

INTERAGENCY COORDINATION IN ENVIRONMENTAL HAZARDS

(Pursuant to S. Res. 27, 88th Cong., as amended)

TUESDAY, JUNE 4, 1963

U.S. SENATE,
SUBCOMMITTEE ON REORGANIZATION
AND INTERNATIONAL ORGANIZATIONS
OF THE COMMITTEE ON GOVERNMENT OPERATIONS,
Washington, D.C.

The subcommittee met, pursuant to recess and subsequent to postponement, at 10:05 a.m., in room 1318, New Senate Office Building, Senator Abraham Ribicoff presiding.

Present: Senators Ribicoff, Pell, Gruening, Javits, and Pearson.

Also present: Julius Cahn, staff director, Subcommittee on Reorganization and International Organizations, Committee on Government Operations; Jon Newman, administrative assistant to Senator Ribicoff; Jerome Sonosky, legislative assistant to Senator Ribicoff; Gerard Manges, assistant counsel to Senator Javits; and Allen E. Pritchard, administrative assistant to Senator Pearson.

Senator RIBICOFF. Before we receive testimony this morning, I wish to report briefly on a serious matter that has just come to my attention.

RELEASE OF NAMES OF "PROTEST REGISTRATION" PRODUCTS TO PUBLIC

Two weeks ago the Secretary of Agriculture told this subcommittee that he strongly supported the recommendation of the Wiesner report to end the practice of "protest registration." That is the device whereby a pesticide which has been disapproved by the Department of Agriculture may nevertheless be sold to the public without any indication whatever as to the disapproval. This is an exception to the normal registration procedure, and though it occurs infrequently, there are products being bought today that the Department has disapproved as unsafe for the uses for which they are being sold. Last week, Senator Pearson and I introduced legislation to close this shocking loophole.

Now I have learned that members of the press have asked the Department of Agriculture for the names of those products that have been marketed under "protest registration," and the Department has refused to make this information public.

I believe the Department's action is utterly indefensible. It is bad enough that a loophole in the law permits a product to go on sale without warning to the public after the Department has found the product unsafe for use. The law can, and I hope will, be changed.

But it is a mockery of regulation for the Department of Agriculture to find a product unsafe and then refuse to tell the public the name of the product.

I have this morning requested the Department of Agriculture to make available to the press by the end of the day a list of every product sold under "protest registration," including the type of product, the manufacturer, the reason for disapproval of the product, and current information as to sale of the product. This list should include products now on the market and those that have been marketed in the past under "protest registration."

Furnishing this information is properly the responsibility of the Department of Agriculture.

If the Department fails to furnish this information by the end of the day, I want to assure the Department and the press that I will disclose this information on the floor of the U.S. Senate tomorrow.

I fully recognize that proper protection must be accorded a manufacturer in submitting confidential information such as trade secrets to a Government agency. But no such issue is involved here. The issue here is the public's right to know and the Government's duty to tell the public why it has disapproved a product that is on sale right now.

Miss Carson, on behalf of the committee, we certainly welcome you here. You are the lady who started all this. There is no question in the mind of any American today that we are dealing with a very serious and complicated problem. There is a great void in the information.

We are dealing with many forces which people say are still mysterious, and it is the purpose of this committee to try to be as constructive as we possibly can, and I think that all people in this country and around the world owe you a debt of gratitude for your writings and for your actions toward making the atmosphere and the environment safe for habitation, not only by human beings but for animals and nature itself. We welcome you here.

Will you please proceed as you see fit.

STATEMENT OF RACHEL CARSON, BIOLOGIST AND AUTHOR

Miss CARSON. Thank you, Mr. Chairman and members of the committee. I do appreciate this opportunity to be here this morning and to discuss with you these problems of contamination of the environment and the control of pesticides. The contamination of the environment with harmful substances is one of the major problems of modern life. The world of air and water and soil supports not only the hundreds of thousands of species of animals and plants, it supports man himself. In the past we have often chosen to ignore this fact. Now we are receiving sharp reminders that our heedless and destructive acts enter into the vast cycles of the earth and in time return to bring hazard to ourselves.

This problem you have chosen to explore is one that must be solved in our time. I feel strongly that a beginning must be made on it now—in this session of Congress. For this reason I was delighted when I heard, Mr. Chairman, that you were planning to hold hearings on the whole vast problem of environmental pollution.

EXHIBIT 15

STATEMENT PREPARED BY RACHEL CARSON

Mr. Chairman, I appreciate the opportunity to discuss with you this morning the problems of environmental hazards and the control of pesticides.

The contamination of the environment with harmful substances is one of the major problems of modern life. The world of air and water and soil supports not only the hundreds of thousands of species of animals and plants; it supports man himself. In the past we have often chosen to ignore this fact. Now we are receiving sharp reminders that our heedless and destructive acts enter into the vast cycles of the earth and in time return to bring hazard to ourselves.

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Contamination of various kinds has now invaded all of the physical environment that supports us—water, soil, air, and vegetation. It has even penetrated that internal environment within the bodies of animals and of men. It comes from many sources: radioactive wastes from reactors, laboratories, and hospitals; fallout from nuclear explosions; domestic wastes from cities and towns; chemical wastes from factories; detergents from homes and industries.

When we review the history of mankind in relation to the earth we cannot help feeling somewhat discouraged, for that history is for the most part that of the blind or short-sighted despoiling of the soil, forests, waters, and all the rest of the earth's resources. We have acquired technical skills on a scale undreamed of even a generation ago. We can do dramatic things and we can do them quickly; by the time damaging side effects are apparent it is often too late, or impossible, to reverse our actions. These are unpleasant facts, but they have given rise to the disturbing situations that this committee has now undertaken to examine.

I have pointed out before, and I shall repeat now, that the problem of pesticides can be properly understood only in context, as part of the general introduction of harmful substances into the environment. In water and soil, and in our own bodies, these chemicals are mingled with others, or with radioactive substances. There are little understood interactions and summations of effect. No one fully understands, for example, what happens when pesticide residues stored in our bodies interact with drugs repeatedly taken. And there are some indications that detergents, which are often present in our drinking water, may affect the lining of the digestive tract so that it more readily absorbs cancer-causing chemicals.

In attempting to assess the role of pesticides, people too often assume that these chemicals are being introduced into a simple, easily controlled environment, as in a laboratory experiment. This, of course, is far from true.

My own studies in this field of environmental pollution have been confined largely to pesticides and I am glad, Mr. Chairman, that you have chosen to begin with this highly important problem.

It seems to me that the most significant knowledge that has developed within the past year has been the piling up of evidence about the wide dispersal of pesticide chemicals, far beyond the point of application. I should like to cite some examples to illustrate this spreading contamination.

To begin on a small scale, we accept as fact the often repeated statements that it is not the deliberate intention to spray reservoirs. Yet studies by the Massachusetts Division of Fisheries and Game during the past year, covering to date 11 reservoirs that serve as public water supplies, show that fish in these reservoirs are heavily contaminated with DDT. The average amount found in the fish from all waters examined in the Sudbury, Assabet, and Concord regions of eastern Massachusetts was 85.4 ppm; the maximum concentration of 96.7 ppm was found in two places, including the Framingham Reservoir, a source of drinking water for a large area. It might be pointed out that this is nearly 14 times the legal tolerance for DDT in foods.

Although it is not difficult to imagine the paths by which domestic water supplies become contaminated, there are now examples of a different sort that defy easy or comfortable explanation. Such, for example, is the situation on Prince of Wales Island in southeastern Alaska. I am told by the Fish and Wildlife Service that its biologists have sampled resident fish in four drainage systems on this island and have found DDT, sometimes with its metabolites, in two of them.

There is no record of applications of DDT on this island. The nearest town, other than small native villages, is more than 50 miles away.

An even more remote region, not far below the Arctic Circle, has been yielding extraordinary data to the Fish and Wildlife Service for several years. This is the Yellowknife region on the Upper Yukon River, in the Northwest Territory of Canada. It is an important waterfowl breeding area, wild, remote from any human settlements. No spraying of insecticides is known to have occurred within several hundred miles. Yet DDT and its metabolites have been found for several years both in the eggs of waterfowl and in their young. This alone might have been explained by the fact that the waterfowl are migratory and could easily have picked up the poison during their sojourn in the United States. Transfer to the eggs and young could then have followed. But there is no such explanation for the fact that native vegetation in this same area has now been found to contain residues.

The most disturbing of all such reports, however, concerns the finding of DDT in the oil of fish that live far at sea. Such residues have been found in fish caught off both coasts of North America, as well as off South America, Europe, and Asia. The species concerned include halibut living on the floor of the Pacific Ocean, and tuna, a fish of the open ocean that rarely comes close to land. Oil from some of these marine fish have contained DDT in concentrations exceeding 300 ppm.

All this gives us reason to think deeply and seriously about the means by which these residues reach the places where we are now discovering them. I must emphasize that no one can answer this question with complete assurance today, but I should like to call your attention to certain known facts that do have a bearing on the problem.

The ways by which pesticide residues may be transported over long distances are basically three: by air, by water, and in the bodies of living organisms, either indirectly through food chains or directly.

A report last year by the U.S. Department of Agriculture established the fact that aerial spraying comprises about 22 percent of the total acreage sprayed in the United States. Studies by Prof. George Woodwell of the University of Maine (and which confirm earlier studies by Canadian biologists) show that of the DDT used in forest spraying, less than half falls directly to the soil. Of each 0.5 pound released by the spray plane approximately 0.2 pound reaches its target. The remainder is presumably dispersed as small crystals in the atmosphere. These minute particles are the components of what we know as "drift"—the phenomenon that plagues every householder who receives contaminating spray from his neighbor across the street, or from his Government's spray planes several miles away. We are now beginning to wonder how vast the reach of "drift" may be. It was known a decade ago that the herbicide 2,4-D could drift as far as 15 or 20 miles in quantities sufficient to damage vegetation. The drift of insecticides is less readily observed, but when the matter is properly studied I predict we shall discover some startling facts.

It appears that little application has been made of our knowledge of atmospheric movements. Various factors influence the direction and speed of air currents. Among these is convection, or the upward flow of air which takes place when the ground temperature exceeds that of the air. Conceivably, this force could lift the very fine particles of spray materials to an altitude at which strong horizontal winds could come into play, effecting transport for long distances. We know this happens with other materials. Scientists of the Woods Hole Oceanographic Institute have studied the behavior of salt nuclei, drawn from the surface of the ocean and lifted high into the atmosphere. These tiny particles are carried great distances—at least as far as 400 miles. And we know that the upper atmosphere transports a whole assemblage of living objects—seeds, pollen spores, tiny spiders, and insects—and through such transport oceanic islands are colonized. It is therefore a speculation that should be tested that the upper atmosphere may be carrying chemical particles as well as radioactive debris, and that the pesticide contamination of such remote places as those I have mentioned may be the result of a new kind of fallout.

Another factor that may contribute to atmospheric contamination is the tendency of DDT to be evaporated from the surface of water. Therefore aerial spraying may not be the sole source of chemical pollution in the atmosphere. Various studies by the Public Health Service over a period of years have clearly established the fact that rains washing over sprayed lands carry pesticides as runoff into ponds, streams, and rivers. From here, we may assume, there is further transport into the sea and into the atmosphere.

Little thought seems to have been given to the possibility of transport in dust. Yet, on a small scale, we had a vivid example of this last April, when health officials on Long Island charged that the airborne dust from potato fields, carrying arsenic and other insecticide residues, was a menace to public health. This dust had compelled the closing of a public school on several occasions, because it clogged the ventilation system. On a broader scale, it is only reasonable to assume that dust from heavily sprayed lands, especially in some areas where conditions are right, may carry insecticides for exceedingly long distances. The Dust Bowl of the 1930's gave us our most dramatic demonstration of the long-range transport of soil particles, but this is a phenomenon that goes on regularly in varying degree. When we remember that insecticides remain in soil for long periods, varying from months to a decade or more, the probability of this type of dispersal is increased.

A final and especially interesting means of pesticide transportation is that which occurs in living animals, whether directly or indirectly. Direct transportation may occur over many hundreds of miles, as when woodcock carry heptachlor from southern wintering grounds in the area of fire ant treatment all the way to breeding areas in the Canadian Maritime Provinces. A less obvious but exceedingly important method of transportation by living organisms is that which occurs when a chemical passes from one link to another in a natural food chain, usually becoming concentrated as it goes. We now have a number of impressive demonstrations of this phenomenon. Several have been studied by biologists in California.

At Big Bear Lake, for example, toxaphene, a chlorinated hydrocarbon, was applied at a dosage of only 0.2 ppm. Later it was found that the minute plankton organisms in the lake had picked up this chemical and had concentrated it to a level of 78 ppm. The buildup continued through the food chain, with fish containing 200 ppm and a fish-eating bird (a pelican) containing 1,700 ppm. The story does not end there. Plankton organisms collected at the lake poisoned hatchery trout when fed to them. Ten months after the insecticide was applied to the lake, fish were again able to live in these waters. The lake was accordingly restocked with trout. However, when fillets from the trout were analyzed, they were found to contain 8 ppm of toxaphene. I might add that this experience convinced the California Division of Fish and Game that toxaphene is unsuitable for rough fish control, but the experiment did provide some very instructive data on transfer of chemicals through food chains. The same sort of phenomenon has been worked out in detail at Clear Lake, Calif.

I should like to add a word about the concentration or buildup of the chemicals. There is nothing surprising about this—especially about the initial concentration by the plankton. Aquatic organisms are well known to have marked ability to extract minerals and other substances from the water and concentrate them. Marine organisms in particular can do this. For example, the percentage of silica in rivers is 500 times that in the sea, because marine diatoms withdraw so much to construct their shells. Huge quantities of cobalt are extracted from seawater by lobsters and mussels, and of nickel by various mollusks, yet human chemists recover these elements only with difficulty. Oysters concentrate zinc at a level about 170,000 times that in the surrounding water. It should come as no surprise, therefore, to find some of these marine invertebrates collecting and concentrating such chemicals as DDT. As Secretary Udall reported to you recently, oysters exposed to levels of only 1 part per billion for 1 week then contained 182,000 parts per billion in their tissues. The implications for the human being who likes to eat oysters—or other forms of marine life—are obvious. A current publication by two Fish and Wildlife Service biologists contains this statement: "In the sea, there is the possibility of a continuous recycling and concentration of the more stable pesticidal compounds until they pose a real threat to man's own welfare."

All the foregoing evidence, it seems to me, leads inevitably to certain conclusions. The first is that aerial spraying of pesticides should be brought under strict control and should be reduced to the minimum needed to accomplish the most essential objectives. Reduction would, of course, be opposed on the grounds of economy and efficiency. If we are ever to solve the basic problem of environmental contamination, however, we shall have to begin to count the many hidden costs of what we are doing, and weigh them against the gains or advantages.

