

and proceedings of the meetings of the various state horticultural societies and vegetable growers' organizations. The various technical forestry publications have many articles on the control of weeds in forest nurseries and of weed trees in forests.

The chemists who devise, make, and study the chemicals involved in weed control publish an immense amount of valuable material. The *JOURNAL OF AGRICULTURAL AND FOOD CHEMISTRY*, *Agricultural Chemicals*, *Farm Chemistry*, and other chemical journals publish many articles on this work.

Agricultural Engineering and other publications in that field have articles on the cultural control of weeds and on equipment for applying sprays.

Research institutes, such as Boyce Thompson Institute and Battelle Memorial Institute, have done extensive work in this field and their publications contain valuable information.

The regular bulletins of the agricultural experiment stations are now publishing considerable fundamental information on cultural and chemical weed control.

Because public health is interested in the control of weeds which affect public health (ragweed, poison ivy, and the like), important weed control literature has appeared in their publications. Veterinarians have also been brought into

weed control through stock poisoning by weeds and possible hazards to livestock from use of weed control chemicals.

The control of aquatic weeds is discussed in publications as widely divergent as TVA reports, irrigation reports, and reports of state divisions of wild life.

The many farm papers have made great efforts to keep their readers informed on weed control progress, and many significant articles involving practice have appeared there. Publications dealing with the maintenance of rights-of-way of railroads, telephone lines, and power lines, and publications from the various state highway departments have much information on the use of chemicals in brush and weed control.

Because the newer weed control chemicals are often applied by air, many aviation conferences have published articles on the use of the airplane in weed control.

The chemical companies concerned with developing new herbicides also publish many important articles, sometimes in house organs and sometimes elsewhere.

One of the most important advances in weed control literature was the establishment in 1952 of the journal *Weeds*. This journal has gained rapidly in stature and importance, and promises to become an authoritative voice in the field. It is now the official journal of the Weed Society of America.

The successive volumes of the *Annual Review of Plant Physiology* present fundamental material of great interest and value to weed control specialists.

This is by no means a complete list, but it is extensive enough to indicate that there may be difficulty and confusion in rounding up weed control literature.

Are there any general guides to this material? There are first of all the established abstracting journals, *Biological Abstracts*, *Section D* (Plant Sciences) and *Chemical Abstracts* in the United States, *Herbage Abstracts* and *Field Crop Abstracts* in Great Britain, and others. These have a large and important place. A complete indexed quarterly bibliography of the literature in weed control has been prepared since 1951 by the Weed Investigations Section, Field Crops Research Branch, A.R.S., U. S. Department of Agriculture, and published in the journal *Weeds*. It is also available from the section as reprints. The Information Section, Unit of Experimental Agronomy, Department of Agriculture, Oxford University, Parks Road, Oxford, England, publishes a weekly reference list of abstracts on weed control, particularly valuable to workers in the United States in keeping up with European work.

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PESTICIDES LITERATURE

Use of the Entomological Literature by the Agricultural Chemical Specialist

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The literature of entomology is extensive and widely diverse in origin. Organization and indexing procedures for this literature are in operation and greatly expedite literature searching. Exhaustive searches of this literature are hampered by some confusion as to chemical and insect terminology, and difficulties in locating minor or borderline subject matter in abstracts and indexes. Discussions of special problems in this category include application equipment, formulation and compatibility of insecticides, personal and public hazards associated with insecticides, injury to plants and animals, legislation regarding labeling, packaging, and tolerance requirements, and patent surveys.

