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Part I

INDUSTRY RESPONDS TO NEW PHILOSOPHIES

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The title should probably have read: "Industry Responds to Old Philosophies." In 1939, Harold Shepherd wrote a book called "The Chemistry and Toxicology of Insecticides." Its introductory paragraph includes these statements: "Unfortunately, as in the control of human disease, the use of chemicals is depended upon often when other means would serve better. The control of insects with insecticides is such a conspicuous means of dealing with insect pests that other methods that should be in operation at the same time to improve the efficiency of control or to eliminate in part the need for insecticides are often forgotten." Having said this, Dr. Shepherd proceeded to write the first definitive book on insect toxicology.

I, too, would like to preface my discussion about the handling of agricultural pesticides, with recognition of and deference to the highly logical and desirable concept of pest control by nonchemical means.

THE PAST CENTURY. The wish to manage insect populations by natural means has been very great but while new concepts have been dramatic, their actual practice on a commercial scale has developed little in the last century. The first attempts to introduce foreign parasites go back a hundred years to about the time the first arsenicals were being tried on apples and potatoes. Neither program was very successful at first. But about 1890 the introduction of an Australian Coccinellid into California gave spectacular control of the cottony cushion scale—and lead arsenate did the same for the control of the gypsy moth. Today, while the science and practice of biological control has expanded tremendously, the science and practice of chemical control has expanded much more. About twenty-five years ago we in industry saw the balance of emphasis between biological and chemical control tipping strongly toward chemical control and deployed our research and economic efforts accordingly. Our basic faith in chemical research has not been diminished by anything that has happened during this past quarter of a century.

MOSQUITO CONTROL IS SPECIALIZED ENTOMOLOGY. Before we get further into this discussion of pest control strategies, some reference frames should be blocked in. What I say today will frequently be irrelevant to mosquito control. I am speaking in the larger reference frame of the pesticide industry—sale of a billion dollars

worth of manufactured technical pesticides in an attempt to mitigate a $25 billion annual loss. Without wishing to denigrate your large and important field of research, or to diminish your contribution to American health and comfort, it must be said that mosquitoes are a very small part of our total pest control problems and mosquito insecticides provide a very small part of the pesticide market. This is why government carries a major burden of mosquito control research and development, and it is why you must, when possible, fit agricultural insecticides into your field and not expect industry to do major research and development, or to undertake the expensive registration process on products, solely for the mosquito control market. So please let me speak in generalities, leaving it to you who are experts in mosquito control to apply my generalities to your specifics.

I attended the California Mosquito Control Association meetings in Stockton at the end of January and came away with the impression that in California we have more mosquito control problems than anybody. We have 60 mosquito abatement districts which spend $8.3 million of tax money to control mosquitoes on 36,000 square miles, about 15 percent of the state's area. But in contrast, we in California produce 25 percent of the nation's food on 3 percent of the nation's farms using about 12 percent of the nation's pesticides. Our farm income last year was $4.5 billion from 42.5 million tons of production. For this we spent $125 million for pest control and still lost $160 million in 1970 to pests, for a total pest loss of $285 million. Most of the $8.3 million spent for mosquito control in California goes for salaries, facilities and equipment—the pesticide market for control of mosquitoes in California is probably less than 5 percent of the market for control of agricultural and other pests.

We have some serious and specific problems in California mosquito control. Modern chemical insecticides are not forthcoming to control resistant strains of *Culex tarsalis* and *Aedes nigromaculis* in central California. Oils can be used, but because of necessary volume and frequency of sprays may cost 10 to 15 times as much to apply as the once efficient phosphates and carbamates. Biological control with *Gambusia* minnows or *Notonecta unifasciatus,* both of which are efficient predators, is impossible in pastures where water dries up between irrigations. Fast-breeding mosquitoes can always build up faster than slow breeding predators. The obvious, but difficult, solution is better land management, meaning replanting pastures on re-leveled land and then managing irrigation water so well that none persists long enough to mature a hatch of larvae. The farmer who breeds these mosquitoes gains little by their control. He feels, rightly or wrongly, that his tax support of the local abatement district delegates to them the responsibility, and should relieve him of additional major cost and effort for mosquito control. This unfortunately means that he must be cajoled or coerced into spending time or money for clearing breeding areas. This attitude tends to place pest management in the hands of lawyers and sheriffs, a form of pest management not viewed sympathetically by entomologists, public health officials or farmers.

THE PAST DECADE. To return to generalities, let's have a look at the decade since *Silent Spring* hit the *New Yorker* in June, 1962. During this decade the previously conceived sterile male technique was the major and almost the sole advance that actually came into large scale control practice. However, the initial success on the screwworm was not repeated on other species and even the screwworm program requires continuing heavy investment and has had occasional set-backs.

