

**PEST CONTROL PROGRESS
AND
PROBLEMS IN OREGON**

**PROCEEDINGS OF A CONFERENCE
SPONSORED BY THE
OREGON INTERAGENCY PESTICIDE COUNCIL**

NOVEMBER 15-16, 1966

OBJECTIVES OF THE OREGON INTERAGENCY PESTICIDE COUNCIL ARE TO:

- Provide means of communication and exchange of information between the various public agencies using, or interested in the use of pesticides.
- Encourage interagency interest in area-wide pest control projects.
- Sponsor in-service training and provide information in the technology of pest control for the members of the various agencies involved.
- Stimulate research on new pest control problems and on the development of safer and improved methods of pest control.
- Sponsor or provide opportunities for the dissemination of information on pest control to the public.

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November 15-16, 1966

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PEST CONTROL -- PROGRESS AND PROBLEMS IN THE FEDERAL GOVERNMENT

Colonel John M. Geary, USAF, BSC
Chairman, Federal Committee on Pest Control

There are many problems inherent in the use of modern chemical pesticides, most of which can both protect and harm man and his environment.

Much has been done in many fields concerning pesticides. Unfortunately the expert workers in these areas often hold opposing views as to the needs for pesticides and the uses to which they should be put. It is time to broaden our perspectives, to try to understand the opposing point of view and to integrate research work. In brief, cooperation is needed.

It is estimated that an increase of 208% in food production will be needed in the United States by the end of the century. Pests are now estimated to cause the loss of 7 to 21% of vegetable crops, 6 to 19% of grain crops, and 15 to 17% of saw timber. They also cause a loss in milk flow of 10 to 20% and a reduction in poultry weight gains and egg production of as much as 25%. It is obvious that control of agricultural pests must continue.

Health is another area threatened by pests. There are over 200 diseases of man which can be transmitted by arthropods. Other diseases are transmitted by rodents and other animals. And there are many pest borne diseases of animals. Prior to World War II, the United States was highly malarious. There were 2,700,000 cases in 1934 alone. Although the rate was on the decline, DDT helped greatly in reducing these numbers to nearly zero in the United States and in Italy and other countries. Yet malaria is still the No. 1 disease and cause of death in the world. The World Health Organization reports 19,740 cases in Paraguay in 1966 through September 24, 1966, and a resistant strain of Plasmodium falciparum is causing many cases among American troops in Vietnam.

We are still plagued with other arthropod borne diseases, even in the United States. Dallas, Texas had 179 confirmed or presumptive cases of St. Louis encephalitis in this year's outbreak. Corpus Christi had 98, and there were 88 in Louisiana. There are also a few cases of plague each year in the southwest. The use of chemical pesticides to control the arthropods that can transmit such diseases to man is vital.

The use and development of pest control methods in order to protect our health and agriculture must continue. For some time to come, these methods will undoubtedly be mostly chemical. However, new and better methods of controlling pests are being evolved, and when the need for them becomes a necessity they will be available. Meanwhile, there is a strong trend away from the persistent general purpose materials and toward short-residual specific purpose types.

Nearly all pesticides are toxic to some form of life other than that which they are designed to control. Of first consideration to man are the effects on himself. There have been frequent statements that no one has died

due to the proper use of pesticides, and these may well be true if the word "proper" is emphasized. In 1965, there were reports of 779 children under the age of five who ingested insecticides. There were 785 who ingested polishes and waxes, and 16,328 who ingested aspirin. These figures do not indicate that pesticides are safe. The chronic effects on man are not well understood and may be more serious than the acute ones.

The fish kills due to pesticides and the presence of DDT in bald eagles, Antarctic penguins and in the eggs of Arctic birds have been well publicized. They are probably only an indication of the total contamination of the environment.

We are now contaminating the water, soil and general environment at an unknown rate. There is a great emphasis on measurement, but not enough emphasis on what the figures mean. We do not know enough about the amount of pesticide contamination in the environment, we do not know where it is, how it got there, and in what form it now exists. In addition, we do not have complete knowledge of the amounts of pesticides that can be safely tolerated in our foods. When we add the menace of environmental pollution to the pressures of modern civilization we can envision a grim future.

There is a present lack of an integrated approach; we are too busy with brush fires to take proper protective measures. We badly need a surveillance program to help prevent gross contamination. We should have routine sampling of the effluent of chemical manufacturing plants, of streams in heavily treated agricultural areas and of other possible sources of contamination. We should be aware of potential trouble before it becomes an actual danger.

These problems are not unsurmountable but are susceptible to scientific solution and enlightened coordination. We must stop fussing about whether pesticides are the saviors of man or the destroyers of the environment, and learn to use them for the benefit of the former and with safety to the latter.

In 1961, the Secretaries of Defense, Agriculture, Interior, and Health, Education, and Welfare agreed that a system of coordination was needed to cope with the rapid increase in the use of modern chemical pesticides. The Federal Pest Control Review Board was formed in June 1961, to deal with the problem. The Board was reorganized in 1964 as the Federal Committee on Pest Control (FCPC). The Committee is composed of two members appointed by each of the four Secretaries, and each member has an alternate. A full time executive secretariat assists the Committee.

The FCPC coordinates Federal, and Federally supported, pest control activities, recommends administrative action and may suggest legislation. It works not only with the signatory departments, but with all Federal agencies. It also can offer advice to state and local groups, upon request, and may deal with other nations. The latter efforts are subject to approval of the Department of State.

The FCPC has no regulatory powers, but its recommendations on proposed pest control programs are generally accepted. Few proposals have been approved without some changes, when submitted for the first time.

Four subcommittees have been formed to assist the FCPC.

1. Program Review. This subcommittee, which is just being formed, will scrutinize all submitted programs to determine the need, feasibility and possible dangers involved. Safety precautions will be stressed and recommendations for changes will be made if indicated.

2. Monitoring. This subcommittee has submitted, and the parent committee has approved, a plan for comprehensive nationwide monitoring of pesticide residues in people, fish and wildlife, food and feed, air, soil, and water. Consideration is now being given to means of expansion of this plan. Plans are also being made for the regular publication of monitoring information in a "Pesticides Monitoring Journal" under an interdepartmental editorial board.

3. Research. This group studies all Federally supported research to identify areas where work can be strengthened. It keeps in close touch with efforts to develop safer pesticides, to develop other methods of pest control and with progress in the development of integrated systems. Through the FCPC, it can recommend that research be started or expanded. If duplication is found, coordination can be suggested.

4. Information. The responsibility of the Information Subcommittee is to promote public understanding of pest control problems and what the Federal government is doing to solve them. It is also involved with surveys to determine what the public knows about pesticides.

A trend has been apparent in recent years towards establishing organizations similar to the FCPC at state and local levels. At least 30 non-Federal pest control bodies are now functioning with varying degrees of responsibility. The Oregon Interagency Pesticides Council is an example of such an organization. The FCPC hopes to serve as a basic model for state groups, and certainly will cooperate in every way possible.

Such local and state groups are indispensable to the safe use of pesticides. One fact alone makes this clear. It is that private, non-Federal users on farms and in forests, gardens, and homes apply about 95% of all pesticides employed in the United States.

The functions of the Departments of Agriculture, Interior, and Health, Education, and Welfare as regards pesticides are well known. Among their responsibilities are research, education, direct control, regulation and registration, protection of fish and wildlife, monitoring, toxicology, protection of man and animals, establishing of tolerances and many other activities.

The involvement of the Department of Defense with pesticides is not so well understood. Defense is in a different position in that it is directly responsible for all its own pest control activities. It is responsible for its own lands, much with fish and wildlife, its own real property; stored food and fabrics; and must serve as a health department for its own people.

I want to reiterate that we need cooperation. Cooperation between those who must control pests and those who must protect the environment.

Cooperation between the Federal and State governments.

Cooperation between governments and the public.

Cooperation to assure that we protect our health, food, environment and everything else that may be affected by pest control activities.

Cooperation in research, in planning, in monitoring, and in informing the public and each other.

Cooperation so that our use of pesticides becomes limited to necessary use, and safe use.

PESTICIDE RESIDUE MONITORING IN
OREGON'S AGRICULTURAL, AQUATIC,
FOREST AND WILDLIFE
ENVIRONMENTS

PESTICIDE RESIDUE MONITORING: SOIL, AIR, AND PLANTS

James M. Witt
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In some research laboratories monitoring programs receive "short shift" because of previous histories of poor monitoring programs. An example is the early radionuclide programs where large amounts of data were collected in volumes as thick as telephone books, but from which no general conclusions could be drawn because there was no way of coordinating and simplifying the data. When cause/effect relationships cannot be established from a set of monitoring samples because the relationships and interactions of the various sampled strata are not known, it would have been better not to have expended the effort at all.

Monitoring programs can be categorized in the following types:

- 1) Grab-Sample programs. This type of program is usually initiated in the face of the dearth of information concerning the residues of pesticides in a certain type of environmental strata and an immediate need to know the facts concerning the pesticide contamination situation. Someone will say, "Let's go get some samples and see what's there!" This has the effect of providing some kind of an immediate answer, but usually is of little lasting scientific value because general principles cannot be derived from such samples because they have not been related to other environmental situations in any meaningful way.
- 2) Enforcement programs. Generalizations cannot usually be drawn from this type of program with anymore facility than from the grab sample type of program and for the same reason. However, they adequately serve the purpose for which they were intended--that of enforcement of the law. Within this limitation, these programs usually prove to be satisfactory.
- 3) Surveillance programs. These programs usually relate the residues found to a single effect, usually that of a specific pesticide treatment. Within this limitation, such programs usually adequately meet their intended purpose.
- 4) Cause/Effect monitoring. This type of program is equivalent to an epidemiology study and is the most sophisticated and difficult type of monitoring program to conduct. The deposition and transport of the pesticide and the exposure and accumulation of pesticide by organisms or other strata in the environment which have known biological relationship are measured in this type of study. When the sampling program is well-planned and well carried out, conclusions of lasting benefit and which can be generally applied to other situations are usually derived.

