 2,708,182*).

Soc. anon. matieres colorantes et products chimiques Francolor
Amino-aryl sulfonates (*Brit. 694,929, Fr. 983,965*).

Soc. anon. innovations chim: Sinnova ou Sadic
Sulfonated aromatic ethers (*Fr. 983,931*). Sodium alkylbenzene (*Fr. 985,042*).

Stamicarbon N. V.
Apparatus for sulfonation (*Brit. 718,551*).

Standard Oil Development Co.
Refining alkylaryl sulfonates (*U. S. 2,688,633*). Recovery of mahogany sulfonates (*U. S. 2,692,278*).

Sun Oil Co.
Gaseous sulfonating agent (*U. S. 2,722,543*). Mahogany sulfonates (*U. S. 2,724,697*).

Tanaka, Y.
Reaction product of undecyl methyl ketone, phenol, and sulfuric acid (*Japan 2430–54*).

Quesnel, G. L.
Quaternary ammonium derivatives (*Fr. 983,467*).

Union Tecnica Ind. Chim. e Agr.
Mixture of alkylaryl sulfonate polyoxyethylene esters (*Ital. 484,068*).

U. S. Am. as per the Secy. of Agr.
Sulfonated substituted gluconamides (*U. S. 2,670,345*).

Universal Oil Products Co.
Alkylaryl sulfonated detergents (*U. S. 2,670,390, 2,698,864, 2,703,330, 2,717,243*).

Vereinigte Glanzstoff-Fabriken
Hydrochlorides of amino-substituted petroleum hydrocarbons (*Ger. 767,087, 12q*).

Wyandotte Chemicals Corp.
Polyoxyethylene derivatives (*Brit. 722,746*).

Zeppelin-Chemie Konstanz
Refining condensation products of degraded proteins and fatty acids (*Ger. 842,491, Cl. 12p*).

Many other communications on soaps and detergents were reviews or contained general information on history, economy, manufacture, or description of commercial products. For convenience of presentation these are classified and cited under the subject treated:

Reviews:
History of soap and detergent making (Gellendien—*Fette u. Seifen 56,* 170; Levey—*J. Chem. Ed. 31,* 521). Developments in soapmaking (Palmason—*Chemistry & Industry 1955,* 722; Marroc—*Rev. franc. corps gras 2,* 496). Progress and problems in detergent chemistry (Stüpel—*Chimca, Switz. 9,* 175). Development of alkylaryl sulfonate-type detergents (Bunce—*School Sci. & Math. 54,* 637). Detergent patents (McCutcheon—*Soap & Chem. Specialties 31,* No. 6, 73). Detergents in Britain (Kertess—*Ibid.* No. 8, 37). Soap in Soviet Russia (Adams—*Ibid.* No. 12, 50). Soap in Columbia (Knorr—*Seifen-öle-Fette-Wachse 81,* 431). Soap industry in Taiwan (Sun & Ho—*Chemistry, Taiwan, 1955,* No. 1, 49). Detergent industry in Japan (Mikumo—*Coal Tar, Japan 6,* 473).

Raw materials:
Properties of fatty acids and oils in relation to soap making (Marroc—*Rev. franc. corps gras 2,* 577). Fatty alcohols as detergent raw material (Hatcher & Sullivan—*Proc. Chem. Specialties Mfrs. Assoc. 1953,* 170). Impurities in soap stock (Smith—*Am. Perfumer Essential Oil Rev. 65,* No. 6, 73).

Manufacture of soap:
The Mazzoni continuous process (Fock—*Seifen-öle-Fette-Wachse 81,* 79; Lanteri—*Fette u. Seifen 56,* 250; Massa—*Grasas y aceites, Spain 5,* 78; Ricard—*Rev. franc. corps gras 2,* 695). New continuous saponification processes (Weber—*Seifen-öle-Fette-Wachse 81,* 201, 241). Semicontinuous saponification (de Negourski—*Rev. quim. ind., Rio de Janeiro, 23,* 170). Use of statistical methods in soap making (de Jong—*Rev. franc. corps gras 2,* 703). Rapid method of making soap diagrams (Loury—*Ibid.* 225). Coagulation of curd soaps in making soap powders (Weber—*Seifen-öle-Fette-Wachse 81,* 140, 159). Spraying in spray drying (Barboux—*Rev. franc. corps gras 2,* 699). Spray drying of synthetic detergents (Stüpel & von Segesser—*Seifen-öle-Fette-Wachse 80,* 545). Storing fat and soap chips (Smith—*Am. Perfumer Essential Oil Rev. 65,* No. 5, 42). Glycerine technology (Eeckelaers—*Rev. franc. corps gras 2,* 681). Glycerol distillation (Stage—*Fette u. Seifen 57,* 415).

Soap defects:
Defects in toilet soaps (Fock—*Seifen-öle-Fette-Wachse 81,* 324, 349, 380). Rancidity in soaps (Myddeton—*Am. Perfumer Essential Oil Rev. 65,* No. 4, 56). Improving color of soap (Zilske—*Seifen-öle-Fette-Wachse 80,* 548, 585). Blisters in soap (anon.—*Rev. franc. corps gras 2,* 737).

Miscellaneous soap products:
White toilet soap (Weber—*Seifen-öle-Fette-Wachse 81,* 1). Cake detergents (Manneck—*Ibid.* 162, 192). Potassium soaps (Somadadhan & Ghose—*Indian Soap J. 20,* 183). Transparent soaps (Wells—*Soap & Chem. Specialties 31,* No. 6, 39; No. 7, 43). Floating soap (Wells—*Ibid.* No. 9, 41; No. 10, 45). Soap flakes (Weber—*Ibid.* No. 10, 73). Spray process soap (Stockmann—*Oils & Oilseed J., India, 7,* No. 12, 8; Tum—*Seifen-öle-Fette-Wachse 81,* 137).