The second conclusion that seems apparent is that a strong and unremitting effort ought to be made to reduce the use of pesticides that leave long-lasting residues, and ultimately to eliminate them. This, you will remember, was one of the recommendations of the President's Science Advisory Committee. I

strongly concur in this recommendation, for I can see no other way to control the rapidly spreading contamination I have described.

There are several other recommendations I would like to suggest, bearing on various specific aspects of the immensely complex pesticide problem. These are as follows:

1. I hope this committee will give serious consideration to a much neglected problem—that of the right of the citizen to be secure in his own home against the intrusion of poisons applied by other persons. I speak not as a lawyer but as a biologist and as a human being, but I strongly feel that this is or should be one of the basic human rights. I am afraid, however, that it has little or no existence in practice.

I have countless letters in my files describing situations in which a person has been subject to personal injury or to the loss of pets or valuable horses or other domestic animals because poisons from a neighbor's spraying invaded his property. Residents of Norfolk, Va., have informed me that they were told last winter that the State had the authority to apply poisons to their land but assumed no responsibility for injury that might result. It is a matter of record that dairy farmers in New York State suffered contamination of their land by Federal-State spraying for gypsy moths, with the inevitable result that their milk later contained illegal residues and was condemned by the State as unfit for market.

Under such circumstances, what is the citizen to do? You may recall the opinion of the U.S. court of appeals in the case in which a group of Long Island citizens sought an injunction to prevent a repetition of the spraying to which they had been subjected. Since no date for repeated spraying had been set, the court could not grant an injunction, but it did make a significant ruling which I should like to insert in the record:

"* * * It would seem well to point out the advisability for a district court, faced with a claim concerning aerial spraying or any other program which may cause inconvenience and damage as widespread as this 1967 spraying appears to have caused, to inquire closely into the methods and safeguards of any proposed procedures so that incidents of the seemingly unnecessary and unfortunate nature here disclosed, may be reduced to a minimum, assuming, of course, that the Government will have shown such a program to be required in the public interest."

I have been informed by affected citizens in New York State that the current gypsy moth spraying has been done with no advance notice whatever. Some of these people learned of the spraying quite by chance 2 or 3 days before the planes began their work. They were told by their attorneys that in this limited time no appeal to the courts was possible. It is clear, therefore, that the intent of the court as indicated above is thwarted in such cases.

As a minimum protection, I suggest a legal requirement of adequate advance notice of all community, State, or Federal spraying programs, so that all interests involved may receive hearing and consideration before any spraying is done. I suggest further that machinery be established so that the private citizens inconvenienced or damaged by the intrusion of his neighbor's sprays may seek appropriate redress.

2. In another area, I hope this committee will give its support to new programs of medical research and education in the field of pesticides. I have long felt that the medical profession, with of course notable individual exceptions, was inadequately informed on this very important environmental health hazard. It was sobering to have the President's science advisers confirm this view by saying, "Physicians are generally unaware of the wide distribution of pesticides, their toxicity, and their possible effects on human health." The panel also found a complete lack of any federally sponsored research to develop methods of diagnosing pesticide poisoning, especially when this takes the form of chronic, rather than acute illness. I am told that in the medical schools today, because of the many subjects to be taught, the attention given the whole field of toxicology is greatly reduced. Yet this is happening at a time when toxic substances are being introduced into the environment at a rate never before approached.

The plight of the person affected by these poisons is pitiful. Many case histories have come to me in letters. As a rule these people can find no physician who understands their problem. Indeed, I remember several cases in current medical literature in which the physician, even though told of the patient's exposure to such relatively common insecticides as malathion or lindane, had never heard of the chemical and did not know the appropriate treatment. About 10

years ago the American Medical Association had a special committee on pesticides which from time to time published authoritative information on the toxicology of these chemicals. I have seen none of these reports for several years. I do not know whether the committee is still functioning; if it is, it is hard to see why the American Medical Association last fall recommended that physicians seek information to allay their patients' fears, not from unbiased scientific literature, but from one of the pesticide trade organizations.

I should like to emphasize, however, that many individual physicians are aware of the hazard and of the need for research in this field. Some of the most interesting letters I receive are from doctors. In what I believe to be the first recognition of this problem by a medical organization, the Illinois Medical Society on March 17 of this year approved a resolution directing attention to delayed and indirect effects of pesticides and calling for a thorough study of the problem. I should like to introduce a copy of this resolution into the record at this point.

RESOLUTION

STUDY AND EVALUATION OF TOXICANTS

Whereas the total consequences to man and his renewable resources from the present widespread and often unrestrained dissemination of toxic substances into the environment are only vaguely known and some effects cannot yet even be surmised; and

Whereas the indirect and untoward effects of pesticides, insecticides, rodenticides, and kindred chemicals are frequently long delayed, difficult to trace and apparent safe minimal accumulations in air, soil, water, fiber, food and all tissues can in time accrue to harmful or even lethal levels; and

Whereas these toxicants often have a profound latent effect on flora and fauna not originally intended for suppression or eradication; and

Whereas these toxicants are among the most potent ever known and such new incompletely evaluated substances are being developed annually; and

Whereas these lethal agents can be purchased by anyone, anywhere without adequate controls to guard against their misuse: Now, therefore, be it

Resolved, That the Board of Trustees of the Illinois State Medical Society go on record that efforts to manipulate ecologic balances by governmental agencies, private industry and individuals through the use of toxicants and radiation needs urgent and conscientious study for the development of wise and effective controls; and be it further

Resolved, That in the opinion of the Board of Trustees of the Illinois State Medical Society the present state of knowledge dictates a policy of caution, inquiry, maturity of judgment and statesmanship; and be it further

Resolved, That the Director of the Illinois Department of Public Health through the Bureau of Hazardous Substances and Poison Control be requested to undertake a study of all toxicants, current and future sold or used in Illinois, and prepare a report for appropriate distribution.

(Approved by board of trustees of the Illinois State Medical Society on March 17, 1963, in Chicago, Ill.)

8. I should also like to see legislation, possibly at the State level, restricting the sale and use of pesticides at least to those capable of understanding the hazards and of following directions. To me it is shocking that these chemicals can be bought and applied by illiterate and even by mentally deficient persons. We place much more stringent restrictions on the sale of drugs—which at least are not sprayed from powerful machines. Someone wrote me recently about a man who was thought to have contracted hepatitis from a spray he had been using, making the pertinent observation that the man could buy the chemicals that made him ill with no restrictions, but had to have prescriptions to buy the drugs to cure him.

4. I should like to see the registration of chemicals made a function of all agencies concerned rather than of the Department of Agriculture alone. The deficiency in the present law has been pointed out in the report of the President's Science Advisory Committee. Many of the miscellaneous uses of chemicals, as in mothproofing, floor waxes, household sprays, and garden pesticides, have a direct relation to human health. It seems not only logical but necessary that the Department of Health, Education, and Welfare should participate in decisions regarding the registration of chemicals so used. Similarly, many, probably the majority of pesticides are used at some time in such a manner that they affect wildlife and commercial and recreational fishery resources. The Depart-

ment of the Interior needs to have a voice in the registration and labeling of such chemicals.

I have already trespassed upon your time and patience, and I shall mention only two more recommendations.

5. It seems to me that our troubles are unnecessarily compounded by the fantastic number of chemical compounds in use as pesticides. As matters stand, it is quite impossible for research into the effect of these chemicals on the physical environment, on wildlife, and on man to keep pace with their introduction and use. It is hard to escape the conclusion that the great proliferation of new chemicals is dictated by the facts of competition within the industry rather than by actual need. I should like to see the day when new pesticides will be approved for use only when no existing chemical or other method will do the job.

6. In conclusion, I hope you will give full support to research on new methods of pest control in which chemicals will be minimized or entirely eliminated. You have heard from Secretary Freeman what some of this work is. One of the outstanding values of biological controls is that they are specifically adapted to a particular species or group of species. Therefore, since our problems of pest control are numerous and varied, we must search, not for one superweapon that will solve all our problems, but for a great diversity of armaments, each precisely adjusted to its task. To accomplish this end requires ingenuity, persistence, and dedication, but the rewards to be gained are great.

PESTICIDES ONLY A PART OF THE LARGER PROBLEM OF ENVIRONMENTAL CONTAMINATION

Miss CARSON. Contamination of various kinds has now invaded all of the physical environment that supports us—water, soil, air, and vegetation. It has even penetrated that internal environment that lies within the bodies of animals and of men. It comes from many sources: radioactive wastes from reactors, laboratories, and hospitals; fallout from nuclear explosions; domestic wastes from cities and towns; chemical wastes from factories; detergents from homes and industries.

When we review the history of mankind in relation to the earth we cannot help feeling somewhat discouraged, for that history is for the most part one of the blind or shortsighted despoiling of the soil, forests, waters, and all the rest of the earth's resources. We have acquired technical skills on a scale undreamed of even a generation ago. We can do dramatic things and we can do them quickly; by the time damaging side effects are apparent it is often too late, or impossible, to reverse our actions. These are unpleasant facts, but they have given rise to the disturbing situations that this committee has now undertaken to examine.

I have pointed out before, and I shall repeat now, that the problem of pesticides can be properly understood only in context, as part of the general introduction of harmful substances into the environment. In water and soil, and in our own bodies, these chemicals are mingled with others, or with radioactive substances. There are little understood interactions and summations of effect. No one fully understands, for example, what happens when pesticide residues stored in our bodies interact with drugs repeatedly taken. And there are some indications that detergents, which are often present in our drinking water, may affect the lining of the digestive tract so that it more readily absorbs cancer-causing chemicals.

WIDE DISPERSAL OF PESTICIDES

In attempting to assess the role of pesticides, people too often assume that these chemicals are being introduced into a simple, easily controlled environment, as in a laboratory experiment. This, of course, is far from true.

It seems to me that the most significant knowledge that has developed within the past year has been the piling up of evidence about the wide dispersal of pesticide chemicals, far beyond the point of application. I should like to cite some examples to illustrate this spreading contamination.

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Although it is not difficult to imagine the paths by which domestic water supplies become contaminated, there are now examples of a different sort that defy easy or comfortable explanation. Such, for example, is the situation on Prince of Wales Island in southeastern Alaska. I am told by the Fish and Wildlife Service that its biologists have sampled resident fish in four drainage systems on this island and have found DDT, sometimes with its metabolites, in two of them. Yet there is no record of applications of DDT on this island. The nearest town, other than small native villages, is more than 50 miles away.

An even more remote region, not far below the Arctic Circle, has been yielding extraordinary data to the Fish and Wildlife Service for several years. This is the Yellowknife region on the upper Yukon River, in the northwest territory of Canada. It is an important waterfowl breeding area, wild, remote from any human settlements. No spraying of insecticides is known to have occurred within several hundred miles. Yet DDT and its metabolites have been found for several years both in the eggs of waterfowl and in their young. This fact alone might have been explained by the fact that the waterfowl are migratory and could easily have picked up the poison during their sojourn in the United States. Transfer to the eggs and young could then have followed. But there is no such explanation for the fact that native vegetation in this same area has now been found to contain residues.

The most disturbing of all such reports, however, concerns the finding of DDT in the oil of fish that live far at sea. Such residues have been found in fish caught off both coasts of North America, as well as off South America, Europe, and Asia. The species concerned include, besides others, halibut living on the floor of the Pacific Ocean, and tuna, a fish of the open ocean that rarely comes close to land. Oil from some of these marine fish have contained DDT in concentrations exceeding 800 parts per million.

All of this gives us reason to think deeply and seriously about the means by which these residues reach the places where we are now discovering them. No one can answer this question with complete assurance today, but I should like to call your attention to certain known facts that do have a bearing on the problem.

TRANSPORT OF PESTICIDE RESIDUES

The ways by which pesticide residues may be transported over long distances are basically three: by air, by water, and in the bodies of living organisms, either indirectly through food chains or directly.

A report last year by the U.S. Department of Agriculture established the fact that aerial spraying comprises about 22 percent of the total acreage sprayed in the United States. Studies by Prof. George Woodwell of the University of Maine show that of the DDT used in forest spraying, less than half falls directly to the soil. Of each 0.5 pound released by the spray plane approximately 0.2 pound reaches its target. The remainder is presumably dispersed as small crystals in the atmosphere. These minute particles are the components of what we know as "drift"—the phenomenon that plagues every householder who receives contaminating spray from his neighbor across the street, or from his government's spray planes several miles away. We are now beginning to wonder how vast the reach of "drift" may be. It was known a decade ago that the herbicide 2,4-D could drift as far as 15 or 20 miles in quantities sufficient to damage vegetation. The drift of insecticides is less readily observed, but when the matter is properly studied I predict we shall discover some startling facts.

It seems that little application has been made of our knowledge of atmospheric movements. Various factors influence the direction and speed of air currents. Among these is convection, or the upward flow of air which takes place when the ground temperature exceeds that of the air. Conceivably, this force could lift the very fine particles of spray materials to an altitude at which strong horizontal winds could come into play, effecting transport for long distances. We know this happens with other materials. For example, scientists of the Woods Hole Oceanographic Institute have studied for many years the behavior of salt nuclei, drawn from the surface of the ocean and lifted high into the atmosphere. These tiny particles are carried great distances—at least as far as 400 miles. And we know also that the upper atmosphere transports a whole assemblage of living objects—seeds, pollen, spores, tiny spiders, and insects—and through such transport oceanic islands are colonized. I think, therefore, it is a speculation that should be tested that the upper atmosphere may also be carrying chemical particles as well as radioactive debris, and that the pesticide contamination of such remote places as those I have mentioned may be the result of a new kind of fallout.

Little thought seems to have been given to the possibility of transport in dust. Yet, on a small scale, we had a vivid example of this last April when health officials on Long Island charged that the airborne dust from potato fields, carrying arsenic and other insecticide residues, was a menace to public health. This dust had actually compelled the closing of a public school on several occasions because it clogged the ventilation system. On a broader scale, it is only

reasonable to assume that dust from heavily sprayed lands, especially in some areas where conditions are right, may carry insecticides for exceedingly long distances.

A final and especially interesting means of pesticide transportation is that which occurs in living animals, whether directly or indirectly. Direct transportation may occur over many hundreds of miles, as when woodcock carry heptachlor from southern wintering grounds in the area of fire ant treatment all the way to breeding areas in the Canadian Maritime Provinces. A less obvious but exceedingly important method of transportation by living organisms is that which occurs when a chemical passes from one link to another in a natural food chain, usually becoming concentrated as it goes. We now have a number of impressive demonstrations of this phenomenon. Several have been studied by biologists in California.

At Big Bear Lake, for example, toxaphene, a chlorinated hydrocarbon, was applied at a dosage of only 0.2 parts per million. Later it was found that the minute plankton organisms in the lake had picked up this chemical and had concentrated it to a level of 73 parts per million. The buildup continued through the food chain, with fish containing 200 parts per million and a fish-eating bird (a pelican) containing 1,700 parts per million.