It has sometimes been stated that monitoring programs produce only data which "everybody already knows." If this is so, it is because "everybody already knows" diametrically opposite conclusions. That is, large groups of

persons already know that the entire environment is contaminated with pesticides and, conversely, large groups of persons also already know that there are no problems of pesticides contaminating the environment. Both such groups operate best without the facts. Monitoring tells us whether or not pesticides are present, what kind of pesticides they are, and how much pesticide is present. Only after such facts are available can it be determined whether or not a problem exists and, if a problem does exist, provide the basis for finding a solution. It is at this point where research or controlled experiments begin and can provide the answers for reducing or solving the problem.

Monitoring first identifies the problem, both qualitatively and quantitatively. Epidemiological studies on pesticides--or well planned cause/effect monitoring surveys--are extremely difficult to conduct. This is because the "causes" are multiple and the controlling parameters are (also multiple and) unknown, or become apparent only after the study is nearly completed. In addition, the effects are multiple, unknown and masquerade as common effects from unrelated causes. The conditions affecting and effecting pesticide presence, or the causes, are the source or use of the pesticide, the transport of the pesticide through the environment and retention, accumulation, degradation, and metabolism of the pesticide within the environment. The detection and identification of the presence of a pesticide in an environmental locus is the basis of any monitoring program. It is necessary for the establishment of a pesticide as a cause in a cause/effect relationship.

This detection and identification of the pesticide can be extremely difficult because it usually involves extremely small amounts of pesticide (unless one is accounting an accumulator species). The development of extremely sensitive analytical methods made it possible to approach the problem in this manner, but the fact that extremely small amounts of the pesticide can be determined, also make positive identification, that is, identification by supplementary procedures, difficult and sometimes impossible. The use of gas chromatography coupled with one of the sensitive detectors such as the electron capture detector is usually the analytical method of choice because of its sensitivity and universality. While the specificity of this method is adequate for research on problems in controlled experiments, its specificity in monitoring programs is compromised because of interfering compounds and the lack of control samples with which to characterize the interfering compounds. Unknown pesticides, multiple pesticides, and metabolites of pesticides all contribute to the difficulty of obtaining positive identification. In a research problem, a whole year might be spent to identify a metabolite in a controlled experiment. The same effort is required for such an identification in a monitoring program, but such time is seldom available in the monitoring program because of the systematic approach usually required in the analysis of a large number of disparate samples. All these factors contribute to the difficulty in establishing cause/effect relationship desired in a monitoring program.

In the monitoring of soil for the presence of pesticides, problems are encountered with regard to the previous history of the soil, how to take the sample, how to extract the sample, and the ever-present problem of dealing with artifacts. The history of the soil sample is more critical than with many other types of environmental samples because of the permanence of the soil. Air, water, plants, and biota are removed by death or transport

and replaced at reasonable frequent intervals, but soil remains in place for long periods of time and, thus, has a longer and more complex history of pesticide exposure than do most other environmental components. The selection of an adequate sample of soil must take into consideration which aspect of the presence of pesticide in the soil is being determined. If the purpose is to determine the amount of pesticide which might be blown as a dust from the top 1/64th of an inch of soil into the surrounding environment, then sampling the soil with a boring device will artificially dilute the concentration. Generally, the purpose will be to determine the pesticide deposited on this site of the soil's surface, in the root zone of the soil, or leached into the subsoil region. Which of these determinations is being attempted must be specified before the sampling plan is formulated. The number and distribution of sampling sites necessary to be composited to make an adequate sample which will describe a given field or type of area has not been well established. Although there are a number of designs recommended for thoroughly sampling a given area, it has not been established whether less intensive sampling will give an unacceptable variance to the results or whether more intensive sampling will yield more reproducible results. Because of the ability of soils to absorb some compounds in an almost irreversible manner, it is difficult to determine an adequate extraction system for pesticides from soils. It may be that many of the disparities in soil pesticide work result from an inability to recover the pesticide present from some soil types. Even sandy soil, low in organic matter, contains a large quantity of extractable organic matter which is capable of producing analytical artifacts which confound the detection systems. It is difficult to provide adequate control samples from untreated areas, because the soil is not uniform from site to site and within the same soil type. This problem of non-uniformity of soil samples presents greater difficulty in the provision of adequate control samples in soil sampling than it does in plant sampling.

Although air has been monitored for pollutants for many years, most of the sampling systems have been concerned with the sampling of particulate matter or the sampling of chemicals which can be sampled in a scrubber system such that the chemical being trapped will react with a component in solution in the scrubber's system. The adequacy of the various solvent systems for the trapping of vapors in the air has not been well-established. There are problems of working with different types of solvents, particularly the volatile solvents, and there are problems in establishing not only the ability of the solvent to initially trap pesticide but the ability of the solvent to retain the pesticide following trapping. Data on the feasibility and the validity of some of these systems has only recently been gathered. Different systems are needed depending on whether the pesticide can be trapped from the air in the vapor form or whether it is being carried as particulate matter. The direction and velocity of the drifting pesticide as well as whether it is particulate or vapor, affects the design of the intake of the sampling system and the necessary rate of sampling. The extremely low levels of pesticide usually encountered in air sampling cause analytical problems because sampling of air by solvent scrubber systems traps a surprisingly large amount of extraneous material which can cause analytical artifacts which must be distinguished from the pesticide. While these are at low levels, so is the pesticide which must be determined.

The sampling of plants in a monitoring program is similar to sampling target crops in agricultural pest control programs. However, one must also

consider which plants to sample as the plants will differ in their capabilities for interception of the pesticide. This becomes particularly acute when we consider that the interception in environmental contamination problems usually involves the interception of extremely small particles which will often be wafted around the plant since the particles will lack sufficient mass to penetrate the boundary layers of air sweeping around the plant. There are differences in the retention ability of the plant for these pesticides, and there is an additional difficulty in the selection of representative samples due to the non-uniformity of given species over large areas.

Once the environment has been thoroughly sampled for pesticide and the presence of pesticides has been demonstrated in many of the various components of the environment, it must be determined whether or not the amounts and location of the pesticides have any biological significance. It is unrealistic to state that all pesticide in the environment is deleterious and that we wish to achieve "zero contamination." There must be a threshold for biological activity in the biological systems of the environment just as there is a threshold for biological activity in single organisms. And so, rather than have zero contamination, we must determine where is the "zero biological effect." If this is not known, then none of the monitoring data can be intelligently interpreted.

An effective program for monitoring pesticides must be comprehensive, must identify the samples with regard to locus, time, and history, must show both quantitative and qualitative identification of the pesticide, and must be interpretable in terms of interaction between the various environmental systems and in terms of the threshold of the biological effect of the pesticide.

PESTICIDES AND PESTICIDE RESIDUE MONITORING

J. D. Patterson, Chief Chemist
Oregon State Dept. of Agriculture

There are five Oregon laws enforced by the State Department of Agriculture which have to do with pesticides and which in one way or another may involve monitoring of either the pesticide or the residue resulting from its use.

These laws are: 1) Oregon Food Act, 2) Meat Inspection Law, 3) Animal Feed Law, 4) Chemical Applicator Law, 5) Pesticide Law.

The Oregon Food Law establishes residue tolerances for pesticides on raw agricultural foods which are the same as found in the Federal Food and Drug laws. Monitoring is carried on the year around and is divided between dairy products and agricultural crops, which are spot checked throughout the state beginning in the spring and following through to the end of harvest. About 300 dairy products such as milk, cream, cheese, butter are checked yearly and about 200 tests are made on vegetables and fruits found on the Oregon market. Our findings are exchanged with FDA, who also do monitoring work on Oregon food. When a large scale application of pesticides is planned, such as a county wide or forest control program, monitoring is carried on both before and after the spray application to check on any food residue problem resulting from the control program. This may involve cooperation with other agencies such as Forest Service, both state and federal, Wildlife Service, Bureau of Land Management, Extension Services, etc.

In the enforcement of the Oregon Meat Inspection Law, a spot checking of both red meat and poultry is made for presence of pesticide residue. This is also done in cooperation with the Federal Meat Inspection work of the USDA. No meat samples have been found actionable during 1966.

A certain amount of checking is done on commercial feedstuffs sold for animal feeds for the presence of residues. This work has shown some questionable feeds which were produced from screenings of seed crops which had been treated with a chlorinated hydrocarbon. All other commercial feeds were found acceptable. This field is also monitored by FDA.

The Oregon Chemical Applicator Law requires a license of anyone engaging in commercial application of pesticides and the investigation of reported damages resulting from their work. Four hundred and thirty-five licenses were issued in 1966 covering both ground and air applicators. Cooperation is had with Federal Aviation Authority who also have an interest in control of air application of pesticides. A yearly training school for applicators, held at Oregon State University, covers new materials, methods of application, safety and use of materials such that excessive residues will not result from their work. Thirty-nine reports of loss were filed in 1966 which was an increase of nine over 1965. These losses usually occurred as a result of drift during application.

In summary of past year's work in monitoring pesticides and residues resulting from their use, it can be said that residue levels in the state's food supply is at a minimum as shown by both the department findings and those results reported by cooperating Federal agencies surveying food on the Oregon market. Areas where possible high residues may occur appear to be mainly in root crops. This may be due to growing crops on soil previously treated with pesticides. Continued checking of cross contamination resulting from common use of mixing equipment for different pesticides also will require special surveillance in order to avoid application of nonapproved pesticides not suitable for the problem.