Builders and additives:
Builders (Smith—*Am. Perfumer Essential Oil Rev. 65,* No. 4, 54). Phase equilibria of solutions of alkali orthophosphates (Wendrow & Kobe—*Chem. Rev. 54,* 891). Condensed phosphates (Thilo—*Angew. Chem. 67,* 141; Schuster—*Seifen-öle-Fette-Wachse 81,* 28, 53). Silicates (Landmann—*Ibid.* 25; de Nagourski—*Rev. quim. Ind., Rio de Janeiro 23,* 146; Smith—*Am. Perfumer Essential Oil Rev. 65,* No. 4, 54). Soda ash as a soap builder (Smith—*Ibid.* No. 2, 52). Cellulosic carboxydextrins in soap making (Antykov.—*J. Appl. Chem. U.S.S.R. 26,* 771). Permulgin additive (Weber—*Seifen-öle-Fette-Wachse 81,* 345). Perfuming soap (Wells—*Soap & Chem. Specialties 31,* No. 2, 33; No. 3, 50; No. 4, 51; DiGiacomo & Stoller—*Ibid.,* No. 7, 41; Wight—*Ibid.,* No. 11, 48; Sfiras—*Rev. franc. corps gras 2,* 406). Optical brighteners (Siegrist—*Soap & Chem. Specialties 31,* No. 11, 44; No. 12, 58; Adams—*Perfumery Essential Oil Record 45,* 303). Disinfectant phenolic additives (Jerchel & Oberheiden—*Angew. Chem. 67,* 145). Hexachlorophene (Paoletti—*Boll. Soc. ital. biol. sper. 28,* 1602). Iodine liberating chemicals (Gershenfeld—*Soap & Chem. Specialties 31,* No. 5, 164; No. 6, 163). Germicidal soaps (Goldschmiedt—*Ibid.* No. 8, 40). The germicide N-[2-(2-dodecylaminoethylamino) ethyl] glycine (Lhoest & Mirimanoff—*Schwiez. Apoth-Ztg. 92,* 713).

Synthetic detergents:
Reviews (Dios Guevara—*Bol. soc. quim. Peru 20,* 83; Cooke—*Ceylon Coconut Quart. 5,* 131; Herrera—*Grasas y aceites, Spain 5,* 167; Sisley—*Rev. franc. corps gras 2,* 584; Brooks—*Chem. Products 18,* 136). Detergents from albumins (Struve—*Seifen-öle-Fette-Wachse 81,* 4). Fatcarbohydrate derivatives (Sisley—*Rev. franc. corps gras 2,* 305). Nonionic detergents (Cook—*Soap & Chem. Specialties 31,* No. 5, 47; Mayhew *et al.*—*Ibid.* No. 7, 37; *Proc. Chem. Specialties Mfrs. Assoc. 1955,* 156). Sultones from sulfonation (Chapman—*Univ. Microfilms, Ann Arbor, No. 9229,* 117 pp.). Alkyl sulfates (Linder—*Seifen-öle-Fette-Wachse 81,* 83). Alkylaryl sulfonates and detergents from petroleum sources (Inskeep & Mussard—*Ind. Eng. Chem. 47,* 2; Sherwood—*Petroleum, London 18,* 10; Li & Su—*Chemistry, Taiwan, 1955,* No. 1, 43; Martens—*Seifen-öle-Fette-Wachse 80,* 517; Griesinger & Hersberger—*World Petrol Congr. Proc. 3rd Congr. 1951,* Sect. V, 97; Snell & Reich—*Ibid.* 99; Snell *et al.*—*Ibid.* 109; Skeen & Snell—*Ibid.* 119; Lewis *et al.*—*Ibid.* 127). Cation-active fatty substances (Heide—*Faserforsch u. Textiltech. 2,* 273). Cost of construction of a sulfonation plant (Hardy—*Ind. Eng. Chem. 47,* No. 4, 79A). Mechanical dishwashing detergents (Albrecht—*Soap & Chem. Specialties 31,* No. 2, 44).

Theories on detergency:
General theory of surface active agents (Kaertkemeyer—*Ind. Chim. Belge 20,* 633). Surface active substances in solution (Stauff—*Z. Elektrochem. 59,* 245; Saha—*Indian Soap J. 19,* 259; Roth—*Fette u. Seifen 56,* 932). Surfactant properties (Hilfer—*Drug & Cosmetic Ind. 76,* 761). Structure and composition of detergents (Manneck—*Seifen-öle-Fette-Wachse 81,* 133). Theory of washing (Kling—*Z Elektrochem. 59,* 260). Micelle formation and solubilization in nonaqueous solvents (Singleterry—*J. Am. Oil Chemists' Soc. 32,* 446).

Analysis and evaluation:
Qualitative analysis of washing agents (Hempel & Hintermaier—*Fette u. Seifen 57,* 185). Detection and quantitative determination of surface active agents with ion exchangers (Winterscherdt—*Seifen-öle-Fette-Wachse 81,* 433). Review of development of analytical methods for soap and detergents (Harris—*Proc. Chem. Specialties Mfrs. Assoc. 1953,* 126). Analysis of synthetic soaps (Tschoegl—*Revs. Pure & Appl. Chem., Australia 4,* 171). Analysis of alcohol sulfates and alkylaryl sulfonates (Lassieur—*Chim anal. 37,* 39). Detergency measurements (Armbruster & Ridenour—*Chem. Specialties Mfrs. Assoc. Proc. 1952,* 123; Manneck—*Seifen-öle-Fette-Wachse 80,* 583, 611; *81,* 275, 321).

Toxicity and germicidal action:
Evaluation of germicidal soaps (Gee & Seidenberg—*Proc. Chem. Specialties Mfrs. Assoc. 1954,* 70; Zilske—*Seifen-öle-Fette-Wachse 80,* 467, 491). Bactericidal and bacteriostatic power of detergents (Vallee—*Teintex 20,* 92). Detergent and disinfectant, Quartasept (Reuter—*Fleischwirtschaft 7,* 60). Toxicity of soap, detergents and sanitizers (Barail—*Chem. Specialties Mfrs. Assoc. Proc. 1952,* 132; Faillie—*Ibid. 1954,* 134). Skin toxicity and sensitivity of cosmetic materials (Lubowe—*Ibid.* 135). Irritant and sensitizing effect of detergents (Birmingham—*Ibid.*

140). Emollients in detergents (Suter—*Ibid.* 141). Dermatology from detergent additives (Vicklund—*Ibid.* 143). Soap and dermatology (Sidi—*Rev. franc. corps gras 2,* 602). Manufacturers' liability on detergent products (Thomssen —*Soap & Chem. Specialties 31,* No. 8, 75).