I might add that similar concentrations of pesticides have been found in waterfowl, which of course are migratory, and which are shot by the hundreds and are often carried home to the dinner table.

The story at Bear Lake, however, does not end with the accumulation in the fish and birds of the lake at that time. Plankton organisms collected at the lake poisoned hatchery trout when fed to them. Ten months after the insecticide was applied to the lake, fish were again able to live in these waters. The lake was accordingly restocked with trout. However, when a little later fillets from the trout were analyzed, they were found to contain 3 parts per million of toxaphene. I might add that this experience convinced the California Division of Fish and Game that toxaphene is unsuitable for rough fish control, which had been the purpose of the application, but the experiment, I think, did provide some very instructive data on transfer of chemicals through food chains. The same sort of phenomenon has been worked out in detail at Clear Lake, Calif.

CONCENTRATION OF CHEMICALS BY LIVING ORGANISMS

I should like to add a word about the concentration or buildup of the chemicals. There really is nothing surprising about this—especially about that initial concentration by the plankton. Aquatic organisms are well known to have marked ability to extract minerals and other substances from the water and concentrate them. Marine organisms in particular can do this. For example, the percentage of silica in rivers is 500 times that in the sea, because marine diatoms withdraw so much to construct their shells. Large quantities of cobalt are extracted from seawater by lobsters and mussels, and of nickel by various mollusks; yet human chemists recover these elements from the sea only with difficulty. Oysters concentrate zinc at a level about 170,000 times that in the surrounding water. It should come as no surprise, therefore, to find some of these marine invertebrates col-

lecting and concentrating such chemicals as DDT. As Secretary Udall reported to you recently, oysters exposed to levels of only 1 part per billion for 1 week later contained 132,000 parts per billion in their tissues. The implications for the human being who likes to eat oysters—or other forms of marine life—are obvious.

ACTION NEEDED TO LIMIT WIDESPREAD DISPERSION OF PESTICIDES

All the foregoing evidence, it seems to me, leads inevitably to certain conclusions. The first is that aerial spraying of pesticides should be brought under strict control and should be reduced to the minimum needed to accomplish the most essential objectives. Such reduction would, of course, be opposed on the grounds of economy or efficiency. But if we are ever to solve the basic problem of environmental contamination, we must begin to count the many hidden costs of what we are doing, and weigh them against the gains or advantages.

The second conclusion that seems apparent is that a strong and unremitting effort ought to be made to reduce the use of pesticides that leave long-lasting residues, and ultimately to eliminate such chemicals. This, you will remember, was one of the recommendations of the President's Science Advisory Committee. I strongly concur in this recommendation, for I can see no other way to control the rapidly spreading contamination I have described.

There are several other recommendations I would like to suggest, bearing on various specific aspects of the immensely complex pesticide problem. These are as follows.

NEED TO PROTECT INDIVIDUALS AGAINST INDISCRIMINATE APPLICATIONS OF PESTICIDES

1. I hope this committee will give serious consideration to a much neglected problem—that of the right of the citizen to be secure in his own home against the intrusion of poisons applied by other persons. I speak not as a lawyer but as a human being, but I strongly feel that this is or should be one of the basic human rights. I am afraid, however, that it has little or no existence in practice.

I have countless letters in my files describing situations in which a person has been subjected to personal injury or to the loss of pets or valuable horses or other domestic animals because poisons from a neighbor's spraying invaded his property. Residents of Norfolk, Va., have informed me that they were told last winter that the State had the authority to apply poisons to their land but assumed no responsibility for injury that might result. It is a matter of record that dairy farmers in New York State suffered contamination of their land by Federal-State spraying for gypsy moths, with the inevitable result that their milk later contained illegal residues and was condemned by the State as unfit for market.

Under such circumstances, what is the citizen to do? You may recall the opinion of the U.S. Court of Appeals in the case in which a group of Long Island citizens sought an injunction to prevent a repetition of the spraying to which they had been subjected. Since no date for repeated spraying had been set the court could not grant an injunction, but it did make a significant ruling which I should like

to insert in the record. I quote from the opinion of the court of appeals:

* * * It would seem well to point out the advisability for a district court, faced with a claim concerning aerial spraying or any other program which may cause inconvenience and damage as widespread as this 1967 spraying appears to have caused, to inquire closely into the methods and safeguards of any proposed procedures so that incidents of the seemingly unnecessary and unfortunate nature have disclosed, may be reduced to a minimum, assuming, of course, that the Government will have shown such a program to be required in the public interest.

I have been informed by affected citizens in New York State that the current gypsy moth spraying has been done with no advance notice whatever. Some of these people learned of the proposed spraying quite by chance 2 or 3 days before the planes began their work. They were told by their attorneys that in this limited time no appeal to the courts was possible. It is clear, therefore, that the intent of the court as indicated in the above quotation is thwarted in such cases.

As a minimum protection, I suggest a legal requirement of adequate advance notice of all community, State, or Federal spraying programs, so that all interests involved may receive hearing and consideration before any spraying is done. I suggest further that machinery be established so that the private citizen inconvenienced or damaged by the intrusion of his neighbor's sprays may seek appropriate redress.

NEED FOR FURTHER MEDICAL RESEARCH AND EDUCATION

2. In another area, I hope this committee will give its support to new programs of medical research and education in the field of pesticides. I have long felt that the medical profession, with, of course, notable individual exceptions, was inadequately informed on this very important environmental health hazard. It was sobering to have the President's science advisers confirm this view by saying, "Physicians are generally unaware of the wide distribution of pesticides, their toxicity, and their possible effects on human health." The panel also found a complete lack of any federally sponsored research to develop methods of diagnosing pesticide poisoning, especially when this takes the form of chronic, rather than acute illness. I am told that in the medical schools today, because of the many subjects to be taught, the attention given the whole field of toxicology is greatly reduced. Yet this is happening at a time when toxic substances are being introduced into the environment at a rate never before approached.

The plight of the person affected by these poisons is pitiful. Many case histories have come to me in letters. As a rule these people can find no physician who understands their problem. Indeed, I remember several cases in current medical literature in which the physician, even though told of the patient's exposure to such relatively common insecticides as malathion or lindane, had never heard of the chemical and did not know the appropriate treatment. About 10 years ago the American Medical Association had a special committee on pesticides which from time to time published authoritative information on the toxicology of these chemicals. I have seen none of these reports for several years. I do not know whether the committee is still functioning; if it is, it is hard to see why the American Medical Association last fall recommended that physicians seek information to allay their

patients' fears, not from unbiased scientific literature, but from one of the pesticide trade organizations.

I should like to emphasize, however, that many individual physicians are aware of the hazard and of the need for research in this field. Some of the most interesting letters I receive are from doctors. In what I believe to be the first recognition of this problem by a medical organization, the Illinois State Medical Society on March 17 of this year approved a resolution directing attention to delayed and indirect effects of pesticides and calling for a thorough study of the problem. I should like to introduce a copy of this resolution into the record at this point.

RESOLUTION ON STUDY AND EVALUATION OF TOXICANTS

Whereas the total consequences to man and his renewable resources from the present widespread and often unrestrained dissemination of toxic substances into the environment are only vaguely known and some effects cannot yet even be surmised; and

Whereas the indirect and untoward effects of pesticides, insecticides, rodenticides, and kindred chemicals are frequently long delayed, difficult to trace and apparent safe minimal accumulations in air, soil, water, fiber, food, and all tissues can in time accrue to harmful or even lethal levels; and

Whereas these toxicants often have a profound latent effect on flora and fauna not originally intended for suppression or eradication; and

Whereas these toxicants are among the most potent ever known and such new incompletely evaluated substances are being developed annually; and

Whereas these lethal agents can be purchased by anyone, anywhere without adequate controls to guard against their misuse: Now, therefore, be it

Resolved, That the board of trustees of the Illinois State Medical Society go on record that efforts to manipulate ecologic balances by governmental agencies, private industry, and individuals through the use of toxicants and radiation needs urgent and conscientious study for the development of wise and effective controls; and be it further

Resolved, That in the opinion of the board of trustees of the Illinois State Medical Society the present state of knowledge dictates a policy of caution, inquiry, maturity of judgment, and statesmanship; and be it further

Resolved, That the director of the Illinois Department of Public Health through the Bureau of Hazardous Substances and Poison Control be requested to undertake a study of all toxicants, current and future sold or used in Illinois, and prepare a report for appropriate distribution.

(Approved by Board of Trustees of the Illinois State Medical Society on March 17, 1968, in Chicago, Ill.)

NEED FOR LEGISLATION TO RESTRICT THE SALE AND USE OF PESTICIDES

3. I should also like to see legislation, possibly at the State level, restricting the sale and use of pesticides at least to those capable of understanding the hazards and of following directions. To me it is shocking that these chemicals can be bought and applied by illiterate and even by mentally deficient persons. We place much more stringent restrictions on the sale of drugs—which at least are not sprayed from powerful machines. Someone wrote me recently about a man who was thought to have contracted hepatitis from a spray he had been using, making the pertinent observation that the man could buy the chemicals that made him ill with no restrictions, but had to have prescriptions to buy the drugs to cure him.

REGISTRATION SHOULD BE THE CONCERN OF ALL AFFECTED AGENCIES

4. I should like to see the registration of chemicals made a function of all agencies concerned rather than of the Department of Agriculture alone. The deficiency in the present law has been pointed out in the report of the President's Science Advisory Committee. Many of the miscellaneous uses of chemicals, as in mothproofing, floor waxes, household sprays, and garden pesticides, have a direct relation to human health. It seems not only logical but necessary that the Department of Health, Education, and Welfare should participate in decisions regarding the registration of chemicals so used. Similarly, many, probably the majority, of pesticides are used at some time in such a manner that they affect wildlife and commercial and recreational fishery resources. The Department of the Interior needs to have a voice in the registration and labeling of such chemicals.

I have already trespassed upon your time and patience, and I shall mention only two more recommendations.

NEED TO LIMIT THE NUMBER OF PESTICIDES IN USE

5. It seems to me that our troubles are unnecessarily compounded by the fantastic number of chemical compounds in use as pesticides. As matters stand, it is quite impossible for research into the effect of these chemicals on the physical environment, on wildlife, and on man to keep pace with their introduction and use. It is hard to escape the conclusion that the great proliferation of new chemicals is dictated by the facts of competition within the industry rather than by actual need. I should like to see the day when new pesticides will be approved for use only when no existing chemical or other method will do the job.

FURTHER RESEARCH ON NEW PEST CONTROL METHODS

6. In conclusion, I hope you will give full support to research on new methods of pest control in which chemicals will be minimized or entirely eliminated. You have heard from Secretary Freeman what some of this work is. One of the outstanding values of biological controls is that they are specifically adapted to a particular species or groups of species. Therefore, since our problems of pest control are numerous and varied, we must search, not for one superweapon that will solve all our problems, but for a great diversity of armaments, each precisely adjusted to its task. To accomplish this end requires ingenuity, persistence, and dedication, but the rewards to be gained are great.

Thank you.

INTELLIGENT USE—NOT ELIMINATION—THE OBJECTIVE

Senator RIBICOFF. Thank you very much for this most enlightening testimony, and for what is even more important, your recommendations. Miss Carson, there can be no doubt that you are the person most responsible for the current public concern over pesticide hazards.

It also appears to me that in the public mind the issue has been reduced to a sharp conflict between Rachel Carson on one hand and the

manufacturers of agricultural chemicals on the other. It seems to me the issues here can't be drawn that sharply.

I wonder whether your position has been somewhat misunderstood or perhaps misinterpreted. I think it would be helpful if we could have the basis of your outline made clear for the record, and also for the future guidance of this committee. For instance, isn't it fair to say that you are not trying to stop the use of chemical poisons?

Miss CARSON. That is a fair statement; yes. It would not be possible, even if we wished to do so, to eliminate all chemicals tomorrow.

A great deal of the discussion of "Silent Spring" and of the issues has, as you say, been placed on an all-or-none basis, which is not correct. This is not what I advocated, sir.

Senator RIBICOFF. In other words, you recognize that many of these chemical poisons have produced many benefits both to public health in combating disease, and to nutritional health in improving the quality of our food supply.

Miss CARSON. They have produced benefits. My concern is about the serious side effects.

I think that we have had our eyes too exclusively on the benefits, and we have failed to recognize that there are also many side effects which must be taken into consideration. However, what I have advocated is not the complete abandonment of chemical control. I think chemicals do have a place. In fact, I have cited with great approval the coordination of chemical and biological controls such as is applied, for example, in the apple orchards of Nova Scotia.

Senator RIBICOFF. And am I correct, then, that your primary objective is against the indiscriminate use of pesticides and use where they are not necessary, and their excessive use even where they are necessary?

Miss CARSON. That is correct, and I think that instead of automatically reaching for the spray gun or calling in the spray planes, we must consider the whole problem. We must find out first whether there is any other method that can be used.

If there is not, then we should use chemicals as sparingly and as selectively as we can, and we should use them in such a way that we do not destroy the controls that are built into the environment.

Senator RIBICOFF. In other words, you do not believe that next spring will be the silent spring, but that injury to wildlife and to man himself will become an ever-increasing threat in the years ahead, unless proper safeguards are developed and new techniques, such as biological controls, are put into practice.

Miss CARSON. I think we must begin now to take account of the hazards and to change our methods where and when we can.

Senator RIBICOFF. Thank you very much. Senator Gruening?

THE QUESTION OF CONFLICT BETWEEN CHEMICAL AND BIOLOGICAL CONTROLS

Senator GRUENING. Miss Carson, every once in a while in the history of mankind a book has appeared which has substantially altered the course of history. I think that sometimes those books are in fiction form and sometimes not.

One can think of many examples, such as Uncle Tom's Cabin, for instance. Your book is of that important character, and I feel you have rendered a tremendous service.

I want to ask you one or two questions bearing on answers you have just given which appear to me to be somewhat in contrast to what you have said if not in your prepared testimony today, then in contrast with what appears in your book, "Silent Spring," which I think is a tremendously important piece of research.

You just said in answer to Senator Ribicoff that you felt there should be pesticide control, and we should try to find alternative methods of destroying pests. In your testimony you say that one of the conclusions you have come to is that aerial spraying of pesticides should be brought under strict control, and should be reduced to a minimum need to accomplish the objectives. Now in reading your book it seems to me you go further than that. I would like to quote the following passages.

First on page 246 you say:

At the end of a decade or more of intensive chemical control, entomologists were finding that problems they had considered solved a few years earlier had returned to plague them.

In other words, insecticides haven't solved the problem of killing insects.