PESTICIDE TOXICITY AND WATERFOWL MORTALITY

Patrick J. Godsil
Federal Water Pollution Control Administration

The Klamath Basin Study of the Federal Water Pollution Control Administration was organized in December 1963 at the request of the States of California and Oregon and the United States Fish and Wildlife Service to study the involvement of water use on reported waterfowl kills at the Tule Lake Wildlife Refuge in the fall of 1960 and 1961. In 1964 the United States Fish and Wildlife Service was able to establish and report that these fish-eating birds died from cumulative concentrations of DDT and toxaphene in their bodies.¹

The Study established headquarters at Klamath Falls, Oregon to investigate this agricultural pollution problem in June 1964 and began to fulfill the following project objectives:

1. Measure and identify pollutants responsible for wildlife and fish mortality.
2. Determine the relationship between land use and pollutants.
3. Determine the extent to which irrigation water application practices increase or decrease the concentration of mineral pollutants in surface water.
4. Recommend and test practices for the control or elimination of possible damaging effects caused by pesticides and other pollutants used in various agricultural practices, wetlands, and wildlife management.
5. Determine the effects of nutrients and other fertilizers which leach through the soil or run off directly into surface waters.

To accomplish these objectives four basic programs were begun:

1. Computation of waterflows, including studies of water entering and leaving the area, evaporation rates, and ground water supplies.
2. Obtaining an overall mineral balance of the Lost River drainage area, with the assistance of a mathematical model that is being devised for the entire Basin.

¹ Keith, James O., Milton H. Mohn, and Richard A. Wilson, Relation of Pesticides to Waterfowl Mortality at Tule Lake Refuge. Annual Progress Report, Wildlife Research Work Unit, Denver Wildlife Research Center.

3. Measuring, qualitatively and quantitatively, the pesticides at key locations and tracing their buildup in the refuges and the Klamath River.
4. Determining the effects of these contaminants upon fish, bottom-dwelling organisms, plankton, algae, and other aquatic plants. This is accomplished by collecting samples of ecological communities and analyzing them for pesticide residues.

Results to date have shown that with improved agricultural pesticides the threat to wildlife in the National Refuges due to pesticide toxicity has greatly decreased. The following table describes maximum concentrations, in parts per billion, of endrin found in various strata of Tule Lake during the 1965 and 1966 irrigation seasons.

Maximum Endrin Concentrations (ppb)
in Tule Lake

	<u>1965</u>	<u>1966</u>
Water	0.23	0.13
Suspended Material	300.00	250.00
Live Chubs	1500.00	1700.00
Live Large- mouth Bass	500.00	175.00
Live Clams	150.00	75.00

In addition to the pesticide monitoring program for the Klamath-Lost River Basin, the Study has conducted general benthic and phytoplankton studies to evaluate the impact of water use on water quality throughout the Basin. Further studies are being planned to relate water use to the effect of nutrients on water quality in the Basin.

SURVEILLANCE OF THE 1965 BURNS TUSSOCK MOTH CONTROL PROJECT

Glenn L. Crouch
United States Forest Service

In June 1965, the United States Forest Service aerially sprayed 66,000 acres with DDT to control an outbreak of Douglas-fir tussock moth in central Oregon. Although most of the area is remote from human habitation, it does serve as big game and livestock summer range, and has a few fishable streams, including a tributary of the John Day River.

Because of the intense interest in pesticides, and the current controversial status of DDT usage, the Forest Service, in cooperation with appropriate state and federal agencies, organized a surveillance program to study effects of the control chemical on factors other than the target species.

The surveillance effort was conducted by the Oregon State Game Commission, Oregon State University, the Bureau of Sport Fisheries and Wildlife of the U. S. Department of Interior, and the Agricultural Research Service and Forest Service of the U. S. Department of Agriculture.

Personnel from these agencies obtained short-term information about treatment effects on air, water, aquatic insects, fish, big game, and range cattle. Longer-term research studies are investigating DDT levels and persistence in range forage, in a natural aquatic food chain; and movements of the chemical through the soil and into runoff waters.

All field phases of short-term studies have been accomplished, and chemical analyses of samples are nearing completion. Longer-term research studies are investigating DDT levels and persistence in range forage, in a natural aquatic food chain; and movements of the chemical through the soil and into runoff waters.

All field phases of short-term studies have been accomplished, and chemical analyses of samples are nearing completion. Longer-term research is continuing.

The Forest Service issued a surveillance progress report in March 1966, which contained information strongly suggesting that the tussock moth outbreak was successfully controlled without adverse effects on non-target organisms. A final report covering short-term investigations and the current status of research studies will be prepared as soon as all residue analyses data are available and participating agencies have evaluated their results.

MONITORING PESTICIDE RESIDUES IN WILDLIFE

B. J. Verts
Department of Fisheries and Wildlife
Oregon State University

Effects of pesticides on terrestrial wildlife were classified as either direct or indirect. Insecticides produce both indirect and direct effects while the effects of herbicides are primarily indirect.

Problems in sampling wildlife populations for monitoring pesticide residues, relating pesticide residue levels to effects on wildlife populations, and interpreting results of chemical analyses and bioassays were discussed.

VIEWPOINTS OF SOME OREGONIANS

ON PEST CONTROL

AGRICULTURE AND PEST CONTROL

Loren H. Milliman
Editor, Oregon Grange Bulletin

Except for nudists during mosquito season, no group is more enthusiastic about pest control than are American farmers.

Both the National Grange and the Oregon State Grange have adopted numerous resolutions dealing with various phases of pest control. The National Grange recognizes the responsibility farmers must assume to apply pesticides according to directions. On the other hand, the National Grange points out the responsibility of enforcement authorities to see that the game is played according to the rules. When the rules are changed in mid-season, farmers should be indemnified for losses suffered through condemnation of their crops as a result of discovery of miniscule residues, if the farmers followed instructions issued by the manufacturer and approved by proper governmental agencies.

Also, national and state governments should observe the same control or eradication provisions for noxious weeds on productive land purchased or acquired by governmental agencies that is required of private owners.

Implementation of integrated control, and expansion of biological control, are also favored.

Possibly we should reassess terminology used concerning pest control. To improve our "image," would it not be preferable to speak of "crop protectants" rather than "pesticides"?

Improved means of communication between all groups connected with manufacture, supply, application, utilization, and general supervision of the use of crop protectants is needed. Also, we need better means of impressing the general public with the importance of using crop protectants. Translating the discoveries of research workers into language that can be understood by the housewife has largely been overlooked.

MEDICAL ASPECTS OF PESTICIDE USE AND ABUSE

Lewis J. Krakauer, M.D., F.A.C.P.
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A measured view of the use of pesticides in the past few decades would suggest that these agents have been a major boon to mankind. The effect of pesticide usage in furthering the productivity of food stuffs and the quality of food stuffs has been well-documented. More important have been the great advances in the areas of public health attributable to pesticides, with regard to the use of these agents against such diseases as malaria, yellow fever, trypanosomiasis, and other diseases responsible for a major worldwide morbidity and mortality.

Such important benefits should not blind us, however, to the potential risk of these agents, and for concern about the need for control and research in their use and influence upon human beings. It is suggested that there is a paucity of significant data in the medical literature on this subject. Pertinent areas of medical concern are discussed. These would include:

1. Chromosomal influences,
2. Hepatic influences from long-term use as well as short-term use,
3. Bone marrow influences from long-term, as well as short-term use.

The pitfalls of drawing scientific conclusions from experimentation on lesser species must be repeatedly emphasized. The use of higher animal forms (e.g. monkey species) should be encouraged as well as further research on human volunteers and on humans under chronic exposure.

The difficulty of evaluating drug effects upon humans is discussed. The fact that some serious side-effects have become apparent with drugs used in humans after many years and after millions of dosage exposures illustrates the need for vigilance for any exogenous chemical substance to which the human organism is exposed.

Finally, it is suggested that it should not be necessary for society to prove the possible dangers of an agent to which populations have been exposed. Rather, it should be the responsibility of the manufacturer and the regulatory agencies to demonstrate to an extraordinary degree the safety of any agent which is proposed for marketing.

THE FOREST INDUSTRY AND PEST CONTROL

Norman E. Johnson, forest entomologist
Weyerhaeuser Forestry Research Center
Centralia, Washington

Weyerhaeuser Company's attitude toward pest control can be summarized as follows:

1. We recognize that the control of pests, including insects, diseases, wildlife and weeds, will increase the amount of wood we can grow and harvest from our lands.
2. We believe in analyzing thoroughly each pest control project with respect to cost per/benefit ratios taking into full consideration other forest values.
3. We use chemicals for insect and rodent control if this is the only practical route to take after evaluating other controls such as priority logging, salvage or cultural treatments. We do use herbicides regularly to rehabilitate lands neglected in earlier days. We now plant or seed our lands as soon as possible after logging in order to reduce brush and animal competition.
4. We believe that chemicals can be used safely in the forest and will do whatever we can to see that these tools are kept available for our use.

VIEW POINT OF A LEGISLATOR ON PEST CONTROL

Senator Walter C. Leth
Oregon State Legislature, Salem

Many years ago if one were to eat an apple one would be asked the question, "What is worse than taking a bite out of an apple and finding a worm"? The answer was at that time, "Half a worm." Now however, many might believe that there are things worse than finding either a worm or half a worm in eating an apple. I refer, of course, to the emphasis that has been put on the use of various pesticide materials, particularly from the standpoint of dangerous ones. "Silent Spring" and many other writings have created in the minds of many people serious doubts as to the nutritional as well as safe aspects of eating fresh fruits or vegetables -- to say nothing of processed ones. For fear that you have already seen it I am reluctant to use it, but on the other hand -- for fear that you have not seen it makes me disposed to use the forward from the 14th Annual Report, 1965, New Mexico Department of Agriculture, entitled, "Food is Safe, and Pesticides Use is Up" which I have taken from the N.A.C. News and Pesticide Review October, 1966.

It is as follows:

"Not one documented case of ill health in man, not to mention death, can be blamed on the proper use or even improper use of pesticides, as far as sickness from pesticide residues on food is concerned. The critics of pesticides have been unable to disprove this statement.

Americans are better fed with greater choice of foods with less cost to the consumer than any other country in the world because of our modern pesticides. Yet, there are people who would have our housewives believe that they are poisoning their families every time they serve a meal. Claims and counterclaims of self-appointed experts, who usually don't know what they are talking about, have baffled and confused today's homemakers.