AS IN MOST FIELDS OF RESEARCH or other investigational endeavors (2), the literature of entomology presents many aspects, and for efficient searching it must be organized consistently and systematically. The present paper is concerned primarily with finding exist-

ing entomological and ancillary data, discussions, and reviews. Because agricultural chemical specialists may be concerned with any phase of entomology, requisite literature searches can become very broad indeed. In addition to literature sources of its own profession,

entomological information occurs frequently in such other sources as the publications from the fields of botany, genetics, hygiene, medicine, pathology, physiology, public health, zoology, and related fields. During the past 20 years chemistry and physics have become so

Table I. Number of Serial Publications of Entomological Interest Originating in Various Parts of the World, 1947^a

Argentine Republic	30
Australia and territories	54
Austria	22
Belgian Congo	4
Belgium	23
Brazil	35
British Colonies, protectorates, and mandated territories	110
Bulgaria	4
Burma	4
Canada	40
Ceylon	10
Chile	11
China	20
Colombia	3
Cuba	4
Czechoslovakia	22
Denmark	14
Ecuador	2
Egypt	7
Eire	4
Finland	15
France (including Algeria)	106
French Colonial Empire	20
Germany	138
Greece	2
Guatemala	2
Hungary	11
Iceland	3
India (including Pakistan)	55
International	9
Iraq	1
Italy (and former colonies)	75
Japan	42
Korea	1
Mexico	12
Netherlands and colonies	45
New Zealand	12
Norway	14
Palestine	7
Papal States	2
Paraguay	2
Persia (Iran)	2
Peru	6
Philippines	6
Poland	20
Portugal (and colonies)	16
Romania	18
Siam (Thailand)	1
Spain	17
Sweden	26
Switzerland	35
Turkey	5
Union of South Africa	25
U.S.S.R.	58
United Kingdom and Channel Islands	185
United States, territories, and possessions	382
Uruguay	3
Venezuela	7
Yugoslavia	8

^a According to list compiled by Commonwealth Institute of Entomology (5).

strongly allied with pest control problems that entomological information may now be found abundantly in publications from these fields, also.

To illustrate, an exhaustive survey of the recognized literature which frequently contains entomological information would involve the detailed examination of more than 1800 separate publications, exclusive of trade journals, technical pamphlets, house organs, patents, and dissertations. In Table I are listed the countries of the world and the number of journals and other formal publications of entomological interest or content originating in each (5). These publications include annals, bulletins, circulars, contributions, journals, memoirs, monographs, papers, proceedings, reports, reviews, studies, and transactions of more or less regular issuance.

Since the list in Table I was compiled (5) in 1947, some of the more than 1800 items originally included no longer exist, because of World War II and more recent international developments, but a larger number of new publications has undoubtedly materialized during the intervening 8 years. The predominantly English-speaking countries contribute 45% of this list.

As part of the broad consideration of entomological literature, there should be some mention of books. Those written in English are listed by subject in the "Cumulative Book Index," which was started in 1899 (7). Between 1943 and 1954 more than 470 books solely concerned with some aspect of entomology were published (7). Of these, 33 dealt principally with insecticides. In 1952, the U. S. Department of Agriculture sponsored a book on insects (27) as a volume of the "Yearbook of Agriculture" series; this book contains a compilation of the results of nearly 100 years of many facets of the study of insects. Publication of a very useful manual "Guide to the Chemicals Used in Crop Protection" (17) has been initiated by the Canada Department of Agriculture; this manual includes summary information on names, history, manufacture, physical, chemical, and biological properties, formulations, and analysis. Special mention might be made of the serial publication "Pesticides" (15), issued periodically by the California Department of Agriculture, which reports the results of prescribed examination of official samples of all pesticides marketed in California.

It is thus readily apparent that any attempt to locate all available information relevant to a given topic can be very difficult if not impossible and that something less than complete coverage often suffices. However, as pointed out by Mellon and Power (18), in at least three kinds of literature searches knowledge of everything recorded on a

topic is important: searches to determine merely all that is known, searches to establish priority of publication, and searches to settle the question of novelty or completeness of disclosure for patents. Less ambitious searches may be satisfied with abstract-type and index-type publications, on the assumption that their coverage is complete for all practical purposes.

Generalized Approaches

In entomology, as in any other field of science, location of much of the published information is not easy. Success depends largely upon knowing exactly what to seek and then where to look in the constantly increasing volume of literature.

There are many pitfalls in exploring the entomological literature, including changing trade names for chemicals, and the increasing and confusing use of cryptograms, and changing common names of insects, mites, spiders, and ticks.