Soap and detergents in use:

Use of surface active agents (Tschakert—*Seifen-öle-Fette-Wachse 80,* 609, 635, 661, 690). Place of soap among household detergents (Naudet—*Rev. franc. corps gras 2,* 313). Application in production and processing of some synthetic fibers (Weigand—*Fette u. Seifen 57,* 564). Use in textile processing (Rordorf—*Z. ges. Textil-Ind. 55,* 554, 850; Pacifico & Giers—*J. Am. Oil Chemists' Soc. 32,* 231). Use in the wool textile industry (Stoves—Fibres-Natural *Synthetic 15,* 19). Cleaners for airliners (Southwick—*Soap & Chem. Specialties 31,* No. 1, 44). Effect of synthetic detergents on waste treatment (Flett *et al.*—*J. Am. Oil Chemists' Soc. 32,* 166).

CHEMICAL ANALYSIS. A new method for the determination of total fatty acids in soaps was based on heating an excess of calcium chloride solution with a solution of the sample, filtering and titrating the excess calcium with ethylenediaminetetraacetate (Webster & Robertson—*Analyst 80,* 616). Two other methods for the same purpose are derived from the dairy industry; they are similar, respectively, to those of Gottlieb-Rose (Marini—*Olii grassi, colori, minerali saponi, vernici 27,* 124) and of Gerber (Lukaszewicz—*Rocziniki Panst. Zakladu Hig. 2,* 101). Chlorides were determined in detergents by removing chlorine ion on "Dowex-2" resin, eluting with *N* alkali and titration with silver nitrate (Pomeranz—*Chemist Analyst 43,* 89). A procedure for determining soluble silicates was based on reaction with hydrofluoric acid in hydrochloric acid solution (Lawson *et al.*—*Anal. Chem. 27,* 1810).

Apparatus has been designed for accurately determining free caustic alkali or free acid under an inert atmosphere (Blank & Emendorfer—*J. Am. Oil Chemists' Soc. 32,* 531). Use of this apparatus has shown that free fatty acid values when run under usual laboratory conditions are not affected by carbonation from air; but free alkali values are slightly low, and conversely unsaponified values are high.

The pH of various concentrations of pure laurates of lithium, sodium, potassium, rubidium, caesium, and ammonium have been recorded in a study on hydrolysis of these soaps (Laurent & Boyer—*Bull. soc. chim. France 1955,* 334).

A scheme for analysis of ortho-, pyro- and triphosphate in the presence of each other involved, respectively, determinations of total phosphorus, determination of phosphate, and conversion of triphosphate to phosphate with a subsequent phosphate determination (Netherton *et al.*—*Anal. Chem. 27,* 860). Calculation of the amount of each constituent is made from the data of these three separate analyses.

Data have been recorded to indicate that the analysis of crude glycerol by specific gravity corrected for ash and organic impurities can be as accurate as the bichromate method (Guseva—*Masloboino-Zhirovaya Prom. 19,* No. 8, 27). A comparison of the dichromate and periodate methods indicated that the latter was simpler, more accurate, and inexpensive (Grynberg & Fredowicz—*Przemysl Rolny i Spozywczy 8,* 313). In tests on the accuracy of the periodate method with regard to technique employed, it was found that the oxidation of glycerol takes place in 48 hours and secondary reactions may continue after this period (Hartman—*J. Chem. Soc. 1954,* 4024). On the basis of the observations improved technique for the determination has been designed.

A procedure described for determination of organically bound sulfate in sulfonated oils involved extraction with ether from a solution of the weighed sample in brine containing sodium acetate and acetic acid, ashing, and titrating the ash (Stehlik & Novarik—*Ceskoslav kovurstvi 3,* 56). The Am. Soc. for Testing Materials Method procedure for analysis of petroleum sulfonates was modified to permit the analysis of sodium alkylaryl sulfonate detergents (Weiss *et al.*—*Anal. Chem. 27,* 198).

Polyethenoxy ester detergents were analyzed for number of ethenoxy units by determining saponification equivalent, carbon and hydrogen content, iodine numbers and by calculations from weights of samples (Ballum *et al.*—*Trans. Ill. State Acad. Sci. 47,* 81). Another method for the same purpose was based on the difference in melting point of camphor and a specific mixture of the sample and camphor (Karabinos—*Soap & Chem. Specialties 31,* No. 4, 49). The relation between the length of the polyethenoxy radical and the acid radical of these was named the "HLB value" and has been recommended for characterization of these nonionic detergents (Griffith—*Am. Perfumer Essential Oil Rev. 65,* No. 5, 26). This relationship can also be evaluated by titration with aqueous phenol (Karabinos—*Soap & Chem. Specialties 31,* No. 6, 50). Titration with phenol is also recommended as a control test in maintaining proper residual nonionic in textile scouring operations, metal cleaning baths, drill fluids, etc. (Davis *et al.*—*Ibid.* No. 12, 73). The compounds can also be characterized by density and refractive index (Carriers—*Fette u. Seifen 57,* 563).

A comprehensive scheme for qualitative and quantitative analysis of surface active agents is based on preanalysis tests for quaternary ammonium bases, pyridinium compounds, salts of amines, nonionic products, naphthalene rings, secondary alcohols, polyhydric alcohols, nitrogen determination, inorganic material; followed by design of means of separating these from each other for their quantitative estimation (Kortlant & Dammers—*J. Am. Oil Chemists' Soc. 32,* 58). The ultraviolet spectrograms of anionic compounds containing no nitrogen, anionics containing nitrogen, and cationic compounds containing nitrogen have been recorded for use in their qualitative detection (Reid *et al.*—*Analyst 80,* 682). Cation compounds of amines or ampholytractive substances were distinguished on the basis of their color reactions with tetraphenyl diboroxide (Neu—*Fette u. Seifen 57,* 568; *Reichstoffe, Parfums, Seifen 1955,* No. 8, 6). Synthetic detergents in solutions may be determined with the *p*-toluidine method, but the method is only recommended for plant control work (Stüpel and von Segesser—*Fette u. Seifen 57,* 344). Mutual titrations of anion and cation detergents using fluorescent indicator has been demonstrated (Ino *et al.*—*J. Chem. Soc. Japan, Chem. Sect. 76,* 220). Phenolic ether detergents can be determined colorimetrically by reaction with formaldehyde in the presence of sulfuric acid to form a carbonium ion, which polymerizes to a colored complex (Rosen—*Anal. Chem. 27,* 111).