Individuals who try to create the "hysteria" about agricultural chemicals compare findings on the effect of chemicals on birds, bees and fish to man, or they cite cases where a child or even an adult has taken a large quantity of pesticide direct from the bottle. Such examples do not apply to the use of pesticides in growing, protecting and preserving our foods.

Pesticides are poison. They kill insects, weeds, fungi, rats, mice, and other vermin. They are dangerous if not handled properly, or if they are left lying around where small children can find them. However, the hazard to man from chemical residues on food is almost non-existent. Pesticides and their use are strictly enforced by both Federal and State laws. Before a pesticide is ever put on the market, it has been thoroughly and extensively tested for years by qualified experts.

The housewife can be confident that the foods she buys are safe and nutritious. They are not full of poisons as some food faddists would have her believe -- and best of all, the worms and bugs haven't made a mess of them.

Eat and enjoy the high-quality foods we have available and be thankful that modern pesticide chemicals make it possible."

We as legislators cringe when we hear the statement, which is frequently made, "There ought to be a law," because so many people feel that the final answer to any problem is to pass a law, not realizing just how enforcement might be accomplished or to know where it actually might be enforceable from a practical point of view. In our State we also give many State Agencies the right to legislate by regulation which has the effect of law or statute and to which there is considerable opposition on the part of many legislators. When a law is passed or a regulation issued, it does not fully accomplish what is often intended. Frequently legislators may not fully understand the impact of certain legislation that may be desired or which might be pressured to the end that serious damage can result. I want to hasten to say that this is not an indictment against other legislators because when you consider that we have upwards of 1,500 separate bills introduced into a single session, it is difficult for any legislator to know about all the problems of the State that might be covered in such a tremendous volume of proposed legislation. What I am trying to say is that we should certainly get all the information possible to legislators that would enable them to exercise the best possible judgement in correcting any problem of society. The end product should always be what is best for the citizens of the state, not the self-interested groups affected necessarily by such legislation.

I've been tremendously pleased by the attitude and the work of various segments of the food industry in-so-far as pest control is performed and food safe guarded. I know of no exception in the food industry, (which I am fairly closely identified with), where processors are cognizant of the tremendous responsibility they carry in offering the public the most wholesome food products. In Oregon I can attest to the fact that this is true and that the industry "leans over backwards" to render this kind of performance.

The State Department of Agriculture has done outstanding work on behalf of Oregon Citizens and, of course, is of real value to the processing and other parts of the agricultural industry in Oregon. The competence and advice offered the chemical and food industries of this state as well as the department's regulations are most helpful.

The cranberry episode of a few years ago is good testimony to this statement. Our department was ahead of the Federal people in the knowledge of the problem involved with cranberries and the analyses that had been run and the information obtained with respect to all of the lots of cranberries available in Oregon for public consumption.

As a legislator I am very strongly interested in research as the best tool we can employ in further developing the agricultural resources of Oregon. Much of the controls as we know them today, and the recommendations

for the elimination as well as control of various pests is a direct result of Oregon State University Research and other state, federal, or private agencies. We have learned to lean on the Oregon State Extension Service for the magnificent job that has been done in developing the Oregon Handbooks on Insect Control, Weed Control and Plant Disease Control. I know of no other work done anywhere in the United States on the scale and of the total benefit that these handbooks provide the food processing and other agriculture industries in Oregon.

Obviously, ultimately, biological controls might be much desired over the pesticides now used in many instances and some progress is being made. I believe, however, that in this total area we can justify considerably more research, especially where there is indication that such controls can be adequate, effective and efficient, and long lasting. This, of course, does not preclude continuing research in any direction that will make for more nutritious, safe, and cheaper food products for our people.

In connection with the research or any other items that affect legislative action, I would like to have you each become a self-appointed lobbyist. The word lobbyist is frequently associated as being almost a "dirty" word, but in my opinion a lobbyist is any person who in any way attempts to influence legislation. This may be on a professional or paid basis, or might be merely a telephone call from a local citizen to a legislator. Much of the most effective lobbying that is done, is done by just Mr. Average Citizen apprizing his legislative representative of interest or desires that he may have. This you can do and it would be of utmost help where chemical or other research is contemplated to follow through and be sure that your legislative representative knows what the facts are and what your interests are in effecting legislation.

Much has been said about the dangers of pesticides and, of course, the industries that are involved in pesticides have been roundly criticized by many people, some who in good faith have been critical where others who have had some crack-pot ideas or who haven't fully sought the full facts might have also been involved.

Pesticides are not as bad as they have been painted as was outlined in the first part of this presentation from New Mexico, in fact a lot of research has been done and I'm sure all of you are aware of the test that was made in one penitentiary where the intake of DDT was studied and various safe amounts determined by voluntary participation by prisoners. This has offered investigators a good source for study and has tended to indicate that such a chemical can be used with considerable safety if used properly.

The extensive use of chemicals is greatly affecting the quality of water in many areas, and this question of water purity is becoming more and more a real issue because of inability to have adequate supplies not only for domestic uses but for manufacturing purposes as well. Some sources of water even are now endangering the production of certain crops where water with various kinds of pollution is used for irrigation purposes. The matter of uses of chemicals is becoming more and more a critical issue because of the very rapid growth in population and development of new or more industries

in this state. It well behooves us to understand all of these problems and conduct the necessary research to keep abreast of them.

The best control of pests and the greatest understanding of the various problems involved is through an improved public relations and education program. The better informed we can make the general public, the better acceptance we will have on the practices that are used.

The Agri-Business Council (a newly developed organization in this State) may be of benefit in carrying this word to the general public. I am sure that organization can use all of the help that all of you can give. There is no sound substitute for accurate information and consequent knowledge of problems. I'm particularly impressed with the recognition of this particular point of view by the U.S.D.A. I presume all of you already have seen and have heard about the 13-minute color movie produced by the United States Department of Agriculture. This film has focused attention to families and to consumer-oriented groups and demonstrates how modern safe pest controls and techniques protect agriculture and assure an abundant supply of food products. I'm sure that this film is readily available for those who wish to show it before clubs and other groups.

The chemical industry is seriously criticized and the legislator is constantly under pressure to pass more laws to effect more controls and, of course, the argument usually used is the danger of chemicals with children. I'm sure all of us have heard this for many many years, that children are made ill and some have died as a result of improper use of household chemicals and their improper storage. Aspirin and various other common ones are really some of the chief offenders.

I was intrigued by a statement in a magazine with respect to, and it was characterized with the designation of "Larry the Label." This illustration, if it can be called that, was to impress every one with the importance of a label -- to know what it is and just what it represents and how much it really costs to have it there and then to follow it. The proper labeling is the ostensible warning for any one if he knows how to read. Children should first of all learn what a skull and crossbones means on any label, even before they are old enough to read. Part of any child's education and training should be an aversion to strange materials, strange bottles and other containers as potentially hazardous and as dangerous enemies.

I think that I could summarize by saying that if all of us as consumers as well as professional people handling various materials would exercise complete honesty and good judgement, we would do far more to safe-guard the human race than the laws that we might want to pass.

CITIZEN'S VIEW OF THE PESTICIDE PROBLEM

Allan L. Kelly, Past President
Oregon Division
Izaak Walton League of America

As a businessman and a member of the Izaak Walton League, I am not equipped to indulge in a technical discussion of the many compounds or techniques that are applied to control noxious plants and animals. I do have some impressions and a concern, as a citizen, for the potential environmental pollution that may result from such programs. The conservationist who favors multiple use, the recreationist, and the preservationist, have become increasingly more concerned over this subject, due to the increasing awareness brought about in part by publications such as Rachel Carson's Silent Spring, technical reports and releases through other media.

The Izaak Walton League is a national organization dedicated to the "wise use" of all natural resources.

The organization's motto is "Defenders of Soils, Woods, Waters, and Wildlife."

The organization has enjoyed much success in implementing constructive legislation and programs at national and state levels because its interests are broad and it has consistently endeavored to base its conclusions upon factual information.

The Izaak Walton League's policy on "Pesticides" is an example:

1. The League recognizes that control of pests is both desirable and necessary to the public interest.
2. The biological control of pests should be developed and applied to the fullest practical extent. When pesticides are required for pest control, they should be of highly selective character.
3. Laws must be enacted at all governmental levels to fully protect the public from immediate and cumulative effects of pesticide use. These laws should recognize that the public interest goes beyond maintaining the public health to include protection of fish, wildlife, esthetic and related values.
4. Close cooperation should be mandatory -- beginning well in advance of any major proposed pesticide program -- between all interested Federal Agencies, and between Federal agencies and

appropriate State agencies. This law should require that every request for a major pesticide program authorization be accompanied by a fully comprehensive joint report of all agencies concerned -- Federal, State, and local -- such report to explain the nature and purpose of the proposed program and the hazards which it would create, and to recommend formulations, dosages, and times and methods of application of the poisons. This law should further require that each of the affected agencies have personnel in the field during program implementation to assure full protection of the public interest.

5. Each state, at the least, should enact legislation to regulate custom applicators of pesticides. Such applicators should be required by law to be licensed by the State, and no license should be issued until the operator has demonstrated responsibility and capability to properly handle and use pesticides. Severe penalties should be levied against applicators who employ practices which endanger the public interest, or who otherwise do not act in accordance with the State regulations. All law in this field, and enforcement of that law, must be based upon standards which will assure maximum protection of the broad public interest.
6. Pesticide research must be public research to the extent necessary to protect the public interest, but should be private research with regard to development of products which are acceptable to the public. Pesticides manufacturers, rather than public agencies, should be required to prove clearly the "safety" of their products before they can be sold.

It appears to me that the foregoing League's positions on Pesticides are being implemented at the National level and in the State of Oregon within the limits of existing knowledge.

My fear is that our limited knowledge of the ultimate effect of chlorinated hydro carbons and other long lives or cumulative compounds may be grossly inadequate and that in our impatience we may be overlooking much less hazardous biological controls that nature has provided for control of nuisance plants and animals.

Like many other League members, my primary incentive for membership in the League is my interest in hunting, fishing, and other forms of outdoor recreation. I know that these values are influenced by the environmental manipulations practiced by agriculture, forestry, mining, and all other land or water users.