Although some trade names reach the permanent literature and are indexed, most of them may be considered transient as far as indexing is concerned. The Entomological Society of America now requires that new chemicals, if designated only by code, symbol, or generic name, must be described as to nature and must have the composition fully disclosed in its publications. Presumably, indexing would incorporate the chemical descriptions of the compounds involved, but it is clear that many common names, proprietary or trade names and company numbers, and designations firmly established through use will persist. This situation is unfortunate, but efforts to ease it are being made. Thus, the most recent official list of common names for insecticides (13) includes 80 recently developed insecticides and 10 fungicides as revised and approved by the Committee on Insecticide Terminology of the Entomological Society of America. Definitions and some of the other commonly used designations for these materials are also listed; the literature searcher will do well to explore all of these terms when consulting abstract and index publications. This list does not include synonymous names that may have been applied outside the continental United States.

Precise chemical designations for specific compounds are sometimes changed as the result of revisions by nomenclatural committees; an example is the variety of chemical names that have been used to designate *p,p'*-DDT in *Chemical Abstracts* during the past 10 years.

Another current problem involves the increasing use of cryptograms—i.e., letters or numbers and letters plus

Table II. Some General Characteristics of Available Abstract Journals (1, 2, 6, 26)

Publication	Scope	Frequency of Issue	Issuing Organization	Date of Origin	Subject and Author Index
<i>Biological Abstracts</i>	General	Monthly	Union of Am. Biol. Societies	1926	Subject ^a
<i>British Abstracts</i> ^b	Includes patents	Monthly	Several	1924	Both
<i>Bulletin Analytique</i>	General	Irregularly	Nat. Recherche Centre	1940	...
<i>Bulletin de la Société Chimique de France</i>	Pure chemistry	Monthly	Fr. Chem. Soc.	1858	Both
<i>Chemical Abstracts</i>	Includes patents	Biweekly	AM. CHEM. SOC.	1907	Both
<i>Chemisches Zentralblatt</i>	Includes patents	Weekly ^c	Akad.-Verlag	1830	Both
<i>Chimie & Industrie</i>	Includes patents	Monthly	Soc. chim. ind.	1918	Both
<i>Experiment Station Record</i>	Agriculture	20/yr. ^d	U. S. Dept. Agr.	1889	Subject
<i>Japanese Chemical Abstracts</i>	Includes patents	Monthly	Japan. Chem. Abstr. Soc.	1927 ^e	Both
<i>Journal of Science of Food and Agriculture</i>	Agriculture ^f	Monthly	Soc. Chem. Ind.	1950	Both
<i>Nutrition Abstracts</i>	General	Quarterly	Bur. Animal Nutrition	1931	Both ^g
<i>Physiological Abstracts</i>	Biochemistry ^h	Monthly	Physiol. Soc.	1916	Both
<i>Review of Applied Entomology</i>	General	Monthly	Commonwealth Inst. of Entomol.	1913	Subject
<i>Science Abstracts</i>	Physics ⁱ	Monthly	Inst. Elec. Eng.	1898	Both ^g

^a Also by authors under fields of interest, geographical areas, and systematic classification.

^b Formerly *British Chemical Abstracts* (prior to 1949); now published in sections such as agricultural, analytical, applied, medical, etc.

^c Number of volumes per year varies.

^d Ceased publication in 1946 with Vol. 95.

^e Covers from 1887.

^f Includes horticulture, food, sanitation, sewage, atmospheric pollution, and apparatus.

^g Indexed in *Chemical Abstracts*.

^h And physiology of plants and animals.

ⁱ Section A.

numbers to designate chemical compounds and mixtures. Examples of current interest are AATP (parathion, *O,O*-diethyl *O-p*-nitrophenyl phosphorothionate), BHC (a mixture of isomers of 1,2,3,4,5,6 - hexachlorocyclohexane), DDD and TDE [1,1-dichloro-2,2-bis(*p*-chlorophenyl)-ethane], DDT [1,1,1-trichloro - 2,2 - bis - (*p* - chlorophenyl)-ethane], G-410 (pentachlorophenol), and many others. Occasionally, a cryptogram may be assigned a compound without realization that the symbol has already been pre-empted by previous and other usage. To illustrate, in its early history technical grade hexachlorocyclohexane was known simply as 666, until it was disclosed that a cough remedy widely used in southern United States was also called 666.