And then you say on page 257:

This possibly marked the end of an era—

when you refer to the fact that to overcome the scale in the fruit orchards of California they had brought in a predatory insect from Australia, which had completely eliminated the scale, and solved the problem, and then they started using pesticides again, which destroyed the predatory insects and the scale returned, and you have other illustrations of that kind, in which chemical pesticides killed even the beneficial insects, the predators which had killed the pests which were to be destroyed. And you quote Dr. Paul De Bach of the Citrus Experiment Station in Riverside, who said:

The vedalla can be maintained—

that was the parasite which was brought in from Australia that destroyed this scale—

only by repeated releases and by the most careful attention to spray schedules, to minimize their contact with insecticides. And regardless of what the citrus growers do, they are more or less at the mercy of the owners of adjacent acreages, for severe damage has been done by insecticidal drift.

In other words, the insecticide disposed of a useful predator, and the predator once destroyed can with difficulty be reinstated.

And then on page 266 you say:

* * * The short-lived triumphs that now strongly support the alarming view that the insect enemy has been made actually stronger by our efforts—

our pesticide efforts. And then finally on page 279 you say:

Now at least, as it has become apparent that the heedless and unrestrained use of chemicals is a greater menace to ourselves than to the targets, the river which is the science of biotic control flows again, fed by new streams of thought.

Now my question is: Doesn't that lead to the conclusion that we should stop insecticides and turn instead to biotic controls?

Miss CARSON. No; I don't think you can see it all as black or white or all or none.

I think that the conclusion that follows from all of the examples that you have quoted is that the chemicals have often been used heedlessly, and without regard to the total environmental situation in which they were used.

For example, in California a great deal of time and expense had been gone into importing these parasites and predators which had established excellent control, and then some spraying was done without regard to the effect on this balance that had been established. Now, that is the sort of thing that Dr. Pickett in Nova Scotia, whom I have quoted, tries to avoid. He makes a very careful study of the biological controls that are in effect, perhaps naturally or perhaps he has introduced them, and when he does have to use chemicals, he uses them at a time of the year and in such a concentration and of such quality that he does not destroy those biological controls.

Now this is good. It is a combination of the two methods, but one does not destroy the other. But very seldom has that sort of thing been taken into account.

So I think that we have too often just automatically called in the spray planes or whatever, and have not studied the whole situation—have not found out that perhaps we can do the job with a less toxic chemical than one we are using, or perhaps we can use a smaller amount.

In other words, there just hasn't been enough thought given to it, but I don't think that one can say from all this we must never use chemicals, we must use all biological controls. On the other hand you can't say that biological controls are to be disregarded, and we will use all chemicals, because we must also consider what we are doing to this matter that you people are studying now, the pollution of the environment by the chemicals.

But there is no easy and simple solution, and certainly we cannot say that tomorrow we abandon all chemicals. I don't believe that for one moment.

I think there must be a gradual reduction. Perhaps we will never get away from all of them, but I think we can greatly reduce the quantity of very toxic and very persistent chemicals.

Senator GRUENING. Well, now it is obvious that we are facing a very, very difficult problem of regulation here. You have on the one hand a tremendous investment and profit motive of those who manufacture these chemicals, as against the nonprofitable introduction of parasites.

There is no money in introducing parasites to destroy the evil insects. So you have this tremendous conflict.

Miss CARSON. Yes; but I think you balance the public interest there against the other.

Senator GRUENING. Well, I think it is up to those who are concerned with the public interest to try to achieve that, but that isn't always easy.

APPROPRIATE GOVERNMENT ORGANIZATION TO DEAL WITH ECOLOGICAL PROBLEMS

What would you think of creating in one of the agencies—you see, there are several agencies that are concerned with this. There is the Department of Health, Education, and Welfare, which is concerned

primarily with the health of human beings. You have the Department of Agriculture, which is concerned with agricultural production and elimination of pests that destroy vegetation, food and fiber and you have the Department of the Interior, which is concerned with fish and wildlife.

What would you think of creating a department of ecology that would have an overall supervision of these functions, or at least an agency of ecology in one of those departments that would try to coordinate these conflicting interests?

There certainly would be conflict on the one hand between the people who want to preserve animals, wildlife, fish, and those who want to preserve agricultural products, and overall, of course, the effect on human beings, which is the most important of all.

Miss CARSON. This department you are thinking of would also include the ecology of man?

Senator GRUENING. Yes, indeed, primarily the ecology of man. It seems to me that we are dealing essentially with an ecological problem here.

Miss CARSON. Well, it certainly is a good objective. Whether it is feasible to do this I don't really know.

Certainly the agencies that are concerned in one way or another with the natural resources are so numerous and so widely spread throughout the Government that I don't know whether it is feasible to take them all out and put them together or not.

DIFFICULTY IN RESTRICTING SALE OF PESTICIDES TO QUALIFIED INDIVIDUALS

Senator GRUENING. You have given some very graphic examples of the loss of human lives after brief and casual exposure by some people who were not aware of the danger of herbicides, pesticides, and other things, and it seems to me that there is a red flag that we should all take note of, because certainly no pesticide is worth using if it is going to jeopardize human life.

One of your recommendations is only those intelligent enough to use pesticides should be allowed to use them. It is going to be very difficult to enforce that.

Miss CARSON. It is a good objective though.

Senator GRUENING. I have no other questions.

Senator RIBICOFF. Senator Pearson?

Senator PEARSON. Miss Carson, I was very pleased the chairman put a question to you, and also Senator Gruening, that developed further that your position is one of balance, and that you have recognized that part of the President's scientific report, and also the testimony of the Secretary's, which points out that great good has come out of the use of some of these pesticides. I hope what I have said is an accurate position that you hold.

Miss CARSON. There has been benefit.

MISS CARSON'S BACKGROUND AND EXPERIENCE

Senator PEARSON. If I were an attorney interrogating an expert witness, I would just waive your qualifications as a brilliant writer, which are apparent. But we are dealing with a subject here which is quite confusing for one such as myself. The correct identification

of certain compounds and the degree of effect of them is extremely important. I wonder—you described yourself in your testimony as a biologist—if for the benefit of the committee and the record you would further state your studies and qualifications.

Miss CARSON. Yes, I will be glad to.

Senator PEARSON. Besides your own research for this book.

Miss CARSON. Yes. To go back to my background, I was graduated from college with a major in zoology. I went on to Johns Hopkins University in Baltimore, where I took my master's degree in zoology, there specializing in embryology and genetics.

I then became quite interested in ecological matters or the basic relation between organisms and their environment.

I carried on studies at the Marine Biological Laboratory in Woods Hole, and then in 1936, I believe, I became a biologist on the staff of what was then called the U.S. Bureau of Fisheries. I was for 16 years a Government biologist with the Bureau of Fisheries, and with its successor, the Fish and Wildlife Service.

I resigned from the Service in 1952, in order to devote my further time to writing. But before I left the Service, as you will remember, in the mid-1940's the new synthetic insecticides had come into use, and we in the Service were faced with the problem of trying to determine the effect of these pesticides on birds and fishes and other wildlife. That was a concern felt by many people in the Service in those years, and I shared it.

About 5 years ago then I came back to this subject, to begin a study of what had happened in the more than a decade of use—about a decade and a half of use of this great variety of new and very toxic chemicals.

So about 5 years ago I began this survey of the problem, which I have continued and which led to the writing of "Silent Spring."

JOINT AGENCY PARTICIPATION IN REGISTRATION OF PESTICIDES

Senator PEARSON. Thank you. I know this committee is concerned with the intergovernmental relationship of the agencies that work in this field. I appreciate the fact that you have made recommendations. I think it is around page 13. As the chairman observed, you said:

I would like to see the registration of chemicals made a function of all agencies concerned, rather than the Department of Agriculture alone.

Now I think the Senator from Alaska touched on this. My first impression is that if we are going to have all of these agencies make a registration, we may have this constant duplication, which we are so often justifiably criticized for. I am wondering if I have misunderstood this recommendation, or if perhaps a single agency should be assigned this responsibility.

Miss CARSON. I meant a joint decision rather than simply a decision of Agriculture. I meant there should be consultation.

Senator PEARSON. I see.

Miss CARSON. And that the responsibility should be shared, not simply the responsibility of the Secretary of Agriculture to make the final decision.

Senator PEARSON. I think that is all.

Senator RUBINOFF. Senator Javits!

Senator JAVITS. Miss Carson, I am very glad to see you. I am sorry I was late, but I was engaged in other business affecting the rights not of bugs and insects but of human beings.

I would like to ask you a question or two about New York. I think that some of your testimony is concerned with our own experience in New York.

I might say that one thing that it seems to me you have done today, which is very important because of the great and justified prominence which you have had for your fine book, is that you have put in focus your concept. Consequently, the people don't feel you are in favor of eliminating any effort to deal with pests and so on, but rather you want to bring the matter under strict control to avoid to the maximum harm to human kind, and the other animals with which we are surrounded. Is that a fair statement?

Miss CARSON. I think we must maintain control. I am not for abandoning efforts to control insects.

Senator JAVITS. I think that is most important, because many people apparently have taken a sweeping view of your position.

Miss CARSON. However, I would like to amplify that by saying that I think sometimes we rush into control by rather drastic methods, sometimes in a situation that perhaps does not at the moment require action. I think we are very often too quick to step in.

DIFFICULTIES IN LIMITING MASS SPRAYING PROGRAMS

Senator JAVITS. Now, I, too, am impressed with your suggestions for notice in advance of the utilization of these techniques. The Chair has very graciously given me a letter which the Chair received from New York State Assemblyman Joseph Nowicki, from Rockland County, N.Y., in which he complains that faced with a spraying operation for the gypsy moth in New York, he was unable to make contact with the people here who had the authority to stop it or delay it.

Your statement on this obviously ties in with that complaint. It so happens that my office did make contact for the community with the authorities who could stop it or delay it, but the authorities felt that there was not a sufficient showing to warrant their stopping or delaying it, and so they turned us down and went ahead with it.

Now techniques of notice and hearing, perhaps even court review, to which you referred, are very important, and would be very helpful. However, what would you say, Miss Carson, to the other side of the coin, in view of the fact that we are charged with the responsibilities of Government?

Suppose a Government agency seriously believes that there is grave and immediate menace which would grow, and, perhaps get out of control if it did not deal with it then and there, or very promptly, at least so promptly that you couldn't go through the notice and procedures with which I thoroughly agree, which are endemic to our free society.

Do you have any ideas as to how, first, this is a possibility, and, secondly, is there anything that we can do to provide against it which will not just open the thing up all over again?

Miss CARSON. Well, I know that the Department of Agriculture has made this claim, that they would be hampered in dealing with

an emergency situation. However, I think that they have invoked this idea in many cases, where actually there was no emergency.

I don't happen to believe that the gypsy moth situation in New York represents an emergency. I think perhaps you have seen a very fine statement on the gypsy moth problem, which has been prepared by the Massachusetts Audubon Society. I would like to submit it to you later for possible inclusion.

Senator RIBICOFF. It will be included in the record at this point.

EXHIBIT 16

ARTICLE ON GYPSY MOTH CONTROL PROGRAM¹

THE PESTICIDE PROBLEM

STATE TO SPRAY 200,000 ACRES FOR GYPSY MOTH SUPPRESSION

The department of natural resources has just asked the legislature to authorize the expenditure of \$200,000 to spray one-half pound of DDT per acre over parts of central and western Massachusetts to suppress a predicted severe outbreak of gypsy moths this spring.

Commissioner Foster has expressed concern for the problem of environmental pollution by insecticides and acknowledged that there are virtually no commercial timber values at stake. He still maintains that such a program is justified to protect the tourist industry of the region (said to be adversely affected by any serious defoliation of the Berkshires), and to abate the nuisance—for 6 to 8 weeks' duration—of excessive numbers of caterpillars in the woods. He apparently does not believe—as we do—that the evidence now available indicates that serious long-term wildlife losses result from the compounding of such programs.

At the heart of the matter is the inability or unwillingness of our political leaders and the public to recognize the ecological complexity of our environment and the evidence of damage already available. Modern proponents of progress refuse to acknowledge that man must function as a part of his environment. We have accepted the laws of physics because they are so immediate and obvious in their reaction if we do not. Biological laws are just as inflexible, but we continue to ignore them because the results of violating them (in marked contrast to the law of gravity) are so often expressed years, or decades later that impatient man cannot recognize them or refuses to be concerned, hoping that they will somehow go away.

Simply stated, it is a basic conflict of belief—

Man is a part of nature and must abide by its rules.

v.

Man can stand apart from nature in a synthetic environment—that he has already so totally disrupted the "balance of nature" that he must and can take over complete control.

In our view, the latter course may some day be achieved in part, but only when our knowledge of ecology is so vast that we can accurately predict and assess the impact of our manipulation of biological forces. We will never control these forces in the true sense of the word, just as we can never control the law of gravity. Physicists and chemists work today's technological marvels only because they understand and work with physical laws.

Basic to this immediate gypsy moth problem are several major needs:

1. A complete overhaul of our outdated legislation on insect pest control which now directs the department of natural resources to control the gypsy moth. We applaud Commissioner Foster's recommendation that this be done.

2. For the appropriation of sufficient funds—modest when compared to the cost of present control efforts—so that local testing and factfinding work can be done to perfect alternative control methods, several of which appear extremely promising.

¹ Massachusetts Audubon Newsletter, special issue, Apr. 20, 1963, pp. 1-8.

We have recorded ourselves with Commissioner Foster and the commissioner of administration as vigorously opposed to this proposed program on several basic premises:

1. The short-term nuisance is not sufficiently severe to justify the expenditure of the large sum involved.

2. Every such program increases the level of DDT in the environment, causing long-term and severe mortality to many forms of wildlife, some of which are of major economic significance to the Commonwealth.

3. Such programs, by disrupting natural control factors, prolong an outbreak and bring about new ones in other insect species.

We can only assume that Commissioner Foster is not well acquainted with the mass of research evidence which now documents the pollution of our environment by long-lived chemicals and which results in major wildlife damage. Otherwise his refusal to give the public and our government the leadership it so badly needs would seem based on his appraising as unimportant the wildlife resources which are affected.

In an open letter dated April 1, 1963, to Thomas Flint, president of the Massachusetts Association of Conservation Commissions, Commissioner Foster has explained his department's reasoning in continuing its gypsy moth spray program. Its length (four typewritten pages) precludes complete quotation here, but while our differences are not limited only to these, we feel we must quote excerpts and indicate our response to what we consider to be highly selective interpretation of the evidence:

I—Page 1, paragraph 3: "Protection from insects and disease can be as important to the forest as protection from fire * * *."

Rebuttal—Yes, this is true as a general statement, but in this context it infers that the gypsy moth poses such a threat. However, the commissioner has acknowledged that there are no economic forest values to protect, since there is no significant utilization of forest products in western Massachusetts. Several studies of the effect of gypsy moths on the forest indicate that in fact the long-term result may often be to improve the quality and growth of the forest as a whole.