In this age of specialization there is a tendency for every person to become narrow in his concepts and oblivious to values other than one specific product or service he is attempting to provide.

There have been many instances in which applications of pesticides have caused substantial and direct mortality of fish and game resources and little is known about the cumulative or indirect effects upon the survival or production of beneficial species including Homo sapiens. It is of note that technical reports can often produce different interpretations by the reader.

In some instances, foresters, farmers, and other users of chemical pesticides have demonstrated a "Don't Give a Damn" attitude and in these situations it is essential that there be some legal safeguards to protect the public interest.

I would like to give you some statistics which reveal the importance of Oregon fish and game resources to the people of Oregon.

In 1965, 333,000 licensed hunters and 587,000 licensed fishermen, plus an undetermined number of unlicensed landowners and juveniles were consumptive users of Oregon's fish and game resources.

They enjoyed approximately 7,500,000 man-days of hunting and fishing and took about 132,000 big game animals, 1,250,000 million game birds and a bountiful harvest of salmon, steelhead, trout, and warmwater fish. When analyzing the economic and social value of the fish and game resources, primary attention should be given to the 7,500,000 man-days afield and this applies to only two forms of recreation. The Outdoor Recreation Resources Review Commission Report states, "Outdoor recreation activity, already a major part of American life, will triple by the year 2000."

Just take a look at the publication "National Survey of Fishing and Hunting" - 1965 - published by the U. S. Department of Interior:

2,573,000 Varmint hunters (non-game species)
 \$4 Billion - Spent by fisherman and hunters nationally
 \$3 Billion sport fisherman
 \$1 Billion hunters
 522,759,000 Fishing recreation days
 185,819,000 Hunting recreation days

Can the value of recreation, with those living things that contribute so much to it, be placed in a subordinate position to other interests? Whether viewed through the rifle scope by the hunter or by the family on a Sunday outing, the big game animal provides recreation by its existence. With over 1/3 of our State's population participating on consumptive uses of the fish and game resources and nearly all of the remainder interested in seeing, it is logical that any practice which jeopardizes those resources will arouse public concern.

In the past, protection has been largely limited to those species of the animal kingdom that are of material value to humans. "If you can't eat it or wear it - it has no value." It has now been recognized that

nearly every other creature has an aesthetic value and a place in man's environment. This concept greatly broadens the opportunity for pest control programs that will offend and arouse substantial segments of the population.

In conclusion, I would like to refer back to the stated policies of the Izaak Walton League.

1. There is need for judicious control of noxious plants and animals. There is a need for greater knowledge of potential control methods and their influences upon the total environment.
2. There is a need for vigilant control of pesticide programs to assure that the existing knowledge is beneficially applied.
3. I believe the creation of this interagency committee, the Oregon laws governing the control of pesticides and pesticide applicators, and the national concern for all forms of environmental pollution are commendable signs that the people of America are conscious of a problem and are making a sincere effort to find constructive solutions.

Every citizen has the right to expect the Congress, the State legislature, and each of the agencies and industries responsible for regulation in use of pesticides to exercise vigilance and good judgment in their respective fields.

If they do, the responsible conservation and recreationist organizations should readily commend that accomplishment.

If they do not, these organizations have a job to do by using their rapidly increasing influence, due to the ever greater number of people engaged in all phases of recreation, who are vitally interested, but often concerned, over the threats to the natural resources of our land.

SOME PERSONAL EXPERIENCES WITH EFFECTS OF PESTICIDES

Mrs. G. F. Staender, Member of
Mazamas of Portland and
Conservation Committee of
Oregon Audubon Society

Speaking for my husband, a school teacher, and myself, we are citizens concerned about the effects of pesticide (chlorinated hydrocarbons) residues on wildlife -- especially on birds. We have spent the past three summers in the remote Brooks Range in Arctic Alaska, studying the wildlife and collecting samples for pesticide residue analyses by the U. S. Fish and Wildlife Service under the direction of D. Glen Crabtree, Chief of Pesticide - Wildlife Studies at the Federal Research Center, Denver, Colorado. We have received grants from the Research Committee of the Mazamas for each summer's work.

Studying birds intensively since 1958, we spent evenings, weekends, holidays and vacations in this absorbing activity as we hike and climb mountains. Winter vacations have been spent studying birds in California and summers in Arctic Alaska with Canadian birds en route.

In 1963 we became aware that the Western bluebirds were in trouble when they returned in the spring and began nesting in our back yard at Lake Oswego. Each summer since 1958 we had watched successful rearing of two or three broods, but in 1963 out of the clutch of five eggs, only one hatched and that young died on the second day. Immediately the birds moved to the next birdbox and soon there were five more eggs. About to begin incubation, we noticed the female on the perch appeared to be ill as she struggled to enter the birdbox. We watched as she made several attempts then fell down and died. That was the last of our bluebirds.

This strange incident made us decide to begin observing the nestings of other birds on our one-third acre. That same year we observed that two pairs of House Finches nesting repeatedly in the vines around our house were 100 percent sterile as we watched their incubations and frustrations. We found that the White-crowned sparrows and Song sparrows had a high percentage of sterile eggs.

We know from tests conducted by the Fish and Wildlife Service that chlorinated hydrocarbon contamination has varying effects on birds and other animals, depending on amounts contained. These residues are stored in the fat of the animal and sometimes effects are not forthcoming until that fat is used. Effects vary from sterility to paralysis and death. In the Pesticide-Wildlife Studies, plumage on a male duck has been changed to that of a female by feeding it chlorinated hydrocarbons.

In 1964 we were commissioned by the U. S. Fish and Wildlife Service, through Mr. Dick Griffith of the Portland office and Dr. John Aldrich of Washington, D.C., to collect samples for pesticide residue analysis in the Brooks Range, Alaska, near the Arctic Ocean. They wanted samples from an area remote from where any aerial sprays are applied.

We have hiked a total of more than 1,500 miles in the Brooks during the past three summers, locating nests, tagging them, returning to keep records of their incubations, collecting eggs that did not hatch and young birds that died in the nest. Samples were air dried, packaged and shipped air express to the Federal Research Center immediately after we came out of the wilderness. So far, samples analyzed proved that each animal sample (birds, mammals, worms) except one fish, contained DDT residues--some in considerable amounts--highest content being in worms we had collected from under rocks in an arctic stream close to the crest of the mountain range. Next highest contamination was in young Rough-Legged Hawks and they had enough to affect their reproductive processes.

In 1966 we returned to visit the nest of the same hawk family and found them to be 50 percent sterile and in this same area we found that bird populations had decreased alarmingly in two years.

In 1964 we had been told by naturalists at Mt. McKinley Park that there was a marked decrease in small bird populations and the Eskimos at Bettles Field told about a tragic decrease in birds nesting in that area.

In the last eight years we have seen with our own eyes how the bird populations are going down and down from California to Alaska; except the Starling populations, which are exploding beyond imagination in spite of all handicaps. Perhaps they have built up a resistance from centuries of exposure to the carbons of the cities in Europe.

All hawks are now endangered including our National Symbol, the Bald Eagle. The Whooping Crane, which the Service has struggled with on the verge of extinction, is now contaminated. More species are being added to the endangered list constantly. Not a living creature is without DDT residues, including you and me.

The Mazama Council has recently passed a resolution supporting Senate Bill 3608 (Senator Gaylord Nelson, Wisconsin) to ban the sale of DDT in public health, agriculture, and forest management in the United States, beginning next July 1.

I would like to quote Senator Nelson in a Senate speech. "We do not know the long-term effect of DDT on human beings but the evidence of its devastating effect on wildlife should be due cause for alarm. What a great irony it would be if, in our frantic efforts to kill insects, we eliminated man and made the world safe for bugs."

RESEARCH PROGRESS AND PROBLEMS

IN OREGON

HERBICIDE RESIDUES IN THE FOREST¹

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Herbicides are valuable tools for vegetation management on forest lands, but a critical examination of their contribution to environmental contamination is necessary. Early attempts in this regard showed that the information necessary for this evaluation was not available.

In 1963 scientists at Oregon State University initiated a five-year investigation of contamination of the forest environment accompanying chemical brush control operations. The goals of this program are to provide the land manager with guidelines for estimating the degree of contamination which might be anticipated for a given practice and to provide the scientific basis necessary for formulation of sound forest spray policies.

During the aerial application of chemicals a small portion of the spray material is lost to the air through drift and volatilization. The majority of the chemical is intercepted by vegetation or the forest floor with small amounts falling directly on surface waters. Because of the nature of forest spray operations, contamination of the air has not been a serious hazard.

Because most herbicide intercepted by vegetation will enter the environment of the forest floor with time, the forest floor is the major receptor of spray materials. Emphasis is currently being placed on studies of herbicide behavior in forest litter and soil, however, little data is available as yet.

Stream contamination is the most important expression of environmental contamination in the forest, and studies of stream contamination have constituted a major portion of the research effort. The use of 2,4-D, 2,4,5-T, and amitrole-T in western Oregon and 2,4-D in eastern Oregon over the past three years have been monitored. Careful evaluation of contamination data and consideration of certain characteristics of treated areas has shown that an important relationship exists between the manner in which the spray unit is layed out and the level of stream contamination which results from treatment.

¹This investigation was supported by Research Grant WP 00477 from the Federal Water Pollution Control Administration, Department of Interior

In western Oregon where 2,4-D and 2,4,5-T are applied, streams usually border but do not enter the spray unit. Maximum levels of contamination of around 25 ppb (parts per billion) are often found immediately below the unit, but the chemical persists for only a few hours after treatment. However, in a treatment area which included live streams, maximum concentrations of 80 ppb were found, but again persistence was short.

Where amitrole-T is applied for salmonberry control in western Oregon, streams are usually included in the spray unit. In one such unit where the treated area was narrow and long with a live stream traversing the long axis, a maximum concentration of 400 ppb of amitrole was found. However, there was a 100 fold decrease in concentration in 10 hours which reflects the small size (9 acres) of the spray unit. Concentrations of amitrole to 100 ppb were found immediately below another spray unit but a sampling point located one mile downstream yielded only a single sample which contained a measurable amitrole residue. Data from this area show the importance of downstream movement in reducing the concentration of stream contaminants.