The names of insects and related organisms are the logical and generally used subject headings for indexing purposes in entomology. The basic names of insects are the scientific (or binomial) ones; these names, with certain exceptions, conform to a rather

exact plan which is guided by an international commission. As with chemical names, scientific names for insects usually have a strange sound and their use is often too pedantic for the general public. Therefore, common names are bestowed on pests and other insects which attract attention or are commonplace. Often such names develop in localities; accordingly, the same kind of insect may have several different common names associated with different communities, and especially with different countries. This problem has been discussed by Metcalf, Flint, and Metcalf (19), who report that the corn earworm is also known in this country as the tobacco budworm, cotton bollworm, tomato fruitworm, and vetch worm.

A discussion of the function of insect names, the relative roles of scientific and of common names, and the principles for the use of common names was detailed in a report (17) of the Committee on Common Names of Insects for 1952 of the American Association of Economic Entomologists. This report points out that

the problem of proper usage of common names was recognized officially by this association as early as 1903, and that efforts were initiated then to encourage uniformity in the usage of common names for insects. The committee feels that common names are primarily intended for use in situations where relationships with the general public are involved.

Both the common name and the scientific name should therefore be utilized in literature searches. In 1922, suggested rules governing the choice of common names were adopted (20) by the American Association of Economic Entomologists. The list of approved names has been brought up to date at intervals, until at present nearly 1300 species have been included (12, 22). The committee report (17) mentioned above expressed the opinion that, because its common names activities are neither primarily international nor based on priority, agreement with other lists is not necessary; however, other available lists are always consulted for use as guides. Two other valuable lists with

Table III. General Characteristics of Some Important Serial Index Publications

Publication	Scope	Frequency of Issue	Issuing Organization	Date of Origin	Subject and Author Index
<i>Agricultural Index</i>	General ^a	Monthly ^b	H. W. Wilson Co.	1916	Subject
<i>Bibliography of Agriculture</i>	General	Monthly	U. S. D. A. Library	1942	Both
<i>Index of American Economic Entomology</i>	General ^c	Annually	Entomol. Soc. Am.	1905	Subject
<i>Review of Applied Entomology</i>	General ^d	Annually	Commonwealth Inst. of Entomol.	1913	Both
<i>Zoological Record</i>	General ^e	Annually	Zoological Soc.	1864	Both

^a Selected agricultural periodicals, books, and bulletins are indexed.

^b With periodical accumulation.

^c For North America including Panama Canal Zone.

^d See Table I.

^e Principally biology and taxonomy.

Table IV. Sources for Review-Type Articles of Current Interest

Publication	Scope	Frequency of Issue	Issuing Organization	Date of Origin
<i>Advances in Chemistry Series</i>	Symposia in U. S.	Irregularly	AM. CHEM. SOC.	1950
<i>Annual Reports Chemical Society</i>	International	Annually	Chem. Soc.	1904
<i>Annual Review of Biochemistry</i>	International	Annually	Annual Reviews, Inc.	1932
<i>Annual Review of Entomology</i>	International	Annually	Annual Reviews, Inc.	1956 ^a
<i>Chemical and Engineering News</i>	International	Weekly	AM. CHEM. SOC.	1923
<i>Chemical Reviews</i>	International	Bimonthly	AM. CHEM. SOC.	1924
<i>Industrial & Engineering Chemistry</i>	Symposia ^b	Monthly	AM. CHEM. SOC.	1909
JOURNAL OF AGRICULTURAL AND FOOD CHEMISTRY	Surveys within U. S.	Monthly ^c	AM. CHEM. SOC.	1953
<i>Journal of Science of Food and Agriculture</i>	International	Monthly	Soc. Chim. Ind.	1950
<i>Physiological Reviews</i>	International	Quarterly	Am. Physiol. Soc.	1921
Trade journals	Nontechnical ^d	Various	Various	...
<i>Transactions of the Faraday Society</i>	Symposia	Monthly	Faraday Soc.	1905

^a First volume will appear in early 1956.