A procedure for determining anionic detergents in sewage effluents is based on the well-known principle of the formation of a complex with methylene blue; and its extraction with chloroform and spectroscopic determination (Longwell & Maniece—*Analyst 80,* 167). A procedure using thymol blue is based on the transition range of this indicator through absorption (Peter—*Fette u. Seifen 56,* 997). A continuous recorder to detect surface active agents in sewage reaching water supplies is based on continuously measuring surface tension (Hettche—*Vom Wasser 20,* 137).

PHYSICAL CHARACTERISTICS. Electron microscope observations on dried residues of sodium soaps from water and alcohol solutions show that various forms, such as plates, fibrells, etc. may be obtained, depending on pH, solvent, concentration, etc. (Kling & Mahl—*Fette u. Seifen 57,* 643). The fibrells were deposited from gels. In similar comparisons of pure soaps of mixed fatty acids dried by infrared irradiation the fibrells or dense fibrous structure were characteristic of mixed fatty acid soaps, (Ezaki—*J. Chem. Soc. Japan, Ind. Sect. 57,* 713).

Benton *et al.* (*Can. J. Chem. 33,* 1384, 1798) recorded results of the mesomorphic behavior of alkali metal stearates as observed by optical and density observations. In this work stearates having substituents in the hydrocarbon chain exhibited less pronounced mesmorphism than did the normal soap. Blokker (*J. Am. Oil Chemists' Soc. 32,* 216) recorded the phase relationships of C_8–C_{18} alkyl sulfate-soap-water systems at 50°. These phase relations showed a striking resemblance to those of the corresponding fatty acid soaps which had been previously described.

The melting points, solubility, and specific conductance, critical micelle concentration and surface tension of the solutions were determined for the guanidine soaps of lauric, palmitic, stearic, and oleic acids and compared with those of alkali soaps (Inoue—*J. Chem. Soc. Japan, Ind. Sect. 57,* 330). The surface tension, wetting power, and foaming of a large number of quaternary ammonium detergents was also measured (Bolle *et al.*—*Mem. services chim. etat. 38,* No. 2, 171).

Surface and interfacial tension measurements have been made on solutions of seven commercial dairy cleaning detergents (Mohr & Mohr—*Kiel. Milchwirtsch Forschungsber 5,* 163) and on the sodium salts of alkylaryl sulfonates of alkyl chains C_6–C_{18} (Amatsu *et al.*—*J. Chem. Soc. Japan, Ind. Sect. 57,* 379). The interfacial tensions were with butterfat and kerosine, respectively. The data bore no relationships to the detergent qualities. Surface tension measurements of sodium dodecyl sulfate solution with and without presence of dodecanol has shown that the mixtures act like normal soap in forming associated molecules (Burcik & Newman—*J. Colloid Sci. 9,* 498).

Measurements of the effect of various concentrations of sodium laurate at xylene-water interfaces have shown good

agreement of the amount of soap absorbed at the interface to that theoretically calculated from the Gibbs absorption equation when the amount of soap was below the critical micelle concentration (Ghosh & Rakshit—*J. Indian Chem. Soc. 31,* 817). The absorption of surface active agent at air-water interface could be calculated from surface tension data from the Gibbs adsorption isotherm equation only when excess of the neutral electrolyte was present in the detergent solution (Pethica—*Trans. Faraday Soc. 50,* 413).

The viscosity of most, but not all, polyoxyethylene-type nonionic detergents first increased and then decreased by addition of progressive amounts of water from 40 to 300 ml. per 200 grams of detergent (Karabinos & Ballun—*Euclides, Madrid, 15,* No. 167, 8). Viscosity measurements were also recorded with turbidity measurements on solutions of polyoxyethylene condensates of octylphenol (Kushner & Hubbard—*J. Phys. Chem. 58,* 1163). The data were correlated with the molecular weight of the micelles formed. Similar correlations were made for polyoxyethylene sorbitan and a polyoxyethylene ether detergent using viscosity and diffusion coefficient measurements (Okuyama & Chujo—*Bull. Chem. Soc., Japan 27,* 259). The viscosity of 100:100 mixtures of paraffin oil: sodium oleate and water on increasing the water content, increased to a maximum at an approximate ratio of two moles of water to one mole of soap (Solnyshkin—*Kolloid. Zhur. 17,* 46). Viscosity measurements were used to observe micelle formation and effect of salts on these in detergent solutions of polymers such as carboxymethylcellulose, potassium polyvinyl sulfate, polyacrylic acid and others (Saito—*Kolloid-Z 137,* 93, 98).

Conductivity of soap solutions was also interpreted in terms of the formation, size and distribution of the micelles (Stigter —*Rev. trav. chim. 73,* 611). Such measurements were also recorded for solutions of myristyl sulfate (McBain—*J. Colloid Sci. 10,* 223) and sodium abietate (McBain—*Ibid.* 219).

Hutchinson *et al.* (*J. Phys. Chem. 58,* 1124) have recorded the heats of solution of several alkyl sulfates in water. With decyl sulfate there was an abrupt change in the integral heat of solution at a concentration which corresponded closely to the critical micelle concentration.