Treatment units in eastern Oregon are usually larger but farther apart than in western Oregon. In many instances live streams are included in the sprayed area. Maximum concentrations of 2,4-D to 100 ppb with detectable levels of chemical found for several days are common under these situations. On the other hand, in one area where live streams only bordered the spray unit, the 2,4-D persisted at measurable levels for only a few hours with a maximum concentration of 25 ppb. The results from this spray unit are similar to those found in connection with units in western Oregon where live streams are excluded from the sprayed area.

In one other area, 220 acres of a marshy area were treated with 2,4-D. Several small live streams were included, and standing water was noted at the time of treatment. Concentrations of 2,4-D approaching 1,000 ppb reflect the consequence of treating such an area. Concentrations of 2,4-D around 100 ppb were found 4 days after treatment and levels around 5 ppb were found 12 days after treatment when the last sample was collected. The particular situation sampled in this instance probably represents one of the most dangerous in terms of possible stream contamination.

The influence of the concentrations and lengths of persistence of the herbicides detected in these studies on stream organisms is difficult to determine exactly at our present state of knowledge. A biologically safe level of 100 ppb has been proposed for the phenoxy herbicides. This level is defined as that concentration which could be tolerated for an extended period of time by nearly all members of the food chain. On this basis it is clear that the use of herbicides as monitored in western Oregon and in most cases in eastern Oregon poses little threat to fish or downstream water users.

The most important thing learned from these studies is that the greatest contamination results from the direct application of spray materials to surface waters. While the application of herbicides for brush control does not constitute a great water contamination problem, in certain sensitive situations only the lowest possible level of contamination is acceptable. In these cases the land manager can attain this by orienting the spray unit in such a way as to avoid direct application of herbicide to surface waters.

INSECTICIDE RESIDUES IN OREGON'S FORESTS

Robert F. Tarrant, Principal Soil Scientist
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Forest lands comprising only one third of the total area of the United States receive about one half the total precipitation and yield about three fourths of the total streamflow. Forest lands annually receive an average of 45 inches of precipitation -- more than twice that falling on other lands; forest lands annually yield about 20 inches of runoff -- almost seven times that from other lands. Thus, what we do to affect water purity in the forest has a powerful impact on the Nation's water supply.

In a relatively short time, pesticides have become nearly indispensable tools for achieving forest management goals. Our success in balancing the timber budget of the United States within the next 30 years will depend greatly on protection and cultural practices that now include the use of pesticidal chemicals. Pesticides for forest use appear to be here to stay, and forest managers have a strong responsibility to guard against possible environmental contamination when using them.

The pesticide--forest water problem, might be summarized thus:

1. We need pesticides to accomplish desirable goals in intensive forestry;
2. We have a strong responsibility to deliver uncontaminated water at the forest boundary; and
3. We neither know much about the magnitude of pesticide residues in the forest environment generally, and in forest waters specifically, nor do we understand well their impact on the biosystem.

The pesticide residue research program of the U. S. Forest Service at the Forestry Sciences Laboratory, Corvallis, Oregon, is oriented toward answering specific questions within three broad problem areas:

1. How much pesticide residue is now in the forest ecosystem?
2. How do residues persist and move about in the forest ecosystem to become water pollutants? and
3. How do pesticide residues affect forest soil fertility?

CHEMICAL TREATMENT OF WATER FOR FISHERY MANAGEMENT
AND AQUATIC WEED CONTROL

Robert L. Borovicka*
Fisheries Biologist
Bureau of Land Management
Portland, Oregon

A major purpose of chemical treatment to control fish populations is to direct the production of the water to a desirable species of fish. Aquatic weed control may be necessary to provide good harvest of the fish population, boat access to fishing areas and clearing growth for chemical fish control.

Rotenone and some Toxaphene has been used in Oregon for fish control. Toxaphene has not been used since 1961 because of residue problems. Approximately 80 major lakes and reservoirs were treated by the Oregon Game Commission that had combined surface areas of approximately 19,500 acres at the time of the project. At least 2,800 miles of stream have been chemically treated to remove undesirable populations of fish. All waters treated in Oregon by the Game Commission are listed in the text. Aquatic weed control for fisheries has been limited to test work on coastal and Willamette Valley lakes. Irrigation, drainage districts, and private operators conduct most of the aquatic weed control in Oregon. Extreme caution is necessary to protect aquatic organisms.

Problems and possible solutions to chemical treatment are listed. New chemicals for fish control such as Fintrol-5 and Squoxin may be used in the future. Oregon State University is conducting research to select best chemicals for aquatic weed control on coastal lakes.

* Before July 1, 1966
Coordinating Biologist with
Oregon Game Commission

STUDIES ON THE EFFECT OF THE INSECTICIDE SEVIN ON MARINE
ANIMALS AND ITS STABILITY IN MARINE SYSTEMS¹

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Department of Agricultural Chemistry
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The acute toxicity of Sevin (1-naphthyl N-methylcarbamate) and its hydrolytic product 1-naphthol to 10 species of marine animals including larval and adult forms was determined. Sevin was more toxic to crustaceans than to mollusks and fishes. Sevin was considerably more toxic than 1-naphthol to the crustaceans but less toxic than 1-naphthol to the mollusks and fishes.

The growth of juvenile cockle clams (Clinocardium nuttallii) exposed to sublethal concentrations of Sevin and 1-naphthol was impaired at concentrations below 1 mg/l. At similar concentrations, Sevin did not inhibit growth of the clams as much as 1-naphthol.

A working laboratory model of an estuary has been constructed and some representative estuarine animals have been successfully maintained in the model for several weeks. Six additional experimental models are now being constructed. A description of these models is given and their use in laboratory studies is discussed.

In laboratory studies the degradation of Sevin and 1-naphthol dissolved in seawater proceeded faster at higher temperatures. At 20° C., and in the absence of mud 43 percent of the Sevin dissolved in seawater was converted to 1 naphthol within 17 days. The remainder of the Sevin either escaped by volatility or was converted to undetectable products. In the presence of mud, Sevin and 1-naphthol declined rapidly to low levels within eight days. These compounds were absorbed by the mud where decomposition continued. In a preliminary field experiment, Sevin could be detected in the mud for 42 days; however, 1-naphthol could only be detected in significant quantities for one day.

¹These studies have been supported by Public Health Service Research Grant 5 R01 EF 00628-03 from the Division of Environmental Engineering and Food Protection.

ALGAL PROBLEMS IN OREGON WATERS

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The eutrophication problem in Oregon's Klamath Lake, presently under study, is not unique. Other examples are well known, including lakes in Switzerland, Yugoslavia, Brazil, and scattered lakes in the United States. There is widespread concern over this problem, because water supplies of the Nation are limited in quantity and, therefore, precious because algal blooms, where present, interfere with many valuable water uses, and because the waters of the country seem to be growing more algae than in the past.

While Klamath Lake receives no appreciable algal nutrients via the sewage route, nitrogen, phosphorus, and other nutrients required in lesser concentration reach the lake:

1. Through tributaries draining a 3,800 square mile watershed
2. From irrigated farmland drainage and
3. From fecal contributions of dense waterfowl populations.

Opportunities for ecological control that depend on limitation of nitrogen or phosphorus input currently seem remote. Moreover, annual nitrogen outflow from the lake system is greater than the inflow. This suggests that Aphanizomenon flos aquae, the principal alga present, is capable of fixing atmospheric nitrogen. This presumed capability currently is being examined through laboratory study.

FATE OF PESTICIDES IN FOOD CHAINS

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Studies of the transfer and accumulation of pesticides in the aquatic environment are being carried on by the Department of Fisheries and Wildlife at the Pacific Cooperative Pollution and Fisheries Research Laboratories, Oregon State University. Laboratory stream communities composed of algae, herbivorous and carnivorous insects, snails (Oxytrema silicula), and sculpins (Cottus perplexus) have been exposed to dilute concentrations of dieldrin (0.06 and 0.60 ppb) for periods up to two months. Aquarium experiments have been performed to determine rates of uptake of dieldrin through food and through water. Studies have also been made of the rate of loss of dieldrin from the tissues of fish and tubificid worms. The accumulation of DDT and its metabolites in different components of a natural stream community was monitored in Rattlesnake Creek in Malheur National Forest for one year following application of this compound for control of the tussock moth.

Analyses of the results of the laboratory stream experiments are not yet complete. In general, the rates of accumulation of dieldrin in the different components of the communities exposed to concentrations of 0.06 ppb appeared to increase in the following order: snails, algae, carnivorous, insects, sculpins, and herbivorous insects. A similar order was indicated for streams exposed to 0.60 ppb except that sculpins accumulated greater amounts of dieldrin than did the herbivorous insects.

Results of aquarium studies in which guppies, sculpins and tubificid worms were held either at one concentration of dieldrin for different periods of time or at different concentrations of dieldrin showed that these animals were able to accumulate in their tissues much greater concentrations than those of the water in which they were held.

Guppies held for two days at a concentration of 40 ppb of dieldrin then placed in fresh water retained in their tissues approximately three fourths and two thirds of the accumulated dieldrin after 2 and 16 days, respectively. Tubificid worms that had accumulated approximately 150 ppb of dieldrin retained, after a period of 16 days in fresh water, approximately 60 ppb of dieldrin.

Results of experiments in which different groups of sculpins were fed ad libitum tubificid worms containing approximately 0.4, 3.4 and 26.5 ppm dieldrin for periods of 1, 2, 4, 8, 16, and 32 days indicated that the

sculpins accumulated similar amounts of dieldrin in their tissues whether they were fed poisoned worms with low dieldrin concentrations for the longer time periods or were fed worms with high concentrations for shorter periods of time.