New parasite introductions have been made and have helped in the suppression of a few newly introduced species, fully justifying the time and money spent in their development. However, parasite and predator introductions have accomplished little in the continuing battle against flies and mosquitoes, or the cosmopolitan pests of major crops and forests.

The continuing scientific marvel of the

discovery, isolation and synthesis of pheromones has yet to be applied on any practical scale. Light traps have failed to replace sprays even at high cost. The advances made in bacterial, and especially in viral, control in the development of juvenile hormone analogs, and in feeding attractants are gratifying, but are simply specialized forms of chemical pesticides, subject to the same problems of safety, effectiveness and regulation as other chemicals. In spite of tremendous political pressures and heavy expenditures in research, the simple fact is that indirect pest control research has not produced much but hope and promises during the past decade. This has been fine and necessary research—we in industry support it and are willing to see our tax dollars spent for it. Perhaps we have not studied the problems in sufficient depth, but for the present it does not seem to justify diversion of our limited research staff and budgets.

In contrast, let us look at the record of accomplishment in chemical control research. In this reference frame there have been major developments that make chemical control better and safer, even if not cheaper. The use of granules to give better control of pesticide placement, ultra low volume techniques to reduce the amount of chemical used, and a better appreciation of the old principles of integrating chemical control methods with the time-tested techniques of resistant varieties, controlled planting, crop residue disposal, and careful timing of application to avoid bees and parasites and to meet the time of major pest attack, have all become, not only a part of our *philosophy*, but more importantly, a part of our *practice*. Much of this advance in chemical control techniques comes from public laboratories and they should be given due credit.

But, the most important advances of the past decade have been in the field of chemistry, not biology. Through chemistry we recognized the theoretical and sometimes practical disadvantages of lead, mercury and of some uses of persistent chlorinated hydrocarbons. More importantly, we were able to develop, manufacture, market and *use* substitutes in all areas of pest control. The contributions of Shell Chemical Company during this decade can be cited, not because they are unique, but because they are typical of the contribution of other companies and are more familiar to me. PLANAVIN® and BLADEX® herbicides are selective, relatively nonpersistent herbicides. VAPONA®, RABON® and GARDONA® insecticides combine freedom from hazard in use with insecticidal effectiveness and are being increasingly used where DDT was formerly employed. A broad line of ectoparasiticides and endoparasiticides has been developed for pet and farm animal use. A line of house and garden aerosols has been developed. The famous NO-PEST® Strip controls the release of pesticides in safe but effective amounts. These products have met increasingly stringent criteria for safety in a decade of mounting concern and anti-pesticide propaganda. They have been approved by regulatory agencies, and used by wildlife, public health and agricultural specialists.

During this period of public debate and sometimes of open hostility, the use of chemical pesticides has more than doubled. Seizures of food for illegal residues, massive wildlife kills and incidence of illnesses and deaths from pesticide poisoning have not been entirely eliminated, but have been significantly reduced during the last five years of the decade. Residues of persistent materials in water and soil are going down. Fish, pelicans, eagles and ospreys are continuing to breed and produce eggs that hatch into healthy fry and fledglings.

The past century and the past decade have given us a philosophy that is both old and new. Chemical insecticides can and must be used safely, economically and effectively. They have done 90 percent of our work during the past decade and century—they will remain equally important during the next century and decade.

THE NEXT DECADE. All of us have learned some important things during the past decade. If we are to progress in the seventies we must not forget these lessons of the sixties. We would hope that the

environmentalists and the industrialists, the prosecutors and the defendants, the thinkers and the doers, the biologists and the chemists, the taxpayers and the tax spenders, the students and the professors, the saints and the sinners, and the producers and the consumers have all learned, and that their wisdom will be reflected in their actions during this next decade.

We have learned, or reinforced what we should already have known, namely, that there is no simple available alternative to chemical pest control. We will keep on trying because nonchemical control is such an entrancing will-o'-the-wisp, but since we are going to use chemicals, we must put more of our research on *how*. The best source of funds for this *how* research is diversion of some of our negatively directed research on how to eliminate chemicals. The problems of safety and insect resistance can keep us fully challenged.

Nonchemical techniques are generally not commercially saleable and therefore must be the province of public research. *Chemicals* for pest control have always been the province of private commercial research, although their *use* has been guided by the research programs of publicly supported laboratories. This division of entomological research between public and private sectors is logical and we in the pesticide industry would not recommend a change. We feel that a publicly suported search for new chemicals which must be manufactured and distributed in volume would be uneconomic and impractical. We feel that nonchemical control methods are not likely to be adaptable to private development, and that therefore their development and exploitation should be a public function.