Many investigators studied critical micelle formation by means of the dye solubilization method. A spectral study of the method has indicated that the results can be affected by the dye concentration and presence of insoluble salt (Mukerjee & Mysels—*J. Am. Chem. Soc. 77,* 2937). The influence of these factors in inducing mixed micelles and their transition to normal micelles were discussed in this work. Another spectral study of the method using bromophenol blue as the dye has shown that the change in absorption maximum occurs at a concentration lower than the critical micelle concentration (Zutrauen & Minassian-Saraga—*Compt. rend. 240,* 869). The dye solubilization method of measuring the critical micelle concentration was used to demonstrate: that no significant isomerization occurs during sulfonation of dodecyl sulfate (Williams *et al.*—*Trans. Faraday Soc. 51,* 728); to measure the self diffusion coefficient of micelles formed by sodium dodecyl sulfate in water and in salt solutions (Stigter—*J. Phys. Chem. 59,* 330); for the discoveries that the log of the rate of change of critical micelle concentration of fatty acid soaps with alcohols is a linear function of the number of carbons in the alcohol and with a given alcohol there is a linear function of the number of carbon atoms in the soap molecule (Shinoda —*Ibid. 58,* 1136); and to show that the relation of the log critical micelle concentration to the concentration of the bivalent anion, potassium alkyl malonates, has twice the mean slope of that of fatty acid soaps (Shinoda—*Ibid. 59,* 432).

A theory proposed to account for production of metachromatic colors in solutions of anionic detergents was based on: (a) chromatropes exist as anionic clusters or micelles, (b) cations are firmly bound at high cationic charge, (c) the metachromic dyes exist in solution in set equilibrium among polymeric-dyes with different charges; and (d) the chromotropic micelle selectively and reversibly binds dye ions of highest charge to shift their equilibrium into the intermicelle space (Schubert & Levine—*J. Am. Chem. Soc. 77,* 4197).

The weights or size of micelles in solutions of the following detergents have been determined: sodium dodecylbenzene sulfonate, sodium dioctyl sulfosuccinate, isoöctylphenol monoetheylene glycol ether, *tert*-dodecyl monoethylene glycol thioether, polyoxyethylene glycol tall oil esters (Mankowich—*J. Phys. Chem. 58,* 1027), sodium and barium dinonylnaphthalene sulfonate in nonpolar solvents (Kaufman & Singleterry—*J. Colloid Sci. 10,* 139), sodium dodecyl sulfate (Phillips & Mysels—*J. Phys. Chem. 59,* 325), sodium dodecyl sulfate (Kushner & Hubbard—*J. Colloid Sci. 10,* 428), and for various alkylaryl sulfonates and polyethylene glycol ethers (Mankowich—Ind. Eng. Chem. 47, 2175). In most of the above work the effect of salts and detergent builders on the size of the micelles was measured. In a discussion on micelle size it was emphasized that all micelles in a soap solution are not the same size as is often assumed (Hermans — *Proc. Kominkl. Ned. Akad. Wedenschap 58B,* 91).

The micelles of sodium dodecyl sulfate-salt solution in a cellulose dialysis bag do not pass through the membrane, but on decreasing the salt concentration they become smaller and diffusion through the membrane occurs (Harrap & O'Donnell —*J. Phys. Chem. 58,* 1097).

Some data were recorded on colloidal solutions of organic compounds in soaps. Results from benzene in aqueous solutions of sodium oleate, rosin soap, castor oil soap and Gardinol has suggested that ability of soaps to colloidly dissolve hydrocarbons does not indicate their washing ability (Shkodin *et al.* —*Ukrain. Khim. Zhur. 19,* 386). In test with a single soap and different organic compounds, the polar high molecular weight alcohols were more soluble than the comparable hydrocarbon but with nitrobenzene versus benzene the latter, though nonpolar, was over three times as soluble as the former (Markina *et al.*—*Kolloid. Zhur. 16,* 366). In study of the sodium oleate-xylene systems by light scattering technique, the particles increased in size and anisotropy during gel formation, in accord with existing theory of the formation of gels in organic solvents (Sundaram—*Proc. Indian Acad. Sci. 40A,* 176; *J. Univ. Bombay 23,* Pt. 3, No. 6, 1). The size of the particles in these gels did not depend on the concentration of the soap solution. In a system of octyl alcohol and sodium stearate studied at temperatures of 45–135° the particles decreased in size during cooling and gelation (Desai & Sundaram —*Proc. Natl. Inst. Sci. India 20,* 598). In a comparison of sodium oleate gels of aromatic versus aliphatic alcohols and ketones, the benzene nucleus behave like the equivalent of three carbon atoms in an aliphatic alcohol; and in ketones with a phenyl group next to the carbonyl group the aromatic nucleus was equivalent to five carbon atoms (Booij *et al.*—*Koninkl. Ned. Akad. Wetenschap. Proc. 57B,* 340). Introduction of methylene groups between the benzene nucleus and the carbonyl group decreased the value to three carbon atoms. In a system of gelatin-hexadecyltrimethyl-ammonium bromide-potassium cyanate, binding of gelatin and surface active agent was affected by salts in low concentration according to the "continuous valence rule," but high ratio of salts suppressed coacervation (de Jong & Weijzen—*Ibid.* 285, 297).

PERFORMANCE AND USE TESTING. A common electric household mixer was adapted to measuring foaming of detergents by replacing the bowl with a graduate (Sisley & Loury—*Rev. franc. corps gras 1,* 390; *Soap & Chem. Specialties 31,* No. 4, 44). A new foam tester for low foaming dish-washing detergents is based on spraying detergent solution against a steel baffle and catching the foam in a glass jar (Fineman *et al.*— *Soap & Chem. Specialties 31,* No. 8, 43; No. 9, 50). In a discussion on measuring foam stability the effect of presence of impurities on the results obtained was emphasized (Nakashima—*Rept. Ind. Res. Inst. Osaka Pref. 6,* No. 2, 37). In investigations on the effect of various inorganic materials on foaming of sodium laurate, alkali metal ions increased foam stability in the order: lithium<sodium< potassium<caesium, and the order for anions was: iodine<hydroxyl<sulfate<nitrate<carbonate<silicate<chloride (Camp & Durham—*J. Phys. Chem. 59,* 993). Nonionics do not foam much above their cloud point. Their foaming properties are not affected by hydrochloric acid, but are lowered by many other electrolytes, and the highest initial but less stable foam is produced by the products of higher cloud point (Knowles & Krupin—*Proc. Chem. Specialties Mfrs. Assoc. 1953,* 175). In tests on effect of alcohols on foaming of potassium decanoate, the C_2–C_4 alcohols were defoamers, whereas C_5–C_{10} alcohols promoted foam (Nagagaki & Shinoda—*Bull. Chem. Soc. Japan 27,* 367). Slow draining foams became fast draining over a specific narrow range of temperature (Epstein *et al.*—*J. Phys. Chem. 58,* 860). Long chains in the detergent favored slow drainage while branching and presence of nonterminal functional groups were unfavorable.