^b Prior to appearance of *Advances in Chemistry Series* in 1950 several symposia of entomological interest appeared here.

^c Prior to 1955 published biweekly.

^d Occasionally semitechnical.

respect to usage in the United States are the "Liste Officielle des Noms Français des Insectes d'Importance Economique au Canada" (including French, English, and scientific names, 27) and the "Common Names of British Insects and Other Pests" (3).

Where to Look

Explorations of the literature generally start with abstracts, serial index publications, and reviews.

Abstracts and abstract periodicals are probably the most informative sources of where material of interest may be found, as abstracts are essentially annotated references. The most commonly used and generally available abstract journals for entomological information are collated in Table II with their pertinent characteristics. Those that appear more frequently than annually always contain both author and subject indexes in their annual index units. Although most abstracts are accurate, they vary tremendously in quality and detail. Probably the most important abstracting journal, because of the detailed abstracts and the period covered, is *Chemisches Zentralblatt*, which was started in 1830. However, *Chemical Abstracts* may be preferred for recent material, for it now systematically covers well over 5000 journals; for borderline subjects it should be checked against other sources. For material of less definite chemical import, the *Review of Applied Entomology* in conjunction with some of the index publications may suffice. Thus, the approximately 1800 journals and other publications counted in Table I are all routinely abstracted for this review. Abstract periodicals are not adequate for dissertations, government technical reports, industrial bulletins, reviews, and symposia, but many trade journals and

some house organs are regularly abstracted.

Serial index publications concerned with entomological data and information are listed and compared in Table III. These publications supplement those listed in Table II, but the principal function of an index publication is to index rather than to abstract. Most technical periodicals publish their own internal index units at least annually; the present discussion is limited to those index units of broader than self-coverage. The most complete coverage for a specified geographical area is attempted by the *Index of American Entomology* which includes all journals in the field of entomology, selected journals in general science and in specialized fields where entomological information may be subordinated (as in chemistry, forestry, horticulture, medicine, etc.), selected publications of academies and museums, nearly all publications on or containing entomology issued by the U. S. Department of Agriculture and the state agricultural experiment stations, and selected series from state governments and state extension services. World-wide coverage of a general, very broad nature from an extensive list (Table I), is afforded by the *Review of Applied Entomology*. Comprehensive coverage, where available, is afforded by the *U. S. Department of Agriculture Library Bibliography of Agriculture*; all literature received by this library is indexed in this publication. Other index publications of occasional value in entomological problems include the *Index Medicus* and the *Industrial Arts Index*.

Reviews are surveys of literature published during a certain period and may be critical evaluations or mere summaries (26), appearing as articles, monographs, or books. The present discussion is limited to journals consisting

largely of review-type articles or occasionally containing review articles of entomological interest. Incidentally, review articles are rarely mentioned in abstract journals, so that the usual way to find a desired review is to examine the individual series (26).

In Table IV are collated the major sources for recent reviews pertaining to entomological precepts. Other useful sources for occasional reviews of interest are *Science Progress*, *Scientific American*, *Scientific Monthly*, and the annual *Survey of American Chemistry*.

Directory The Entomological Society of America sponsors the publication of a directory, "Entoma" (14), of products, manufacturers, machinery, and services in the fields of insect and plant pest control. This directory is brought up to date at intervals; the tenth edition provides coverage for 1953-54. Most of the material in "Entoma" is not otherwise readily available; besides cataloging the information listed above, it includes general discussions and data on trends and developments, selection and application, labeling and packaging, kinds of insecticides and their uses, solvents, spreaders, nomenclature of insecticides, safety measures, sources of insecticides, and many others. This directory should be acquired by everyone interested in any phase of economic entomology, for its abundant and accurate information may simplify almost any literature searching problem. Mention should also be made of the value of the annual "Bluebook" issued by the trade journal *Soap and Chemical Specialties* (formerly *Soap and Sanitary Chemicals*), of the New Products Section in each January issue of the trade journal *Farm Chemicals*, and of recent editions of Frear's "Pesticide Handbook" (10). This handbook

(10) is particularly valuable for ascertaining the composition of commercially available pesticides by trade names.