II—Page 1 paragraph 4: "* * * the spring of 1963 will mark a peak year * * *," and paragraph 5—"* * * without artificial control, some three successive seasons of defoliation would be expected to result. * * *"

Rebuttal—The 60,000 acre "artificial control" program carried out last year was justified primarily on the basis that it would prevent a far larger program in 1963. The 1962 area will be resprayed this year.

III—Page 2, paragraph 5—"Individual instances of fish and wildlife damage have been documented, mostly in the South, the West and in Canada, frequently involving more toxic materials and invariably the result of a misuse of pesticides."

Rebuttal—Among the hundreds of references available to refute this statement, is the U.S. Fish and Wildlife Service's Circular 143, "Effects of Pesticides on Fish and Wildlife in 1960," p. 29 (table), "Effects * * * of single application of DDT in oil solution" at 0.2 pound per acre produces moderate kill of crustaceans and fish, and some kill of amphibians and reptiles. At 1 pound per acre produces a heavy kill of crustaceans and fish, moderate kill of amphibians and reptiles, and some kill of birds.

IV—Page 2, paragraph 6—"We examined the record of the last major * * * control program (1952) * * * observers could detect no direct mortality * * * a decade later no significant decline * * * appears evident as the result of this control effort."

Rebuttal—No research study or other credible record known to us was made at the time and none has been done since; so far as we know there is no significant evidence to examine. Since 1952 a significant decline is evident in more than a dozen species of birds in Massachusetts generally.

Dr. John Buckley, Director, U.S. Fish and Wildlife Research Center: "I think there is no doubt that the use of pesticides has resulted in extreme damage to wildlife. We can't measure this on a continentwide basis, but where we have conducted careful studies following heavy treatment we have had losses up to 80 percent or more."

A very important point must be made here concerning Commissioner Foster's denial of wildlife damage, as quoted above, at dosage rates of one-half pound per acre. The reader's attention is called to the data on the red-shouldered hawk and the osprey which appears elsewhere in this

paper, two species which at first glance appear far removed from danger of harm by DDT. Yet in fact the poisons responsible for their loss are the indirect impact of "safe programs" acting through the food chain, including drift into unintended areas and runoff through our streams.

The persistence of DDT in the environment is so great that each one-half pound spray program compounds upon those that have been applied before.

V—Page 2, paragraph 7—"The 60,000-acre control program conducted in western Massachusetts last spring, using three-quarters of a pound of DDT to the acre, checked the first stages of the epidemic satisfactorily without significant damage or complaint experienced."

Rebuttal—To our knowledge no investigation has been made, but in any event it is impossible to measure the damage (a) without detailed prior studies, (b) within 1 year of the application, and (c) before migrant birds have returned.

VI—Page 3, paragraph 1—Quoting National Academy of Sciences—National Research Council report (1962) re pesticide-wildlife problems: "Wildlife losses associated with the gypsy moth and other forest insect-control programs have been minimal and confined largely to a few fish and other aquatic forms. This is in general accord with research findings which have shown that DDT, applied at the rate of 1 pound per acre, poses no serious hazards to wildlife except fish and some other aquatic life where the threshold may range between 0.1 and 0.5 pound per acre, depending on a number of factors such as the depth, turbidity, chemistry, and the temperature of the water."

Rebuttal—This report is a notorious "whitewash," and we assume that its failure to be impartial is one reason why the President's Science Advisory Committee has been asked to study and report to him on this problem.

VII—Page 3, paragraph 3—"A careful study of the 1958 spruce budworm spray program in Maine supported by the Conservation Foundation indicated no significant effect on fish or riffle insect populations even at applications of 1 pound of DDT to the acre."

Rebuttal—While in its conclusion this report states that insects and fish showed prompt recovery after the poisoning was stopped, it also documents the following:

Regarding insects (p. 19): "Population reductions attributable to the effects of DDT approximated 50 percent by number and 48 percent by volume."

Regarding fish (p. 48): "Blocking nets were operated in 13 brooks for 170 net-days after spraying. The total observed mortality was 8,844 fish; 216 of these were brook trout. Only 17 dead fish were found on blocking nets prior to spraying; none of these were trout."

"Dead trout collected immediately after spraying contained from 4.2 to 25.9 parts per million DDT. *Trout collected alive 3 months after spraying contained from 2.8 to 198 parts per million of DDT (italics ours).* DDT was found in trout collected from three brooks outside the sprayed area, but concentrations in all cases were less than within the sprayed area."

A similar study made in Maine by the U.S. Fish and Wildlife Service in 1958 and 1960 showed considerable fish mortality and reduction of aquatic invertebrates.

VIII—Page 3, paragraph 4—"From the scientific evidence at hand, the department, therefore, feels secure in stating that the proposed program will have no significant effect on Massachusetts fish and wildlife populations. It is fortified in this respect by the fact that a small concentration of insecticide is used, that the operation is under the expert control at all times, and that one application can be expected to rid an area of a gypsy moth infestation for the balance of each cycle."

Rebuttal—Our position as outlined in our policy statement on pesticides is our rebuttal to this. But, referring to "expert control at all times," we wish to point out that the most careful possible control in experimental applications performed by Commissioner Foster's department within the last 2 years resulted in a very large variation of insecticide on the target area. It has been amply demonstrated that up to 80 percent of the spray released from an aircraft may never reach the target, resulting in gross overspraying of certain areas; this is the hazard of aerial spraying.

IX—Page 3, paragraph 7—"If the program is authorized by the legislature, the department will be permitted to utilize existing bond issue funds which, if replenished by the end of the session, will cause no undue interference with previously authorized programs."

Rebuttal—The bond issue referred to is that "for the acquisition of land for recreational facilities * * * and for the development and improvement of now existing areas * * *" i.e., the purchase of open space by local conservation commissions and new State parks. We certainly hope the money is replenished by the legislature. We have not been able to secure an answer to our query: "Why not ask that the money be appropriated directly?"

X—Page 3, paragraph 8 —"* * * the Department feels that * * * [to do nothing] would be untenable in an urban State such as Massachusetts, particularly since the proper tools for control are at hand."

Rebuttal—1. The areas to be sprayed cannot be classified as "urban" in our opinion.

2. DDT cannot be considered a proper tool when we know that the DDT spread in 1952 is still poisoning wildlife today.

3. In the light of the total failure to control this outbreak last year (in fact the infestation has vastly increased over last year), how can such a statement be justified?

XI—Page 4, paragraph 2—"We are convinced that a control program should be undertaken on the basis of need, supported by scientific evidence, not as the result of popular vote."

Rebuttal—We applaud this sentiment enthusiastically. Nevertheless, popular opinion may not have been overlooked: page 3, paragraph 5 of the commissioner's memo reports that department personnel visited local officials in all 58 towns affected and "only one community has replied in the negative" (to the proposed spraying).

The commissioner has been unable to substantiate any economic need.

It is our considered opinion that in determining to proceed with this program the department of natural resources has ignored important scientific evidence and has been unwilling to resist the popular pressure to do something about a problem which in the long-term best interest of a majority of Massachusetts citizens would be better off if left alone.

It may appear that we have been overly strenuous in our objection to this program, but we are convinced that our objections are well founded. Aside from the damage which will be caused to wildlife by yet another 50 tons of DDT in our environment, the following considerations are important:

1. The intensity of this infestation and the history of its buildup indicate that the cycle is at its peak.

2. While the intensity—and hence the damage—of an outbreak can be forecast by the number and size of egg masses, its future can apparently also be forecast by these same figures: less than 300 eggs per mass is a strong indication that the population is at or beyond its peak and will soon "crash"; more than 500 eggs per mass indicates that the population is healthy and growing.

3. Apparently the factors that cause the moth population to "crash" are "density-dependent" (i.e., do not come into play until peak numbers are reached)—thus it seems probable that as peak numbers are suppressed by spraying, so also is the "crash" postponed.

We submit that until it can be conclusively shown that programs such as this are not damaging wildlife populations, are not destroying our estuarine and marine resources through water runoff, are not sterilizing our soils—in short, that they are not destroying more important resources than they seek to protect, such programs should not be continued.

In the meantime, we believe the best course to follow—though perhaps not a popular one with a few alarmed and vociferous inhabitants of the infested area—would be as follows:

1. Allow aerial spraying only for spot protection of specific stands of commercially important pine and hemlock, and around focal points of tourist use.

2. Apply spray by mistblower to residual street trees, camps, recreation areas, and similarly sensitive spots where the caterpillars create a bona fide nuisance.

It is a fair prediction, based on the scientific evidence at hand, that (a) defoliation of trees will not be complete, and that even where it exceeds 95 percent only a small percentage of the total forest will be permanently damaged;

(b) the population will "crash" in mid-June after 6 to 8 weeks of swarms of caterpillars; (c) refoliation of the forest will be sufficiently advanced by the third week of July so that the casual observer will not even notice that there has been a problem; (d) the infestation will have passed and the problem will not be here to plague us next year; (e) another compounding of wildlife damage will have been avoided; (f) the citizens of Massachusetts will have saved some money.

The Massachusetts Audubon Society's increasing concern for the threat to wildlife—and inherently to man—from the present uncontrolled use of chemical pesticides has reached the point where we must make clear to our members and other interested citizens our conclusions and recommendations on this matter. This special newsletter issue does this. In this, as in all questions with answers dependent upon scientific research, we can only give our best considered opinion as of that time. If later research discloses any reason for changing our opinion as here stated, we will so inform our members and the public.

Miss CARSON. Thank you. But it does point out the fact that this is not an emergency that calls for immediate action, perhaps not in any particular season at all. And there are being developed other methods of controlling the gypsy moth which perhaps, if we would just be a little patient and a little restrained, could be put into effect.

I recognize that there might be situations, where that objection would be valid. But it seems to me that they are few enough that surely there could be some way devised to take care of them. And I think the great majority of situations would call for the other sort of treatment, where there is adequate advance notice. If you don't have that, it seems to me there are going to be endless abuses.

Senator JAVITS. But you do feel, Miss Carson, that when our chairman, and I am sure he will, considers legislation in which I hope we all join, he might consider whatever legislative techniques are available to deal with real emergencies.

Miss CARSON. Yes.

Senator JAVITS. Sometimes, for example, we leave that to the President. We go that far. Sometimes we permit rapid recourse to the courts.

I am sure we can devise an appropriate legislative technique. However, you would feel that we do need a carefully safeguarded escape hatch for real emergency situations?

Miss CARSON. I think that would be quite acceptable, if it can be worked out.

Senator JAVITS. Mr. Chairman, may I ask unanimous consent to include in the record the letter from New York State Assemblyman Nowicki, which the Chair has so graciously turned over to me, and also a letter which I have from the Department of Agriculture, pursuant to efforts to get the Department to delay this program, which I would like to read into the record, because Miss Carson might like to comment.

Senator RIBICOFF. Without objection, it is so ordered.

EXHIBIT 17

LETTER FROM NEW YORK STATE ASSEMBLYMAN ON GYPSY MOTH PROGRAM

THE ASSEMBLY,
STATE OF NEW YORK
Albany, May 28, 1963.

DEAR SENATOR RIBICOFF: Recently, the Federal Government in conjunction with the State government conducted an aerial spray program in an attempt to eradicate the gypsy moth here in Rockland County. The spraying was conducted by means of helicopters and light airplanes and consisted of a diluted solution of DDT and Sevin.

You are probably aware by now of the great opposition which developed to the use of these insecticides here in the county and I was asked specifically by an individual concerned with this problem to let you know of the difficulty encountered in trying to fix the responsibility for the decision to spray. The local agricultural agent advised me that this program was initiated by the Federal Government but required the cooperation of the State government. Thereafter, I communicated by telephone with the Commissioner of Agriculture and Markets, who in turn had me speak with his Deputy Commissioner. I was then told that the New York State Department of Conservation and also the Department of Agriculture and Markets had cooperated with the Federal Government in making known the spawning grounds of the gypsy moth throughout the State where damage by the moth was prevalent. The Federal Government, which provides the funds for this program, completed the arrangements for spraying.

All attempts to reach someone in Federal authority to temporarily halt the program proved fruitless since no one seemed to be able to tell me who could make this decision. The Chairman of the Rockland County Board of Supervisors met with the same rebuff. Whether or not one agrees with the desirability of aerial spraying with these insecticides is immaterial. The most frustrating part of the ordeal was that no one seemed to know, or desired to tell, who had the ultimate responsibility for deciding when and where this spraying would be done. All of these decisions were made without the knowledge of the local governing bodies and apparently with the attitude that the spraying would be completed regardless of the wishes of the local inhabitants.

In order to prevent the future reoccurrence of this type of indiscriminate disregard of the rights of local residents it would be appreciated if you would look into the situation and suggest that a better means of communication be developed between the Federal authorities and the local officials in the areas where the spraying is to be conducted.

Sincerely,

JOSEPH F. X. NOWICKI.

Senator JAVITS. This is dated the 17th of May, about 10 days before Mr. Nowicki's letter, but very contemporaneous with his experience. It is addressed to my administrative assistant and is signed by George A. Barnes, Assistant to the Secretary of Agriculture; it reads as follows:

I want to assure you that the gypsy moth control program in Rockland and Westchester Counties was carefully planned by experienced scientists and is being carried out by experienced technicians of this Department and that the spray operation as a whole was reviewed and approved in advance by the inter-departmental Pest Control Review Board consisting of representatives of the Secretaries of Agriculture, Interior, and Health, Education, and Welfare.

The program is being carried out in cooperation with the New York State Department of Conservation and the State Department of Agriculture. A total of 3,200 acres in Westchester County and 7,000 acres in Rockland County is involved. The work in Westchester County has been completed; the spraying in Rockland County should be completed in the next day or two.

The insecticide used in Westchester was Sevin, which is less toxic than DDT. In Rockland certain areas are being treated with Sevin and some with DDT. In the Rockland operation, the Department is making the application by helicopter in order to insure precision in the treatment. Only wooded areas and some fence rows are involved, as the gypsy moth attacks trees, mainly hardwoods and evergreens.

Is there any comment, Miss Carson, which you would care to make upon this matter?

Miss CARSON. This all applies to New York State?

Senator JAVITS. Yes, that particular operation.

Miss CARSON. I do have some information, or at least I received by telephone information about the gypsy moth spraying in New Jersey (and in fact I have suggested to the person that he write this information to Senator Ribicoff) which does indicate such abuses as spraying of dairy farms, which supposedly are not included. My informant also gave an example of the destruction of an enormous number of bees.

I have only hearsay information that such things have happened in New York, but more direct evidence on New Jersey. And I think that despite what is no doubt thought to be careful planning, there is a great deal of such destruction of property occurring.

