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An Evaluation of the Pesticide Literature— Problems, Sources, and Services*

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I. INTRODUCTION

Pesticide literature includes literature from many and varied scientific fields. It is exceedingly scattered and sometimes difficult to retrieve. This may be true in any field of scientific endeavor, but in recent years, agricultural research and development have become major activities of an increasingly large number of commercial and nonprofit organizations. This has created complexity and scattering of valuable information.

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II. PROBLEMS

Vastness of the Literature.—When you consider that the utilization of literature in any one of the allied fields results ultimately in the publication of more and more, this fact alone is sufficient to explain the vastness of the pesticide literature. However, by analysis of any one single phase of pesticide research, "insecticides," for example, we find that there are four types of insecticides: contact poisons, stomach poisons, systemic insecticides, and fumigants.¹ The term also covers the allied fields of attractants, repellents, and chemosterilants. Chemically these may be arsenicals, carbamates, chlorinated hydrocarbons, organophosphorus compounds, etc. In addition to information on the chemistry and synthesis of such com-

pounds, their effectiveness in laboratory and field tests, methods of application, formulations, mode of action, and toxicity tests produce extensive literature. While other areas of the pesticide field may not be as vast, they are by no means "cut and dried". Research in adjuvants and synergists is another vast field in itself, and when applied to each area of the pesticide field, the literature becomes gigantic in scope.

These are but a few of the ramifications of pesticide literature. I have not mentioned the economic, legislative, or manufacturing aspects which must also be considered when setting up a special Library to serve pesticide research.

Terminology.—Those concerned with pesticides are constantly confronted with the problem of keeping abreast of current and past developments on the subject of chemical control. In view of the great number of commercial and experimental compounds now being tested and those used during the past decade, it is becoming increasingly difficult to recognize the relationships of the various chemicals which may be coded in several ways and given synonymous chemical or trade names.

Research and development procedures, in themselves, help to confuse the issue. In the development, processing, and marketing of one of American Cyanamid's less complex products, Cygon** Insecticide, for example, it was first identified as Experimental Insecticide 12,880; its generic name is dimethoate. Chemically it is identified, using the *acid* base, as: phosphorodithioic acid, O,O-dimethyl S-methyl carbamoylmethyl ester; using the *ester* as the base, it becomes: O,O-dimethyl S-(N-methyl-carbamoyl) methyl phosphorodithioate. Dimethoate is also known sometimes as methyl dimethyldithiophosphorylacetaide. The chemical formula is



It was assigned the trademark "Cygon" by American Cyanamid; in Europe, it is known as "Rogor," making a total of eight terms for the same compound. These multi-terms lead to inconsistencies in indexing. In 1961, Chemical Abstracts indexed Cygon under dimethoate, phosphorodithioic acid, and Rogor. No entries appeared under Cygon and there were no cross references.

The quest for literature sources obviously becomes, not a simple process of going to an index or catalog and looking under a given subject heading, but rather, it becomes a "sleuthing" job. Inexperienced searchers or those unfamiliar with a product find it difficult to be sure they have done a thorough searching job.

Chemical Nomenclature.—Chemical nomenclature presents a problem in the literature of any research field. This is especially true of agricultural research because it is rarely possible to arrive at good scientific compound names which are not very complex. The more complex a chemical compound, the more names it may have and the more ways it can be indexed. The *best* name for a chemical compound is difficult to ascertain because the possible names are, in themselves, complex and all may be correct, depending on the point of view from which a compound is named.

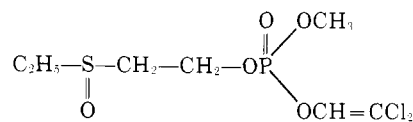
The International Union of Pure and Applied Chemistry has made valiant effort to stabilize chemical nomenclature.

Unfortunately, this has been impossible. There have been approximately seven revisions in nomenclature through the years in which the I.U.P.A.C. has attempted to build on the already established nomenclature. More than 50,000 new compounds are added to the list each year; they become more and more complex, and the I.U.P.A.C., even though making as few changes as possible, feels that utility of a compound name is more important than any prior rule governing nomenclature.

In practice, particularly in organic chemistry, there will never be just one correct name for a compound. Large compilations, such as Beilstein and Chemical Abstracts often use differing principles, and to introduce fundamental changes now would make chaos of their indexes; nor is a single rule feasible when large sections of chemistry maintain differing customs.²

Trademarks.—Regular readers of technical literature are well aware of the flood of new trademarks. These usually convey not the slightest suggestion of the nature of the compound, nor the use for which it is intended. Often, the appearance of these in the literature is the first clue that a compound is being manufactured. To keep the researcher aware of the competitive field, the Library must be in a position to translate trade names into chemical compounds.