Samples of water, algae, herbivorous and carnivorous insects, dace and trout were collected from Rattlesnake Creek in May, 1965, before the application of DDT, in July and October, 1965, and in February and May, 1966. Analyses of residues have been completed for all but the last sample. In general, these results show that very little pesticide was accumulated in any component sampled. The largest residue observed, 1.2 ppm, was in trout during the first post-spray sample. In most samples the concentrations of DDT and its metabolites increased in the following order: water algae, carnivorous insects, herbivorous insects, dace and trout.

BIOLOGICAL CONTROL OF INSECTS

USE OF PREDATORS

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The definition of biological control from an economic or utilitarian aspect is pertinent. Biological control may be considered the reduction or maintenance of a pest population below the point of economic significance by the action of another living organism. Most successful attempts at establishing such control have been against introduced pests with introduced enemies.

To date there have been no successful biological control efforts in Oregon with the use of predators. A predator being defined as an organism which requires more than one prey to complete its immature development.

Studies of the natural enemies of the Douglas-fir beetle, Oregon's most serious forest pest, have shown that the native predators are ineffective in preventing epidemics. Eighteen foreign predators of the balsam woolly aphid, an introduced forest pest, have been introduced into Oregon and five of these have become established. However, none of these have given any measurable degree of economic control.

USE OF ATTRACTANTS

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The study of sex attractants is of recent origin, but has received considerable impetus in the last few years due, no doubt, to the adverse criticism of pesticides. The attractive substances of several economically important insect pests have been isolated and identified, but only a few have been synthesized. Because field tests have shown that natural extracts from the insects or their frass attract flying insects over considerable distances, there is much speculation and even hope that control or even complete eradication of some destructive species may be achieved by the use of attractants, perhaps joined with chemo-sterilants. The not too distant future should tell. If not the only tool of control in some species, certainly at least it could be a welcome component in an integrated control approach.

Bark and timber beetles are among the most destructive insects of the coniferous forests of the Northwest and there is usually no effective control (either by application of insecticides or sanitation salvage); this new approach by attractive substances is of particular interest.

Attractant studies at Oregon State University during the last four years have concentrated on two important species: the Douglas-fir beetle and the Trypodendron ambrosia beetle. Both species are monogamous and the females of both produce a powerful attractant soon after entering the host. There are similarities as well as dissimilarities in attraction production between these two species which are related to their biology. Whereas, it is the virgin female of the Douglas-fir beetle which produces the attractive substance, in the ambrosia beetle the attraction is produced only by mated females.

In addition to these beetle-produced attractants, to which the beetles in flight respond en masse, there are also host substances, particularly resins, by which the dispersing beetles find their suitable breeding material.

The effects of environmental factors, particularly temperature, light intensity and wind velocity, upon the olfactory responses of the beetles are discussed. The possibilities in using these substances in survey and control of beetle populations are outlined.

USE OF VIRUSES

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Among the pathogens causing diseases of insects, certain of the viruses promise to be valuable substitutes for chemicals in insect control. A nucleopolyhedrosis virus of the Douglas-fir tussock moth is presently undergoing intensive research in an effort to develop a practical control method free of any of the existing or potential hazards of chemical insecticides. It is expected that within the next year this research will have progressed to the operational-type field test stage.

USE OF PARASITES TO CONTROL INSECTS AND USE OF INSECTS TO CONTROL WEEDS

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Attempts to control insects by the use of parasites are not new in Oregon. Since 1924, over 30 species of parasites have been introduced into Oregon, by federal and state workers, in an attempt to control 14 important species of economic pests. At least nine parasitic species are established and some control has been obtained on six different pests.

Six insects have been introduced in attempts to control various noxious weeds of foreign origin. The goat weed beetle has been very successful against St. Johnswort, and the cinnabar moth shows promise against tansy ragwort.

AGRICULTURE

PESTICIDES IN OREGON ORCHARDS

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Due to the necessity of controlling a wide variety of agricultural pests the orchard is considered a likely source of environmental contamination by pesticides. This possibility has been considered in a study of data gathered over a twenty-year period in two commercially-operated university orchards. Soil analyses for DDT and its metabolites and analogs showed that about 40 percent of the DDT applied to the orchard since 1946 is still present in the soil, most of it in the top six inches. Only traces of these pesticides (less than 1 percent) were found at the three-foot depth. About 10 percent of the DDT appears to have been converted to DDE. A comparison of the 1965 soil residues with the 1946 to 1950 residues indicates that the DDT concentration in the upper level of soil has not changed appreciably. It is suggested that this apparent leveling-off effect may be due to improved application methods which came into use in the early 1950's. Part per billion levels of pesticides were present in water thought to emanate from one of the orchards. Waste land adjacent to the orchard had accumulated about 1 percent of the total DDT applied. Considering all avenues of loss except evaporation and degradation, approximately 50 percent of the DDT applied to the orchards has been accounted for.

EFFECTS OF TRACE AMOUNTS OF PESTICIDES ON BEE BEHAVIOR

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The aim of the program was to determine whether chronic exposure to very low levels of pesticides had any effect on the behavior of lower organisms. Concern has arisen because the background levels of pesticides in the environment have reached a relatively high level, and with its slow rate of decay there has been some fear expressed that it may be adversely affecting natural systems. It was our intent to analyze the effects of low levels of pesticides through observation of those insects exhibiting highly complex, innate behavior patterns.

Communication in the honey bee is highly complex and stereotyped, based principally on optical, olfactory and mechanical signals. Since most other lower organisms rely on one or other of these means of mating information, the honey bee is unique in that all three are used concurrently.

Sublethal dosages of Parathion (in the range of less than 0.03 micrograms per bee) proved to have little effect on the optical and olfactory components of communication, but seem to have a profound effect on the peripherally located mechanical receptors.

Foraging bees that were trained to an artificial checking place over a half-mile from the hive were given an oral dose of Parathion. Upon their return to the hive their communication dances were significantly altered so that they were unable to indicate the true position of the food source. The bees which received the faulty information flew off in a direction other than that of the true position of the food source, but consistent with the angle indicated by the poisoned bees.

Treatment with Parathion of the receptor fields responsible for the transmission of information on the direction of the food source resulted in a dance deviation corresponding to that of bees that had been fed orally with this material. This suggests that Parathion acts initially as a toxin to the peripheral nervous system and affects the ability of lower organisms, at least, to undergo normal communication. It can also be concluded that optical or olfactory orientation is not disturbed. This would verify the conclusion that the central nervous system is least susceptible to trace amounts of organic phosphates.

DEVELOPING AND TESTING NEW CHEMICALS AND METHODS OF APPLYING THEM

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Weeds cost American farmers over \$5,000,000,000 annually. In 1960, the losses in yield and quality of crops was \$2,512,000,000. The control for the same period was \$2,603,000,000, making a total cost of \$5,116,000,000. Agronomic crops showed the greatest loss, nearly \$3,500,000,000; horticulture crops, over \$500,000,000; grazing lands, over \$1,000,000,000; and aquatic sites, over \$100,000,000. *

In 1962, it was estimated that over 70,000,000 acres of land were treated with herbicides. This is an increase of nearly 20,000,000 acres over a three-year period. In 1962, over one hundred different herbicides and formulations of herbicides were used commercially in crop weed control. It is estimated that 25,000,000 acres of corn and over 19,000,000 acres of small grains were selectively sprayed.

Testing Program

Herbicides, like other pesticides, have a planned development program. Chemical companies start with minute amounts. The new chemicals are subject to many tests. Less than a tenth of one percent of them actually have use values. It is estimated that the total costs of the developing and testing a new pesticide is more than \$2,000,000.

Our research workers received small quantities of the new pesticide. These are tested on the Experiment Stations. Before the Experiment Station workers test these programs, they are informed by the chemical company representatives of their potential use.

In 1966, weed workers in the Farm Crops Department of Oregon State University screened approximately 150 different compounds. These compounds were applied pre-emergent and post-emergent on numerous field crops and weeds. Many of these formulations were applied at two rates. Chilean and Hawaiian weed workers are cooperating in their own countries in such trials. These two outlying test sites make it possible to be testing herbicides under field conditions throughout the entire year.

* A Survey of Extent and Cost of Weed Control and Specific Weed Problems; ARS 34-23-1, August 1965.

Formulations showing special qualities are tested in larger plots on the Experiment Station, on branch stations, and frequently on well-planned off-station sites.

Sinbar, a uracil, and Karmex, a urea material, are products of the DuPont Chemical Company. Both of these materials have gone through the detailed screening program and have shown special qualities for controlling weeds selectively in peppermint and small grains.

Over twenty off-station plots were treated with Sinbar in 1966. These plots were at two rates, and many, at two times of application. All plots show excellent weed control. Oil tests from these plots do not show residues of Sinbar.

Karmex diuron is now used selectively by most farmers in the Willamette Valley for the control of annual grasses in fall-seeded grains. Several years ago, one hundred acre plots of winter wheat were treated throughout the Willamette Valley. These plots were established cooperatively through the County Extension Agent, Experiment Station workers, and the DuPont Chemical Company. Karmex is now registered for use on all winter cereals and has a special registration for eastern Oregon, Idaho, and Washington. The other area registration is for the control of broad-leaved weed seedlings.

Education Facilities

Bulletins, fact sheets, and mimeographs are common methods of acquainting farmers with new herbicidal developments. No herbicide is recommended for field use until registered with the Department of Agriculture and Pure Food and Drug Administration.

The Oregon Weed Control manual is prepared each year by subject matter specialists in the various departments of Oregon State University. This manual covers all the recommended herbicides, indicating rates, time of application, and crops to be treated. These manuals are considered the field guide on herbicide uses.

Field demonstrations by County Extension staff, research workers, and industry personnel are valuable tools in promoting new herbicides and herbicide uses.

RESEARCH ON ENVIRONMENTAL CONTAMINATION BY CHEMICALS

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One of the major technical problems demanding solution today is that of chemical contamination of the environment. Chemicals -- inevitable concomitants of man's activities - in growing numbers and amounts are becoming a part of our daily environment. Unless this trend is halted abruptly it may result in great overburdens of chemicals in the environment.