Various laboratory observations were discussed in relation to detergency or mechanism of detergency. An electron microscope was used to observe soil in soap solutions from which water had been removed while in the frozen state (Hock— *Textile Res. J. 25,* 682). Micellar configurations and the mechanism of detergent action resulting from the observations are indicated. In a discussion on energetics in washing it is suggested that when the difference in tension of wetting the object by the detergent solution and an oily liquid is smaller than the interfacial tension of the two liquids the oil forms a

spherical segment with a contact angle; this droplet then requires "residual work of laundering" for detachment (Kling & Lange—*Kolloid-Z. 142*, 1). This "residual work of laundering" was recommended as a suitable criterion for comparison of washing media. A technique for measuring contact angles of detergent solutions on solid surfaces was devised and demonstrated in testing cleaning of dairy equipment (Mohr & Mohr —*Kiel Milchwirtsch. Forschungsber. 6*, 29). Electroösmotic and electrophoretic measurements have shown that the negative charge which builds up on fibers in water is increased by anionic detergents, remains almost unchanged by nonionics, and is greatly reduced and even changed into a positive charge with increasing concentrations of cationics (Kling—*Melliand Textilber. 36*, 166). In washing, anionic detergents cause an increase of negative charge on fiber and soil and thus improved detergent action. With cationics a reversal may occur on fiber only leading to redeposition of soil. In tests on deposition of carbon on cotton from solutions of sodium dodecyl sulfate, the optimum concentration for protection of deposition of carbon was far below the critical micelle concentration (Vold & Phansalkar—*Rec. trav. chim. 74*, 41). Differences in absorption and suspension isotherms of nonionic detergent systems as determined by surface tension, spectrophotometrically, and with radio-tracer methods were interpreted to indicate that there is selective adsorption of the smaller molecular species (Hsiao & Dunning—*J. Phys. Chem. 59*, 362). Surface tension versus time curves determined on several detergents have been expressed by equations which contain the diffusion coefficient and the spreading pressure of the surface active material (*Schäfer—Z. Electrochem. 59*, 273). The constants of these are related to the rate of wetting.

A comparison of standard detergency tests and visual evaluation of actual laundering have demonstrated that the common laboratory laundering tests do not accurately rate the performances in actual application (McCabe—*Soap & Chem. Specialties 30*, No. 12, 44; *31*, No. 1, 42). A new laboratory test method involved carrying unsoiled white cotton swatches through a number of alternate cycles of soil deposition from aqueous detergent baths and soil removal in fresh detergent bath in a Terg-O-Tometer washer (Bernstein & Sosson—*Proc. Chem. Specialties Mfr. Assoc. 1954*, 166). A new small apparatus for the measurement of detergency was based on a vacuum receptable of the thermos type for solution, a test cloth and a shaking device for the mechanical effect (Tabakoff —*Rev. franc. corps gras 2*, 95). A new method for evaluating textile assistants depended on the colorimetric determination of the amount of dye washed from a specially prepared wool or cotton cloth (Gasser—*Textile Praxis 9*, 186). A "detergent efficiency" equation has been developed which relates detergency to the mechanical work for removal of soil with respect to reflectance measurements from tests in a reference solution and solution containing the test sample (Bacon & Smith—*Am. Dyestuff Reptr. 43*, 619). A new type of wash test apparatus was designed for use of small discs of cloth soiled with radioactive carbon (Hensley *et al.—J. Am. Oil Chemists' Soc. 32*, 138). A chromium phosphate solution containing radioactive phosphorus and bacterial suspension tagged with the radioactive phosphorus was demonstrated as tracer soils for detergency testing, respectively, for washing clothes and cleaning eating surfaces (Armbruster & Ridenour—*Soap & Chem. Specialties 31*, No. 7, 47; *Proc. Chem. Specialties Mfrs. Assoc. 1955*, 148).

Several investigations were on the relation of structures to detergency and other properties. Among alkylbenzene sulfonates detergency of the normal alkyl members increased in effectiveness from chain length 9 to 18, with branched chains the optimum effect occurred with 12–14 carbon atoms in the alkyl chain (Griess—*Fette u. Seifen 57*, 24, 168, 236). Foaming was best at 10- or 12-chain length in the normal compounds and at 14 carbon atoms for the branched alkyl compounds. The effects of binary mixtures and presence of builders were also measured in this work. Tests on polyoxyethenoxy detergents demonstrated that maximum detergency was at 12 to 14 unit chain lengths (Cronin *et al.— Trans. Ill. Acad. Sci. 47*, 196). With sulfated tallow alcohols a built mixture containing both saturated and unsaturated alcohol sulfates was better than either one separately or mixtures of either with other synthetic detergents (Osipow *et al.—Ind. Eng. Chem. 47*, 492). In tests with fatty alcohol sulfates of various chain length, the odd-numbered were better wetting agents, and when odd-chain and even-chain compounds were combined five points of singularity were found in the composition-wetting time curve; two were minimums and three maximums, indicating synergism (Wemelle—*Ind. chimique 42*, 73, 105, 137). The synergism in ternary and quaternary mixtures was not as marked as in binary systems. Synergism was observed also in detergent systems containing different individuals of, respectively, anionic, nonionic and cationic compounds and in specific mixtures of two different types (Rosch—*Fette u. Seifen 57*, 583).