Recently, we were asked to find the chemical formula for Nexion-1378 sold by Cella



and the patent covering the compound which was assigned to Boehringer.

The chemical formula was easily obtained by consulting the fourth edition of "Guide to the Chemicals Used in Crop Protection" by Hubert Martin, published by the Canada Department of Agriculture. It was then possible to scan Boehringer patents to find the one which covered it.

Another request, "What is the generic name for the emulsifier and spreader, Triton B-1956?" was quickly satisfied by consulting D. E. Frear's pesticide handbook and the Rohm and Haas data sheets in our file of Other Company literature (Triton B-1956 is a modified phthalic glycerol alkyd resin).

This type of request cannot be handled simply by referring to one of the index journals. Most trade names can be considered "transient" as far as indexing is concerned.

It is only recently that some journals have begun to carry alphabetical lists of products advertised. Lists of advertisers have been common practice, but one seldom knows that a given concern markets a product of interest. The most satisfactory practice is to include a key number with each advertisement on a tear-out mailing card. Information on competitive products can easily be obtained in this way.

In addition to Martin's "Guide to the Chemicals Used in Crop Protection," which is invaluable for translating trade names into chemical formulas, Eugene E. Kenaga of Dow Chemical Company published in 1957 an index to experimental and commercial insecticides, listing their scientific, common and trade names, uses, and manufacturers. Also included is a number list which designates

** Trademark of American Cyanamid Co.

the preferred Company name for a compound, the synonymous name used in accordance with principles of C.A. nomenclature, and the alternative name used by the Company in the past. This compilation was revised in 1960 and again in 1963. It is published in "Bulletin of the Entomological Society," Vol. 9, June, 1963, p. 67. *Chemical Week* produced a similar compilation in 1963 for the entire pesticide field.

In spite of these, the maintenance of an extensive file of Other Company literature and a wide selection of chemical and allied product directories, we still find trade name information difficult to obtain at times.

Cryptograms.—Another current terminology problem involves the increasing use of letters or numbers or letters plus numbers to designate chemical compounds and mixtures. In current use are: AATP (parathion, O,O-diethyl O-*p*-nitrophenylphosphorothionate); 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]; and G-410 (pentachlorophenol) to name a few. Occasionally a cryptogram may be assigned to a compound without realizing that it is already in use for something else. Hexachlorocyclohexane was known as 666 until it was discovered that a cough medicine used in the South was also designated 666.³

Genus and Species.—In any scientific field dealing with the use of agricultural chemicals on plants and animals, the problems are magnified by Latin terminology for genus and species.

The scientific names for insects and related organisms conform to a rather exact plan, which is guided by an international commission. As with chemical names, scientific names are used for indexing. Problems develop when special names arise in certain localities for the same insect or organism, and we arrive at many different common names associated with different communities and especially with different countries.

In many instances, pests have synonymous scientific names. Metcalf⁴ and the "Bulletin of the Entomological Society of America," Vol. 6, Dec., 1960, report that the corn earworm is also known in this country alone as the cotton bollworm, tomato fruitworm, and vetchworm. The scientific Latin name is *Heliothis zea*.

All the variations in terminology and nomenclature present a formidable problem in indexing and thus in literature searching and retrieval.[†]

III. SOURCES

Periodicals are the most important part of a library's holdings for immediate results of experimental research and announcements of technical developments.

Primary Journals.—Primary journals are those that contain new or previously unpublished information. They are basic to the field they cover. The variety, nature, and number of journals make evident that facts relating to any one subject are widely scattered, and thus it is difficult to be sure you have located *all* information available.

In any research based on organic synthesis all important chemical journals are needed, including foreign journals—

especially German and Russian. A survey of our 1963 current awareness service, issued weekly at American Cyanamid's Agricultural Center, our abstracting service, and our circulation statistics showed that the ten chemical journals containing articles most pertinent to our work were:

	Pertinent articles, 1963
Angewandte Chemie	98
Journal of General Chemistry of the USSR	89
Journal of Organic Chemistry	74
Journal of the Chemical Society	74
Chemische Berichte	53
Journal of the American Chemical Society	50
Bulletin of the Academy of Sciences of the USSR	35
Annalen der Chemie	26
Bulletin de la societe chimique de France	21
Journal fur praktische Chemie	19

Primary pesticide journals of greatest value to us were:

	Pertinent articles, 1963
Journal of Economic Entomology	157
Journal of Agricultural and Food Chemistry	69
Journal of the Association of Official Agricultural Chemists	59
Weeds	31
Phytopathology	27
Plant Pathology	26
Plant Physiology	17
Bulletin of the Entomological Society of America	17
Canadian Entomologist	13
Nematologica	12

Secondary Journals.—Secondary journals are one of the chief tools in the retrieval of scientific information. These are abstract journals, serials, indexes, and bibliographies. The secondary journals are essentially more organized than primary journals and are issued for the express purpose of providing means for collecting, classifying, and arranging scattered facts already discussed. Without the secondary journals, searching would be a hopeless task.