Senator JAVITS. So if you were doing it now, you would check back in the local community to see if the careful practices referred to in the letter were actually followed as this often is not the case.

CONNECTICUT EXPERIENCE WITH GYPSY MOTH CONTROL PROGRAM

Senator RIBICOFF. Will the Senator yield?

I recall an anecdote in 1957 when I was Governor of Connecticut. The Department of Agriculture—the U.S. Department of Agriculture came into the State of Connecticut with a program to spray the entire State for the gypsy moth; the situation was similar to that which Senator Javits finds in a large section of New York State.

I recall the Connecticut Agricultural Experiment Station scientists felt that this was outrageous—there was no need to spray the entire State. The commercial nursery people were then threatened with a boycott on the shipment of Connecticut nursery products throughout the country.

I recall upholding the Connecticut Agricultural Experiment Station, and telling the U.S. Department of Agriculture that if this was their attitude, they could get out of the State—we did not need them. The U.S. Department of Agriculture then backed down, and only sprayed that section of the State that the Connecticut Agricultural Experiment Station thought needed to be sprayed.

So I do think that if local authorities are aware of the problem, and are knowledgeable in this field, they can tell the Federal Government where to head in, and exert their own views.

Based upon this experience, I do think that there is an opportunity for people at the State level to be effective in this field because they are closer to the picture, and sometimes the Federal authorities are not as aware of the local situation as some of the knowledgeable local people.

Miss CARSON. I think Connecticut has set an excellent example on that sort of planning.

Senator JAVITS. Thank you, Mr. Chairman.

Thank you, Miss Carson.

EFFECTS OF PESTICIDES ON HEALTH

Senator GRUENING. Miss Carson, you call attention to the obvious increase in certain diseases, apparently since the widespread use of insecticides. You call attention to the sharp rise in hepatitis during the 1950's.

It is a fact that many years ago we heard of hepatitis, but it was not considered very common or important at all—now we know that hepatitis is widespread, and is often serious.

You point to the increase in leukemia. You point to the increase in cancer in children.

I am going to suggest to the chairman that at a later hearing we call some medical experts and find out how much of this is due to new causes, possibly insecticides, and how much the greater incidence of these diseases is due to better methods of diagnosis. The fact, of course, is that in the last decade or two there has been a great improvement in diagnosis, so that many diseases which may have existed formerly were not recognized.

But I think this is a very serious matter. I have known of deaths from hepatitis, and deaths from leukemia that apparently were related to some insecticide origin.

I think you have made a very important contribution.

Senator RIMCOFF. I think your suggestion is very fine, Senator Gruening, and we certainly will follow through with it.

ACCUMULATION OF DDT IN WATER SUPPLIES

Miss Carson, your information on public water supply reservoirs in Massachusetts is quite alarming. I ask you first the source of this data, and has it been published?

Miss CARSON. I wanted to get the latest possible information for you, so about 10 days ago, I suppose, I wired to the State aquatic biologist, Mr. William A. Tompkins, and asked him for any information on this that had been released. He sent me a tabulation which I will be glad to have inserted in the record if you wish.

Senator RIMCOFF. We certainly will, at this point in the record.

EXHIBIT 18

DATA ON PESTICIDES IN PUBLIC WATER SUPPLY IN MASSACHUSETTS

THE COMMONWEALTH OF MASSACHUSETTS,
DIVISION OF FISHERIES AND GAME,
Field Headquarters, Westboro, May 22, 1963.

MISS RACHEL L. CARSON,
Silver Spring, Md.

DEAR MISS CARSON: Our pesticide studies have only been in progress for less than a year. During this first year we have been conducting a survey relative to the existence of DDT in the tissues of fishes. Our work has been concentrated on the Sudbury, Assabet, and Concord Rivers here in Massachusetts.

At the present time we are following with interest a gypsy moth spraying program in western Massachusetts. I believe that at the end of this week, we shall have some information relative to the extent of drift from helicopters and fixed-wing planes onto surface waters.

I hope the enclosed may be of some small value.

Very truly yours,

WILLIAM A. TOMPKINS,
Chief Aquatic Biologist.

SUMMARY

During the first segment of this project 32 sampling stations were established and fish and soils collected to determine present DDT levels in the watershed. To date tissues from 565 fishes have been analyzed. Forty-three percent, or 242 fish from this sample contained an average DDT residue constituting 35.4 parts per million of their dry weight. Surface water supplies showed as high concentrations of pesticide residues as recreation areas. Greatest concentration of the residues within the fish are located in the wall of the digestive tract and the brain, or that portion generally not consumed by the public.

Laboratory fishes are presently being exposed to sublethal doses of DDT and their residue storage capacity being measured in the hope of providing a yardstick for decisions concerning necessary recovery time between sprayings in any given watershed.

Summary of DDT plus DDE residues in the tissues of 565 fish samples collected in 1962 from the SUASCO watershed, Massachusetts

Water	Use ¹	Number < 5 parts per million	Number > 5 parts per million	Average parts per million ²
North Pond, Hopkinton.....	Rec.....	9	33	37.6
Lake Williams, Marlboro.....	W. S.....	4	21	29.7
Reservoir No. 1, Framingham.....	W. S.....	4	2	96.7
Reservoir No. 2, Framingham.....	W. S.....	.....	20	59.2
Reservoir No. 3, Framingham.....	W. S.....	8	18	26.2
Ashland Reservoir, Ashland.....	Rec.....	16	9	41.8
Sudbury Reservoir, Sudbury.....	W. S.....	20	6	12.7
Puffer Pond, Sudbury.....	Rec.....	8	10	50.2
Warner's Pond, Concord.....	Rec.....	16	6	22.6
Hare Hill Pond, Harvard.....	Rec.....	15	1	6.7
Little Chauncey, Westboro.....	Rec.....	27	.....	.....
Great Meadows, Concord.....	Rec.....	13	2	8.3
Nuttings Pond, Billerica.....	Rec.....	11	5	46.7
Greenough Pond, Carlisle.....	Rec.....	16	2	17.3
Sandy Pond, Lincoln.....	W. S.....	.....	7	22.5
Milliam Reservoir, Marlboro.....	W. S.....	.....	18	22.7
Fort Meadow, Hudson.....	Rec.....	9	9	18.6
Hopkinton Reservoir, Hopkinton.....	Rec.....	8	4	18.4
Whitehall Reservoir, Hopkinton.....	Rec.....	13	6	24.3
White Pond, Stow.....	W. S.....	3	3	21.5
Gates Pond, Berlin.....	W. S.....	19	4	5.1
Hocomonco Pond, Westboro.....	Rec.....	16	1	15.8
Lake Chauncey, Westboro.....	Rec.....	11	.....	.....
Sudbury River, Sudbury.....	Rec.....	8	4	50.3
Farrar Pond, Lincoln.....	Rec.....	19	4	21.5
Lake Cochituate, Framingham.....	Rec.....	9	16	25.3
Echo Lake, Hopkinton.....	W. S.....	4	.....	.....
Heard Pond, Wayland.....	Rec.....	7	9	23.7
Westboro Reservoir, Westboro.....	W. S.....	24	1	6.4
Farm Pond, Framingham.....	Rec.....	12	13	9.6
Dug Pond, Natick.....	Rec.....	3	18	96.7

¹ Use designated as recreational area or controlled water supply.

² Average parts per million refers to those samples showing over 5 parts per million dried weight.

Miss CARSON. I think there has been no formal report issued as yet.

Senator RIBICOFF. Does the fact that fish with high concentration of DDT are found in these reservoirs mean that the waters of the reservoirs themselves are being contaminated?

Miss CARSON. Well, I think this is something that needs to be investigated. I don't know whether the Massachusetts people have yet moved on to analysis of the water, but I should suspect that would be part of their investigation. I don't think it is necessarily true.

Now in Clear Lake, Calif., they had a situation where they had applied DDD for gnat control. In the beginning, although applied in very small concentration, it was present in the water.

But then what apparently happened later was that all the chemical went into the living organisms in the lake, and there came a time when although it was present in high concentrations in the plankton, fish, and so on, it was not present in the water. But as I say, I think this needs to be investigated.

I know that if I were going to drink the water from some of those reservoirs, I would want to have it definitely established, and I expect they will.

EXHIBIT 19

THE ACCUMULATION OF DDT IN LAKE TROUT IN NEW YORK STATE

STATE OF NEW YORK CONSERVATION DEPARTMENT NEWS

For Release: Friday, September 13, 1963

Concentrations of DDT, a commonly used insecticide, have reached the point in certain lake trout waters under study by the State Conservation Department as to adversely affect lake trout reproduction, Conservation Commissioner Harold G. Wilm said today.

As a consequence of these findings, the commissioner said that the department will discontinue the use of DDT in its forest pest control programs in watersheds inhabited by lake trout, and discontinue its use for the control of black flies and mosquitoes at State campsites in these watershed areas.

A scientific paper setting forth the details of New York's research study in this field was presented today at the annual convention of the American Fisheries Society in Minneapolis by George Burdick, aquatic biologist in charge of water pollution studies for the department's division of fish and game.

The study revealed that DDT is accumulated in the fatty tissues of lake trout, including its eggs, causing serious mortality in the young fry.

Dr. Wilm explained that essential forest pest programs in these watersheds would be continued through the use of other pesticides already on the market which are known to disintegrate much more quickly than DDT.

Prior to the spraying season next spring the department will prepare suggestions for the guidance of the public in the use of DDT on privately owned lands in lake trout watersheds.

The commissioner emphasized that this study is only one part of the State's total effort on the complicated problems posed by pesticides. "We have an interdepartmental committee representing the Departments of Health, Agriculture, Education and Commerce as well as our own, which is at work on other parts of the problem."

THE ACCUMULATION OF DDT IN LAKE TROUT AND THE EFFECT ON REPRODUCTION

(By G. E. Burdick, E. J. Harris, H. J. Dean, T. M. Walker, Jack Skea, and David Colby,¹ New York State Conservation Department)

Nichols (1959)² reported a complete loss of the fry from over 347,000 eggs taken in 1955 from lake trout in Lake George. The loss was characterized by an inflated air bladder and air in the intestinal tract. The fry floated upside down on the surface, eventually sinking and dying. Symptoms appeared after absorption of the yolk sac when the fry were about ready to feed. Pathological examination failed to show the presence of any disease.

Eggs collected in 1956 followed the same pattern. In 1957 and 1958 distribution of eggs from Lake George was made to three hatcheries, providing a check on the hatchery water and procedure. There was no survival in 1957. In 1958 a negligible survival of 0.9 and 1.4 percent occurred, respectively, at two of the hatcheries. Crosses of females from Lake George with males from other

¹The authors wish to acknowledge the assistance given by personnel of the Fish Propagation Section and the fisheries personnel in regions 4 and 5 in the Adirondacks in the collection of lake trout and lake trout eggs for this study.

²Nichols, K. B., departmental communication.

waters failed to survive. Normal survival occurred when males from Lake George were crossed with females from other lakes.

Nichols concluded the problem was in the egg. Since eggs collected prior to 1944 had developed normally, some occurrence in the period from 1944 to 1955 had caused an abnormal condition which affected the production in the hatcheries and possibly in the lake.

Rudd and Genelly (1956) reported their own and others' work to indicate that feeding of DDT to birds may affect the viability of the young after hatching as well as the production and hatchability of the eggs.

Mitchill et al. (1953) reported DDT spraying to have affected the viability of eggs and the nestlings of birds. Springer (1957) also reports an effect on bird reproduction.

Smith (1957) quotes Mathur to the effect that lipoproteins and phospholipids are absorbed from the rainbow trout egg within 1 day of fertilization. The carotenoid pigmented glyceride fat droplets are stated not to be metabolized until a late phase of the yolk sac period, shortly before the yolk is entirely consumed and about the time the fry is ready to take food. The mortality previously described would correspond in time to the period of glyceride fat absorption. DDT and other chlorinated hydrocarbon insecticides are known to be stored, at least in part, in glyceride fats.

During the period from 1951 to 1955 the Conservation Department had distributed about 7,300 pounds of DDT on the Lake George watershed for the control of gypsy moth. In 1956 and 1957 an additional 25,950 pounds was so distributed. State campsites had been sprayed yearly for blackfly control. Many lake front properties had received multiple sprayings or foggings for blackfly and mosquito control. Since these were private contract operations there were no records available of the amounts of DDT that had been used. Occasionally fish kills had been reported to have coincided with the treatments. Private use has been extensive and may have equaled or exceeded the average weight of the chemical distributed in State operations.

The volume of Lake George had been assumed adequate to reduce the concentration in the lake to a very low, nontoxic level after dilution. A preliminary study in 1959 showed the fry from Lake George and another water where the fry were similarly affected contained measurable quantities of DDT and its metabolites. The major forage fish for lake trout in Lake George carried a high concentration, as did the eggs of both lake trout and Atlantic salmon.

Warner and Fenderson (1960), Bridges and Andrews (1961), and Cope (1961) have reported DDT residues found in fish following DDT treatment of a watershed. The species covered do not include lake trout.

CHOICE OF STUDY AREAS

An attempt was made to meet two criteria in choosing the bodies of water to be used in the investigation. There should be some information available on the amount of DDT used in the area and the lake trout population should be adequate for the collection of spawning fish without extended time consuming effort. All of the waters chosen met at least one and usually both of these requirements.

Waters used in this study and an approximation of the amount of DDT applied in the drainage area appear in table 1. The quantities of DDT listed under treatments by State, municipal subdivisions, and private use, where given, were obtained from the records or statements of persons responsible for the purchase or use of the chemical in the years 1960, 1961, and 1962. Where a spray area did not conform to the drainage area tributary to the water the amount used has been prorated according to the relative proportion. Amounts used in fogging have been prorated on the basis of comparative mileage of roads. The amount used in plaster blocks placed directly in stream has also been proportioned on the comparative area. The totals give some measure of the use of DDT in the drainage area. These figures are to be considered minimum for many waters as information on private use was usually not available. When there was known private use, but no figure on the amount was available, a plus sign has been placed after the total to indicate that it should be higher. The ratio between total DDT and the square miles of water surface has been computed in order to place the data on a comparable basis. These figures also use plus signs to indicate under estimation.

Contamination by different methods of application are not exactly comparable since with plaster blocks all the DDT is deposited in the water while airplane

sprays and fogging produce deposits on land as well as in the water. Land deposits provide a reservoir from which leaching and runoff may carry part of the deposit to the water. Fogging results in more of the chemical becoming airborne with greater probability of removal from the watershed than would occur in airplane spraying.

SCOPE OF THE INVESTIGATION

Eggs and adult females were collected on an individual lot basis from the waters listed in table 1. Big Moose Lake was abandoned after 1 year as mature fish were not obtained even with prolonged netting effort. It was not possible to obtain collections from all these waters in each year.