Specialized Problems

In addition to the pitfalls of common names for both insecticides and insects and of cryptogrammic designations, there are still other obstacles to efficient literature searching. Among these the abundance and distribution of the recorded literature merit attention. Abstracts, indexes, and reviews serve to orient the searcher with regard to specific, definite categories of information. Occasionally this necessary categorization may mean that minor or borderline subject matter is not readily apparent to the searcher or is difficult to recognize in subject indexing and sometimes even in abstracting. Such specialized problems in locating desired entomological information include application equipment; formulation and compatibility of insecticides; personal and public hazards to be associated with insecticides; injury to plants and animals; legislation regarding labeling, packaging, and tolerance requirements; and patent surveys. Some of these topics appear regularly as subject headings in indexes. However, information of this sort in a given paper may be handled incidentally to the principal theme and thereby escape notice or justification for subject indexing.

Suggestions for searching for information of these sorts are presented below.

Application Equipment

The field of application equipment is wide in scope and very important to the successful utilization of insecticides. Most reports of developments in this field are both abstracted and indexed, although it may be necessary to ascertain the type of subject indexing used, such as "Spraying Apparatus," "Dusting Apparatus," and "Fumigating Apparatus." Published symposia are not always abstracted in biological and chemical journals, but are usually indexed in the annual index of the periodical involved. Clues for more elaborate searching for literature on equipment may be found in "Entoma" (14). It is further suggested that state experiment station bulletins and news letters be scrutinized for valuable details, and that the trade journals including *Agricultural Chemicals*, *Farm Chemicals*, and current issues of *Soap and Chemical Specialties* be examined for worth-while information about the types and performance of application equipment.

Formulation and Compatibility

The manner of formulation of insecticides is of practical concern to many people interested in applied entomology. Information de-

sired may include the nature of the diluent or extending material, the emulsifier or spreading agent and the amounts required, and the type of equipment or apparatus best suited to mixing the active and inert portions of the formulated insecticide. This literature is scanty with respect to specific instructions for the preparation of even the general classes of formulated insecticides such as emulsions, dusts, and wettable powders. A review of the history, types, and production of an extensive list of synthetic detergents useful as emulsifiers and spreading agents has been published by McCutcheon (16); comprehensive lists of surface-active β -hydroxyethylamines and phenol ethers, their sources, and their composition have been published by Rosen (25).

The Federal Insecticide, Fungicide, and Rodenticide Act of 1947 requires that all economic poisons offered in interstate commerce be registered with the United States Department of Agriculture. According to this act the ingredient statement must appear on the part of the label generally displayed to the public, and the well known common name or correct chemical name of the active ingredient must be given. The ingredients may be designated by the name and percentage of each active ingredient and the total percentage of the inert ingredients, or by the names of each active ingredient in the descending order of the amount of each present, and the names of each of the inert ingredients in the descending order of the amounts of each, and the total percentage of the inert ingredients. Because information concerning the formulation of an insecticide is often a trade secret of the manufacturer or formulator, the option available here allows protection of the formulation if this is desirable.

The compatibility of various insecticides, fungicides, and plant minor element material used together or as successive treatments is frequently a matter of concern. When it is desirable to use various materials together in the same spray mixture, the matter of compatibility should be referred to the manufacturer or formulator, as he may be the only one in a position to know how the combination will affect the performance of the materials in the spray mixture or in the amount of deposit. Compatibility charts are often available from manufacturers or formulators. The trade journal *American Fruit Grower* publishes up-to-date comprehensive information on compatibility. References to information on this subject released by state experiment stations may be found through the subject indexes, usually under "Insecticides, Compatibility" but sometimes under the name of the insecticide.