Since chemical literature predominates in pesticide research, Chemical Abstracts is probably the most important secondary journal in the field. It is the most comprehensive and bases its international selections on all scientific and technical papers containing new information of chemical interest. It also reports new chemical information revealed in the patent literature.

Index Chemicus, which was started in 1960, aims to report molecular formula and chemical name of the thousands of new compounds synthesized each year within thirty days of their appearance in primary journals. Its greatest advantage is promptness in reporting data.

The standard bibliographic services, Bibliography of Agriculture and the Agricultural Index cover the applications of pesticides and pest-control methods. The Bibliography of Agriculture is the most comprehensive single index to agricultural literature. Publications of the U.S.D.A., State Experiment Stations, and Extension

[†] Problems in nomenclature are discussed further in the accompanying paper by N. M. Payne.

Service publications are covered, in addition to various primary agricultural journals. More than 10,000 separate publications are cited under the heading "Entomology" alone.

Because there is such scattering of valuable information in primary journals, a large number of serials are of importance to the pesticide field. In entomology there are more serials published than primary journals. These are published mostly by scientific societies which make a comprehensive effort to summarize advances during the period and to present general trends in the field. They are excellent for keeping up with work outside or allied to one's own.

We have found the following serials of the greatest importance at American Cyanamid Company.

- Review of Applied Entomology (Sect. A and B)
- Advances in Pest Control Research
- Residue Reviews
- Proceedings of the Chemical Society
- Proceedings of the Royal Society (Dublin)
- Quarterly Reviews
- Annals of Applied Biology
- Annals of Botany
- Annals of the Entomological Society of America
- Botanical Review
- Proceedings of the British Insecticide and Fungicide Conference
- Proceedings of the British Weed Control Conference
- Yearbook of Agriculture

Both sections A and B of Review of Applied Entomology abstract heavily the literature dealing with insect control by chemicals. Advances in Pest Control Research is a prime example of a serial of importance to the pesticide field. In it the chemistry, ecology, and pharmacology of pest-control research are summarized annually. The object of Residue Reviews is to provide concise, critical reviews of timely advances in the safe use of pesticides in the growing and storing of foodstuffs. The Yearbook of Agriculture is an authoritative and comprehensive treatment on research developments on an important agricultural subject. The articles are both technical and popular in approach. While not intended as a definitive edition or all-inclusive coverage of a single subject, the Yearbooks do cover a lot of ground and provide libraries with inexpensive tools to various fields of agriculture. In nearly every issue, pest control as it applies to the subject under discussion plays a part.

Patents.—Patents are a valuable source of chemical information. They are important factors in science and industry because they stimulate technological advances and reveal chemical information that might otherwise be lost. Since the criteria for patentability include invention, utility, and novelty, patent specifications sometimes represent the only printed material available on a particular subject. They are used along with technical periodicals and books as background material before entering a new phase of research.

Like the journal literature, the patent literature is voluminous. An unusually complex situation is created in the chemical patent literature by the very nature of organophosphorus chemistry. The almost limitless number of compounds that may be prepared having pesticidal properties has led to a flood of patents in this one field alone.

In order to keep our personnel abreast of new developments and to avoid duplication of effort, an extensive phosphorus punch card system by chemical structure was set up several years ago at American Cyanamid. Information is fed into this file through continuous scanning of the following sources:

Official Gazette	Patentblatt
Official Journal (Patents)	Derwent Patent Abstracts

We have found this file invaluable for quick retrieval of patent information. Recently, we received a request for all process patents on dimethoate. In three to four hours, we were able to find the answer to this request.

Patent files are also maintained for herbicides, plant growth regulators, and nematocides.

To facilitate the problem of recognizing equivalent-to-basic patents issued in various countries, a "convention data" file is maintained. We have found this file most helpful as a space and dollar saver in the acquisition of foreign patents.

We used to find R. C. Roark's "Review of U. S. Patents Pertaining to Pesticides," published by the U. S. Department of Agriculture, quite helpful in our area. Unfortunately, this has been discontinued. Today we subscribe to the U. S. Patent Office's "Phosphorus Compounds" punch cards.

To accommodate the demands from our Development and Sales groups a large number of Trade and Consumer publications are maintained by the Library.

Trade Journals.—Trade journals serve as advertising media. They provide business and commercial information in addition to technical material of interest. One of their greatest values is providing information on commercially available chemicals and equipment.

They are directed to dealers, distributors, manufacturers, and people who will use a product for processing or resale. However, a great deal of technical and scientific information is obtained from them, and future trends in the industry are indicated. Industrial and research chemists cannot afford to neglect them.