Fertilized eggs were divided and a portion of 500 eggs transferred to the Lake George Hatchery for hatching. The hatchery foreman, T. M. Walker, recorded all data on these lots. The remaining eggs were analyzed for DDT and DDE at the Rome Laboratory.

The stripped female was killed and transferred to the laboratory for analysis of DDT and DDE.

PROCEDURES AND METHODS

Lake trout netted for egg collection were stripped, killed, wrapped and placed in a deep freeze. A one-half inch section just anterior to the anal opening was later removed for analysis. In 1960 and 1961 these sections were diced and placed in an aluminum dish in a low temperature refrigerator where they were dried to constant weight by a current of air from a small electric fan. Loss in weight was considered as loss of moisture.

Eggs were dried whole by a similar procedure. After reaching constant weight they were ground in a small Wiley mill.

The flesh and eggs taken in 1962 were dried by lyophilization. The tissue section was comminuted with a small amount of water in a Waring blender. The slurry obtained was lyophilized in 250 and 500 milliliter centrifuge bottles. Eggs were lyophilized whole.

An aliquot of the dried and ground eggs approximately equivalent to about 20 grams of undried eggs was extracted in a Soxhlet apparatus with a 9:1 mixture of petroleum and diethyl ethers. This was followed by a methyl alcohol extraction. Except for 1960 when the fractions were combined for analysis the extracts were analyzed separately. Body tissue samples were extracted with ether mixture only.

Davidow columns (Davidow 1950) were used to separate DDT and DDE from the fatty material. Eluted material was nitrated and methylated according to Schechter, et al. (1954) as modified by Lisk (1960).⁹

The final colored solution was analyzed in a Beckman D B Spectrophotometer and considered as a two component color system. Two density readings were taken at the wavelength of maximum absorbancy for pure p-p' DDT and p-p' DDE. Knudsen's equations for a two component color system were used for calculation (Knudsen, et al., 1940).

The Denver laboratories of the U.S. Fish and Wildlife Service analyzed two aliquots of extracted oils by paper chromatography. This procedure indicated the presence of some DDD (TDE) in the samples.

The wavelengths for maximum absorbance of the colors of DDT and DDD produced by the Schechter-Haller procedure are too close for a satisfactory separation so their concentration was not estimated. DDT analyses in this paper represent DDT and any accompanying DDD which might affect the reading, reported as DDT.

Comparison of the results by the two procedures showed a recovery of 26.4 and 27.5 percent less DDT and DDD by the chromatographic method than was indicated by the Schechter-Haller procedure. The DDE recovery was 25.5 and 9.2 percent less. Except for DDE in the second sample the recoveries were approximately proportional.

MATHEMATICAL AND STATISTICAL TREATMENT

No weights were taken in 1960 previous to dehydration. While the dried weights could be used for comparison, the variation in the amounts of oil present would alter the concentrations much more than if an original weight could be used. Oil would not lose water on dehydration.

⁹ Lisk, Donald J. (personal communication).

The average loss of water in the 1961 material was calculated after subtraction of the weights of the ether-extractable oil from both the original and dry weight of the fish section and the eggs. For the flesh the average was 76.09 percent with a standard deviation of 1.06 percent and a standard error of 0.24 percent. The eggs showed an average loss of 70 percent with a standard deviation of 2.64 and a standard error of 0.59 percent. These averages were used to obtain a theoretical original weight for the 1960 data by a reversal of the procedure. The concentrations in the tissues were then calculated.

The concentrations for the body tissues for 1961 and 1962 are based on the original determined weight previous to dehydration. There may have been some variable loss of moisture from the fish in the deep freeze from the differences in efficiency of wrapping and the passage of time before analysis. Such a variation might affect individual results causing some of them to be higher in DDT in the tissue than they would be otherwise. Use of an average would result in all of the tissue data being somewhat high.

The concentration of the DDT in the egg reported as concentration in the fry which was used in 1961 and 1962 was calculated on the weight of the fry at about the appearance of the syndrome. This involved a special procedure.

A sample of each individual lot of fry was taken 3 days after hatching and again when the hatchery foreman estimated that they were ready to feed. After fixation in 10 percent formalin for a uniform time the average weights of the fish and the yolks were determined. The differences in weights of the two stages were then used to calculate a conversion factor for this period of development in each lot. The yolk remaining at the second sampling varied considerably in quantity. The conversion factor was used to calculate the theoretical weight of the fry at complete absorption of the yolk except for a weight equivalent to that of the ether-extracted oils. An egg count of the dried eggs used in the chemical analysis then enabled the total weight of the fry to be used to determine the DDT concentration based on the analysis. The conversion factor of yolk was found to be variable and reference of the weight of the fry at the approximate time of absorption of glyceride fats and appearance of the syndrome places the data on a firmer toxicological basis than would be the case if the original weights of the eggs were to be used.

The chi-square formula for testing the hypothesis of independence in a 2 by 2 table as presented by Snedecor (1956) was used to determine the significance of the DDT extracted from the egg to the development of the syndrome in the fry. This test was applied to the data for each year and to the combined data of 1961 and 1962.

RELATIONSHIP OF DDT AND DDE

There was no indication that the concentration of DDE has any relationship to mortality in lake trout fry either singly or in combination with DDT. Its presence indicates more DDT originally in the environment than would be evident if only DDT were to be reported. DDE is believed to represent either metabolism of DDT in the fish, or in some link in the food chain from which it is absorbed and stored in the fats and oils. Jones and Moyle (1963) report the presence of DDT, DDD (TDE) and DDE in soils of ponds treated with DDT. They postulate a slow breakdown in the soil to form DDD and DDE. The term soil appears to be used loosely since their soil samples include leaf litter and presumably all living and dead plant and animal matter contained in the dredged sample. The DDD and DDE present could as readily have originated from biological activity as from soil interaction.

Tables 2, 3, and 4 present data on the concentration of DDT and DDE in the oils and tissues of lake trout and the eggs and fry for the years one study was conducted. The presence of DDE in some analyses where DDT was not found in detectable amounts may indicate DDT to be more readily excreted.

DDT IN THE OILS AND TISSUES OF ADULT LAKE TROUT

In the future the amount of DDT in the oils and tissues of lake trout may be determined to be highly important. Figure 1 [not reprinted herein] presents graphically the quantities found in fish from various waters from 1960 to 1962. Except when based on a single fish the bars represent ranges. Yearly differences are evident but it is believed the individual determinations were too variable and the numbers too few to be indicative of any trend. Levels are generally higher in waters where the watershed use of DDT

was high. Exceptions occurred in Fourth, Seventh, and Eighth Lakes of the Fulton Chain where some individuals were found to carry higher or lower concentrations than would be expected in the waters from which they were collected. These waters are connected and these variations are believed to be associated with migration between waters. No barriers to migration exist during most of the period that lake trout are migratory.

DDT in the ether-extracted oils was high even where the use of DDT was not known to be extensive. The figure is reduced appreciably by reporting it as ppm of tissue weight. A smaller quantity of oil in one fish as compared to another proportionally reduces the concentration of DDT when expressed in terms of tissue weight.

Frear (1962) indicated that the Food and Drug Administration had, to January 1, 1962, established a tolerance of 7 ppm of DDT in the fat of certain meats. No tolerances appear to have been established as of that date for DDD (TDE) in meats although the tolerances listed for both compounds in certain vegetables are the same. No tolerances appear to have as yet been placed on fish.

Since the amount of fat in finished meats may be higher and their use in the diet more frequent the transference of tolerances from meat to fish may not be valid. In reporting the concentrations found in lake trout from certain waters it is not the intent of the authors to make any implication concerning their suitability for food.

COMPARISON OF DDT IN THE FLESH AND EGG OILS OF FEMALE LAKE TROUT

Individual determinations of the DDT content of the ether-extracted oils of the adult female and the eggs from that female were made in 1961 and 1962. These are presented in graphical form in figures 2 and 3 [not reprinted herein] to enable easier comparison. The shaded bars represent the concentration found in the eggs, unshaded in the body section of the female. No comparison can be made for 1960 since the DDT in the egg represents a two-stage extraction using an additional solvent.

If a definite relationship could be established between the DDT in the adult and in the egg the concentration in the adult could be used to form a predictive index for the behavior of the egg or fry. The 1961 data indicated too many instances of reversal in the amount present in the egg oils compared to that in the adult and too much variation in the quantities present where there was no reversal for use in such an evaluation. The same condition is shown by the 1962 data.

It is concluded that although there appears to be some relationship between high levels in the adult and high levels in the egg; there was sufficient variation to suggest that oils in the egg may be derived in different amounts from dietary and stored fats and oils. The same result would also be obtained if the amount of DDT in the adult were to change after the time of deposition of fats and oils in the egg so that at spawning time the two might have little similarity or proportionality.

RELATIONSHIP BETWEEN DDT IN THE EGG AND FRY LOSS

In 1960 the ether extracts and the methyl alcohol extracts were combined and the analysis gave the total DDT in the eggs. The extracts were weighed before combination. Since material other than liquids are extracted by alcohol the combined weights cannot be considered as entirely lipid fractions.

In 1960 no initial weights were recorded. The theoretical initial weights have been computed by the method described under mathematical treatment and used for calculation of the concentration of DDT in the eggs. In figure 4 [not reprinted herein] bar graphs represent the concentrations for the individual lots of fertile eggs hatched at the Lake George Hatchery. Lots in which the syndrome appeared and mortality occurred are shaded. If a breakpoint is established at 4.75 ppm and above, all but one of the lots above that point developed the syndrome and experienced mortality. None below this level showed it. Each lot was frozen for analysis when the mortality reached 50 percent, so no significance can be attached to the failure of any lot to show 100 percent mortality.

Test of the hypothesis of independence gave a chi-square of 9.14, probability less than 0.005. Although this would indicate a very high significance for a total DDT of 4.75 and over in the development of the syndrome, it is believed due to a tendency for high total DDT to be associated with high DDT in the ether extract. The 1961 analyses showed that DDT in ether-extracted oil was

consistently higher with a high total DDT than with lower concentrations. In samples with a total DDT of 0.1 milligram and up (about 5 ppm in 20 grams of original weight) the ether extract averaged 77 percent of the total and ranged from 72 to 85.8 percent. Lower quantities of total DDT showed an average of only 58.6 percent and ranged from 5.8 to 78.5 percent. The same relationship could thus be expected if the effect was derived through the glyceride fats and oils contained in the ether extract.

Lipoproteins and phospholipids have been stated to be absorbed from the start of development of the embryo. If they are carrying DDT the lack of significant mortality up to the feeding stage would indicate that the slow rate of utilization and metabolism does not usually result in the accumulation of a lethal dose. The ether extract of the egg which contains the glyceride fats and oils and only a part of the other DDT-carrying lipids would appear to be of greater physiological significance than total DDT which would include all lipids. Consideration of the 1961 and 1962 data is based on the relationship of the DDT of the ether extract to the mortality of the fry.

The 1961 data are presented in figure 5 [not reprinted herein]. Only the DDT in the ether extract was used to compute the concentration based on the calculated weight of the fry at complete absorption of yolk, excluding the weight of the ether extract. The concentration in ppm. for each lot is represented by a bar which is shaded if mortality from the syndrome appeared.

Paper chromatography of two samples of fish oils analyzed at Denver indicated the DDD to be 19.2 and 42.5 percent of the DDT shown by the same method. If the egg oils have as wide a divergence, the close correlation between the DDT-DDD concentration and the appearance of the syndrome would indicate the toxicity of the two compounds to fry to be somewhat similar. No appreciable error appears to be introduced by considering the combination determined at the wavelength of maximum absorbency for p-p' DDT as a single compound.

Dr. Martin Hilfinger of the Pathology Department, New York University Upstate Medical College of Syracuse University, compared many of the fry at the onset of the syndrome with normal fry. No histological or pathological differences were found. The lack of differences does not affect the assumption that the syndrome was caused by the pesticide or its metabolites. It confirms that the syndrome and mortality is not associated with abnormal development. It had previously been established that the mortality was not associated with disease.

Based on the relationship of the concentration of DDT to the development of the syndrome it is concluded that the fry mortality is induced by DDT. It occurs when the Schechter-Haller procedure indicates a concentration in the ether extract of the egg equivalent to about 2.9 ppm or above in the weight of the fry. These concentrations may accumulate as the result of intensive DDT spraying for gypsy moth, blackfly, or mosquito control, or a combination of such sprayings in the tributary watershed.

All lots containing 2.95 ppm DDT and above showed the syndrome and developed mortality. Those with 2.67 or less failed to show it. The relationship was perfect though two lots from Paradox Lake had a lower percentage of syndrome-associated mortality than would be anticipated from the DDT present. The feeding stage was delayed in these lots and an abnormally large quantity of yolk was found present when this stage was assumed to have been reached. It is believed that the experiment on these lots was terminated before maximum development of the syndrome occurred. Production eggs from the lake in this year lost more than 50 percent of the fry with the syndrome.

The test for independence showed a very high significance for an ether-extract DDT of 2.95 and over to the development of the syndrome in the fry. Chi-square was 18.12, probability less than 0.001.

The 1962 data are presented in the same manner in figure 6 [not reprinted herein]. All lots with a DDT concentration of 2.93 ppm or above showed the syndrome and mortality. Only one lot showed a percentage of the syndrome-induced mortality at 2.81 ppm or below. This particular lot did not have an original egg count and the figure has been derived from a count of the eggs left in the body cavity after stripping. A comparison was obtained from the original eggs and eggs remaining in the body cavity of another female and corrected proportionally. This figure should not be assumed to have as high accuracy as the other figures.

Chi-square for independence is 10.02, probability less than 0.005, again indicating significance for concentrations of DDT of 2.93 and above.

The combined data for 1961 and 1962 give a chi-square for independence of 26.56, probability far less than 0.001.

TABLE 1.—Pounds of DDT used in drainage basin and ratio to the surface area of the water for 1960-62 (averaged, except where year is indicated)

Water	Surface (square miles)	Year	State		Towns or villages			Private use	Approximate poundage	Pounds per square mile surface
			Gypsy moth	Other	Airplane	Fog	Blocks			
Fourth, 1 ¹ , 2, 3	4.98	Average	0	42	538	4,562	11	Unknown	5,213	1,048
Seventh ¹	.98	do	0	42	0	920	0	do	982	982
Schroon	6.61	do	0	54	4,440	0	0	Fogging	4,404+	665+
Big Moose	1.98	do	0	0	515	426	9	Unknown	980	490
Paradox	1.40	do	0	15	400	0	0	Some	415+	296+
George	44.44	do	4,548	173	0	0	0	Estimate, 4,000	8,721	196
Blue Mountain	2.06	1962	12,105	170	0	0	0	do	16,275	786
		1960	0	0	290	0	0	Unknown	200	146
		1961	0	0	236	0	0	do	226	150
		1962	0	0	0	256	0	do	256	123
Haquette	8.43	1960-61	0	67	626	570	0	do	1,262	149
		1962	0	67	0	962	0	do	1,049	124
Placid	2.19	1960	0	0	185	0	4	Shore fogging occurs	187+	85+
		1961	0	58	0	0	0	do	58+	27+
		1962	0	15	0	0	0	do	15+	7+
Eighth ¹	.54	Average	0	19	0	0	0	None	19	35
Saranac	7.95	1960	0	180	0	0	0	do	210+	264+
(Upper)		1961	0	170	0	0	0	do	220+	278+
		1962	0	115	0	0	0	do	115+	144+
Saranac	66.70	(?)	(?)	(?)	(?)	(?)	(?)	(?)	(?)	(?)