Personal and Public Hazards

The literature of pesticides toxicology is a topic sufficiently new to many people to justify a brief recapitulation in the present generalized report of entomology as a whole.

All insecticides may be considered toxic to man and other warm-blooded animals, although both the acute and the chronic toxicities may vary widely from compound to compound. Thus, acute toxicities may correspond to a few tenths of a milligram per kilogram of body weight for some of the newer phosphates or to many hundreds of milligrams per kilogram for some of the other insecticidal materials. The Food Protection Committee of the Food and Nutrition Board, National Research Council, distinguishes carefully between hazard and toxicity (23). Toxicity is the capacity of a substance to produce injury; hazard is the probability that injury will result from the use of the substance in the quantity and in the manner proposed. It follows that an estimate of the hazard in relation to any substance must be based upon knowledge of its toxicity and of the details of its use.

Because many organic insecticides can be absorbed directly through the skin, it is important that people working with them or contemplating work with them be cognizant of associated toxicities and hazards. Both general and specific information of this sort may be gleaned from the usual abstract journals and from annual index publications, including *Index Medicus*. It is well to remember the time delay in most abstract journals, however, and to rely most heavily upon the annual indexes of specific, likely journals for the most recent information upon very new materials. Included in this latter category would be the journal of the Association of Food and Drug Officials of the United States (now in volume 17), the several journals concerned with industrial hygiene and with occupational health such as the *Archives of Industrial Hygiene and Occupational Medicine*, journals of the various pharmaceutical societies such as the *Journal of Pharmacology and Experimental Therapeutics*, and trade literature distributed by the manufacturers themselves. The *Index of American Economic Entomology* usually includes large sections of references under "Insecticides, Hazards and Safeguards," under "Insecticides, Toxicity," and under the name of the compound in the general section on "Insecticides." General admonitions and precautions including the use and care of gas masks and similar equipment are to be found in "Entoma" (14), and additional details of toxicity for many of the compounds listed are to be found in the "Pesticopoeia" (24). The medical journals occasionally include brief discussions

of pesticide poisonings and antidotal treatments, but, again, the manufacturer should probably be consulted for fuller details.

Searching the literature for possible hazards to the public from the consumption of contaminated foodstuffs is included under the discussion of legislation.

Injury to Plants and Animals

One of the important considerations in studies of the value of a chemical as an insecticide is whether or not it can be used without injury to the plant or animal concerned. Frequently discussion of this point is not indicated by the title of the paper. Statements concerning injury may not be included in abstracts of papers containing information on injury unless this is the principal theme; in such instances the papers may be indexed under headings such as "Insecticide Injury," the name of the compound involved, or the name of the plant or animal involved. Where discussion of injury is incidental to the discussion of the principal theme, it may be overlooked in both abstracting and indexing. As an alternative, this type of information may be available from a survey of all papers under headings similar to those just mentioned.

The literature on plant injury is expounded in greater detail in a discussion of the literature of plant pathology (1).

Legislation

Legislation of interest for the present generalized report concerning the entire useful literature of entomology would include issuances, regulations, and requirements from both state and federal departments of agriculture in this country. These departments are concerned with the labeling and packaging of insecticides, with their registration and licensing for interstate shipment and for sale, and with permissible tolerances for insecticide-containing residues on and in foodstuffs. It is suggested that the *Federal Register* be consulted for pertinent details.

Patent Surveys

In Table II are listed most of the journals and other periodicals which currently abstract patents and patent information.

The problem of patent searches depends entirely on the objective. The acquisition of a nodding acquaintance with the patent literature is fairly simple, but the preparation of an exhaustive bibliography for a specific patent survey is far from simple and involves the services of a patent bibliographer (26).

Excellent discussions of patents, their structure, and their location have been prepared by Soule (26) and by Fleischer (8, 9). Although these discussions were

designed for exploring the chemical patent literature, they are applicable to most fields, including entomology.