As might be expected, we find Pest Control of greatest use, with Agricultural Chemicals and Chemistry and Industry competing for second place.

Consumer Journals.—Consumer journals are directed to people who use a product. They are designed to acquaint the public (lay-people so to speak) with the products described. They are of particular value to teachers of undergraduate students as an authoritative statement concerning the nature and applications of new products. These journals attempt to prevent misinformation and describe small-scale pest control operations. Safety measures and care of pesticide application equipment are included.

California Farmer, for example, publishes pesticide product information for the farmer with the hope that he will be able to improve his crops and increase his yields.

Western Fruit Grower is in itself a constructive force in national fruit production and publishes such pesticide information as new and improved compounds and application techniques.

The relative importance of trade and consumer journals to our research effort in 1963 is shown in the following lists.

Pertinent articles, 1963

Trade journals		Consumer journals	
Pest Control	103	California Farmer	43
Agricultural Chemicals	91	Western Fruit Grower	39
Chemistry and Industry	90	California Citrograph	21
Chemical Week	86	Exchange (Florists)	19
Farm Chemicals	63	Arizona Farmer Ranchman	19
Mosquito News	48	American Fruit Grower	18
Crops and Soils	41	Agrichemical West	16
Chemical and Engineering News	39	Western Grower and Shipper	10

House Organs.—Considerable practical, technical, and scientific information can be obtained from house organs. Even though their main purpose may be advertising, new developments and ideas in pesticides resulting from chemical research are reported in them.

Agricultural News Letter, published by E. I. du Pont de Nemours and Company, holds the same degree of importance in many agricultural libraries as the primary journals. It publishes results of trials at agricultural experiment stations on the actual use and application of pesticides. Down to Earth is published quarterly by the Dow Chemical Company as a review of Agricultural Chemical progress. World Review of Pest Control, published quarterly by Fisons Pest Control, Ltd., reports international pesticide research.

American Cyanamid's Cyanagrams is a public relations publications and provides information on results of experiments with our products under actual growing conditions on the farm. It is published quarterly and sent to all key people in agricultural, *e.g.*, county agents, vocational agriculture teachers, agricultural colleges, directors of experiment stations, and customers.

Public Documents.—Other pesticides publications of great importance are the *public documents* issued by the United States Government and the governments of foreign countries. These include results of investigations of thousands of government workers conducting research in scientific agricultural endeavor for the benefit of the whole world and are issued as Bulletins, Circulars, Leaflets, etc. It is among this voluminous literature that biological, chemical, physical, and engineering research is consolidated. Much of it is concerned with enforcement of regulations of vital importance to the research man in determining the safety and salability of resulting products.

Some of these publications of importance to our pesticides operation are Plant Disease Reporter and Cooperative Economic Insect Report published by the U. S. Department of Agriculture, Plant Protection Bulletin, published by the Food and Agriculture Organization of the United Nations, and the World Health Organization Publications.

Internal Literature.—In addition to the various types of journals which I have mentioned, is the internal literature. At American Cyanamid, a large technical file is maintained for pesticide research and development groups. This contains correspondence, results of field tests, legislation, and laboratory reports of investigations on our various products. Most of this material is highly confidential and

vital in importance. From it, starting points for possible conception of patentable ideas and publications in journals may develop. This material presents a formidable job of indexing and its effective use is determined by the quality of indexing.

IV. TECHNIQUES

A changing need and a changing environment have altered the organizational model for providing professional information services to research and development personnel. In essence, the change is from a traditional central repository for books and journals available for consultation on request to a dynamic program of bringing to our patrons relevant information from a variety of forms and sources.

Little can be added to any discussion of conventional library techniques which has not been said many times before. However, the basic problem of too much literature still looms. What are the solutions?

One obvious solution is greater selectivity on the part of publishing companies. Do they ask themselves if this material is scientific, are the conclusions valid, will this material make a contribution to the field, has this material been released to other journals? More discriminating publishers would reduce the volume considerably and, I dare say, without much loss of really scientific knowledge.

Too few qualified literature scientists to provide rapid service to patrons has long been a problem in technical information. This is slowly correcting itself, but the obvious solution for any Company with limited staff dollars is to purchase commercially available services. The Derwent Patent Literature Service, Theilheimer's Commercial Abstract Service for Organic Synthesis, and the U. S. Patent Office's Phosphorus Compounds punch cards, are examples.

There is a great need today for commercial services geared specifically to pesticide research. Once these are developed and their value to industry proved, we will have no trouble justifying the expenditure. However, we will never be able to buy services tailor-made to our specific needs. It will always be necessary to search through the material and select the information applicable to our areas of research. Therefore, nothing can replace the discriminating literature scientist, well trained in the techniques of searching and familiar with the literature and Company projects.

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