Some performance testing pertained to builders and additives for detergents. The test for calcium suppression of builders of Miles & Ross was modified by using sodium cetyl sulfate in place of soap as the foaming agent (Ross *et al.— J. Am. Oil Chemists' Soc. 32*, 126). The test measures ability of builders to suppress calcium ion, thus permitting calculation of detergent mixtures with economy of the expensive ingredients. A subsequent report from the same laboratory related deposition of carbon from test soils to the presence of various ions and discussed the measurement of the amount of builders necessary to suppress these ions from the system (Ross *et al.—Ibid.* 200). Here, it was stated that carboxymethylcelluloses prevented redeposition of soil but did not sequester or remove calcium ion to any marked degree. Other data was submitted to indicate that sodium carboxymethylcellulose does not influence the adsorption of detergent on solids nor displace it (Kramer & Hoepfner—*Fette u. Seifen 57*, 340). Soil suspending test of cellulose compounds in built detergents has demonstrated that the carboxymethylcellulose was most efficient among sulfate, succinate, maleate, allyl-, hydroxyethyl- or other oxycellulose, starch, agar, and others (*Karabinos— Sci. Counselor 17*, 129, 156). A method designed for evaluating the iron removal capacity of builders and detergents was based on washing cotton or wool cloth in iron-containing water and analyzing the cloth for iron (Oldenroth—*Fette u. Seifen 57*, 225). Application of the test on bleaches and builders has indicated that phosphates at pH 9.2–9.7 were very suitable for chelating iron.

Detergency tests were made for many other types of cleaning processes. In decontamination of surfaces coated with radioactive material with soap, concentrations of soap up to 2–3 times the critical concentration for micelle formation was most efficient (Chandler & Shelberg—*J. Colloid Sci. 10*, 393). In tests for removing such contaminants from cotton clothing, combinations of builders and anionic detergents were most efficient, especially where greasy dirt was also involved (Talboys & Spratt—*U. S. Atomic Energy Comm. NYO-4990*, 100 pp.). This complete report contains measurements with different radioactive elements and efficacy of other removal materials as starch, silicone water repellents, organic solvents, and other materials. Experiences, i.e. reproducibility, time, suds end-point, etc., were recorded on the common methods for evaluating liquid detergents for hand dishwashing and the data were discussed with regard to future plans on improving the methods (Wells—*Soap & Chem. Specialties 31*, No. 5, 54). A test based on washing fluorescent dye tracer soil from dishes was designed for use in formulating and control of manufacture of the dishwashing detergents (Mizuno *et al.—J. Am. Oil Chemists' Soc. 32*, 437). A three-component formula of alkylaryl sulfonate, alkyl phenol polyethylene glycol ether and alkylolamide designed with this test was three times as efficient on a use-cost basis as the best of these detergents used alone. Spray apparatus and washing methods were standardized for washing milk cans to serve for evaluating the detergents used for the purpose (Mohr *et al.—Kiel. Milchwirtsch. Forschungsber. 5*, 207, 261). Application of this test has shown that aluminum alloy cans require more cleaning than tinned cans; addition of detergent to spent solution does not renew detergency; and has supplied data for the design of continuous washing operations. Rug cleaning tests run by actual commercial on-location-cleaning and plant shampoo has shown that the efficiency of detergents, ranked in order named, were fatty acid condensate, alkylaryl sulfonate, and trichloroethylene in sawdust base (Herrick & Cooper—*J. Home Econ. 47*, 406). In this work soap caused excessive resoiling. A test designed for detergency studies on painted surfaces has indicated that sodium alkylaryl sulfonate, sodium alkyl sulfate, and sodium tripolyphosphate work well for urban soil, and aromatic polyglycol ethers perform best for shipboard soil (Shelberg *et al. —Ind. Eng. Chem. 46*, 2572). A test for efficacy of toilet soaps was run in a specific apparatus in which solution is stirred on a skin portion which was soiled with a mixture of synthetic soil, dye and waste oil (Blaich & Gerlach—*Fette u. Seifen 57*, 33).

For some uses, the germicidal action was the most important property in evaluation of the detergent. A test method for disinfection of surfaces was based on applying test organisms and removing them (Hoffman *et al.—Soap & Chem. Specialties 31*, No. 8, 135). Tests have shown that natural inocula as feces, sputum and dust contained more resistant bacteria than

the usual pure-culture bacteria strains used for determination of bacteriostatic and bactericidal effects of quaternary ammonium compounds (Clausen—*Medd. Norsk Farm. Selskap 17*, 124). In this work new test methods were devised. Tomcsik (*Proc. Soc. Exptl. Soc. Biol. Med. 89*, 459) has visually demonstrated that cationic and anionic detergent action as bactericidal agent occurs through damage and denaturation of the cytoplasmic membrane and the cytoplasm. Ito *et al.* (*J. Pharm. Soc. Japan 75*, 310) also demonstrated damage to cell membrane by detergent and also measured inhibition of respiration caused by the detergent. Garvie & Clark (*J. Appl. Bacteriol. 18*, 90, 107) have evaluated the effect of factors such as humidity, light, carrier, and contaminants on disinfectant properties of quaternary ammonium compounds. Nonionic detergents may stimulate growth of certain bacteria, and they may be inert, or inhibit growth depending on the type of anionic (Kidder *et al.*—*Exptl. Cell. Res. 7*, 256). Ozonized nonionic detergents have bactericidal activity which starts high but decreases rapidly with time (Ferlin & Karabinos—*Trans. Ill. State Acad. Sci. 47*, 86). Some nonionic detergents are decomposed by the action of fungi (Okabayashi—*J. Fermentation Technol. Japan, 32*, 482).

In disinfection processes in which precleaning is with soap followed by a disinfecting detergent, the latter if not compatible, may be ineffective when residual soap is present on the surfaces (Ortenzizo *et al.*—*Proc. Chem. Specialties Mfrs. Assoc. 1954*, 82).

The influence of numerous surface-active agents on hemolysis was recorded (Morikawa—*Folia Pharmacol., Japan, 50*, 193–204). Cationic surface-active agents were much stronger than anionic and nonionic agents. Hutchinson & Bean (*Arch. Biochem. & Biophys. 58*, 81) have shown that hemolysis of human red cells by sodium alkyl sulfates does not occur at an arbitrary three-minute endpoint unless lysin concentration exceeds a certain critical value.