¹ Fulton chain.² Use agriculturally; no figures on amount.

TABLE 2.—DDT and DDE in lake trout (1960). Data for adults from ether extracts; eggs, combined ether and alcohol extracts

Lake	Series 32	Adult				Eggs			
		Oil		Tissue		Oil		Tissue	
		DDT	DDE	DDT	DDE	DDT	DDE	DDT	DDE
Placid.....	21	142.6	284.4	3.4	6.5	45.3	161.8	3.54	12.64
Do.....	22	157.6	257.2	4.7	11.0	(1)	(1)	(1)	(1)
Saranac.....	23	88.0	76.7	6.0	5.2	34.5	44.5	2.74	3.34
Do.....	24	55.6	62.8	3.7	4.2	18.9	52.7	1.47	4.12
Do.....	25	36.2	41.0	2.6	3.0	41.8	21.3	3.14	1.60
Eighth.....	26	61.4	81.3	7.7	3.9	41.5	30.3	2.68	2.54
Do.....	27	112.6	65.4	14.6	8.5	49.7	26.1	3.08	2.09
Do.....	28	94.4	84.5	7.9	7.1	50.5	49.9	4.61	4.46
Big Moose.....	1	202.5	456.2	3.9	8.7	(1)	(1)	(1)	(1)
Do.....	37	212.5	212.5	9.8	9.8	(1)	(1)	(1)	(1)
Raquette.....	38	105.0	56.6	13.2	7.1	45.4	53.5	3.10	3.66
Do.....	39	81.3	40.1	10.1	5.0	65.7	46.1	4.75	3.34
Do.....	40	119.2	64.1	12.6	6.8	87.6	33.3	5.81	5.86
Fourth.....	41	342.6	220.2	60.8	39.1	179.3	170.2	15.15	14.38
Seneca.....	42	56.6	114.2	7.9	15.9	23.9	54.0	1.94	4.38
Do.....	43	69.0	71.7	16.1	16.7	42.2	71.2	3.05	5.15
Do.....	44	57.9	184.9	8.5	27.3	41.8	120.2	2.82	8.13
Fourth.....	45	485.2	305.9	68.4	61.4	234.1	236.0	19.10	19.26
George.....	46	368.8	175.3	65.6	31.2	166.1	108.2	13.55	8.83
Do.....	47	449.5	282.1	62.8	39.1	.....	.....	14.25	13.42

† Insufficient to analyze.

‡ No eggs obtained.

TABLE 3.—DDT and DDE in ppm in the ether extracts of lake trout and eggs (1961)

Lake	Series 32	Adult				Eggs			
		Oil		Tissue		Oil		As fry †	
		DDT	DDE	DDT	DDE	DDT	DDE	DDT	DDE
Seneca.....	53	79.2	172.8	9.1	19.3	2.6	78.9	0.06	2.41
Do.....	54	97.5	75.3	12.9	10.0	44.2	144.8	1.30	4.25
Do.....	55	34.3	132.1	3.7	14.1	.....	.....	.....	.....
Saranac.....	56	ND	61.8	ND	2.2	87.8	135.7	1.83	4.29
Do.....	57	15.9	23.3	1.6	2.5	40.5	39.4	1.42	1.38
Do.....	58	ND	56.2	ND	5.8	.....	.....	.....	.....
Raquette.....	59	121.6	58.8	9.7	4.7	104.6	51.5	2.42	1.19
Do.....	60	139.9	80.2	8.9	5.1	100.1	56.2	2.67	1.50
Do.....	61	139.1	63.5	3.7	4.0	.....	.....	.....	.....
Do.....	62	129.8	74.0	6.6	3.8	94.4	55.5	2.41	1.42
Blue Mountain.....	63	237.3	211.4	16.3	14.6	167.2	177.0	3.51	3.72
Do.....	64	155.5	161.1	8.7	9.0	142.2	130.6	3.39	3.12
Do.....	65	95.1	104.7	10.3	11.4	34.1	29.7	2.65	2.48
Paradox.....	66	150.0	94.1	23.5	14.2	175.4	90.1	4.38	2.24
Do.....	67	223.4	96.6	29.4	12.8	170.7	106.5	4.14	2.58
Fourth.....	69	482.9	208.7	91.1	39.4	355.2	221.1	9.55	6.17
Do.....	70	340.4	167.9	75.1	38.6	299.4	219.9	8.84	6.46
George.....	72	403.1	139.9	81.9	29.4	112.7	50.5	9.99	4.48
Do.....	73	408.5	157.8	62.1	24.0	354.7	147.4	6.53	2.71
Do.....	74	465.5	142.5	64.6	20.1	276.8	164.5	4.04	2.40
Schroon, section drying.....	.....	522.8	1,144.2	11.2	24.5	.....	.....	.....	.....
George.....	48	438.0	170.5	61.0	25.8	200.3	133.8	15.74	10.51
Fourth.....	49	456.4	408.9	44.4	39.5	153.7	282.2	12.18	20.06
Do.....	50	.....	.....	.....	.....	192.6	227.8	15.40	18.21
Schroon.....	.....	203.7	111.1	36.8	20.1	(1)	(1)	(1)	(1)

† Original weight of tissues computed from dry weight using averages for 1961, by the methods described.

‡ Eggs used for splake.

TABLE 4.—DDT and DDE in the ether extracts of lake trout and eggs (1962)

Lake	Series 10	Adult				Eggs			
		Oil		Tissue		Oil		As fry ¹	
		DDT	DDE	DDT	DDE	DDT	DDE	DDT	DDE
Seneca.....	11	30.6	61.1	6.3	12.6	19.8	57.5	0.33	0.97
Do.....	12	9.6	8.4	2.0	1.7	(?)	51.4	(?)	1.22
Do.....	13	45.8	37.8	6.9	5.7	12.9	72.5	.25	1.43
Raquette.....	14	139.4	46.8	10.3	3.6	128.5	11.8	2.61	.25
Do.....	15	208.3	64.2	12.0	3.7	147.9	141.4	3.56	2.30
Do.....	16	66.3	30.4	9.2	4.2	143.9	101.0	2.18	1.63
Schroon.....	17	309.9	323.2	34.2	35.6	194.7	227.2	4.89	5.70
Saranac.....	20	17.8	21.1	1.9	2.3	21.3	35.5	.51	.85
Do.....	21	18.7	10.3	2.0	1.1	(?)	(?)	(?)	(?)
Do.....	22	33.5	13.5	5.0	1.8	11.9	10.5	.33	.29
Seventh.....	24	291.1	55.3	63.9	12.4	145.5	74.1	1.38	.76
Fourth.....	25	421.7	106.6	93.0	23.9	117.0	39.7	2.93	.74
Eighth.....	26	109.7	27.9	5.6	1.4	28.8	31.9	.69	.77
Do.....	27	108.6	27.3	13.4	3.4	323.7	90.0	6.76	1.55
George.....	28	590.0	204.4	76.1	26.4	515.3	62.3	7.68	.93
Do.....	29	833.7	241.3	69.5	20.1	308.2	206.0	8.49	5.67
Do.....	30	608.8	135.2	113.7	25.2	472.7	71.9	9.45	1.44

¹ Computed on calculated weight at yolk absorption.² Not detectable by the method used.³ Calculated, no fertilized egg count obtained.

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GENETIC EFFECTS OF PESTICIDES

Senator RIBICOFF. You have stressed the possible adverse genetic effects which pesticides might have on human development. Do you consider the research effort at the Federal level on this problem to be adequate?

Miss CARSON. No, I don't. I think it is a very inadequate effort.

I feel very strongly that the Food and Drug Administration should have a department of genetics or at least a small staff of geneticists whose opinion and whose knowledge would be taken into account in the studies of these chemicals because, as you know, the genetic effect can be something quite independent of the toxic effect.

Now the studies of the Food and Drug Administration of course are directed toward determining toxicity, and I am not satisfied that those data give any indication as to what genetic effect may result.

My line of reasoning on this, if I may express it briefly, is about as follows. Of course, the whole study of what we might call medical genetics is of quite recent origin, and in the few years that we have been able to study human chromosomes accurately, it has been found by groups of investigators in various medical schools and various universities that many human defects and human illnesses are caused by what seems to be a very slight damage to the chromosomes. It might be simply that a piece of a chromosome was broken off. It might be the loss of a chromosome, or somehow the picking up of an extra chromosome or two. But those apparently slight genetic changes cause a whole group of diseases or defects, especially of congenital defects, very often including mental deficiencies.

Well, now going over to another field, we find also that certain chemicals—and this includes some which are used as pesticides—do cause that type of chromosome damage.

Now I think those two fields of study ought to be gotten together. We should find out whether the pesticide chemicals in the concentrations in which they are used, or at the levels to which they may build up in the human body, are capable of causing these defects and these illnesses.

This is a new field. We simply have to consider at this point, I think, what the possibilities or the probabilities may be. But it seems to me only prudent to anticipate and to investigate rather than to wait until we have a clear and tragic demonstration.

Senator RIBICOFF. In other words, am I correct from what you have said, even though generation spans are quite lengthy, it is possible to determine the genetic effects on human beings through proper research?

Miss CARSON. Of course, the point you have to remember is that our whole knowledge of the science of genetics is based on the studies of laboratory organisms which do reproduce rapidly, and give us sometimes many generations in a year.

We would never have learned the basic facts about chromosomes, almost the mathematics of inheritance, except for the basic studies of Mendel on peas.

The classic and basic genetic studies by Morgan at Columbia were carried on with a little fruit fly, which gives a new generation about every 10 days. The striking thing about genetics is the basic similarity

of genetic systems, the way chromosomes and the way genes behave in all organisms.

Now, of course, one must always be prepared to find differences, but I think that what should be done is to test these chemicals with laboratory organisms that give a rapid turnover of generations. If we got disturbing indications, then, of course, they should be tested on other organisms, on a series of mammals. But if we establish the probability, then we could go further.

Senator RIBICOFF. Senator Gruening paid you the supreme compliment. He read your book backwards and forward, and underlined this statement on page 212 of your book:

Mosquitoes exposed to DDT for several generations turned into strange creatures called gynandromorphs—part male and part female.

Is this a danger to human beings?

COORDINATION OF FEDERAL PROGRAMS RELATING TO CHEMICAL CONTAMINATION

Miss CARSON. Well, I think that is an indication of the kind of chromosome damages I was talking about. Undoubtedly something happened to the sex chromosome.

Senator RIBICOFF. You characterize, Miss Carson, the transport of pesticides and other chemicals in the upper atmosphere as another form of fallout.

Now we are doing a great deal of research on the upper atmosphere as part of the fallout monitoring and aerospace programs. Will you agree with my idea that some of this existing research might be readily expanded to deal with the emergency problem of chemical contamination?

Miss CARSON. I am not familiar with the details of the procedure, but I hope that it could be—that with very little modification there could be such monitoring.

Senator RIBICOFF. That follows up Senator Pearson's suggestion, when you start proliferating all this research. Now we were faced with this same problem in this Government on the problem of radiation fallout, and we formed the Federal Radiation Council composed of all agencies of the Government that were involved in one way or another with all the problems of radioactive fallout.

It seems to me that we could follow up Senator Pearson's suggestion with yours, by combining all agencies of the Government into a Federal Chemical Council in which all departments which had anything to do with these chemicals could get together by coordinating their efforts to assure that there wasn't conflict between one department and another, that all the research and coordination that was necessary was actually being done on the Federal level.

Miss CARSON. I should think it might be—it might easily happen that, at no additional expense or employment of more personnel, the same people who are collecting data on radioactivity could also collect on chemicals.

DEVELOPMENT OF LESS HAZARDOUS PESTICIDES

Senator RIBICOFF. Miss Carson, you conclude that measures should be taken to minimize aerial spraying and the use of pesticides with long-lasting residues?

Do you have any feeling as to the extent of current efforts to develop alternative materials and methods of application? Do you think such developments could be characterized as economically feasible?

Miss CARSON. Characterized as what?

Senator RIBICOFF. As economically feasible.

Miss CARSON. Well, I don't think at the present time enough attention is being given to this.

I would hope, it seems to me that there is a real opportunity for the chemical industry here to do more research on more specific chemicals, on chemicals that do not leave as long-lasting residues as these hydrocarbons do.

I suppose there is a difficulty there from the standpoint of the industry, that if they can produce a chemical that kills a great many different insects on a great many different crops, this is an advantage to them. But in the public interest I think the opposite is true, and I would hope that the industry would attempt to develop more of the highly specific-type of chemical which has been done in certain instances.

POTENTIAL HAZARDS OF HOUSEHOLD PESTICIDES

Senator RIBICOFF. Miss Carson, many of the pesticide materials are intended for home and garden use. Until your book was published, the individual householder probably had little or no appreciation of their potential dangers.

Could you suggest any guidelines which the thoughtful person might follow in the use of these materials in his own home.

Miss CARSON. Well, if I might go back just a little bit further, I think that some attention needs to be given to the type of advertising which introduces the consumer to these chemicals.

I think at the present time and in the past there has been too little to warn the consumer that he is buying and using a very hazardous substance. In fact, the tone of many advertisements of course is quite the contrary.

I would hope that some effort might be made to correct this so that at least when a person buys something, he knows he is getting a dangerous chemical. I suppose there are areas of public education that might be expanded by the industry and perhaps by the Government, but I think there is a great need.

I have had so many people write me and so many people telephone me saying, "Why, I had no idea that this stuff that I was using was dangerous in any way."

Senator RIBICOFF. Senator Gruening?

Senator GRUENING. In this connection, the question that Senator Ribicoff has just asked, you probably saw a two-page spread in the recent issue of the New Yorker in which a lady comes into a shop with a lot of bug killers on the shelf, and she says, "Don't sell me anything Rachel Carson wouldn't buy."

Miss CARSON. Yes.

Senator GRUENING. I think that would be very good advice for householders to follow.

Senator RIBICOFF. Do you want to comment on that?

Miss CARSON. No. I think I will let it speak for itself.

Senator RIBICOFF. Senator Pearson?