Conclusions

The compilation of world-wide sources in Table I provides an illustration that the literature of entomology is extensive and widely diverse in origin. The evidence presented in this paper shows that organization and indexing procedures for this literature are in operation and greatly expedite literature searching. For most purposes, reference to abstracts and indexes offers the most practical approach. However, consideration of detailed searching methods emphasizes the considerable volume of material and personal limitations with respect to over-all coverage. Adequate grasp of the many facets of research in entomology is becoming more and more difficult, and specialization is becoming more and more popular; in fact, it is almost a requirement for proficiency.

Workers in this field are well aware that the volume and diversity of the useful literature are increasing prodigiously. It is clear, therefore, that in the future the student of entomology will have to depend largely upon reviews and symposia for orientation in any given phase of the field. Review papers and symposium papers are neither abstracted nor indexed in a regular manner, with the result that many valuable contributions of this sort are overlooked in literature searches even today.

Acknowledgment

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Literature Cited

- (1) AMERICAN CHEMICAL SOCIETY, *Advances in Chem. Ser.* No. 4, 1-171 (1951). Searching the Chemical Literature.
- (2) *Ibid.*, No. 10, 1, 438-541 (1954). Literature Resources for Chemical Process Industries.
- (3) Assoc. Applied Biologists, "Common Names of British Insects and other Pests," Part 1, 1947; Part 2, 1952.
- (4) Baldwin, M. M., Chester, K. S., *J. AGR. FOOD CHEM.*, in press.
- (5) Commonwealth Institute of Entomology, *Rev. Appl. Entomol.* (Ser. A), 35, 429 (1947).
- (6) Crane, E. J., Patterson, A. M., "Guide to the Literature of Chemistry," Wiley, New York, 1927.

- (7) "Cumulative Book Index," H. W. Wilson Co., New York, 1899 to date.
- (8) Fleischer, J., *Advances in Chem. Ser.* No. 4, 61 (1951).
- (9) *Ibid.*, No. 4, 81 (1951).
- (10) Frear, D. E. H., "Pesticide Handbook," College Science Publishers, State College, Pa., 1953.
- (11) Gurney, A. B., *J. Econ. Entomol.* 46, 205, 207 (1953).
- (12) *Ibid.*, 47, 200 (1954).
- (13) Haller, H. L., *Ibid.*, 48, 112 (1955).
- (14) Langford, G. S., ed., "Entoma," 10th ed., 1953-54. Entomol. Soc. of Am., Executive Secretary, 1530 P St. N. W., Washington 5, D. C.
- (15) Lemmon, A. B., "Pesticides," Calif. State Dept. Agr. Bur. Chem., Sacramento, Serial Pub. 253 (1953-54).
- (16) McCutcheon, J. W., *Soap Sanit. Chemicals* 25 (8), 33; (9), 42; (10), 40 (1949).
- (17) Martin, H., "Guide to Chemicals Used in Crop Protection," Canada Dept. Agr., Ottawa, Ont., 1953.
- (18) Mellon, M. G., Power, R. T., *Advances in Chem. Ser.* No. 4, 37 (1951).
- (19) Metcalf, C. L., Flint, W. P., Metcalf, R. L., "Destructive and Useful Insects," p. 175, McGraw-Hill, New York, 1951.
- (20) Metcalf, Z. P., *J. Econ. Entomol.* 16, 21 (1923).
- (21) Ministry of Agriculture, Quebec, "Liste Officielle des Noms Français des Insectes d'Importance Economique au Canada," 2nd ed., 1952.
- (22) Muesebeck, C. F. W., *J. Econ. Entomol.* 43, 117 (1950).
- (23) National Research Council, Food Protection Committee of Food and Nutrition Board, "Use of Chemical Additives in Food," Washington, D. C., 1951.
- (24) "Pesticopoeia," pp. 69-143, Association of Economic Poisons Control Officials, Inc., College Park, Md., 1953.
- (25) Rosen, M. J., *Anal. Chem.* 27, 111, 114 (1955).
- (26) Soule, B. A., "Library Guide for the Chemist," McGraw-Hill, New York, 1938.
- (27) U. S. Dept. Agr., Yearbook of Agriculture, "Insects," 1952, U. S. Government Printing Office, Washington 25, D. C.

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