Here, then, are the major ways in which the pesticide industry will be responding to the opportunities and challenges of the seventies:

1. BETTER CHEMICALS. New pesticides are rarely found any more by random screening. Intensive organic synthesis research programs are necessary and only industry has such programs. Once a promising chemical shows up, the registration and development of the compound is expensive and extensive. Again, only industry is organized, staffed and experienced to accomplish this. The third vital step in providing better chemicals is manufacture, formulation and distribution. This requires capital investment, engineering experience, and established distribution networks. As with research and development, only industry can do the job of manufacture and distribution.

2. BETTER METHODS. With old chemicals, but especially with new materials, safety and success may depend more on how a chemical is used than on its intrinsic nature. Insofar as field entomology is concerned, state and federal experiment stations will carry much of the load. But they come into the picture only as a new material approaches use on a commercial scale. For from 4 to 10 years before that time industry will have been laying the foundations. It is this basic work with spectrographs, chromatographs, liquid scintillometers, and various other stacks of grey boxes with black knobs, red lights and restless recording pens, that make it all possible. The resulting tables of numbers guide other years of tests with insects, plants, laboratory animals, wildlife, water, soils and even with the air we breathe.

Often in the search for information, instruments are found inadequate, chemical assays inaccurate, biological tests inapt, or mathematical analyses inappropriate. The only answer is to back up and invent a new machine, assay or analysis that is adequate, accurate, apt and appropriate. A large part of the methods we use in modern pesticide research were bought with private, not public, money.

3. BETTER FORMULATIONS. It is a rare material which, like malathion, can be sprayed in ultra low volume directly without dilution, emulsification, solubilization, vaporization, suspension, granulation or other aid to accurate dispersion. Most pesticides used today wouldn't work if the physical properties had not been artfully controlled. The pesticide industry is uniquely qualified to invent new formu-

lations, to oversee their manufacture, to monitor their stability in storage and to get them properly packaged and distributed. It is not a simple matter to provide materials effective at two ounces per acre in Cut Bank, Montana, Gila Bend, Arizona, and Waimea, Hawaii, and have them there on time or effective after storage.

4. BETTER ADVICE. For various reasons, chiefly economic and political, the tax-supported farm advisory services are finding it increasingly difficult to get adequate staff and budget. This means that the average farmer sees his pesticide salesman or dealer more often than his county agent or extension specialist. This in turn means that the ways pesticides are used are more frequently the result of advice from the agricultural chemical industry than from the publicly supported experiment stations.

It now seems likely that the use of some pesticides at least will be permitted only on the written, responsible recommendation or prescription of a licensed expert. The sheer number of pesticide applications that must be made will require that every qualified entomologist or agronomist will have to be enlisted, including all qualified industry salesmen and technologists.

A major industry response to the new philosophies, then, will be to provide expert advice and guidance in the use of modern pesticides.

5. BETTER COORDINATION. While the agricultural chemical industry does not foresee any major replacement of chemicals by nonchemical methods of pest control, the new philosophies will continue to engender new attempts to reduce the use of chemical pesticides. This would require highly sophisticated techniques requiring full cooperation by experiment station personnel, farmers, pesticide suppliers and applicators, and especially by regulatory agencies and officials. The net result will be a greatly increased cost for smaller amounts of more expensive materials. The farmer (and the consumer) will be paying out a bigger part of his dollar for guidance and a smaller part for materials—and he will be paying out more dollars.

Industry's response to new philosophies will be to recognize the commercial opportunities along with the social and legal challenges. The greatly increased cost of pest control is such a commercial opportunity. Our response to the challenges of the sixties was to produce many expensive new chemicals which, because of their demanded specificity and nonpersistence, had to be used frequently and in great variety. The replacement of DDT with phosphates and carbamates has not been enough. In the seventies we must extend control over the products to control over their use. This control will be paid for by the user, and it is this sale of control and advice that will constitute one of industry's major responses to the currently changing philosophy of pest control.

The Farm Service Centers are undergoing a period of trial and development. Originally started to provide limited free services to increase the sale of fertilizers or animal feeds, they rather quickly began to sell soil analyses, record keeping, and computer calculation of feed composition. The next step will be the sale of multiphase entomology in which the crops as well as the pests are managed.

If regulatory entomology imposes new philosophies which are resisted by farmers and public agencies, we hope they will be discussed with us in industry so that the new philosophies or rules will have the necessary support of the chemical industry.

The agricultural chemical industry must operate profitably to continue to exist. We believe our contribution can be not only to economic welfare, but also to environmental conservation and to public health and safety. Our response to the new philosophies of pest control is to devote our technical and economic resources to these ends.