The types of chemicals are as varied and multitudinous as man's activities themselves. From fossil fuels man derives energy to propel his automobiles, warm his homes and run his factories, but in so doing expels into the environment carbon compounds including carbon dioxide, carbon monoxide, and unsaturated hydrocarbons. From the synthetic chemical plants come refractory inorganic chemicals and organics ranging from plastics to pesticides. In his continuing battle for cleanliness man employs mountainous quantities of soaps and synthetic detergents that find their way from plant and home to the environment. Even with the best of efforts some of these chemicals escape from control and become a part of the chemical burden in the environment.

In a bygone era it was stated: "The solution to pollution is dillution." This is no longer true. The resources for dillution are limited. Even though a particular chemical element may be indigenous to the environment, man's use of it usually results in the transformation of properties or placement that makes this particular element or chemical a ghost that is hard to lay to rest. Moreover, granted that the environment possesses the capabilities of transforming chemicals either to a less objectionable form or making them less readily available, there is a limitation to this ability. An overburden of chemicals can thus result in an accumulation of undesirable products.

The concept that is often useful in considering chemical pollution is that the world in which we live is a closed-system space vehicle. In this closed-system vehicle we are unable to rid ourselves of waste products, therefore, we must find a way of dealing with it. By far and way the most satisfactory method of dealing with the transformed products of our activity, would be to reprocess them for use or into a less objectionable form. A cyclic or closed-loop system of product utilization would, in the long run, prove to be the most efficient and the most economical of our natural resources. There may be instances where a product could not be recycled, and in these cases judicious care in their use would have to be exercised.

Chemical pollution of the environment poses many questions to which we have no ready answers. It is true that a great deal of information may exist upon certain chemical pollutants, but on others little if anything is known. Existing knowledge in certain cases could eliminate, or at least minimize, pollution by specific chemicals about which we may know a great deal. However, new chemicals are bursting on us every day and of these we have but little knowledge as to their persistence or hazard. For solution of these problems we need a great deal more information. This information can only come from research and systematic study to answer the broad underlying questions. For example, we need to know specifically the types, quantities and persistence of many of the chemicals that are now entering our environment. We do not have specific knowledge as to the extent these chemicals are distributed. It may well be that with many of these substances their distribution is very curtailed and their life only transient. For others, they may be more refractory to destruction but by virtue of reaction with the environment become virtually immobilized and hence rendered much more innocuous. Certainly we can find examples of this in the case of pesticides about which we know more than almost any other group of chemicals. In answering the question concerning distribution and persistence we will want to know the specific fate of the chemical as well as its quantity and longevity. We will need to understand its interaction with other chemicals, its distribution in different phases -- such as soil, water and air -- and whether in the process of being destroyed by the environment it is converted to a more or less toxic or available compound. Much of our interest in chemical pollution centers around the direct effect of these chemicals on man. We are vitally concerned where an acute effect is felt. It is equally vital, however, to assess the long-term effect of these chemicals on man in terms of whether they result in a direct biochemical pathology or may be a contributor to susceptibility in some pathological condition. What is required here is the development of delicate techniques of biochemical testing for pre-clinical effects on man.

Man's welfare is not limited to just what happens to him directly, but is influenced by indirect effects as well. Thus the welfare of the biological community of which man is a part also has an important bearing on man as well. A change of susceptibility to a pesticide by an insect becomes an event of concern to man and if it happens to be a malaria-bearing mosquito, a threat to man's health. Of equal interest, however, is the possibility that a chemical pollutant will substantially change in specie distribution within a biological community, rendering man's pursuit of food and fiber more or less difficult, depending upon the change. It thus becomes incumbent to answer the question of the effect of chemical pollutants on the biota.

The need to engage in a serious enterprise of eliciting answers to these questions by research is recognized widely. Moreover, this recognition of need was to be found in the ranks of the scientists for a long time. The efforts could only be implemented, however, as society and the political agencies became aware of the problem and were willing to support the required efforts. As the result of the confluence of these two factors we now find a number of agencies and universities pursuing large-scale efforts in attempts to obtain answers on chemical pollutants in the environment. The United

States Department of Agriculture, for example, has long been concerned with residual chemicals accruing in the environment as the result of the use of agricultural chemicals. Under the leadership of this agency and the state experiment stations there has been amassed a great body of knowledge concerning the toxicology, biological effects, and persistence of agricultural chemicals. In this effort the United States Public Health Service of the Department of Health, Education and Welfare has given notable support and made significant contributions in their own laboratories. It would be incorrect to leave the impression that all of the answers regarding agricultural chemicals have been answered, for indeed they have not. We still experience misadventures and regrettable losses of valuable species from misuse of these chemicals. However, it is probably safe to say that of all the environmental pollutants, perhaps more is known about agricultural chemicals than almost any other. Among other groups or agencies that are concerning themselves with chemicals in the environment are the United States Department of Interior, state health agencies, and state departments of agriculture. In addition, a number of our large universities have extensive programs of research on influence of chemicals in environmental health. Some of these efforts are organized into large projects or programs following a well-defined pattern. Such programs are to be found at universities like Rutgers, North Carolina State, Miami University, Florida, Purdue, Michigan State, the University of California, and at Oregon State University. It would be incorrect, however, to presuppose that these large programs represent the total research and training efforts of these and other universities. Using Oregon State University as an example, one would find that the individual research undertakings in a variety of departments exceed in aggregate that of the individual program at any university.

In order to illustrate a small portion of the type of research being conducted on the problem of chemicals in the environment, I should like to describe briefly the grants on "Pesticide Toxicology" in both research and training at Oregon State University. The training program is designed specifically to increase the number of well-trained people to contribute to the research and action programs in managing the problems of chemical pollution. The program is designed specifically around pesticide chemicals but it is recognized that these chemicals provide a model of practically any other type of organic pollutant that may be encountered. Thus, the biology, the biochemistry, and the analytical chemistry involved with pesticide chemicals have a broad general application to other types of organic chemicals in the environment. The chemical and biological principles that underly problems posed by organic chemical pollutants are the same whether dealing with pesticides, effluents of a synthetic chemical plant or waste products or some other of man's activities. We believe that this is a concept that should be more widely understood by those engaged in formulating policies regarding pollutants, both at the level of the appropriation of funds for support of research and implementation of action programs. Thus, research and training on the biology, biochemistry, the toxicology of pesticides and environmental contamination by them takes on a new importance since these efforts provide a foundation for work on other types of organic chemicals and is able to supply many basic principles for solution of problems posed by these

chemicals. In our efforts to enlarge work on chemical pollution of the environment we have a firm foundation on which to build with the work on pesticides serving as a base. This avoids the costly necessity of building up and training new staffs and creating new laboratories. Beginning with the nucleus available from those doing research on pesticides it would be possible to expand our efforts quickly into this area.

The training program at Oregon State University is an attempt to accomplish just this sort of thing by supplying good fundamental information, using the pesticide chemicals as models.

A companion activity to the training program is that of research on the "Toxicology of Pesticides in the Environment." This program has as its threefold objectives:

1. The study of the effect of multi-chemical residues in animals.
2. Development of a strong chemistry base for determining the types, quantities and persistence of chemicals in the environment.
3. The study of how chemicals behave in the environment relative to persistence, transmission and ultimately are destroyed.

The investigation on the effect of multi-chemical residues on animals seeks to determine how organisms take the chemical into their body and in what quantities from a given level of environmental exposure. Then, since many of these organisms serve as a food source in the biotic web, it becomes of importance to determine what happens to the chemical as the succeeding species feeds on these organisms. The pertinent question here is whether the chemical is destroyed, that is - metabolized, by either of the organisms or whether the larger organism that feeds on the lesser accumulates an even higher amount of chemical in its body which in turn is transmitted to the ultimate consumer. Since man is the apex of a segment of this food web, the question is of immediate concern to him. He may be the inadvertent victim of biological magnification of residues. Since organisms of interest to man, including man himself, are likely to be exposed to at least low levels of these residues, it becomes of concern to discover the precise effect of multi-chemical residues. Accordingly studies are going forward in the Oregon State University laboratories to determine the pathological and biochemical effects of these residues on the whole animal and, even further, to study these effects at the sub-cellular level. These efforts are closely integrated with parallel studies that are concerned with the ability of organisms to metabolize the exogenous drugs and others designed to determine possible effects of the chemical on the metabolism of the organism.

A central feature of the research program is devoted to the pesticides. Paramount in this work is the development of methods by which minute quantities of the chemicals may be detected and measured. This calls for the development of new and sophisticated methods of analyses and then to make

this research service available to other investigators and to apply it in monitoring the biota and the environment for the pesticides.

Finally there is an area of research activity devoted to detailed studies of how a chemical behaves when released into the environment. Such questions as to how rapidly the chemical may be bound by the soil and other surfaces, what proportion of it will be distributed in the air by volatility or water by solubilization are of immediate concern. Answers to these questions can help us to determine how widely a chemical might be disseminated in the environment by natural forces and, hence, how wide-scale a pollution problem it might become. Additionally one must ask the question: How rapidly will the chemical be lost from the environment by the various reactions, both chemical and biological, that might tend to destroy a potential pollutant. At the moment we are assaying to determine the chemical factors involved in each of the questions. It is felt, for example, that if we have a full appreciation of the physico-chemical factors such as the properties of the compound and its reactivity it would be possible to go a long way toward predicting the pollution potential of any given chemical. Considerable progress has been made along this line.

The program just described is similar in size and character, although not in scientific objectives, to similar programs at several other universities. This one involves six departments and two major schools at the university, involves 15 senior investigators and about 35 other investigators at different levels. Its policy is guided by a university-wide committee and the program benefits from the advice of an outside consulting board consisting of members of state and federal governmental agencies, medical schools, industry and a practicing physician. In all, it is proving to be a most worthwhile effort in coordinated research, and is contributing significant knowledge to our problems of chemicals in the environment. Hopefully such efforts can be improved and expanded to solve some of these pressing problems that threaten to grow more complex as our population and technology expand.

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