The effectiveness of various anionic detergents for inhibition of trysin has been determined (Viswanatha *et al.*—*J. Biol. Chem. 212*, 301). The theoretical implications of these data were discussed in relation to protein-detergent action. At pH 7.8 and ionic strength, 0.2, it was possible to separate certain complexes of human serum albumin with surface-active compounds by precipitation and electrophoretic methods (Ardry—*Bull. soc. chim. biol. 36*, 595, 603). After addition of anionic detergent to the serum it became impossible to extract lipides therefrom, and cationic detergents render extraction of phosphoaminolipides with ether incomplete.

The effects of alkali washing agents on the pH and acid coat of skin have been measured (Jacobi—*Fette u. Seifen 56*, 928; Ramsay & Jones—*Brit. J. Dermatol. 67*, 1). It is suggested that soap is absorbed on the skin and hydrolyzed by the skin acidity. The four-hour sebaceous secretion on forehead skin was practically the same during periods when soap was used for washing as when sodium alkyl sulfate was used (Kirk & Effersoe—*J. Invest. Dermatol. 22*, 257). Eczema resulting from use of certain commercial washing agents was traced to nickel and chromium which these washing agents contained (Kroepfli & Schuppli—*Dermatalogica 110*, 1).

As uncommonly known applications, soaps and/or detergents were demonstrated for extraction of certain chemicals from hydrocarbon mixtures (Grekel & Hujsak—*U. S. 2,710,831*), for the volumetric determination of metals (Siggia *et al.*—*Anal. Chem. 27*, 1745; Gwilt—*J. Appl. Chem. 5*, 471) and sulfate (Davey & Gwilt—*Ibid.* 474), for improvement of hydraulic stability of soils (Grossi & Woolsey—*Ind. Eng. Chem. 47*, 2253), to reduce caking tendency of stored fertilizer (Tucker—*J. Agr. & Food Chem. 3*, 669), as ingredient of buffing compounds (Larsen—*U. S. 2,699,990*), for accelerating the growth of chicks (Ely—*U. S. 2,717,208;* Ely & Schott—*U. S. 2,717,209*), for improving the digestion of various starches (Yokozawa & Sakurai—*Rept. Food Res. Inst. Tokyo, 9*, 145), for stimulating the growth of calves (Lassiter *et al.*—*J. Dairy Sci. 38*, 407), for improving the wettabilities of insecticidal solutions (Kuwada & Hirota—*Rept. Takamine Lab. 4*, 150, 156; *5*, 143), for impregnating porous soft board with polyvinyl acetate (Austin *et al.*—*U. S. 2,716,617*), for preparing solutions of polyvinylformal and polyvinyl butral (Isemura & Kimura—*J. Polymer Sci. 16*, 92), for degumming of silk fibers (Veneroso—*Ann. sper. agrar, Rome, 8*, 1701), for retting of vegetable textiles (Lourd—*U. S. 2,725,289*), and for removing insecticidal chemicals from fresh vegetables (van Middelem *et al.*—*Proc. Am. Soc. Hort. Sci. 65*, 357, 365). In most of the above communications suitable detergents for the various applications were suggested. Several communications were on experiences on dust-wetting agents in dedusting mines, their testing, method of use, and efficiencies (Sosnovskii—*Bor'bas Silikozom, Akad. Nauk S.S.S.R. Sbornik Statei 1953*, 69, 126; Berkovich *et al.*—*Ibid.* 134; Rebinder *et al.*—*Ibid.* 57; Prokopova & Novakova—*Pracovni Lekarstvi 6*).

Methods were outlined for overcoming difficulties in primary sedimentation and from foam formation due to detergents at sewage treatment plants (Pilpel—*Research, London, 8*, 62). The effect of synthetic detergents on the settling of suspended solids (Degens *et al.*—*Sewage & Ind. Waste 26*, 1081), on frothing and oxygen transfer in sewage (Lynch & Sawyer—*Ibid.* 1193) and observations on decay of detergents (Bogan & Sawyer—*Ibid.* 1069; Hammerton—*J. Appl. Chem. 5*, 517) were published as data pertinent to handling sewage treatment problems caused by detergents.

The Chemistry of Polymerized Oils. V. The Autoxidation of Methyl Linoleate

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EVER SINCE THE DISCOVERY (10) that autoxidation of methylene-interrupted polyene systems results in double bond rearrangement to conjugated forms, there has been uncertainty as to the quantitative amount of such rearrangement. This uncertainty has been linked together with an uncertainty as to the positional isomers formed and, in particular, as to the presence or absence of the 11-isomer in the case of linoleate. Bolland and Koch (4) concluded that some 70% of methyl linoleate hydroperoxide mixed isomers were conjugated double bond forms, leaving some 30% of unconjugated diene isomer(s). These relative proportions were thought to be caused by isomerism in intermediate radical forms so that the conjugated peroxides were the 9-peroxido $\Delta^{10:12}$ and the 13-peroxido $\Delta^{9:11}$, whereas the non-conjugated isomer was the 11-peroxido $\Delta^{9:12}$.

It is unnecessary to repeat here the generally accepted reaction formulae which fit this interpretation. The extensive studies of Bolland clarified the kinetic pathway which occurs, and it was evident that mesomerism in the radicals (R′ and RO'_2) was the likely explanation for the formation of conjugated dienes. However the great technical difficulties inherent in analyzing mixtures of unstable and closely related isomers have, so far, proved insurmountable, and no complete direct experimental demonstration of the exact composition has ever been published. Bergström (3) showed that hydrogenated methyl linoleate hydroperoxide isomers gave methyl 9- and 13-hydroxystearates. Methyl 11-hydroxy stearate was not found, but its total absence could not be rigidly proven. The possibility that the 11-peroxido $\Delta^{9:12}$ form might have rearranged during hydrogenation is not great since such rearrangement does not occur in the case of similarly constituted hydroxy polyenes